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[54] CODE CONTROLLED BROADCASTING SYSTEM

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[52] **U.S. Cl.** **325/53,** 325/53, 325/55, 325/392

[51] **Int. Cl.**.....**H04h 1/04**

[58] **Field of Search**.....325/51, 53, 54, 55, 57, 64, 325/392, 466, 308; 179/15 BT, 15 FD; 340/311; 343/200, 228; 330/21, 26, 31

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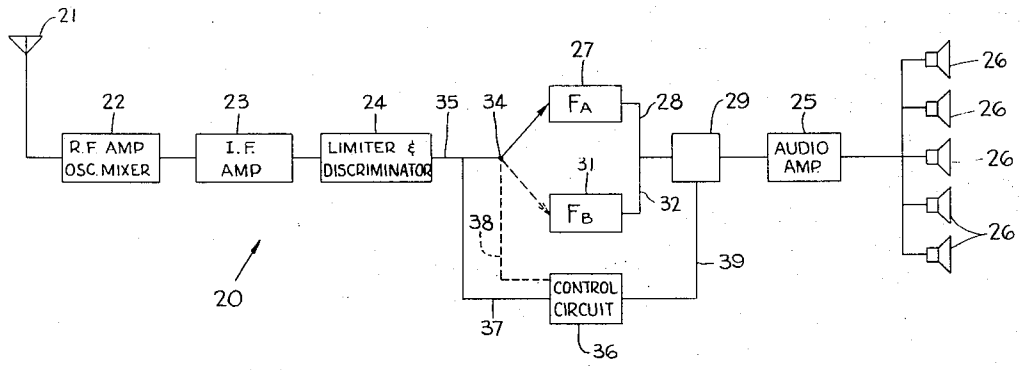
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[57] **ABSTRACT**

A radio broadcasting system includes a transmitter which transmits a program signal such as music on one channel, periodic message signals such as advertising commercials on another channel and a plurality of code signals of different frequencies occuring in time at the beginning of selected ones of the message signals. A plurality of radio receivers each receive the program, message and code signals and include means for audibly reproducing the program and message signals. Each receiver includes first and second filtering means responsive to only the program or message signals, respectively, together with switching means for connecting either of the first and second filtering means in the receiver circuit. Each receiver also includes a control circuit operative in response to the presence of a particular one of the code signals to cause movement of the switching means from one of the filters to the other. The control circuit includes feedback adjusting means in the frequency responsive input portion thereof, a high resistance coupling from input to output, and time delay means associated therewith which together assure that receiver operation is switched from program to message signal reproduction only in response to the particular intended code signal and not in response to other control signals closely spaced in frequency or to transient or spurious signals.

15 Claims, 6 Drawing Figures



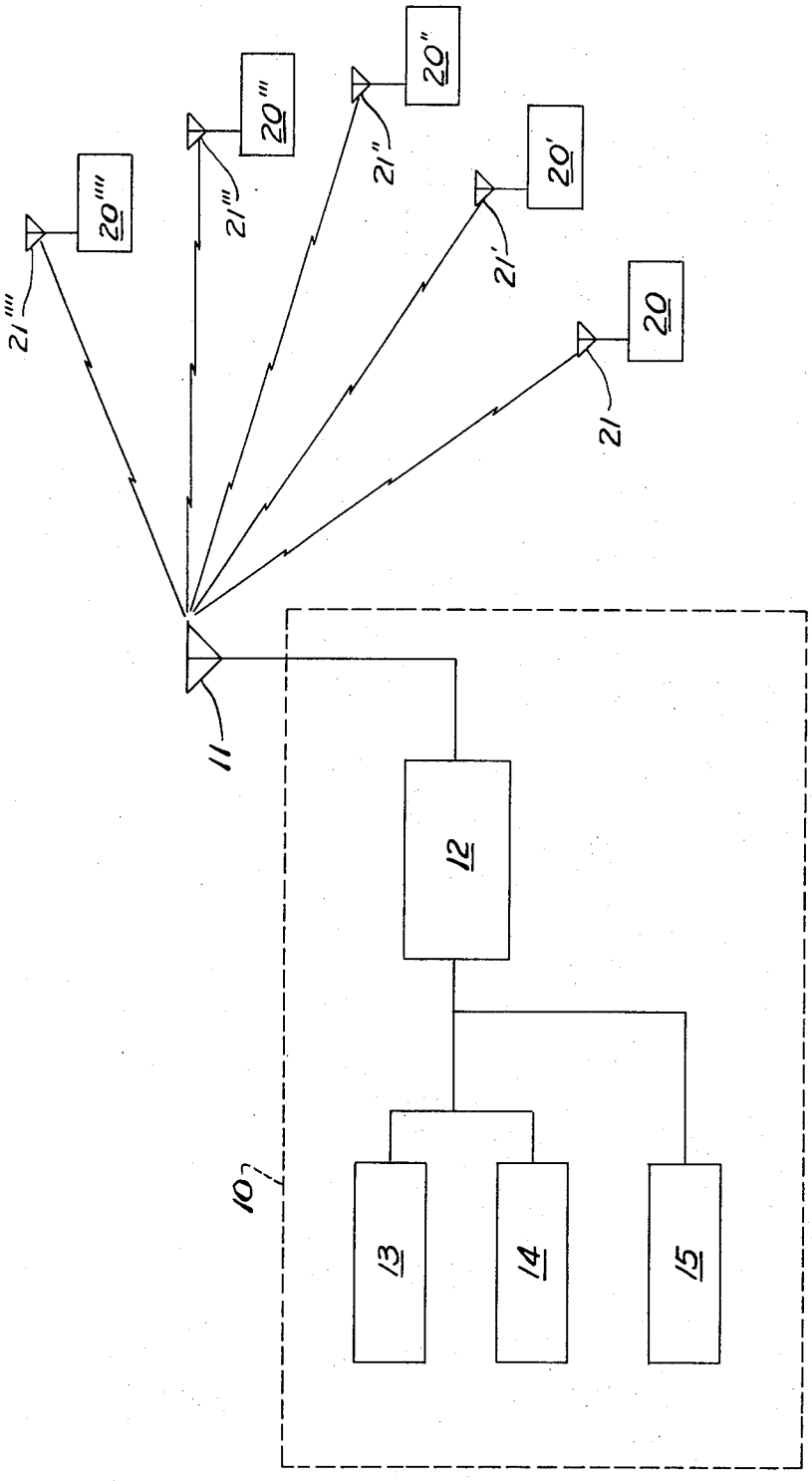


FIG. 1.

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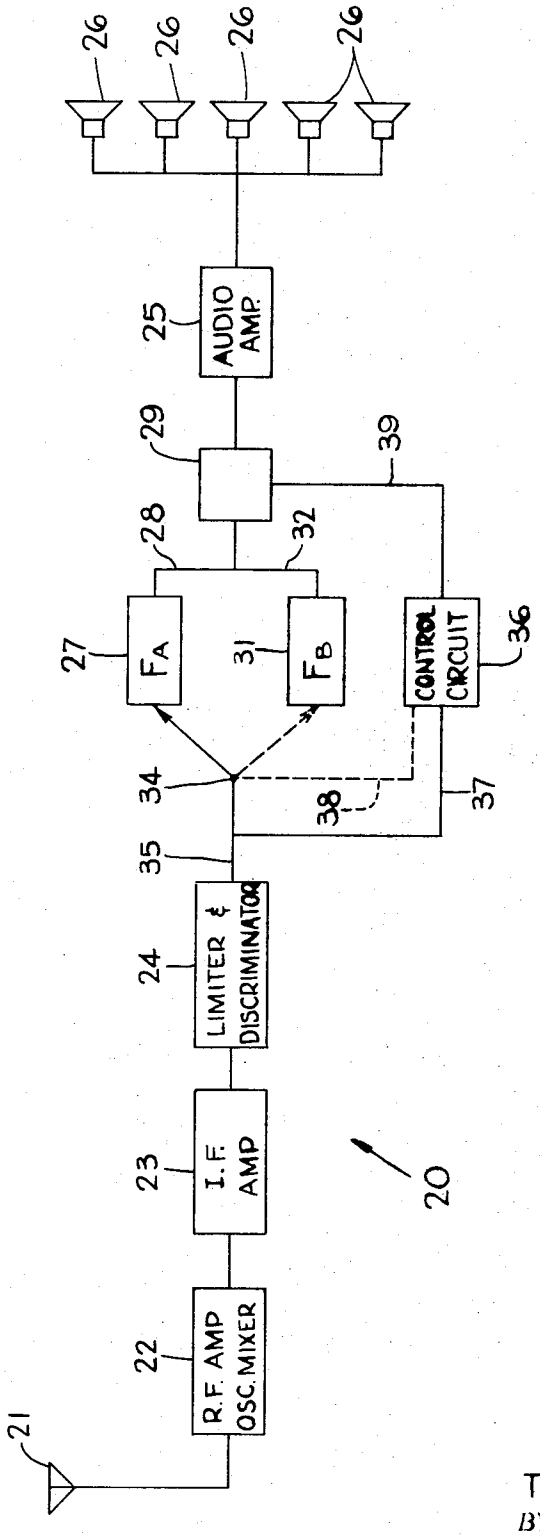


FIG. 2.

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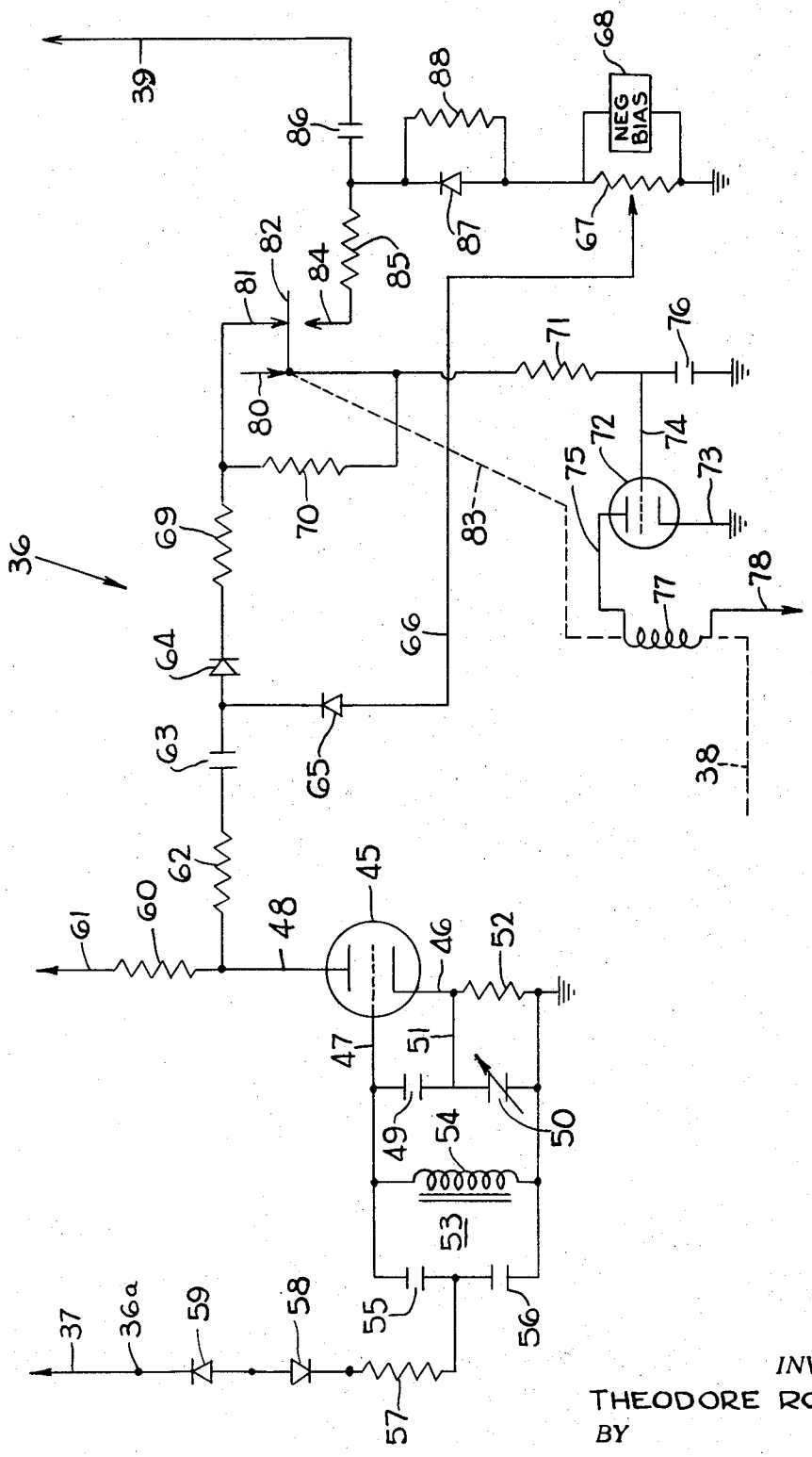


FIG. 3.

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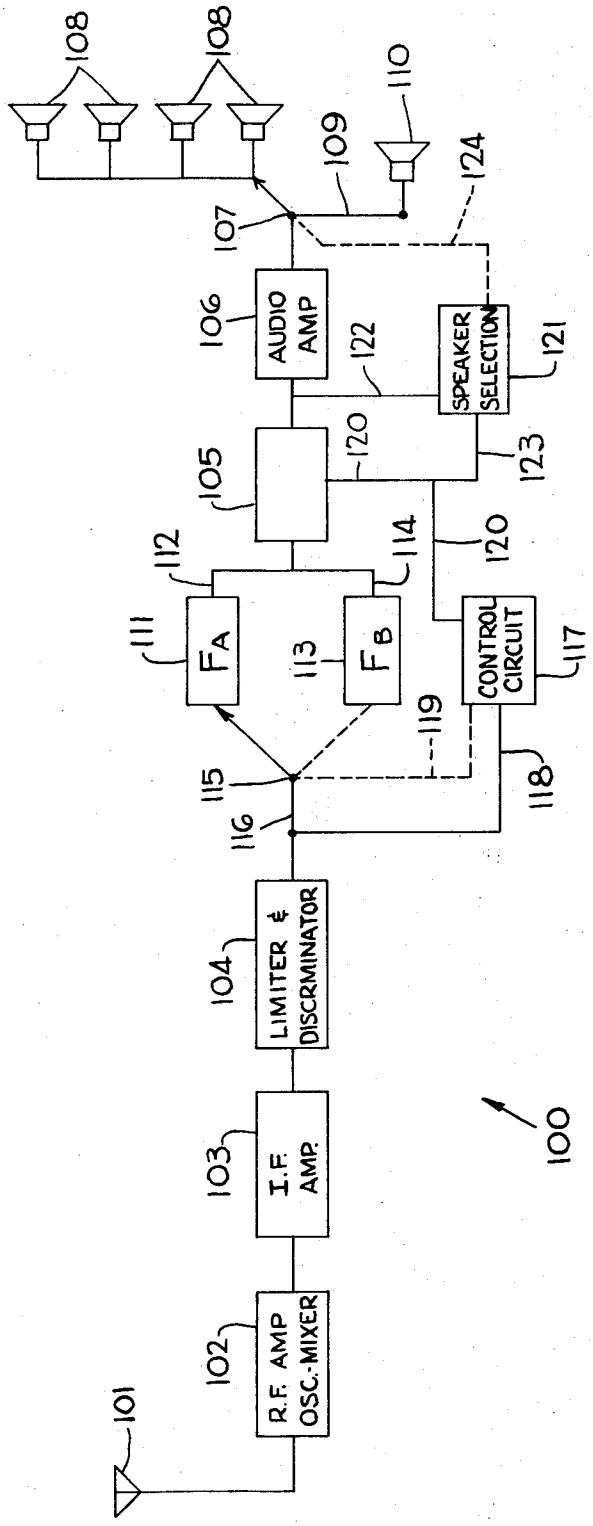


FIG. 4.

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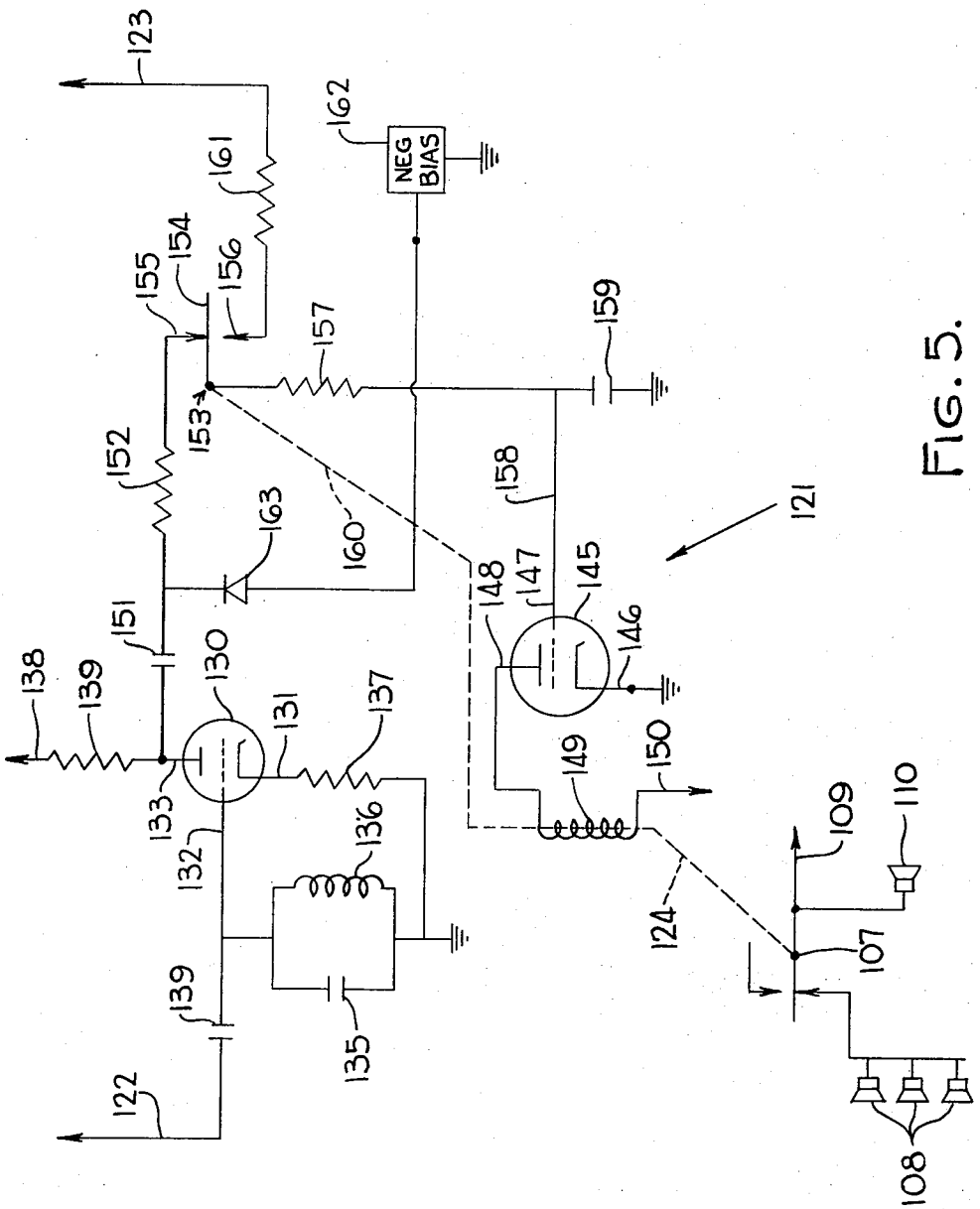


FIG. 5.

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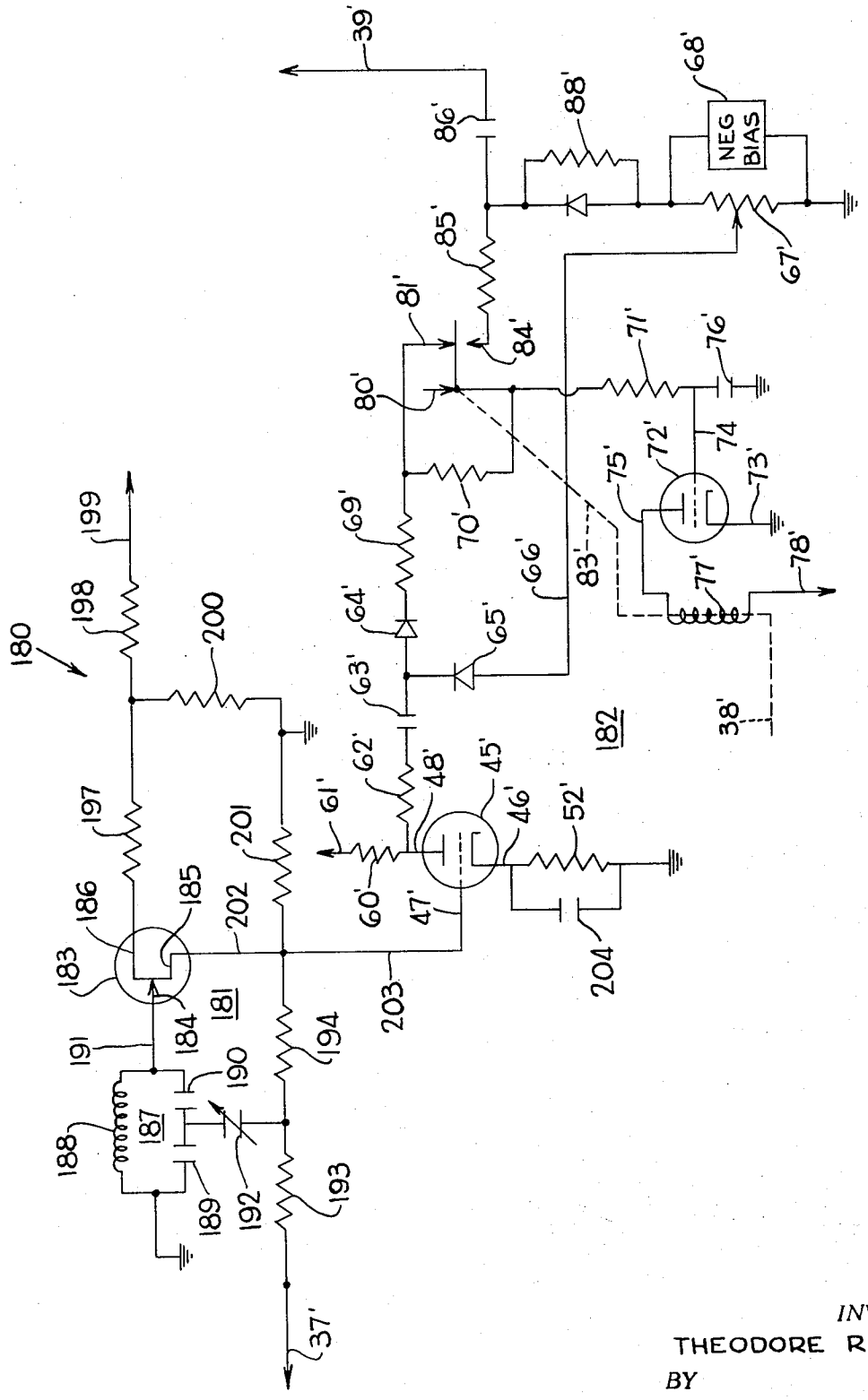


FIG. 6.

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CODE CONTROLLED BROADCASTING SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to radio broadcast systems, and, more particularly, to a system including a single transmitter and a plurality of receivers for broadcasting a program on one channel to all receivers and periodic messages on another channel to selected ones of the receivers, selection being accomplished by coded tones generated along with the particular messages.

One area of use of the present invention is in the broadcasting of background music simultaneously to a large number of business establishments for the pleasure of the customers therein and interrupting the music periodically with speech messages, such as advertising, at selected ones of groups of establishments to provide the customers with information. In recent times there has been a significant growth in the broadcasting of background music to business establishments such as supermarkets or banks. The geographic area included within the normal broadcast range of available equipment generally will contain several supermarket chains each having a considerable number of branches, or likewise, several banks each having a large number of branches. The proprietor or manager of each establishment would like to interrupt the music periodically and substitute an advertising message. With equipment heretofore available, this of course can be done at each location by turning off the broadcast equipment and by using separate audio equipment to broadcast the commercial.

It would, therefore, be highly desirable to provide a radio system with the capability of broadcasting background music along with periodic commercial messages, the commercial being received by selected ones of the receivers and selection be accomplished by coded control signals. One requirement which is immediately apparent is proper routing of commercial messages to the various receivers because of the obvious undesirability of having an advertising message intended for one establishment being improperly received by an entirely different establishment. Such a system might be constructed so that any failure in the portion thereof which provides the routing of messages would result in continued transmission of the music rather than improper routing of the messages. In addition, the larger the number of radio receivers in a given system the closer will be the frequency spacing between the coded control signals thus making more difficult the design of the control signal responsive portions thereof. In particular, that portion of the receiver must have a high degree of sensitivity whereby it causes switching of receiver operation from program to message reception only in response to the occurrence of a particular one of the code signals.

SUMMARY OF THE INVENTION

The present invention provides a radio broadcast system wherein there is transmitted from a single transmitting station a program signal such as music at a first frequency, periodic message signals such as commercials at a second frequency, and a plurality of code signals at different frequencies and occurring in time in correspondence with the beginning of selected ones of the message signals. Each of a plurality of receivers

normally audibly reproduces the program signal and is provided with a frequency responsive control circuit which in response to the occurrence of a selected one of the code signals switches the receiver operation to audible reproduction of a message signal. The frequency responsive control circuit for each receiver is constructed in a manner such that it has a high degree of sensitivity to insure that it provides switching only in response to a particular one of the code signals.

While several specific embodiments of the principles of the present invention are illustrated in the accompanying drawing and described in detail in the following specification, it is to be understood that such embodiments are by way of example and that various mechanical modifications may be made without departing from the spirit of the invention, the scope of which is limited only as defined in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a radio broadcasting system of the present invention;

FIG. 2 is a block diagram of one of the receivers included in the system of FIG. 1 according to the present invention;

FIG. 3 is a schematic diagram of a control circuit according to the present invention included in the receiver of FIG. 2;

FIG. 4 is a block diagram of an alternative embodiment of a receiver included in the broadcasting system of the present invention;

FIG. 5 is a schematic diagram of a speaker selection control circuit included in the receiver of FIG. 4; and

FIG. 6 is a schematic diagram of an alternative embodiment of the control circuit shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A radio broadcasting system according to the present invention includes a single transmitting station and a plurality of radio receivers for broadcasting a program, such as background music, on one channel to all receivers and periodic messages, such as commercials, on another channel to selected ones of the receivers. Selection is accomplished by generating coded tone signals along with the messages according to which receiver is intended to receive a particular message, the receivers, in turn, being provided with control means responsive to particular ones of the code signals. Referring now to the block diagram of FIG. 1, the broadcasting system of the present invention includes a transmitter, designated generally at **10**, for transmitting from an antenna **11** a program signal on one channel and periodic message signals on another channel. The standard transmitter mixer and output amplification stages are represented by block **12**, the output of which is connected to antenna **11**. Connected to the input of transmitter stages **12** are a program signal source **13**, a message signal source **14**, and a coding means **15** as shown in FIG. 1. In a particular application of the present invention the program signal consists of music, and block **13** thus would represent a conventional record player or tape recorder having the acoustical output signal thereof converted and translated through a noise suppressor, preamplifier and automatic volume control and applied to the input of the mixer included

in block **12**. In this same application the message signal consists of speech such as commercial messages and, therefore, block **14** would include a tape recorder or microphone having the acoustical output signal thereof translated through an amplifier to the input of the mixer included in block **12**. A coding means **15** also is included in transmitter **10** for generating a plurality of coded tone signals, each of a different frequency, which occur in time at a point corresponding to the beginning of selected ones of the message signals from block **14**. The code signals from coding means **15** are applied to the input of the mixer in transmitter stage **12**, and each of the signals has a duration relatively much shorter than the normal duration of the periodic message signals provided by block **14**.

In operation, the main carrier of transmitter **10** can be frequency modulated into two subcarriers corresponding to the program and message signals. Preferably, transmission of the program signal is at 67 kilocycles although a variation within the range of 59 to 75 kilocycles is not objectionable. Similarly, transmission of the message signals can be within the range of 37 to 47 kilocycles with transmission at 42 kilocycles being preferred. A plurality of code signals can be generated in the range of 20 to 35 kilocycles, with particular ones of the code signals occurring in time at a point corresponding to the beginning of particular ones of the message signals. In one illustrative example, **19** code signals are generated within the foregoing prescribed range, and the frequency spacing was logarithmic wherein the spaces have a magnitude of 0.5 kilocycle in the lower portion of the range and a spacing of 1.0 kilocycle in the upper portion of the range. In addition, each of the code signals preferably has a duration of about three seconds.

Inasmuch as radio transmitter stations similar to the one described herein are readily familiar to those skilled in the art, the foregoing description is believed to be in sufficient detail. Equipment for taping messages and for recording the desired coded tones or signals on the tape alongside the message under control of a manually operated selector is readily commercially available for use in such radio transmitter stations.

The radio broadcasting system of the present invention further includes a plurality of radio receivers **20**, and each receiver **20** has an antenna **21**. In addition, the receivers **20** are of substantially identical construction as indicated by the use of the prime superscripts in FIG. **1**. Each receiver **20** normally audibly reproduces the program signal from transmitter **10** and is adapted to also audibly reproduce the message signal from transmitter **10** upon switching of the receiver mode of operation. Each receiver is provided with control means responsive to a particular code signal from transmitter **10** for switching receiver operation and thereby resulting in audible reproduction of the message signal as will be described in detail hereafter. A preferred use of the system of FIG. **1** is in broadcasting background music to business establishments for convenience of the customers therein and for broadcasting periodic messages, such as commercials, to selected ones of the receivers. To this end a single radio receiver **20** can be located in one establishment and provided with several speakers positioned around the area in which the customers normally are present. A number of different establishments can be serviced by the present system to be provided with the same background music but with different commercial messages, the number being equal to the number of code signals generated by transmitter **10**. It also will be appreciated that the same commercial message is likely to be broadcast to all of the branches of a particular retain chain, and therefore the total number of receivers included in the system would be greater than the number of code signals. In other words, the capacity of transmitter **10** in terms of the number of code signals which can be provided is the constraint on the number of different commercial messages which can be transmitted in the system. The number of receivers for which the same commercial message is intended is limited only by geographic considerations and the radiation capability of transmitter **10**.

A preferred form of receiver **20** for use in the broadcast system of the present invention is shown in the block diagram of FIG. **2**. The other receivers for use in the system are identical in construction to receiver **20** shown in FIG. **2** with the exception that the frequency responsive portion of each is adjusted or modified so as to be activated by a particular one of the code signals from transmitter **10** as will be explained in detail hereafter. Referring now to FIG. **2**, receiver **20** includes means for detecting the program, message and code signals from transmitter **10** comprising an antenna **21**, connected to the input of a radio frequency amplifier and oscillator-mixer stage **22**, the output of which is translated through an intermediate frequency amplifier stage **23** to the input of a limiter and discriminator stage **24**. The program and message signals are audibly reproduced by means including audio amplifier stage **25**, the output of which is connected to the input of each of a plurality of speakers designated **26** in FIG. **2**. The stages of receiver **20** described so far are those of a standard or conventional radio receiver, and one receiver found readily adaptable for use in the present invention is available commercially under the designation Browning CRA.

In accordance with this invention, receiver **20** is adapted to normally audibly reproduce the program signal, but to be switched in operation to audibly reproduce the message signal when a particular one of the code signals from transmitter **10** activates a control means in receiver **20**. Referring again to FIG. **2**, receiver **20** also includes a first filtering means **27** for passing the program signal and rejecting the message signal. For convenience in illustration, filter means **27** is labeled with the frequency F_A which is that of the program signal. The output of filter **27** is connected to the input of audio amplifier **25** through line **28** and a circuit designated **29** in FIG. **2**. Circuit **29** includes conventional subcarrier amplifier, demodulator and squelch circuits. Receiver **20** further includes a second filtering means **31** for passing the message signal and rejecting the program signal. For convenience in illustration, filter **31** is labeled with the frequency F_B which is that of the message signal. The output of filter **31** is connected to the input of audio amplifier **25** through a line **32** and also through circuit **29**.

Receiver **20** further includes switching means, designated generally at **34**, for connecting either of the first or second filtering means **27** and **31**, respectively,

to the receiver detecting means, in particular to line **35** connected to the output of limiter and discriminator stage **24**. Receiver **20** finally comprises a control circuit **36** responsive to a particular one of the code signals from transmitter **10** and which signal appears at the output of the receiver detecting means for moving switching means **34** to cause receiver **20** to audibly reproduce the message signal upon the occurrence of that code signal. The input of control circuit **36** is connected by means of a line **37**, which in turn is connected to line **35**, to the output of receiver limiter and discriminator stage **24**. The output of control circuit **36** is operatively connected to switching means **34** as indicated by the dashed line **38** in FIG. **2** and which will be described in more detail hereafter. The subcarrier amplifier in circuit **29** is connected through line **39** to control circuit **36** to establish a holding circuit therein as will be described in detail hereafter.

FIG. **3** shows in detail one form of control circuit **36** constructed in accordance with this invention. Control circuit **36** comprises an amplifier including a triode **45** the output of which is rectified and coupled through a high resistance network to an electromechanical transducer for converting signals provided by circuit **36** into mechanical movement to operate switching means **34**. Triode **45** has cathode, grid and plate terminals **46–48**, respectively. The input of triode amplifier **45** is coupled to line **37**, which is connected to the input of circuit **36**, in the following manner. A tapped capacitance comprising the series combination of fixed capacitor **49** and variable capacitor **50** is connected between the input of amplifier **45** and ground. In particular, one terminal of fixed capacitor **49** is connected to grid terminal **47** of triode **45**, and one terminal of variable capacitor **50** is connected to ground. The junction of capacitors **49** and **50** is connected by means of lead **51** to cathode terminal **46** of triode **45** and through a cathode resistor **52** to ground. An LC frequency responsive circuit **53** is connected across the series combination of capacitors **49** and **50**. In particular, circuit **53** comprises an inductor **54** connected in parallel with the series combination of capacitors **55** and **56**. The values of the components of circuit **53** are selected so that it is responsive to the frequency of a particular one of the coded tone signals generated by transmitter **10**. The junction of capacitors **55**, **56** is connected to the input terminal of circuit **36**, here designated **36*a***, through a resistor **57** and the series combination of diodes **58**, **59**. Diodes **58**, **59** are connected in opposed or back-to-back relation wherein the cathode of diode **58** is connected to resistor **57**, the anodes of the diodes are connected together, and the cathode of diode **59** is connected to the input terminal **36*a*** which, in turn, is connected to lead **37**.

The output of triode amplifier **45** is rectified and coupled through a high resistance circuit to an electromechanical transducer at the output of control circuit **36**. In particular, plate terminal **48** of triode **45**, which also is connected through a resistor **60** and a lead **61** to a standard B+ voltage source, is connected through the series combination of a resistor **62** and capacitor **63** to the input of a full-wave rectifier comprising diodes **64** and **65**. The anode of diode **64** is connected to one terminal of capacitor **63** and to the cathode of diode **65**. Diode **65** is suitably biased by means of a lead **66** connecting the anode thereof to the wiper arm of a potentiometer **67** connected across a source of negative bias voltage **68**. A full-wave rectified signal in the form of a square wave is developed across a voltage divider comprising resistors **69**, **70** and **71** and is applied to the input of a triode amplifier **72**. Triode **72** has cathode, grid and plate terminals **73–75**, respectively. Grid terminal **74** is connected to resistor **71** and through a capacitor **76** to ground. Cathode terminal **73** of triode **72** is connected directly to ground, and the output signal from amplifier **72** appears on plate **75**, which is connected to one terminal of a relay winding **77**, the other terminal of which is connected through a lead **78** to a standard B+ voltage source. It is apparent, therefore, that an output signal from triode amplifier **72** causes energization of relay winding **77** which, in turn, provides a mechanical movement which is transmitted through the coupling indicated by the dashed line **38** to the arm of the switching means designated **34** in FIG. **2**. It should also be apparent that other types of signal responsive switching means can be connected to the output of control circuit **36**, such as to the output of amplifier **72**, for switching the operation of receiver **20** from one of the filters **27**, **31** to the other without departing from the spirit and scope of the present invention.

According to a preferred mode of the present invention, the coded tone signals will have a relatively short time duration, preferably about three seconds, which is significantly less than the duration of typical message signals broadcasted in the present system. Control circuit **36**, therefore, is constructed to include a holding circuit for maintaining receiver **20** in a switched condition from one filter to the other upon the occurrence of a selected code signal for as long as the intended message signal is present. Referring again to FIG. **3**, it is seen that a switch **80** is included with one fixed contact **81** connected to the junction of resistors **69** and **70**, and with a movable contact arm **82** normally engaging fixed contact **81** and mechanically coupled to relay winding **77** as indicated by the dashed line **83**. A second fixed contact **84** of switch **80** is connected through a resistor **85** to one terminal of a coupling capacitor **86**, the other terminal of which is connected to lead **39**. It will be recalled from the discussion of the system of FIG. **2** that lead **39** is connected to the subcarrier amplifier in circuit **29** where the message signal will be available. A half-wave rectifier comprising diode **87** is connected to the junction of resistor **85** and capacitor **86**, the cathode of diode **87** being connected to the junction, and diode **87** is suitably biased by virtue of the connection of the anode thereof to potentiometer **67** and negative bias source **68**. A resistor **88** is connected in parallel with diode **87**.

The broadcasting system of FIGS. **1–3** operates in the following manner. Transmitter **10** transmits from antenna **11** a program signal on one channel, for example at a frequency of 67 kilocycles, which is intended for continuous transmission to each of a plurality of receives **20**, as indicated in FIG. **1**. The program signal, for example, can consist of background music which is broadcast to a large number of business establishments such as supermarkets or banks. Transmitter **10** also periodically will broadcast message signals intended for only selected ones of the receivers, selection being ac-

complished by the transmission of code signals by transmitter **10** at a time corresponding to the beginning of particular message signals. The message signals are broadcast on a second channel, for example at a frequency of 42 kilocycles, and advantageously can consist of advertising or other messages for the purpose of informing customers at particular establishments.

Each of the receivers **20** shown in the system of FIG. **1** operates in the following manner. Referring now to FIG. **2**, switching means **34** normally is in the position shown in FIG. **2** whereby filter **27**, which passes only the program signal, is connected in the transmission path of receiver **20**, and filter **31** is therefore switched out of the circuit. The program signal from transmitter **10** is received by antenna **21** and translated through receiver stages **22–24** in a conventional manner, whereupon it is applied to the input of filter **27**. Filter **27** is responsive to the frequency of the program signal, for example 67 kilocycles, and functions to pass that signal but to reject all other signals such as message signals or code signals. The output of filter **27** is applied through line **28** to the input of circuit **29** which in turn is connected to the input of an audio amplifier **25**. The squelch circuit in circuit **29** is of known construction and functions to mute the signal transmitted to audio amplifier **25** should the signal from filter **27** decrease in amplitude below a desired level. The program signal is audibly reproduced and available at the output of the various speakers **26**, which would be placed at spaced locations around the business establishment. Thus, during this mode of operation customers in the establishment would hear music in the background for their pleasure and enjoyment.

Each receiver **20** has the capability of switching from the program signal to a mode of operation wherein it audibly reproduces a message signal. It is important to note, however, that reception of a particular message signal is only by a selected one or ones of receivers **20**, and while that happens the remaining receivers in the system will continue to receive the program signal such as background music. Assume that the receiver shown in FIG. **2** has been receiving and audibly reproducing the aforementioned program signal and that it is now about to receive and audibly reproduce a message signal intended for it and for a relatively short period of time whereupon the receiver will return to its original mode of operation wherein it reproduces the program signal. For a particular receiver **20** to reproduce a message signal two conditions must be met. A first condition is, of course, that the message signal be received by antenna **21**, and a second condition is that the one discrete code signal intended for that receiver which will activate control circuit **36** is present also at antenna **21** and simultaneous with the beginning of the message signal.

The program, message and code signals are translated through receiver stages **22–24**, and are applied simultaneously to the inputs of filter **27** through switching means **34** and of control circuit **36** through line **37**. Assuming that the present code signal is the particular one which will activate circuit **36**, switching means **34** is moved from the position shown in FIG. **2** to the dotted line position whereupon line **35** is connected to the input of filter **31**. Filter **31**, in turn, functions to pass the message signal which, for example, has a frequency of 42 kilocycles, but to reject the program signal. The output of filter **31** is applied through line **32** to the input of circuit **29** and then through audio amplifier **25** and speakers **26**, whereby the message such as a commercial is audibly reproduced. The continued transmission of the message signal through filter **31** for a predetermined time also completes a holding circuit conditioned by the operation of circuit **36** and indicated generally by means of line **39** in FIG. **2**, to maintain operation of control circuit **36** and hence switching means **34** in the position shown whereby the detected signals are applied to the input of filter **31** for the duration of the message signal. The code signal has a duration relatively much shorter than that of the message signal, and according to a preferred mode of the present invention the code signal lasts for about 3 seconds. Also, the code signal must be present for this duration of 3 seconds to develop a voltage level sufficient to maintain operation of control circuit **36** and hold switching means **34** in this position.

The requirement that the code signal be present for a predetermined time, here about 3 seconds, together with the fact that circuit **36** must first be operated before the holding circuit can be established prevents inadvertent switching of receiver operation in response to transient or spurious signals as will be described in more detail hereafter. Thus, during this mode of operation the background music or the program signal is temporarily interrupted at a particular receiver(s) and there is substituted an informative message such as a commercial. At the conclusion of the message, the receiver switches back to operation whereby the background music again is audibly reproduced because upon cessation of the message signal the aforementioned holding circuit is broken causing switching means **34** to return to its normal position as indicated in FIG. **2**.

The broadcasting system of the present invention has several advantageous characteristics. The normal mode of operation of each receiver **20** in the broadcasting system is with switching means **34** in the position shown in FIG. **2** whereby the receiver **20** audibly reproduces the program signal. Switching of the receiver from audible reproduction of the program signal to audible reproduction of a message signal occurs only upon satisfaction of two conditions: the availability of a message signal and the simultaneous occurrence of a particular one of the code signals intended for that receiver. In addition, the time requirement on the code signal for operating circuit **36** prevents switching in response to transient or other spurious signals. Therefore, any malfunction in operation of either transmitter **10** or receiver **20** most likely will result either in continued reception of the program signal or cessation of receiver operation altogether. In other words, unintended switching of any receiver to reproduction of a message signal not intended for it will not occur in the system of the present invention. This is of considerable importance when receivers **20** are located respectively in different commercial establishments, and the advertising messages intended for one or more establishments would be completely foreign to and undesirable in any of the remaining establishments. In addition, the broadcasting system of the present invention has the capability of transmitting from a single receiver both a

program signal consisting of background music and message signals consisting of periodic commercials. There is, as a result, no need to provide separate public address systems at each commercial establishment to provide periodic commercials upon temporary interruption of the background music. All that is required at each establishment is a single receiver with one or more speakers operatively connected thereto as shown in FIG. 2, which receiver is modified according to the present invention to include filters **27** and **31**, together with control circuit **36**.

The operation of control circuit **36**, which was described briefly in the foregoing discussion of the overall system operation, now will be described in more detail. Referring to FIG. 3, the output of receiver limiter and discriminator stage **24** comprises the detected program, message and code signals and is applied through lead **37** to the input of circuit **36**. These signals, in turn, are transmitted through diodes **58, 59** and resistor **57** to the input of tuned circuit **53**. Circuit **53** is responsive to the frequency of only one of the plurality of code signals transmitted from transmitter **10**, and upon the presence of that particular code signal, circuit **53** resonsates to provide a signal to the input of amplifier **45**. The amplified signal then is full-wave rectified by diodes **64** and **65** resulting in a square wave signal across the divider network comprising resistors **69–71** which signal is applied to the input of amplifier **72**. The output of amplifier **72**, in turn, energizes relay coil **77** to move switching means **34** shown in FIG. **2** to the position whereby the line **35** is connected to the input of filter **31**. The energization of relay winding **77** also causes movement of switch arm **82** away from contact **81** and into engagement with contact **84**. A circuit thus is completed from line **39**, which is connected to filter **31**, through capacitor **86**, resistor **85**, and resistor **71** to the input of amplifier **72**.

The message signal present at the subcarrier amplifier in circuit **29** is transmitted through line **39**, half-wave rectified by diode **87**, and is applied to the input of amplifier **72**. The message signal is of sufficient amplitude so as to require only half-wave rectification as provided by the single diode **87**. The rectified code signals of 3 seconds duration will have charged timing capacitor **76**, and the voltage thereon is applied through tube **72** to energize relay winding **77**. The time constant for this mode of operation is determined by the magnitudes of resistors **69** and **71** and capacitor **76** and is made the duration of the code signal, here three seconds, which is significantly greater than the duration of any transient or spurious signals which might be present in the system. This, in turn, prevents inadvertent switching of receiver operation from program to message signal reproduction in response to transient or spurious signals. Were no signal present on line **39**, relay **77** would drop out within three seconds because of the discharge of capacitor **76** through resistors **71** and **85**, the time constant determined by the values of these three elements. Assuming a signal is present on line **39**, however, amplifier **72** will continue to provide an output signal to energize winding **77** for the duration of the message signal transmitted through filter **31**. Upon cessation of the message signal on line **39**, capacitor **76** discharges and amplifier **72** no longer provides an output thereby de-energizing winding **77** with the result that switching means **34** in FIG. **2** returns to its normal position engaging contact arm **81**.

When a relatively large number of receivers are included in the system of the present invention and when the code signals are relatively closely spaced in frequency, it is apparent that circuit **36** should have a flat or horizontal rather than an oblique or inclined frequency-voltage characteristic, so as to have a high degree of sensitivity. In other words, were circuit **36** to have an inclined frequency-voltage characteristic, code signals varying slightly in frequency from the discrete code signal frequency to which it is tuned could cause circuit **36** to provide an undesired output signal. On the other hand, with a horizontal characteristic, the input signal must correspond in frequency precisely with the frequency to which circuit **53** is tuned so that a square wave of sufficient amplitude is developed for application to the input of amplifier **72**. Otherwise the occurrence of an adjacent tone signal might cause an output signal to be generated by circuit **36**, due to the inclined nature of the characteristic, and cause energization of relay **77** and an undesired switching from program to message signal reproduction.

Various features of circuit **36** contribute to the high degree of sensitivity between frequency and output voltage. The relatively loose degree of coupling provides a sharp frequency response. The provision of diodes **58** and **59** connected back-to-back in series with the input of tuned circuit **53**, together with resistors **62, 69** and **70** having relatively large magnitudes place relatively little load on the operation of tube **45**. The tapped capacitance comprising fixed capacitor **49** and variable capacitor **50** connected to the input of tube tube **45** provides automatic feedback control wherein capacitor **49** equalizes the feedback to maintain a constant voltage in the tube plate circuit. Capacitor **50** is varied in magnitude to adjust the feedback in the circuit of tube **45** to compensate for manufacturing tolerances in the magnitudes of inductor **54** and capacitors **55, 56** of tuned circuit **53** and thus permit relatively precise tuning to a desired code signal.

According to a preferred mode of the present invention, various components of control circuit **36** have the following ratings or magnitudes:

Resistor **57** – 0.47 M
Capacitor **49** – 470 uuf
Capacitor **50** – 0–680 uuf
Resistor **62** – 0.47 M
Capacitor **63** – 300 uuf
Resistor **69** – 22 M
Resistor **70** – 10 M
Resistor **71** – 22 M
Capacitor **76** – 0.1 uf
Resistor **85** – 22 M
Capacitor **86** – 300 uuf
Diodes **58, 59** – 1N64

FIG. **4** illustrates a modification of each of the radio receivers included in the broadcast system of FIG. **1** according to a second embodiment of the present invention. In this embodiment the system of the present invention operates to broadcast a program signal to the public areas of a business establishment and periodic message signals only to a private area. Selection among a plurality of receivers is provided by the generation of coded tone signals from the transmitter. One ad-

vantageous use of the system according to this embodiment would be for a bank having a large number of branches, wherein it is desired to broadcast background music from a single transmitting station to the public areas of all the branches and periodic messages to only the manager's office, employee area or other private area but not to the public area. As in the system according to the first embodiment, this system has the capability of transmitting different message signals to different receivers by virtue of the generation of a plurality of code signals, each of a different frequency, and of the inclusion of a frequency responsive control circuit within each receiver as will now be described in detail.

A receiver **100** constructed in accordance with this embodiment of the present invention includes an antenna **101** connected to the input of a radio frequency amplifier and oscillator-mixer stage **102**, the output of which is translated through an intermediate frequency amplifier stage **103** to the input of a limiter and discriminator stage **104**. The program and message signals available at the output of limiter and discriminator stage **104** are audibly reproduced by means of a subcarrier amplifier, demodulation and squelch stage **105**, the output of which is translated through an audio amplifier **106**, and applied through a switching means **107** to each of a plurality of speakers designated **108** in FIG. **4**. The output of audio amplifier **106** is connected also through a line **109** to a speaker **110** for audibly reproducing message signals in an area which is separate or private from that area in which speakers **108** are located. While only one speaker **110** is shown, additional speakers could, of course, be connected to line **109**. The foregoing components of receiver **110** between antenna **101** and audio amplifier **106** are arranged in a standard or conventional manner, and one receiver which was found to be readily adaptable to modification according to the present invention is marketed under the commercial designation Browning CRA.

According to the present invention, receiver **100** further includes a first filtering means **111** for passing the program signal and rejecting the message signal. In preferred form filter **111** is constructed to pass a frequency of about 67 kilocycles, and for convenience is designated F_A in FIG. **4**. The output of filter **111** is connected to the input of amplifier squelch and demodulation state **105** through a line **112**. Receiver **100** further includes a second filter means **113** for passing the message signal and rejecting the program signal. In preferred form filter **113** is constructed to pass frequencies at about 42 kilocycles, and for convenience is designated F_B in FIG. **4**. The output of filter **113** is connected to the input of squelch and demodulation stage **105** by means of a line **114**. Receiver **100** further includes a switching means **115** for connecting either of the filtering means **111**, **113** to the receiver detecting means. In particular, switching means **115** is shown in its normal position connecting the input of filter **112** through line **116** to the output of limiter and discriminator stage **104**.

Receiver **100** further includes a control circuit **117** having an input connected to the output of the receiver detecting means, in this particular illustration the connection being provided by line **118** connecting line **116** at the output of limiter and discriminator stage **104** to the input of control circuit **117**. Control circuit **117** also has an output operatively connected to switching means **115** as indicated by the dashed line **119**, whereby control circuit **117** causes movement of switching means **115** from one of the filters **111**, **113** to the other filter in response to the presence on line **118** of a particular one of the code signals from the station transmitter. A holding circuit for control circuit **117** is provided including line **120** connected thereto and to the subcarrier amplifier in stage **105**.

Receiver **100** finally includes a speaker selection control circuit **121** having a first input connected through a line **122** to the line joining receiver stages **105** and **106** and a second input connected through a line **123** to line **120** connected to receiver stage **105**. The output of speaker selection circuit **121** is operatively connected to switching means **107** as indicated by the dashed line **124** in FIG. **4**. Speaker selection circuit **121** functions, briefly, to move switching means **107** and disconnect speakers **108** from the output of amplifier **106** in response to a signal to amplifier **106** applied through line **122** to one input of circuit **121** and to a signal from amplifier squelch and demodulation circuit **105** applied through line **123** to the other input of circuit **121**. Speaker **110** remains connected through line **109** to the output of audio amplifier **106** regardless of whether switching means **107** is in its normal position as shown in FIG. **4** or is moved therefrom in response to operation of circuit **121**.

Receiver **100** shown in FIG. **4** represents one of a plurality of similar receivers which can be substituted for the receivers **20** in the system of FIG. **1**. As in that system, there is transmitted to receiver **100** from a single transmitting station a program signal, such as background music, on one channel, periodic message signals on another channel, and a plurality of code signals of different frequencies and occurring in time at the beginning of selected ones of the message signals. Receiver **100** operates in the following manner. The program, message and code signals are detected by antenna **101** and translated through the receiver stages **102–104**. Switching means **115** is in its normal position connecting line **116** to the input of filter **111**, and in this mode of operation the program signal, preferably at a frequency of 67 kilocycles, is passed by filter **111** and audibly reproduced by receiver stages **105**, **106** and speakers **108**, **110**. Switching means **107** in this mode of operation is in a position connecting speakers **108** to the output of audio amplifier **106**, whereby the program signal, such as background music, is audibly reproduced in both the public and private areas of the business establishment.

Assume now that receiver **100** is detecting and reproducing the program signal and there is transmitted to the receiver an intended message signal along with the particular code signal to which control circuit **117** will respond. The program, message and code signals are available on line **116**, and the code signal is applied through line **118** to the input of control circuit **117**, whereby the latter by virtue of the connection indicated at **119** in FIG. **4** causes movement of switching means **115** from its normal position to a position connecting line **116** to the input of filter **113**. This will occur, of course, only if the code signal is of sufficient du-

ration, such as three seconds, as in the case of control circuit **36**. As a result, the program signal is no longer translated further through the receiver and the message signal is passed by filter **113** to receiver stages **105** and **106**. The presence of the message signal in stage **105**, and provided the code signal has the given duration, establishes through line **120** a holding circuit for control circuit **117** for the duration of the message signal.

Speaker selection circuit **121** is operated in response to the presence of the message signal on line **122** as will be explained, and operation is maintained by virtue of the connection through line **123**. Selection circuit **121**, in turn, through the operative connection indicated at **124** in FIG. **4**, causes movement of switching means **107** from its normal position with the result that speakers **108** are disconnected from the output of audio amplifier **106**. Speaker **110**, however, remains connected to the amplifier output through the path provided by line **109**. Speakers **108** remain disconnected from amplifier **106** for the duration of the message signal, and when the message signal is ended selection circuit **121** is deactivated and switching means **107** returned to its normal position connecting the output of amplifier **106** to speakers **108**.

Receiver **100**, therefore, functions to audibly reproduce a program signal, for example background music, simultaneously on two sets of speakers, one of which can be placed in the public area of a business establishment and the other in a private area. Receiver **100** functions further to audibly reproduce a message signal only on the set of speakers in the private area, for example in the manager's office of employee area of a bank. To this end, receiver **100** functions to disconnect the public area speakers from the receiver circuit in response to the presence of both the message signal and a particular code signal intended for that receiver. It will be appreciated that while only one speaker **110** is shown in FIG. **4**, a plurality of similar speakers can be provided and positioned at selected locations in the designated private area. It should be apparent also that in a system including a large number of receivers similar to receiver **100**, each having a control circuit **117** responsive to a different one of the plurality of code signals transmitted from the single station, a corresponding number of different message signals can be transmitted and properly routed to corresponding ones of the receivers where they are audibly reproduced on the speaker such as speaker **110** in the selected private area.

In a preferred form of receiver **100**, filters **111** and **113** are responsive to frequencies of 67 kilocycles and 42 kilocycles, respectively, and thus are identical to filters **27** and **31**, respectively, of receiver **20**. Likewise, control circuit **117** is identical in construction to control circuit **36** shown in FIGS. **2** and **3**. In particular, the holding circuit including line **120** is conditioned by the operation of circuit **117**, and the code signal on line **118** must be present for at least a given time, such as three seconds, to develop a voltage level sufficient to maintain the holding circuit and switching means **115** in this position. In addition, line **122** in the circuit of FIG. **4** connects an input of selection circuit **121** to the output of stage **105** and line **123** connects another input to the subcarrier amplifier in stage **105**.

A preferred form of speaker selection circuit **121** is shown in detail in FIG. **5**. Circuit **121** comprises an input amplifier including a triode **130** having cathode, grid and plate terminals **131–133**, respectively. Line **122** from the output of receiver stage **105** is coupled through a capacitor **139** to grid terminal **132** of triode **130**, and a tuned circuit comprising the parallel combination of a capacitor **135** and an inductor **136** is connected between grid terminal **132** and ground. Cathode **131** of triode **130** also is connected to ground through a resistor **137**. A suitable bias voltage available on line **138** is applied through a resistor **139** to the plate terminal **133** of triode **130**. Circuit **121** further comprises an output amplifier including a triode **145** having cathode, grid and plate terminals **146–148**, respectively. The output of amplifier **145**, available on plate terminal **148**, is connected to one terminal of a relay energizing winding **149**, the other terminal of which connected through a line **150** to a suitable source of bias voltage rated B+. Relay winding **149** is mechanically coupled to switching means **107** shown in FIG. **4**, as indicated by the dashed line **124**. Energization of winding **149** causes movement of switching means **107** away from its normal position to thereby disconnect speakers **108** from line **109** connected to the output of audio amplifier **106**.

The output of amplifier **130** is half-wave rectified and applied to the input of amplifier **145** through a network comprising a coupling capacitor **151**, a diode rectifier **163**, a resistor **152**, a switch **153** including movable contact arm **154** and fixed contacts **155**, **156**, and a resistor **157**. Coupling capacitor **151** is connected to plate terminal **133**, switch arm **154** normally engages contact **155** thereby connecting resistor **157** through resistor **152** to capacitor **151**, and a lead **158** connects resistor **157** to grid terminal **147** of triode **145**. Grid terminal **147** also is connected to ground through a capacitor **159**. Relay winding **149** is mechanically coupled also to switch **153** as indicated by the dashed line **160** in FIG. **5**, and contact **156** is connected through a resistor **161** to line **123** which, as shown in FIG. **4**, is connected to line **120** and hence to the subcarrier amplifier in stage **105**. Circuit **121** finally includes a source of negative bias voltage **162**, one terminal of which is grounded and the other terminal of which is connected to the anode of diode **163**, the cathode of which is connected to the junction of capacitor **151** and resistor **152**.

Speaker selection circuit **121** operates in the following manner. The tuned circuit comprising capacitor **135** and inductor **136** is constructed to resonate at a frequency within the modulation of the message signal, which according to a preferred mode of operation is 4,800 cycles. Thus, upon activation of control circuit **117** shown in FIG. **4** in response to the presence of the particular code signal, which causes filter **113** to be switching into the circuit to pass the 42 kilocycle message signal to the receiver amplifier, squelch and demodulation stage **105**, the message signal is present on line **122**. The signal is amplified by triode **130**, rectified by diode **163**, and appears as a square wave across the divided network comprising resistors **152** and **157**. This square wave, in turn, is applied to the input of amplifier **145**. The message signal is of sufficient amplitude so as to require only half-wave rectifi-

cation as provided by the single diode **163**. An amplified signal is applied to winding **149** thereby causing movement of switching means **107** to disconnect speakers **108** from the output of audio amplifier **106**. At the same time, energization of winding **149** causes movement of switch arm **154** to engage fixed contact **156** by virtue of the mechanical connection **160** thereby establishing a holding circuit from the output of the amplifier in **105** through line **123**, resistor **161**, fixed contact **156**, resistor **157** and lead **158** to the input of triode **145**. Winding **149** thus remains energized for the duration of the message signal. Upon cessation of the message signal, contact arm **154** of switching means **153** is returned to its normal position engaging fixed contact **155** and the holding circuit is thereby opened.

FIG. **6** shows a frequency responsive control circuit **180** which is an alternative embodiment of circuit **36** shown in FIG. **3**. Circuit **180** includes a frequency responsive input portion **181** and a buffer stage **182**. Buffer stage **182** includes a major portion of circuit **36** shown in FIG. **3**, and for convenience in description the identical components are labeled with the same numbers but provided with a prime superscript. Input stage **181** includes a semiconductor amplifier in the form of field effect transistor **183** having gate, source and drain terminals **184** through **186**, respectively. Input stage **181** further comprises a frequency responsive circuit **187** comprising an inductor **188** connected in parallel with the series combination of capacitors **189** and **190**. Circuit **187** is connected at the junction of inductor **188** and capacitor **190** through a lead **191** to gate terminal **184** of transistor **183**, and the junction of inductor **188** and capacitor **189** is connected to ground.

Input stage **181** further comprises a variable capacitor **192**, one terminal of which is connected to the junction of capacitors **189** and **190** in circuit **187**. The other terminal of capacitor **192** is connected through a resistor **193** to a lead designated **37'** which, as in the embodiment of FIG. **3**, is connected to line **35** and, hence, the output of receiver limiter and discriminator stage **24**. The junction of variable capacitor **192** and resistor **193** is connected through a feedback resistor **194** to source terminal **185** of transistor **183**. Drain terminal **186** of transistor **183** is connected through the series combination of resistors **197** and **198** and a lead **199** to a source of B positive bias voltage. The junction of resistors **197** and **198** is connected through a resistor **200** to ground. A voltage output from transistor **183** is developed across a load resistor **201**, one terminal of which is connected to ground and the other terminal of which is connected through a lead **202** to source terminal **185**. The voltage developed on resistor **201** is applied through a lead **203** to grid terminal **47'** of amplifier tube **45'**. A compensating capacitor **204** is connected across cathode resistor **52'**.

Circuit **180** operates in a manner similar to that of circuit **36** shown in FIG. **3**. The magnitudes of inductor **188** and capacitors **189**, **190** are selected so that circuit **187** is responsive to a particular one of the coded tone signals. The feedback in the circuit of transistor **183** is adjusted by varying capacitor **192**. This in turn compensates for manufacturing tolerances in the components of tuned circuit **187**. Transistor **183** is a field effect transistor of the 2N3819 type characterized, in part, by having a relatively high input impedance. This, in turn, enhances the overall frequency-voltage sensitivity of circuit **180**. The feedback in the circuit of transistor **183** is capacitive as compared to the inductive feedback in the circuit of tube **45** shown in FIG. **3**.

When the particular coded tone signal is present on line **37'**, circuit **187** resonates and acts as an extremely narrow band filter. Transistor **183** and associated circuitry cause an appreciable multiplication or increase in the Q of resonant circuit **187**. The resulting voltage developed across resistor **201** is applied to lead **203** to turn on tube **45'**. Buffer stage **183** then operates in a manner identical to that portion of the circuit of FIG. **3**.

While several specific embodiments of the present invention have been described in detail, this is done by way of illustration without thought of limitation.

I claim:

1. A radio broadcasting system comprising:

a. a transmitter for transmitting a program signal on one channel and periodic message signals on another channel;

b. coding means in said transmitter for generating plurality of code signals, each of a different frequency, and corresponding in time to the beginning of selected ones of the message signals;

c. a plurality of radio receivers, each of said receivers normally audibly reproducing said program signal and each including means for switching operation to audibly reproduce said message signals and then switching operation thereof to resume reproduction of said program signal;

d. control means in each of said receivers operative in response to only a particular predetermined one of said code signals and connected to said switching means for switching operation of said receiver to audibly reproduce said message signal upon the occurrence of said particular one of said code signals, said control means including frequency responsive circuit means tuned to the frequency of said particular code signal and having means for providing a constant voltage at the output of said frequency responsive circuit means in response to the presence of said particular code signal frequency, rectifier means connected to the output of said frequency responsive circuit means, and a high resistance path connecting the output of said rectifier means to transducer means, and

e. each of said receivers including first and second speaker means connected to the output thereof and wherein said apparatus includes means responsive to the presence of said message signal and to the operation of said control means for disconnecting one of said first or second speaker means from the output of said receiver for the duration of said message signal.

2. Apparatus according to claim **1** wherein each of said receivers includes a first filter means for passing said program signal and rejecting said message signal, second filter means for passing said message signal and rejecting said program signal, switching means being connected in controlled relation to said control means for placing one of said filter means into operation in said receiver in response to the operation of said control means.

3. Apparatus according to claim 2 wherein said first filter means normally is in operation in said receiver and wherein said switching means removes said first filter means from operation and places said second filter means into operation in said receiver in response to the operation of said control means.

4. Apparatus according to claim 1 wherein the duration of each of said code signals is relatively much shorter than the duration of said message signals and wherein said control means includes holding circuit means for maintaining operation of said control means in response to the presence of said message signal and for the duration of said message signal.

5. Apparatus according to claim 1 wherein said control means includes timing means whereby the duration of said code signal must be greater than the time constant of said timing means for operation of said control means to be maintained.

6. In a radio broadcasting system wherein a transmitter transmits a program signal on one channel, periodic message signals on another channel, and a plurality of code signals of different frequencies and occurring in time at the beginning of selected ones of the message signals, a radio receiver comprising:

a. means for detecting the program, message and code signals;

b. means for audibly reproducing the program and message signals;

c. first filtering means connected to said reproducing means for passing the program signal and rejecting the message signal;

d. second filtering means connected to said reproducing means for passing the message signal and rejecting the program signal;

e. switching means for connecting either of said first or second filtering means to said detecting means; and

f. frequency responsive control circuit means including a resonant circuit having an input and an output and tuned to the frequency of a particular one of said code signals, means for connecting the input of said resonant circuit directly to the output of said receiver detecting means, transducer means having an output operatively connected to said switching means, said control circuit means having means coupling the output of said resonant circuit to said transducer means with a horizontal frequency response at the frequency of said particular code signal so that the signal applied to said control circuit means must correspond in frequency precisely with the frequency to which said resonant circuit is tuned in order to operate said transducer means thereby causing movement of said switching means from said first filtering means to said second filtering means in response to the presence of only said particular one of said code signals.

7. A radio receiver according to claim 6 wherein said switching means normally connects the output of said detecting means to the input of said first filter means and is moved to the input of said second filter means in response to the operation of said control circuit means.

8. A radio receiver according to claim 6 wherein the duration of each of said code signals is relatively much shorter than the duration of said message signals and wherein said control circuit means includes holding circuit means coupled to said reproducing means for maintaining operation of said control circuit means for the duration of said message signal.

9. A radio receiver according to claim 6 wherein said control circuit means includes timing means whereby the duration of said code signal must be greater than the time constant of said timing means for operation of said control means to be maintained.

10. A radio receiver according to claim 6 including first and second speaker means connected to the output thereof and further including means responsive to the presence of said message signal and to the operation of said control circuit means for disconnecting one of said first or second speaker means from the output of said receiver for the duration of said message signal.

11. A radio receiver according to claim 6 wherein said means coupling the output of said resonant circuit to said transducer means comprises:

a. first amplifier means having an input and an output;

b. means including a variable capacitor for connecting the output of said resonant circuit to the input of said amplifier;

c. rectifier means coupled to the output of said amplifier means;

d. second amplifier means having an input and having an output connected to said transducer means; and

e. a high resistance path connecting said rectifier means to said input of said second amplifier means.

12. In a radio broadcasting system wherein a receiver includes first and second transmission means to be in operation during corresponding first and second modes of reception and switching means for connecting the receiver detecting means selectively to either of said transmission means, a control circuit for operating said switching means in response to the reception of a particular code signal, said control circuit comprising:

a. a resonant circuit having an input and an output and tuned to the frequency of said particular code signal;

b. means connecting the input of said resonant circuit to the output of said receiver detecting means;

c. first amplifier means having an input and an output;

d. means including a variable capacitor for connecting the output of said resonant circuit to the input of said amplifier;

e. rectifier means coupled to the output of said amplifier means;

f. second amplifier means having an input and an output;

g. a high resistance path connecting said rectifier means to said input of said second amplifier means;

h. capacitive timing means connected to the input of said second amplifier means whereby the duration of said code signal must be greater than the time constant of said timing means for operation of said control circuit to be maintained;

i. means for coupling said output of said second amplifier means to said switching means whereby the latter is moved in response to operation of said second amplifier means; and

j. holding circuit means coupled to one of said first and second transmission means and to the input of said second amplifier means for maintaining operation of said control circuit for the duration of one of said modes of reception upon cessation of said code signal.

13. A control circuit according to claim 12 wherein said means connecting the input of said resonant circuit to the output of said detecting means comprises the series combination of first and second diodes connected in opposed relation.

14. A control circuit according to claim 12 wherein said first amplifier means comprises a triode, wherein said means including said variable capacitor is connected between said resonant circuit and the grid of said triode, and wherein said means further comprises a fixed capacitor connected to said variable capacitor and means connecting the junction of said fixed capacitor and said variable capacitor to the cathode of said triode.

15. In a radio broadcasting system wherein a receiver includes first and second transmission means to be in operation during corresponding first and second modes of reception and switching means for connecting the receiver detecting means selectively to either of said transmission means, a control circuit for operating said switching means in response to the reception of a particular code signal, said control circuit comprising:

a. a resonant circuit having an input and an output and tuned to the frequency of said particular code signal;

b. means including a variable capacitor connecting the input of said resonant circuit to the output of said receiver detecting means;

c. a field effect transistor having a gate terminal and an output terminal, said gate terminal being connected to the output of said resonant circuit;

d. amplifier means having an input and an output, said input being connected to said transistor output terminal,

e. rectifier means coupled to the output of said amplifier means;

f. transducer means having an input and an output;

g. a high resistance path connecting said rectifier means to said input of said transducer means; and

h. means for coupling said output of said transducer means to said switching means whereby the latter is moved in response to a signal on said input of said transducer means.

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