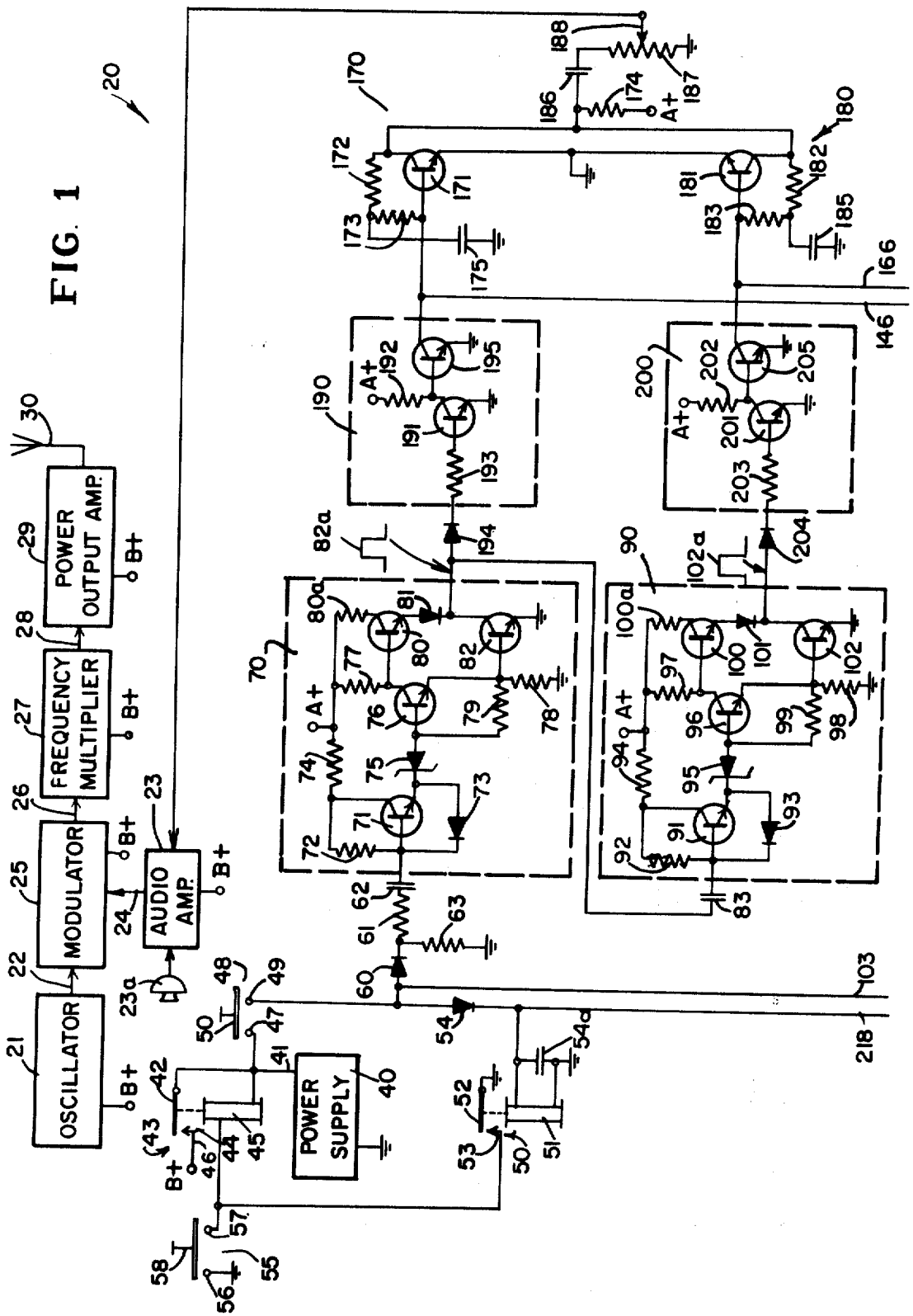
Sept. 10, 1974 K. H. WYCOFF Re. 28,157

TRANSMITTER WITH MEANS FOR GENERATING THE CARRIER WAVE BEFORE GENERATING THE MODULATION COMPONENTS

Original Filed March 3, 1970

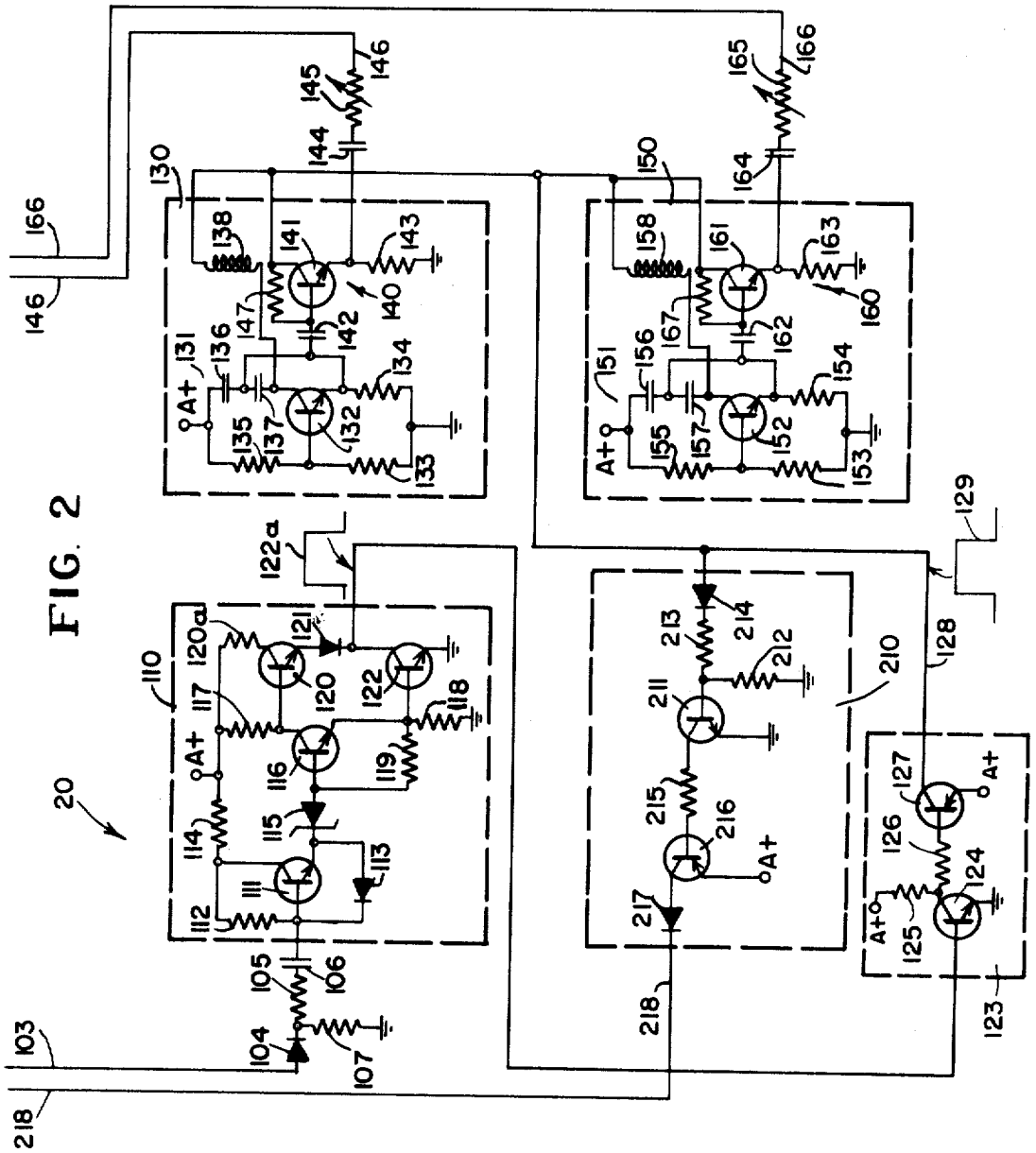
2 Sheets-Sheet 1

FIG. 1



Sept. 10, 1974 K. H. WYCOFF Re. 28,157
TRANSMITTER WITH MEANS FOR GENERATING THE CARRIER WAVE
BEFORE GENERATING THE MODULATION COMPONENTS
Original Filed March 3, 1970 2 Sheets-Sheet 2

FIG. 2



United States Patent Office

Re. 28,157
Reissued Sept. 10, 1974

28,157

TRANSMITTER WITH MEANS FOR GENERATING THE CARRIER WAVE BEFORE GENERATING THE MODULATION COMPONENTS

Keith H. Wycoff, P.O. Box 308,
Lexington, Nebr. 68850

Original No. 3,619,784, dated Nov. 9, 1971, Ser. No. 16,037, Mar. 3, 1970. Application for reissue Jan. 31, 1972, Ser. No. 222,390

Int. Cl. H04b *1/02*

U.S. Cl. 325—155 19 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

There is disclosed an electronic switching device having a transmitter-energized position for coupling a source of operating voltage to a carrier-wave-generating circuit, a further switch coupled to the electronic switch having one position causing the electronic switch to be placed in its transmitter-energized position, a control circuit which provides energizing signals when the further switch is placed in its first position and then in its second position, which energizing signals cause a circuit to generate information for modulation on the carrier wave, a holding circuit which, in the presence of the energizing signals, maintains the energizing switch closed despite placement of the further switch in its second portion.

The present invention relates to communication transmitters wherein the information is frequency modulated on a carrier wave.

It is an important object of the present invention to provide a transmitter wherein the carrier wave is generated prior to any information being generated.

Another object of the present invention is to provide an improved transmitter for use in a selective calling communication system, which transmitter first generates a carrier wave and thereafter modulates the carrier wave with at least one control tone to unsquelch a selected receiver.

Yet another object of the present invention is to provide a transmitter for use in a selective calling communication system, which transmitter generates a sequence of control tones, the overall duration of which is minimized.

Still another object of the invention is to provide a transmitter for use in a selective calling communication system, wherein transmission of the entire control tone or tone is insured.

Another object of the invention is to provide a transmitter with an manually operated spring-[loaded] loaded switch, actuation of which switch causes a carrier wave to be generated and release of which switch causes at least one control tone to be generated and modulate the carrier wave.

Another object of the invention is to provide a control system for use in a selective calling transmitter which causes the tone or tones to be generated thereby to be of constant duration independently of the warmup and other characteristics of the circuit which generates the carrier wave.

Still another object of the invention is to provide an electronic switching device for coupling the source of operating voltage to a carrier-wave-generating circuit, a further switch coupled to the electronic switch which, when actuated, places the electronic switch in its transmitter-energized position, and a control circuit which provides energizing signals for actuating an information-generating circuit upon placement of the further switch in its first position and thereafter in its second position.

In connection with the foregoing object, it is another object of the invention to provide a holding circuit coupled to the control circuit and to the electronic switch and responsive to the energizing signals to maintain the electronic switch closed, desite its being in its second position.

Yet another object of the present invention is to provide first and second tone-generating circuits for a selective calling transmitter, a switch which, when operated causes an operating voltage to be applied to a carrier-wave-generating circuit, a first pulse generator responsive to the placement of the switch in one position and thereafter in its other position to provide a first pulse of limited duration for actuating the first tone-generating circuit, a second pulse generator responsive to the termination of the first pulse to provide a second pulse to actuate the second tone-generating circuit.

In connection with the foregoing object, it is another object of the invention to provide a third pulse generator responsive to the placement of the switch in the one position and thereafter in the other position to provide a third pulse having a duration at least equal to the combined duration of the first and second pulses and commencing substantially with commencement of the first pulse.

Further features of the invention pertain to the particular arrangement of the elements of the transmitter and the component circuits thereof, wherebythe above-outlined and additional operating features thereof are attained.

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

FIG. 1 and 2 are partially schematic and partially block diagrams of a transmitter made in accordance with and embodying the principles of the present invention.

Referring now to FIGS. 1 and 2 of the drawings, there is shown a communication transmitter **20** made in accordance with and embodying the principles of the present invention. The transmitter **20** is adapted to generate an RF carrier wave modulated selectively by audio signals and one or more control tones. Basically, the transmitter **20** is for use in a selective calling communication system which comprises, in addition to the transmitter, a number of receivers, all capable of processing the same frequency carrier wave. Each receiver is squelched in its standby condition and is automatically unsquelched with a carrier wave modulated by the proper control tone or set of control tones for which that receiver is designed. Each receiver will respond to a different control tone or set of control tones, whereby the operator at the transmitter can call a selected receiver without energizing any of the other receivers. In a communication system equipped to transmit and receive voice, the operator at the transmitter, wishing to communicate with a specific receiver or receiver, selects the proper set of control tones for that receiver, which tones are modulated on the carrier wave. The selected receiver will become unsquelched, whereupon the operator can actuate the push-to-talk switch and speak into the microphone. The sounds, of course, are converted into audio signals which are modulated on the carrier wave, the modulated carrier wave being processed by the selected receiver and reconverted to sound waves.

In such selective calling communication systems, it is desirable that the time consumed by transmitting the control tones be minimized in order to maximize the time available for information transmission and minimize annoyance to people listening to the channel. Thus, if, for example, the particular selective calling communication system operates

on the transmission of two control tones transmitted in sequence, the duration of each control tone should be as short as possible, and, at the ame time, the tones should be long enough to insure that they will render operable the selected receiver. In the past, it has been found that, when the operator actuates the push-to-talk switch, the simultaneous generating of the carrier wave and the control tones causes an initial portion of the first control tone to be lost because the carrier wave had not yet been fully on. In order to overcome this, the duration of the first control tones was increased to such an extent that, even if its initial portion was lost when the carrier wave was generated, there would be enough left of the first control tone to energize properly the selected receiver. This, however undesirably prolonged the duration of the first control tone. Another often-used practice is to delay commencement of the first control tone until the carrier wave was fully on. However, this, too, undesirably postponed the time at which the tones ceased. Moreover, the time at which the carrier wave was generated would, of course, vary in different types of transmitters, particularly between transistorized and tube-type sets, and even would vary from transmitter to transmitter with the same design. The invention herein disclosed insures that the carrier wave will be fully on before the control tones are modulated thereon and enables the entire control tone to be modulated on the carrier wave independently of the time at which the carrier wave is produced.

The portion of the transmitter **20** shown in FIG. 1 includes an oscillator **21** which develops on its output conductor **22** a relatively low frequency oscillatory signal. An audio amplifier **23** has its output coupled though a conductor **24** to a first input of a modulator **25**, the second input thereof being coupled along the conductor **22** from the oscillator **21**. The signals on the conductor **24**, which may be either audio signals produced by conversion of sound waves applied to a microphone **23a** or the control tones, are modulated by the modulator **25** onto the relatively low frequency oscillatory signal. The modulated oscillatory signal is applied along the conductor **26** to a frequency multiplier **27** which increases the frequency of the oscillatory signal. The relatively high frequency signal is applied along a conductor **28** to a power output amplifier **29** where the signal strength is increased, thereby to provide a high level, frequency-multiplied carrier wave which is emitted from an antenna **30**.

The transmitter **20** also comprises a power supply **40** which, in a stationary transmitter, is supplied by a conventional 117-volt 60-cycle AC source, and which, in a mobile transmitter, is typically supplied from batteries or a portable generator. The power supply **40** has an output conductor **41** coupled to one contact **42** of a relay **43**, which relay **43** has a second contact **44** and a winding **45**. The relay **43** is energized, in a manner to be presently described, to close the contacts **42** and **44**, which provides on the conductor **46** a B+ operating voltage for the various elements of the transmitter **20**, including, but not limited to, the oscillator **21**, the audio amplifier **23**, the modulator **25**, the frequency multiplier **27**, and the power amplifier **29**. The conductor **41** is also coupled to one of the fixed contacts **47** of a manually operable switch **48**, which switch also includes a second fixed contact **49** and a movable contact **50** that is spring biased away from the contacts **47** and **49**.

There is also provided a second relay **50** having a winding **51** and a pair of contacts **52** and **53**. The winding **51** is coupled between ground reference potential and the cathode of a diode **54**, the anode of the diode **54** being coupled to the contact **49** of the switch **48**. The contact **52** is coupled to ground reference potential and the contact **53** is coupled to the other end of the winding **45**. A capacitor **54a** is coupled across the winding **51**. There is also provided a second manually operable switch **55** which, as will presently be described, constitutes a push-to-talk switch. The switch **55** includes a pair of fixed contacts **56** and **57** respectively coupled to ground reference potential and to the winding **45**, the switch **55** also including a movable contact **58** which is spring biased away from the contacts **56** and **57**.

In use, the power supply **40** is energized by actuating the main on-off switch (not shown) to provide the operating voltage on the conductor **41**. Closure of the manually operable switch **48** causes current to flow through the diode **54** and the winding **51**, thereby to energize the relay **50** and cause closure of the contacts **52** and **53**. This completes a circuit from the conductor **41** through the winding **45** of the relay **43** and the contacts **52** and **53** of the relay **50**, to ground reference potential, whereby current flows through the winding **45** to cause closure of the contacts **42** and **44** to supply B+ operating voltage on the conductor **46**. This operating voltage is used, as previously explained, to power the various stages in the transmitter **20**. If the manually operable switch **55** is actuated, this, too, will complete a circuit for the winding **45** to cause closure of the contacts **42** and **44** to provide operating voltage on the conductor **46**. It should be understood that each of the relays **43** and **50** constitutes an electronic switching device wherein the windings **45** and **51** constitute control elements. By supplying a voltage to these control elements, the contacts associated therewith may be closed. There are other electronic switching means which may be used, such as, for example, a silicon-controlled rectifier, wherein the control element would be the control electrode.

The junction between the contact **49** of the switch **48** and the anode of the diode **54** is coupled through a diode **60**, a resistor **61** and a capacitor **62** to a first pulse generator **70**. The junction of the resistor **61** and the cathode of the diode **60** is coupled to a resistor **63** which, in turn, is coupled to ground reference potential. The pulse generator **70** includes a first NPN-transistor **71**, with a resistor **72** coupled between the collector and base thereof. A diode **73** is coupled between the emitter and base of the transistor **71**, the collector thereof being coupled through a resistor **74** to an operating voltage designated by A+ which is derived from the power supply **40**, as soon as the main switch is turned on. The emitter of the transistor **71** is coupled by way of a zener diode **75** to the base of a second NPN-transistor **76**, the collector of which is coupled through a resistor **77** to the A+ operating voltage, and the emitter of which is coupled by way of a resistor **78** to ground reference potential. A resistor **79** is coupled between the base and emitter of the transistor **76**. A third NPN-transistor **80** has its base coupled to the collector of the transistor **76**, its collector coupled to the A+ operating voltage by means of a resistor **80a**, and its emitter coupled through a diode **81** to the collector of a fourth NPN-transistor **82**. The base of the transistor **82** is coupled to the junction of the resistors **78** and **79**, and the emitter is coupled to ground reference potential.

The output of the first pulse generator **70** is coupled by way of a capacitor **83** to a second pulse generator **90**, which has precisely the same construction as the pulse generator **70**, with corresponding elements being labeled with the same reference numerals with **20** added thereto. In the interest of brevity, further detailed description of the construction of the pulse generator **90** will be omitted.

In operation, actuation of the manually operable switch **48**, in addition to providing the B+ operating voltage for the transmitter components on the conductor **46**, also provides a voltage at the junction of the contact **49** of the switch **48** and the diode **54**. This voltage is applied through the diode **60** which is forward biased thereby so as to present a relatively low impedance. The diode **60** thus defines a charging means for rapidly charging the capacitor **62**, it being understood that the resistor **61** has a relatively small value and does not signifi-

cantly influence the charge time of the capacitor **62**. Upon release of the movable contact **50** of the manually operable switch **48**, the voltage applied to the diode **60** is removed, whereby the capacitor **62** now discharges relatively slowly through the resistor **63** and through several resistors in the generator **70**, including the path defined by the resistors **72** and **74** and the path defined by the resistors **77** and **78**, all of which resistors accordingly define a discharge means. The action just described produces at the output of the capacitor **62** for application to the first pulse generator **70** a negatively directed pulse. The turning on of the main switch (not shown) of the power supply **40** causes the transistors **71**, **76**, and **82** to be rendered conductive and the transistor **80** to be rendered nonconductive. The pulse during the discharge of the capacitor **62** renders nonconductive the transistor **71** which, in turn, renders transistors **76** and **82** nonconductive and transistor **80** conductive. Thus, a positively directed pulse **82a** appears at the collector of the transistor **82** which defines the output of the first generator **70**. The leading edge of the pulse **82a** occurs at the time that the capacitor **62** starts to discharge slowly, and the trailing edge of the pulse **82a** occurs at some point during that discharge. It should be apparent that the capacitor **62** and the resistors **63**, **72**, **74**, **77**, and **78** define a time constant network, the values of which control the duration of the pulse **82a**. In other words, by increasing the value of the capacitor **62** and/or these resistors, the discharge time may be increased so as to increase the duration of the pulse **82a**.

The pulse **82a** is applied to the capacitor **83**, which capacitor charges rapidly at the beginning of the pulse **82a**. Upon termination of the *pulse* **82a**, a negative pulse is developed for application to the second pulse generator **90**. As was the case with the pulse generator **70**, the transistors **91**, **96**, and **102** are normally conductive, and the transistor **100** is nonconductive. The application of the negative pulse renders the transistors **96** and **102** nonconductive and renders the transistor **100** conductive to produce a pulse **102a** on the collector of the transistor **102**, which defines the output of the second pulse generator **90**. The leading edge of the pulse **102a** coincides with the trailing edge of the pulse **82a**. The duration of the pulse **102a** is controlled by the value of the capacitor [**103**] *83* and the resistance provided by the resistors **92**, **94**, **97**, and **98**, these resistors therefore defining a discharge means. It should be noted that the discharge path is through the collector and emitter of the transistor **122**, whereas the discharge path for the capacitor **106** was completed through the resistor **107**.

There is provided a third pulse generator **110** which is shown in FIG. 2, the pulse generator **70** and havcisely the same construction as the generator **70** and having its components labeled with corresponding numerals with **40** added thereto. In the interest of brevity, further detailed description of the third pulse generator **110** will therefore be omitted. The junction of the contact **49** of the switch **48** and the diode **54** is also coupled by way of a conductor **103** through a diode **104**, resistor **105**, and a capacitor **106** to the third pulse generator **110**. A resistor **107** is coupled to the junction of the diode **104** and the resistor **105** and is also coupled to ground reference potential. The appearance of the operating voltage on the conductor **103**, as a result of the actuation of the switch **48**, causes the capacitor **106** to charge, which charging occurs rapidly since the diode **104** is forwardly biased, it being understood that the value of the resistor **105** is such as to affect negligibly the charging time. Thus, the diode **104** provides a means for rapidly charging the capacitor **106**. Upon release of the switch **48** and the consequent removal of the voltage on the conductor **103**, the capacitor **106** slowly *discharges* [discharged] through the resistors **105** and **107** and through the paths defined by the resistors **112**, **114** and **117**, **118**, whereby these resistors define a slow discharge means. Accordingly, there is produced a negatively directed pulse which will render inoperative the transistor **111** in the third pulse generator **110**, which, in turn, renders the transistors **116** and **122** therein nonconductive and the transistor **120** conductive. There is produced on [the conductor **123**, which is coupled to] the collector of the transistor **122**, a pulse **122a**, the duration of which is controlled by the time for discharging the capacitor **106**. The values of the capacitor **106** and the resistors **107**, **112**, **114**, **117** and **118** are selected, such that the duration of the pulse **122a** is at least about equal to the combined durations of the pulses **82a** and **102a**. Because of the concurrence of the leading edges of the negative pulses applied to the generators **70** and **110**, the pulses **82a** and **122a** commence at the same point in time.

In an operative form of this invention, the first, second, and third pulse generators **70**, **90**, and **110** are part of a single integrated circuit.

The output from the third pulse generator **110** is coupled to a switching circuit **123** which includes an NPN-transistor **124** having its emitter grounded and its collector coupled through a resistor **125** to the A+ operating voltage. The collector of the transistor **124** is coupled through a resistor **126** to the base on a PNP-transistor **127**, the emitter of which is coupled to the A+ operating voltage and the collector of which is coupled to a conductor **128**. The pulse **122a** renders conductive the transistor **124** which, in turn, renders conductive the transistor **127** for the duration of the pulse, whereby there appears on the conductor **128** a pulse **129** having a duration equal to the duration of the pulse **122a** and commencing and terminating respectively at the same times.

Continuing the reference to FIG. 2, the transmitter **20** further comprises a first tone-generating circuit **130** which includes an oscillatory portion **131**, the oscillatory [circuit] *portion* **131** being of standard construction and including an NPN-transistor **132** having its base coupled to a resistor **133** to ground reference potential and its emitter coupled through a resistor **134** to ground reference potential. A resistor **135** coupled from the A+ operating voltage to the base of the transistor **132** provides a biasing voltage thereon. A pair of capacitors **136** and **137** is coupled in series between the collector of the transistor **132** and the A+ operating voltage. There is provided a connection between the emitter of the transistor **132** and the junction of the capacitors **136** and **137**. A coil **138** couples the collector of the transistor **132** to the conductor **128**. The tone-generating circuit **130** also includes a first stage of amplification **140** having an NPN-transistor **141** with its base coupled, by way of a capacitor **142**, to the emitter of the transistor **132**, the emitter of the transistor **141** being coupled through a resistor **143** to ground reference potential. A capacitor **144** and a potentiometer **145** are coupled in series between the emitter of the transistor **141** and the conductor **146**. *There is provided a biasing resistor 147 connected between the collector and the base of the transistor 141, the collector of the transistor 141 being coupled directly to the conductor 138 on which the supply voltage appears.*

In operation, turning on the power supply **40** causes the oscillatory portion **131** to produce an oscillatory signal, the frequency of which is determined by the values of the capacitors **136** and **137** and the coil **138**. In an operative embodiment of the invention, the coil **138** had a plurality of taps thereon and, by proper selection of the taps, the amount of inductance furnished by the coil **138** and, thus, the frequency of the oscillatory signal can be varied. The oscillatory signal is coupled through the capacitor **142** and is amplified by the stage **140** to provide an oscillatory signal on the conductor **146**, and, by adjusting the potentiometer **145**, the amplitude of the signal can be selected.

There is also provided a second tone-generating circuit **150** which has the same construction, except for certain parts values, corresponding parts being labeled with the

same reference numerals with **20** added thereto. In operation, turning on the power supply **40** causes the oscillatory portion **151** to produce an oscillatory signal, the frequency of which is determined by the values of the capacitors **156** and **157** and the coil **158**. In an operative embodiment of the invention, the coil **158** had a plurality of taps thereon and by proper selection of the taps, the amount of inductance furnished by the coil **158** and, thus, the frequency of the oscillatory signal can be varied. The oscillatory signal is coupled through the capacitor **162** and is amplified by the stage **160** to provide an oscillatory signal on the conductor **166**, and, by adjusting the potentiometer **165**, the amplitude of the signal can be selected.

The oscillatory signal on the conductor **146** is coupled to a second stage of amplification **170**, which stage includes an NPN-transistor **171** having a pair of biasing resistors **172** and **173** coupled in series between the collector and base thereof. The emitter is coupled to ground reference potential, and the collector is coupled through a load resistor **174** to the A+ supply voltage. The junction of the resistors **172** and **173** is coupled through a decoupling capacitor **175** to ground. Similarly, the oscillatory signal on the conductor **166** is coupled to a further stage of amplification **180**, including a transistor **181** having a pair of biasing resistors **182** and **183** coupled in series between the base and collector thereof, the junction of those resistors being coupled through a decoy by capacitors **185** to ground. The emitter of the transistor **181** is coupled to ground reference potential, and the collector is coupled to common load resistor **174**. There is also provided a capacitor **186** and a potentiometer **187** coupled in series between the load resistor **174** and ground reference potential, the movable arm **188** of the potentiometer **187** being coupled to a second input of the audio amplifier **23**.

Associated with the amplifier stage **170** is a biasing network **190** including a first normally nonconductive NPN-transistor **191** having its emitter grounded, its collector coupled through a resistor **192** to the A+ operating voltage and its base coupled through a resistor **193** and a diode **194** to the output of the first pulse generator **70**. The biasing network **190** also includes a second normally conductive NPN-transistor **195** having its base coupled to the collector of the transistor **191**, its emitter grounded, and its collector coupled to the base of the transistor **171**. The transistor **195** is rendered conductive by virtue of the current flowing through its base-emitter junction through the resistor **192**, whereby there is effectively a low impedance between the collector of the transistor **195** and ground. Accordingly, the base of the transistor **171** is effectively grounded, and no signal applied thereto can be amplified thereby. The pulse **82**a, which is generated by the pulse generator **70**, is coupled through the diode **194** and the resistor **193** to render conductive the normally nonconductive transistor **191**, whereby current flow is diverted from the transistor **195** through the collector and the emitter of the transistor **191**. This substantially increases the impedance between the collector and the emitter of the transistor **195** effectively to unground the base of the transistor **171** to enable the oscillatory signal from the first tone-generating circuit **130** applied to the stage **170** to be amplified thereby.

Associated with the amplifier stage **180** is a biasing network **200** including a first normally nonconductive NPN-transistor **201** having its emitter grounded, its collector coupled through a resistor **202** to the A+ operating voltage and its base coupled through a resistor **203** and a diode **204** to the output of the second pulse generator **90**. The biasing network **200** also includes a second normally conductive NPN-transistor **205** having its base coupled to the collector of the transistor **201**, its emitter grounded, and its collector coupled to the base of the transistor **181**. The transistor **205** is rendered conductive by virtue of the current flowing through its base-emitter junction through the resistor **202**, whereby there is effectively a low impedance between the collector of the transistor **205** and ground. Accordingly, the base of the transistor **181** is effectively grounded, and no signal applied thereto can be amplified thereby. The pulse **102**a, which is generated by the pulse generator **90**, is coupled through the diode **204** and the resistor **203** to render conductive the normally nonconductive transistor **201**, whereby current flow is diverted from the transistor **205** through the collector and the emitter of the transistor **201**. This substantially increases the impedance between the collector and the emitter of the transistor **205** effectively to unground the base of the transistor **181** to enable the oscillatory signals from the second tone-generating circuit **150** applied to the stage **180** to be amplified thereby.

Finally, the transmitter **20** comprises a holding circuit **210**, which holding circuit includes an NPN-transistor **211** having its base coupled through a resistor **212** to ground reference potential and its emitter coupled to ground. The base of the transistor **211** is also coupled through a resistor **213** and a diode **214** to the output of the switching circuit **123**. The collector of the transistor **211** is coupled through a resistor **215** to the base of a PNP-transistor **216**, the emitter of which is coupled to the A+ operating voltage. The collector of the transistor **216** is coupled through a diode *217* to a conductor **218** which is connected to the cathode of the diode **54**.

In operation, the transistors **211** and **216** are normally nonconductive. The pulse **129** produced in response to the pulse **122**a from the pulse generator **110** is of positive polarity and is coupled through the diode **214** and the resistor **213** to render conductive the transistor **211**. Current flows from the A+ operating voltage through the base-emitter junction of the transistor **216** through the resistor **215** and the collector and the emitter of the transistor **211**. Current will accordingly flow through the emitter and the collector of the transistor **216** through the diode **217** and through the relay winding **51** to close the contacts **52** and **53**. Thus, current continues to flow through the winding **45** to maintain the contacts **42** and **44** closed and provide the B+ operating voltage on the conductor **46**, even after the manually operable switch **48** has been opened. During the very short period between the time the switch **48** is opened and the time a voltage output from the holding circuit **210** is derived, the winding **51** remains energized to maintain the supply of the B+ operating voltage to the transmitter *20* [**30**] and thereby continue generating the carrier wave, by virtue of the charge developed across the capacitor **54**a when the switch **48** was closed.

Describing now the overall operation of the transmitter **20**, the operator first determines what receiver is to be called. Assuming that the selective communication calling system with which this transmitter **20** is used functions with a sequence of two control tones, the operator programs the tone-generating circuits **130** and **150** respectively to produce the two control tones to which the selected receiver responds. As previously explained, this selection process may be accomplished by choosing taps on the coils **138** and **158** respectively in the tone-generating circuits **130** and **150**. Thus, when the tone-generating circuits **130** and **150** are energized, they will produce oscillatory signals respectively at the selected frequencies.

The operator then depresses the movable contact **50** of the switch **48**, which, as previously explained, completes the circuit through the winding **51** to close the contacts **52** and **53**. This completes a circuit for the winding **45** to close the contacts *42* [**43**] and **44** and thereby provide an operating voltage for the various components of the transmitter **20**, particularly, the oscillator **21**, the frequency multiplier **27**, and the power output amplifier **29** which together define a carrier wave generating circuit. The application of the B+ operating voltage thus causes a carrier wave to be generated.

Also, the actuation of the switch **48**, as previously explained, rapidly charges the capacitor **62** which feeds the first pulse generator **70** and also rapidly charges, through the conductor **103**, and capacitor **106** which feeds the third pulse generator **110**. Usually, the operator depresses the movable contact **50** of the switch **48** momentarily and then releases the same, thereby to remove the plus voltage and enable slow discharge of the capacitor **62**. The values of the capacitor **62** and the resistor **63** are selected to cause the duration of the pulse **82**a at the output of the generator **70** to be equal to the desired duration of the first control tone. The effective short-circuit placed on the base of the transistor **171** by the biasing network **190** is effectively removed by the application of the pulse **82**a for the duration thereof. Also, the pulse **82**a is applied to the second tone generator **90** which, as previously explained, produces a positively directed pulse **102**a commencing with the termination of the pulse **82**a. The short circuit on the base of the transistor **181** in the amplifier stage **180** furnished by the biasing network **200** is removed by the application thereto of the pulse **102**a. Thus, the amplifier stage **170** which is normally inoperative becomes operative to amplify signals applied thereto for the duration of the pulse **82**a. Thereafter, the amplifying stage **170** again becomes inoperative, and the amplifier stage **180** becomes operative for the duration of the pulse **102**a to amplify signals applied thereto.

The plus voltage at the contact **49** of the switch **48**, applied by way of the conductor **103**, rapidly charges the capacitor **106**, which is then discharged upon release of the movable contact **50**. The negative pulse created thereby is applied to the third pulse generator **110** which, as previously explained, produces a pulse **122**a. The values of the capacitor **106** and the resistor **107** are selected to cause the duration of the pulse **122**a to be equal to or slightly greater than the combined durations of the pulses **82**a and **102**a. The pulse **122**a is applied [along the conductor **123**] to the tone generator circuits **130** and **150** to render them operative to produce at the outputs thereof respectively the first and second control tones. The control tones are applied by way of conductors **146** and **166** respectively to the amplifier stages **170** and **180**. Because the amplifier stage **170** is operative only for the duration of the pulse **82**a, a control tone will be amplified by the stage **170** and applied to the capacitor **184** for the duration of the pulse **82**a. Immediately upon termination of the pulse **82**a, the amplifier stage **170** becomes inoperative and the stage **180** becomes operative to amplify the second control tone from the generating circuit **150** for the desired duration of the second control tone. Of course, the tone-generating circuits **130** and **150** were operative for the entire duration of the pulse *122a* [**122**]. Thus, there is provided across the potentiometer **187** a sequence of two control tones for application to the audio amplifier **23**, the amplitude of the control tones being selected by the setting of the movable arm **188**. In an operative form, each control tone was transmitted for 100 milliseconds.

It is desirable to apply the long duration pulse [**122**] *122a* to the oscillator portions **131** and **151** respectively in the pulse tone-generating circuits **130** and **150** to assure that the second control tone has reached full amplitude at the time the second amplifier stage **180** becomes operative. It should be appreciated that applying the pulses **82**a and **102**a respectively directly to the tone-generating circuits **130** and **150** would function in the desired manner, except it would take a few cycles to develop full amplitude, not only with respect to the first control tone, but also with respect to the second control tone.

The pulse **122**a applied to the holding circuit **210** causes a positive voltage to be applied along the conductor **218** to the relay winding **51** to cause current to flow therethrough and thus to maintain the B+ operating voltage on the conductor **46** for the duration of the pulse **122**a. Accordingly, the carrier wave continues to be generated despite the open condition of the switch **48**. The control tones are amplified in the audio amplifier **23** and are modulated on the oscillatory signal generated by the oscillator **21**. The oscillatory signal modulated by the control tones is increased in frequency by the frequency multiplier **27** and increased in amplitude by the power output amplifier **29** and radiated by the antenna **30**. The selected receiver is accordingly unsquelched. Upon completion of the control tones, the pulse **122**a will have terminated, thereby to deenergize the relay **50** and thus discontinue generation of the carrier wave. However, at this time the operator will normally actuate the push-to-talk switch **55** to cause continued production of the carrier wave as previously described. The operator will speak into the microphone **23**a, the sounds being converted into audio signals for modulation of the carrier wave. The rapid charging of the capacitors **62**, **83**, and **106**, which are respectively coupled to the inputs of the three pulse generators **70**, **90**, and **110** [permit] *permits* them to generate the pulses even if the operator closes the manually operable switch momentarily.

Thus, the operator causes the carrier wave to be generated by actuating the switch **48** and causes that carrier wave automatically to be modulated by the control tones upon release of the switch **48**. With such a construction, there is no chance that the carrier wave will not be fully on before the control tones are generated. The momentary actuation of the switch **48** insures that the entire sequence of control tones will be transmitted.

In an operative embodiment of the transmitter **20**, the various components thereof had the following values; resistor **61**, 2.2 kilohms; capacitor **62**, 3.3 microfarads; resistor **63**, 2.2 kilohms; resistors **72**, **92**, and **112**, 16 kilohms; resistors **74**, **94**, and **114**, 8 kilohms; resistors **77**, **97**, and **117**, 12 kilohms; resistors **78**, **98**, and **118**, 3 kilohms; resistors **79**, **99**, and **119**, 6 kilohms; resistors **80**a, **100**a, and **120**a, 2 kilohms; capacitor **83**, 3.3 microfarads; resistors **105**, **107**, 2.2 kilohms; resistor **125**, 100 kilohms; resistor **126**, 8.2 kilohms; capacitor **106**, 6.8 microfarads; capacitor **136**, 0.047 microfarads; capacitor **137**, 0.076 microfarads; coil **138**, 3 henries; capacitor **142**, 0.01 microfarads; resistor **133**, 8.2 kilohms; resistor **134**, 47 kilohms; resistor **135**, 22 kilohms; resistor **143**, 10 kilohms; capacitor **144**, 0.01 microfarads; potentiometer **145**, 150 kilohms; capacitor **156**, 0.047 microfarads; capacitor **157**, 0.012 microfarads; coil **158**, 0.75 henries; capacitor **162**, 0.01 microfarads; resistor **153**, 8.2 kilohms; resistor **154**, 47 kilohms; resistor **155**, 22 kilohms; resistor **163**, 10 kilohms; resistor **172**, 47 kilohms; resistor **173**, 220 kilohms; capacitor **164**, 0.01 microfarads; capacitor **185**, 0.01 microfarads; potentiometer **165**, 150 kilohms; capacitor **186**, 0.1 microfarads; potentiometer **187**, 5 kilohms; resistor **182**, 47 kilohms; resistor **183**, 220 kilohms; resistor **192**, 22 kilohms; resistor **193**, 100 kilohms; resistor **202**, 22 kilohms; resistor **203**, 100 kilohms; resistor **212**, 2.2 megohms; resistor **213**, 100 kilohms; resistor **215**, 10 kilohms.

What has been described, therefore, is an improved transmitter for use in a selective calling communication system which transmitter first generates a carrier wave and then modulates the carrier wave with one or more control tones and insures that the carrier wave is fully on before it is modulated.

While there has been described what is at present considered to be a preferred embodiment of the invention, it is understood that various changes and modifications can be made therein without departing from the spirit and scope of the invention, and it is intended that all such changes and modifications be covered as fall within the scope of the appended claims.

What is claimed is:

1. In a transmitter having a carrier-wave-generating circuit and an information-generating circuit and a modulator for modulating the carrier wave in accordance with the information, the combination comprising electronic first

switching means having a transmitter-energized position for coupling a source of operating voltage to the carrier wave generating circuit, second switching means coupled to said first switching means and having a first position to couple a voltage thereto for placement thereof in its transmitter-energized position and having a second position to isolate the voltage from said first switching means, a control circuit operatively coupled to said second switching means and responsive to the placement thereof in said first position and thereafter in said second position to provide energizing signals, said information-generating circuit being coupled to the output of said control circuit and being responsive to the application thereto of the energizing signals to generate information for modulation on said carrier wave, and a holding circuit operatively coupled to said control circuit and to said first switching means and responsive to the application of the energizing signals to maintain said first switching means in its transmitter-energized position despite said second switching means being in its second position, whereby movement of said second switching means to its first position causes said carrier-wave-generating circuit to generate said carrier wave and the subsequent movement of said second switching means to said second position causes said information-generating circuit to generate said information.

2. In the transmitter set forth in claim 1, wherein said electronic first switching means is a relay having a winding coupled to said second switching means and a pair of contacts respectively coupled to the source of operating voltage and the carrier-wave-generating circuit, the transmitter energized position occurring when said contacts are closed.

3. In the transmitter set forth in claim 1, wherein said second switching means is manually operable.

4. In the transmitter set forth in claim 1, wherein said second switching means is closed in said first position and is open in said second position.

5. In the transmitter set forth in claim 1, wherein said second switching means is manually operable and is spring loaded to said second position.

6. In the transmitter set forth in claim 1, wherein said control circuit is electrically coupled to said second switching means.

7. In the transmitter set forth in claim 1, wherein said holding circuit is electrically coupled to said control circuit.

8. In the transmitter set forth in claim 1, wherein said control circuit includes a capacitor, charging means coupled from said second switching means to said capacitor for rapid charge thereof when said second switching means is placed in said first position and then in *said* second position, discharge means coupled to said capacitor for slow discharge thereof while said second switching means is in its second position, and an electronic switch coupled to said capacitor and responsive to the rapid charge and slow discharge thereof to provide energizing pulses.

9. A transmitter comprising a carrier wave generating circuit, a first tone-generating circuit for generating a first control tone having a given frequency, a second tone-generating circuit for generating a second control tone having a different frequency, a modulator coupled to said tone-generating circuits and to said carrier wave generating circuit for modulating the carrier wave in accordance with the control tones, electronic first switching means having a transmitter energized position for coupling a source of operating voltage to said carrier wave generating circuit, second switching means coupled to said first switching means and having a first position to couple a voltage thereto for placement thereof in its transmitter energized position and having a second position to isolate the voltage from said first switching means, a first pulse generator operatively coupled to said second switching means and responsive to the placement thereof in its first position and thereafter in the second position to provide a first pulse having a first predetermined duration, said first tone-generating circuit being coupled to the output of said first pulse generator and being responsive to the application thereto of said first pulse for generating said first control tone for said first predetermined duration, a second pulse generator coupled to the output of said first [tone control circuit] *pulse generator* and responsive to the termination of said first pulse to provide a second pulse of a second predetermined duration, said second tone-generating circuit being coupled to the output of said second pulse generator and being responsive to the application thereto of said second pulse for generating said second control tone for said second predetermined duration, and a holding circuit operatively coupled to said pulse generators and to said first switching means and operative in the presence of said pulses to maintain said first switching means in its transmitter energized position despite said second switching means being in its second position, whereby movement of said second switching means to its first position causes said carrier-wave-generating circuit to generate said carrier wave and the subsequent movement of said second switching means to its second position causes said first and second tone-generating circuits respectively to generate said first control tone followed substantially immediately by said second control tone.

10. The transmitter set forth in claim 9, wherein said carrier-wave-generating circuit includes an oscillator for applying a given frequency oscillatory signal to said modulator, a frequency multiplier circuit coupled to the output of said modulator for increasing the frequency of the modulated oscillatory signal, and an amplifier circuit for increasing the level of the higher frequency modulated oscillatory signal.

11. The transmitter set forth in claim 9, wherein each tone-generating circuit includes an oscillator portion and an amplifier portion, one of said portions of each of said tone-generating circuits being inoperative and respectively coupled to said pulse generators, whereby the provision of said first pulse causes said one portion in said first tone-generating circuit to become operative to cause said first control tone to be generated, and whereby the subsequent provision of said second pulse causes the corresponding portion of said second tone-generating circuit to become operative to cause said second control tone to be generated.

12. The transmitter set forth in claim 9, wherein said first pulse generator includes a first capacitor, first charging means coupled from said second switching means to said first capacitor for rapid charge thereof when said second switching means is placed in said first position and then in said second position, first discharge means coupled to said first capacitor for slow discharge thereof, while said second switching means is in its second position, and a first electronic switch coupled to said first capacitor and responsive to the rapid charge and slow discharge thereof to provide said first pulse, said second pulse generator including a second capacitor, second charging means coupled from the output of said first pulse generator to said capacitor for rapid charge thereof upon termination of said first pulse, and said second discharge means coupled to said second capacitor for slow discharge thereof, and a second electronic switch coupled to said second capacitor and responsive to the rapid charge and slow discharge thereof to provide said second pulse.

13. A transmitter comprising a carrier-wave-generating circuit, a first tone-generating circuit for generating a first control tone having a given frequency, a second tone-generating circuit for generating a second control tone having a different frequency, a modulator coupled to said

tone-generating [circuit] *circuits* and to said carrier-wave-generating circuit for modulating the carrier wave in accordance with the control tones, electronic first switching means having a transmitter-energized position for coupling a source of operating voltage to said carrier-wave-generating circuit to generate the carrier wave, second switching means coupled to said first switching means and having a first position to couple a voltage thereto for placement thereof in its transmitter-energized position and having a second position to isolate the voltage from said first switching means, a first pulse generator operatively coupled to said second switching means and responsive to the placement thereof in its first position and thereafter in its second position to provide a first pulse having a first predetermined duration, said first tone-generating circuit being coupled to the output of said first pulse generator and being responsive to the application thereto of said first pulse to said first tone-generating circuit for generating said first control tone for said first predetermined duration, a second pulse generator coupled to the ouput of said first [tone control circuit] *pulse generator* and responsive to the termination of said first pulse to provide a second pulse of a second predetermined duration, said second tone-generating circuit being coupled to the ouput of said second pulse generator and being responsive to the application thereto of said second pulses for generating said second control tone for said second predetermined duration, a third pulse generator operatively coupled to said second switching means and responsive to the placement thereof in its first position and thereafter in its second position to provide a third pulse having a duration of at least about equal to the combined duration of said first and second pulses and commencing substantially with the commencement of said first pulse, and a holding circuit coupling the output of said third pulse generator to said first switching means and operative in the presence of said third pulse to maintain said first switching means in its transmitter-energized position despite said second switching means being in its second position, whereby movement of said second switching means to its first position causes said carrier-wave-generating circuit to generate said carrier wave and the subsequent movement of said second switching means to its second position causes said first and second tone-generating circuits respectively to generate said first control tone followed substantially immediately by said second control tone.

14. The transmitter set forth in claim **13**, wherein each tone-generating circuit includes a normally inoperative oscillator portion and a normally inoperative amplifier portion, one of said portions in said first tone-generating circuit being coupled to said first pulse generator so as to become operative for the duration of said first pulse, the other portion in said first tone-generating circuit being coupled to the output of said third pulse generator to become operative for the duration of said third pulse, the portion in said second tone-generating circuit corresponding to said one portion being coupled to said second pulse generator so as to become operative for the duration of said second pulse, the other portion in said second tone-generating circuit being coupled to the output of said third pulse generator to become operative for the duration of said third pulse.

15. The transmitter set forth in claim **13**, wherein each tone-generating circuit includes a normally inoperative oscillator portion and a normally inoperative amplifier portion, the amplifier portion in said first tone-generating circuit being coupled to said first pulse generator so as to become operative for the duration of said first pulse, the amplifier portion in said second tone-generating circuit being coupled to the output of said second pulse generator to become operative for the duration of said second pulse, the oscillator portion in each of said tone-generating circuits being coupled to the output of said third pulse

generator to become operative for the duration of said third pulse.

16. A transmitter comprising a carrier-wave-generating circuit, a microphone for converting sound applied thereto into audio signals, a tone-generating circuit for generating at least one control tone, an audio amplifier for receiving and amplifying the audio signals and the control tone, a modulator coupled to said audio amplifier and to the carrier-wave generating circuit for modulating the carrier wave in accordance with the audio signals and the control tone, first electronic switching means including a first control element and a pair of first terminals respectively coupled to a source of operating voltage and to said carrier-wave-generating circuit, second electronic switching means including a second control element and a pair of second terminals coupled in series with said first control element and a current source, a first manually operable switch coupled in series with said second control element and a current source, whereby closure of said first manually operable switch couples current through said second control element electrically to connect said second terminals to cause current to flow through said first control element electrically to connect said first terminals and to cause the operating voltage to be supplied to said carrier-wave-generating circuit, a control circuit electrically coupled to the second mentioned of said first pair of terminals and responsive to said first manually operable switch being sequentially closed and then opened to provide energizing signals, said tone-generating circuit being coupled to the output of said control circuit and being responsive to the application thereto of the energizing signals to generate the control tone for modulation on said carrier wave, and a holding circuit coupled to said control circuit and to said first electronic switching means and responsive to the application of the energizing signals for maintaining said first electronic switching means in its transmitter-energized position despite said *first* manually operable switch being opened, whereby movement of said first manually operable switch to its first position causes said carrier-wave-generating circuit to generate said carrier wave and the subsequent movement of said first manually operable switch to said second position causes said tone-generating circuit to generate said control tone, a second manually operable switch coupled in parallel with said pair of second terminals and having a closed position to cause current to flow through said first control element electrically to connect [four of] said first terminals to cause the operating voltage to be supplied to said carrier-wave-generating circuit, whereby closure of said second manually operable switch causes a carrier wave to be generated on which may be modulated audio signals induced in response to sounds applied to said microphone.

17. The transmitter set forth in claim **16**, wherein each of said electronic switching means is a relay having a winding which corresponds to said control element and a pair of contacts which correspond to said pair of terminals.

18. The transmitter set forth in claim **16**, wherein each of said manually operable switches is spring loaded to its open position.

19. In a transmitter having a carrier wave generating circuit and a power supply therefor and an information-generating circuit and a modulator for modulating the carrier wave in accordance with the information, the combination comprising switching means coupled to the power supply and having a first position to couple a voltage thereto for energization thereof and having a second position to isolate the voltage from the power supply, a control circuit operatively coupled to said switching means and responsive to the placement thereof in said first position and thereafter in said second position to provide energizing signals, said information generating circuit being cou-

pled to the output of said control circuit and being responsive to the application thereto of the energizing signals to generate information for modulation on said carrier wave, and a holding circuit operatively coupled to said control circuit and to the power supply and responsive to the application of the energizing signals to maintain the power supply energized despite said switching means being in its second position, whereby movement of said switching means to its first position causes said carrier wave generating circuit to generate said carrier wave and the subsequent movement of said switching means to said second position automatically continues transmission of the carrier wave and causes said information-generating circuit to generate said information.

References Cited

The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

UNITED STATES PATENTS

2,974,221	3/1961	Peth	325—64
3,496,467	2/1970	Lundgren	325—55 X
3,500,458	3/1970	Cannalte	325—169 X
3,513,399	5/1970	Wycoff	325—55 X

ALBERT J. MAYER, Primary Examiner

U.S. Cl. X.R.

325—152, 169; 340—171