

2,427,670

3 Sheets-Sheet 1



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Sept. 23, 1947.

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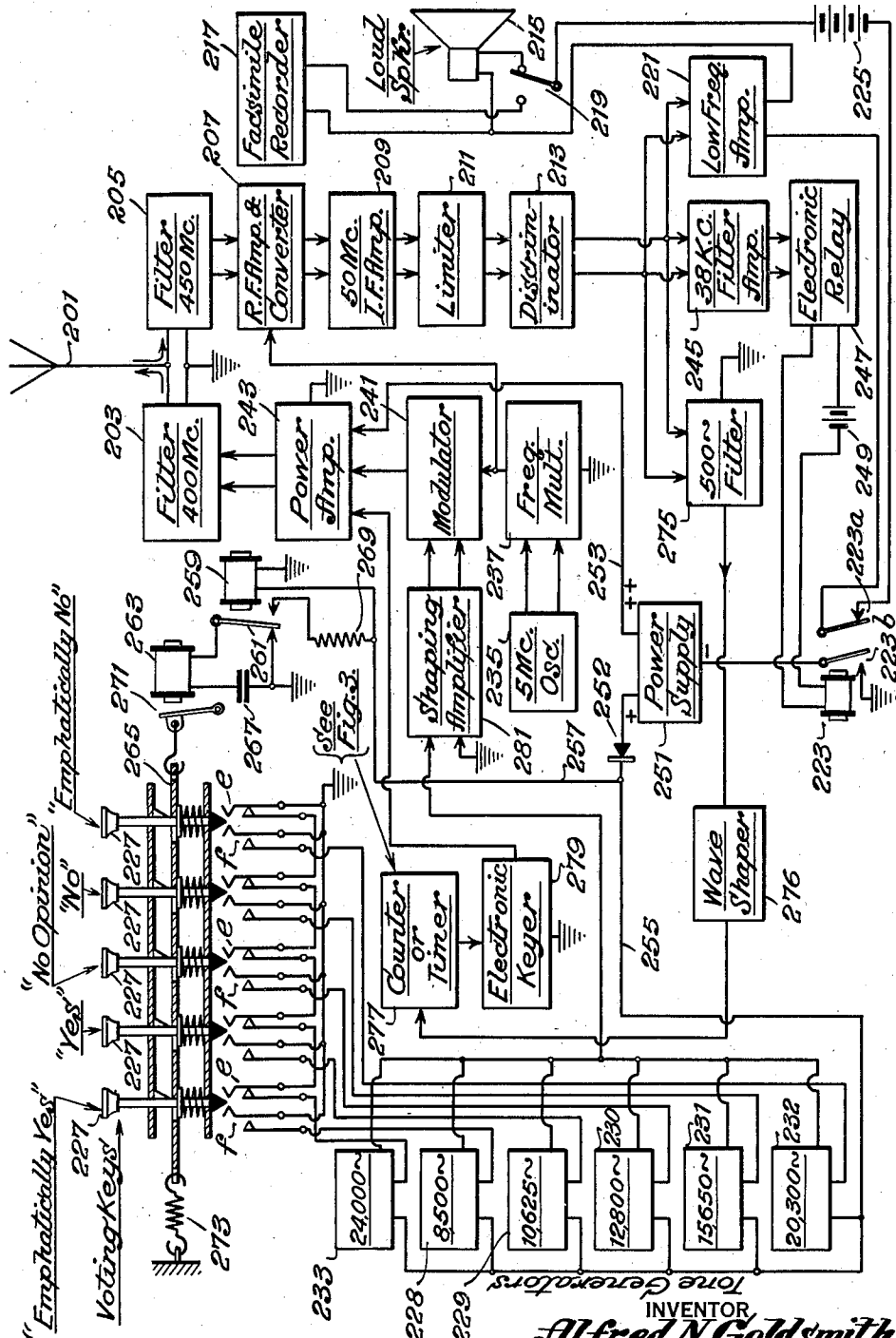
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RADIO CENTERCASTING SYSTEM

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Fig. 2.



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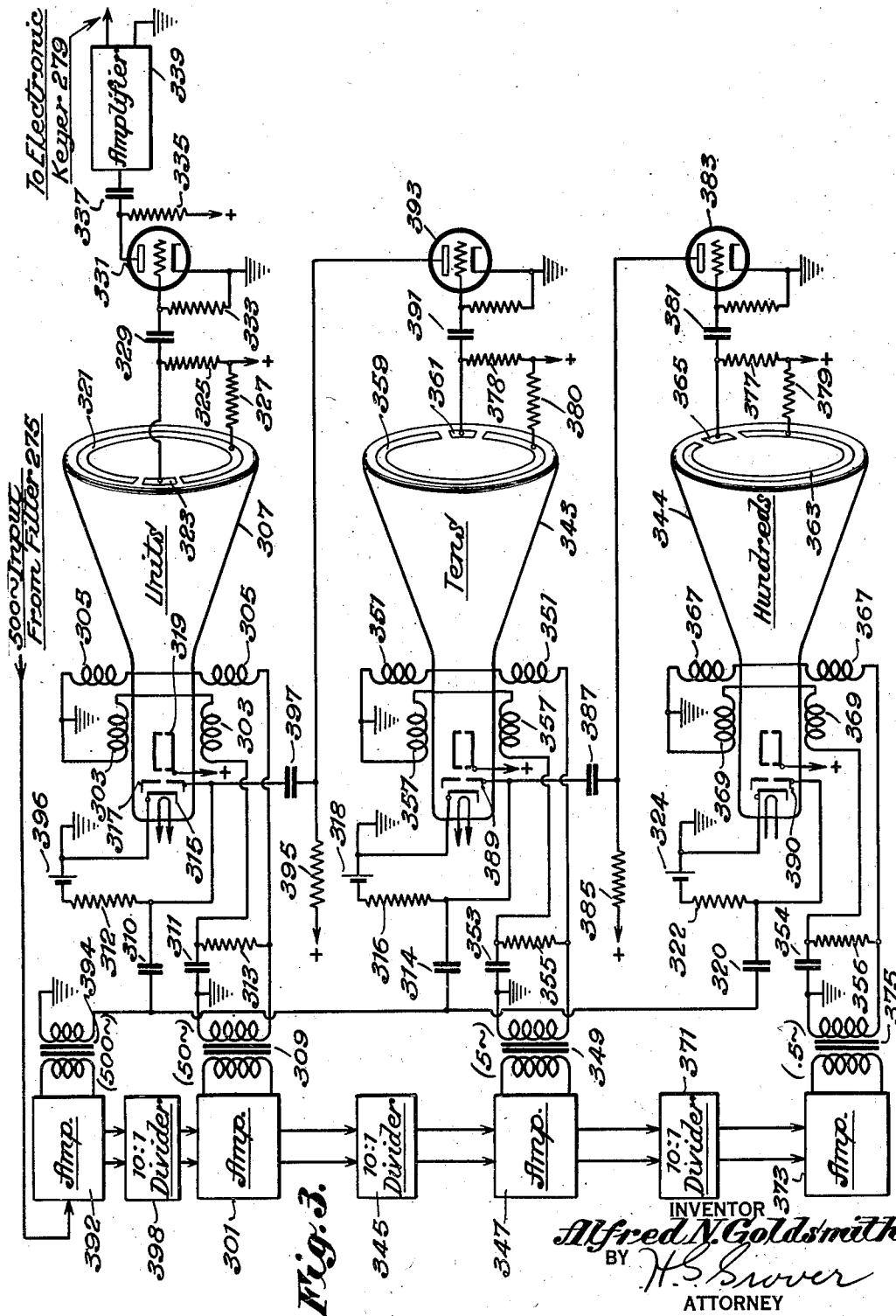
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UNITED STATES PATENT OFFICE

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RADIO CENTERCASTING SYSTEM

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This invention relates to polling systems and more particularly to a radio communication system which may appropriately be termed a "radio centercasting system" in contradistinction to a radio broadcasting system.

In carrying out my invention, I propose to employ radio communication channels for the purpose of gathering information, such as public opinions, from groups of respondents who may be selected members of the public. Each of these respondents is to be provided with radio receiving and transmitting equipment so arranged as to communicate with a central station where opinions may be automatically collected, classified and analyzed.

The major limitation of broadcasting is obvious. It is, so to speak, centrifugal, that is, it flies outward from a center to reach the multitudes; but leaves them, in turn, as inarticulate as before, save through age-old and cumbersome methods of comment and criticism. Thus, the broadcasting system is one-sided.

In order to complement broadcasting, I propose to employ centercasting, which is centripetal, in that intelligence flies inward to a focal point. It has been practically demonstrated that, in conducting a poll of public opinion, when a comparatively small number of typical persons is selected representing an average cross-section of a community, these persons may be engaged to register their votes on any question, and their votes will, with an astonishing degree of accuracy, correspond with the voting opinion of the entire community.

It is an object of my invention to provide a centercasting system which, in effect, will be operable to transmit from a central station to a plurality of outlying respondent stations a query upon which an expression of public opinion is desired, and thereafter to enable each respondent at his polling station to register his individual opinion by means of a choice of any one of a number of votes, such votes to be automatically transmitted from each respondent station to the central station, at which latter point they are to be accumulated and classified.

It is another object of my invention to provide a centercasting system in which each respondent shall be equipped with a radio transceiver whereby he may be informed of a question concerning

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which a poll is to be taken, and may thereafter register his vote in one of a number of ways, such registration being eventually translated into radio signals for transmission to a central station where all of the signals from different respondents are utilized to control an operable integrating or counting and tabulating system.

It is still another object of my invention to provide a centercasting or polling system in which the different votes, as registered by scattered respondents, shall be transmitted in very rapid succession so that they may be accumulated within a very short period of time at the central station. To carry out this object, it will be understood that one of the features of the invention resides in the provision of synchronizing devices all controlled from the central station in such manner that the signals at different respondent stations will be initiated in a predetermined time sequence.

A further object of my invention is to provide a centercasting system in which different opinions are expressed by different modulation frequencies applicable to a given carrier wave.

A still further object of my invention is to provide a centercasting system in which each respondent station shall be adapted first to store a vote, and subsequently to transmit signals representing that vote.

It is another object of my invention to provide a polling system in which a plurality of votes stored at different respondent stations shall be translated into a train of signals the voting significance of which may be registered at a central receiving station.

It is still another object of my invention to provide a system of the class described in which a control signal may be sent out from a central station for the purpose of starting and stopping the operation of various respondent transmitters, such starting and stopping being obtained by a time sequence method, whereby the responses produced in the central station may be capable of accumulation in a predetermined order.

The foregoing and other objects and advantages of my invention may be achieved with the aid of apparatus presently to be described, and by the adoption of novel methods which are either explicitly set forth, or otherwise implied, in the text of this specification.

My invention will now be described in more detail, reference being made to the accompanying drawings in which:

Fig. 1 shows diagrammatically a preferred arrangement of apparatus units to be used at a central station both for transmission and reception of intelligence relating to centercasting;

Fig. 2 shows diagrammatically an arrangement of apparatus units at a respondent station, it being understood that in a given centercasting system a large number of such respondent stations may serve to transmit signals representing polls of public opinion, and that such signals can be received and counted at the central station;

Fig. 3 shows a preferred circuit arrangement for use at each respondent station and serving to so control the same from the central station as to provide successive transmission of signals in a predetermined order; and

Fig. 4 shows a time graph of potential charges in a certain pair of capacitors shown in Fig. 1.

Referring first to Fig. 1, I show therein an antenna 101, which may be of any suitable type, but which is here shown as of the well-known turnstile type, such as is preferred for ultra-high frequency transmission. Transmitting apparatus is shown generally at 103. A suitable power supply 251 is indicated for each transmitting apparatus. The output from the transmitter is fed to a filter 105 and thence to the antenna 101. For illustrative purposes I have indicated the filter 105 as tuned to a frequency of 450 megacycles. The actual transmission frequency to be used in my centercasting system, however, is one which will doubtless be governmentally assigned.

Signalling energy which is collected by the antenna 101 may be fed through a filter 107 and thence to receiving apparatus which is indicated generally at 109. This apparatus may include a heterodyne receiver, discriminator, limiter, and amplifier. In using a discriminator of any well-known type, it is assumed that the system would employ frequency modulation. Other modulating systems, however, may be used if desired.

Both the receiver and the transmitter may be frequency-controlled by means of a single oscillator 111. The output from this oscillator may be fed in parallel to two frequency multipliers 113 and 115. Assuming that the oscillator frequency is controlled by a piezo-electric crystal having a natural frequency of 5 mc., this frequency will preferably be multiplied in the unit 113 in order to obtain the 450 mc. carrier to be used by the transmitter 103. The 5 mc. frequency of the oscillator may also be multiplied in the unit 115 for the purpose of producing a suitable heterodyne oscillator frequency to be mixed with an incoming carrier wave of normally 400 mc. received by the receiver 109.

The output from the transmitter 103 may be modulated by voice signals, by facsimile signals, or by pure sine waves of frequencies such as 38 kilocycles and 500 cycles. The 38 kc. frequency is used for setting up a condition for transmission by the respondent stations when a vote is to be counted. The 38 kc. oscillator source for this purpose is shown at 117. The 500 cycle source 119 is shown connected in parallel with the source 117 and is used for actuating each of the respondent stations in succession so that the votes may be counted serially.

A selective switch 121 is shown having four positions and may be manually operated, if desired, in order to obtain different conditions for transmission from the central station. The switch 121

may normally rest on its contact *a* when no signals are being sent. Contact *b* provides for the transmission of voice signals as initiated by the microphone 123. Contact *c* provides for connection to the transmitter of a facsimile scanner 125, assuming that intelligence is to be transmitted to the respondent stations in the form of pictures or graphic characters. When the switch 121 is turned to its contact *d* the 38 kc. oscillator output will first be used as a continuous modulation of the carrier wave to prepare the respondent stations for transmitting their vote signals. At a suitable time a start key 127 may be actuated for initiating a train of 500-cycle waves whereby selection of each respondent station is made in turn for transmitting its vote. The vote gathering process may be so rapid that it is only necessary to transmit the 500-cycle waves for a very limited time, say for two seconds, in order to serially select and produce a response in each one of the respondent stations associated with the central station, up to the limit of 999 in number. As will presently be shown, these votes may be gathered and counted at the rate of 500 per second, or at even higher speeds, if desired.

The output from the receiver 109 after being rectified is fed to all of the parallel-connected filters 129, 131, 133, 135, 137, and 139. These filters are arranged to accept different low modulation frequencies, each characteristic of a different voting opinion as registered at the respondent stations. For example, filter 129 may be arranged to accept an impulse characterized by a frequency of 8500 cycles for indicating that the voter's registration is "Emphatically yes." Filter 131 will accept an impulse characterized by a frequency of 10,625 cycles for registering "Yes." The remaining filters may respectively accept frequencies 12,800 cycles, 15,650 cycles, and 24,000 cycles for registering respectively "No opinion," "No," "Emphatically no," and "No vote."

Each of the filters 129, 131, 133, 135, 137, and 139 is connected to a different vote counter 141. These vote counters are labeled respectively to indicate the nature of the vote to be registered therein.

The particular form of apparatus to be used as a vote counter may be varied within wide limits. For rapid counting of the votes, however, it is preferable to use apparatus which is fundamentally electronic in action. Such counters are well-known in the art and need not be described in detail. Reference is here made to an article in "Electronics," the issue of April 1942, on page 62 therein, where counters and frequency divider circuits are described by D. L. Jaffe, the title of said article being "Wide band amplifiers and frequency multiplication." The use of frequency dividers is also mentioned in connection with electronic counters. Electronic circuits useful for counting purposes are also described in the August 1939 issue of "Electronics" in an article by H. J. Reich entitled, "Trigger circuits." See pages 14 to 17 of this publication.

In the absence of counters which would exactly register each individual vote, integrating meters can be employed in the position of the units 141 for obtaining rough indications of the voting strength affirmatively or negatively in regard to any question put to the voters.

The transmission of the 500-cycle wave train must be limited to a number of cycles not greater than the counting range of the counter or timer at the central station, and likewise at each respondent station. Similar to revolution coun-

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ters of the mechanical type, I provide an electronic impulse counter at the central station and an impulse counting selector at each respondent station. When the central station counter has caused a train of impulses to be sent out up to the limit of the counting range it would repeat from a zero registration unless the counting impulses were to be stopped. This would cause unwanted multiple voting at some or all of the respondent stations. Accordingly, I provide at the central station means to send out a limited number of cycles, say 999 as a maximum number. If the respondent station selectors were adapted to count up to a higher number, then, of course, the counting impulses would be continued up to the highest selecting number of any respondent station.

It is preferable to shape the output wave from the tuning fork generator 119 and to apply a square wave tone frequency to the transmitter 103. The multi-vibrator tube 102 delivers this square wave output first across capacitor 120, and thence to the grid 155 in an amplifier tube 153. A connection is made with the anode 156 across capacitor 130 to terminal *d* on the selector switch 121. The movable contact of this switch when turned to contact *d* feeds both the 500-cycle counting waves and the 38 kc. waves from generator 117 to the modulator in the transmitter 103.

The operation of the multi-vibrator tube 102 under control of impulses from the tuning fork generator 119 is explained as follows:

The tube 102 contains a cathode 104 common to two triode systems. The first system comprises grid 106 and anode 108. The second system comprises grid 110 and anode 112. The anodes are fed with positive potential from the source 161 through resistors 114. The cathode 104 is connected to the anode 134 in a control tube 128. This control tube possesses a cathode 130 and a control grid 132. A start-key 127 is used to initiate a control of tube 102 by a train of pulses from the generator 119. Previously, however, the tuning fork generator 119 is made operative to supply its output pulses continuously. A cathode resistor 136 connects the cathode 130 through contacts 150 and 152 of the start key 127, and thence to ground. The negative terminal of source 161 is grounded. Before the key 127 is depressed, no current can be fed through the multi-vibrator tube 102 or the control tube 128 which is in series therewith. This is true because tube 128 must first be rendered conductive by grounding the lower end of the cathode resistor 136. Manipulation of the start key 127 accomplishes this in the following manner and further provides that the left side of tube 102 of the multi-vibrator tube 102 shall first become conductive in response to the control pulses from the generator 119. An input circuit from the cathode 104 extends through a grid biasing source 126, through contacts 146 and 144 of the start key 127, and thence through grid resistor 122 to the grid 106. Upon depressing the key 127 contacts 144 and 146 should not open until after contacts 150 and 152 have closed for applying operating potential to tubes 102 and 128. Thus, a cut-off bias from source 126 will momentarily be applied to grid 106, so that the first impulse from tuning fork generator 119 will be effectively applied to grid 106 after contact is made between contacts 144 and 146. At this time the biasing source 126 will be removed from circuit connection with the grid 106. Impulses from the tuning fork

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generator 119 are thereafter applied through grid resistor 122 to the grid 106 for rendering the left-hand portion of the tube 102 conductive. The key 127 may be held down for the duration of the full number of 500 cycle waves which is to be transmitted. In the arrangement shown this will take two seconds.

The multi-vibrator 102 operates in a conventional manner. That is to say, when the left side becomes conductive, the drop of potential on its anode 108 produces a surge impulse across capacitor 118 and through resistor 124 such that the grid 110 becomes biased to cut-off. The potential rises on anode 112, thereby delivering a surge impulse across capacitor 116 and through resistor 122 for similarly biasing grid 106 to cut-off. A conductive state on either side of the tube, therefore, renders the other side non-conductive. The timed operations of the circuit are subject to synchronization by the generator 119. A square wave output signal is delivered to the grid 155 of tube 153, as has already been stated. This signal is utilized in two ways. One way is to modulate the transmitter 103, and the other is to locally count the cycles of the tuning fork generator up to a predetermined limit, after which modulation of the transmitter is to cease. The circuit connections for tube 153 include an anode resistor 157 connected to the positive terminal of source 161, and a cathode resistor 159 connected to ground. The grid 155 is neutrally biased by means of resistor 158, one end of which is connected to the cathode 154. The 500-cycle waves impressed across capacitor 120 produce an interrupted flow of current in the tube 153 which varies the potential drop across resistor 159. A suitable tap on this resistor is connected to the input circuit of a frequency divider 160 of conventional type. This divider preferably has a ratio of 10 to 1 between its input and output frequencies. The output frequency is, therefore, 50 cycles in the case illustrated.

A 50-cycle current is now fed to another frequency divider 162, also having a 10 to 1 ratio between its input and output frequencies. Thus, a 5-cycle wave may be delivered across capacitor 163 to the grid of a gaseous discharge tube 164. Tubes 164 and 165 are both gaseous and are connected in series, being fed with energy from the source 161 across resistors 174 and 175.

The control grid of tube 164 is biased negatively with respect to its cathode by means of a biasing source 168 which produces a potential drop across the potentiometer 167. Grid resistor 166 is connected to a suitable point on this potentiometer. Similarly, the control grid of tube 165 is biased negatively with respect to its cathode by means of source 170 and a potentiometer 171 connected across the terminals thereof. A suitable tap on potentiometer 171 provides connection through grid resistor 169 to the grid of tube 165.

The circuit arrangement of tube 164 and 165 is similar to that which is shown and described in U. S. Patent No. 2,250,819, granted July 29, 1941, to M. Wolf. In that patent gaseous tubes similar to tubes 164 and 165 are shown to be useful in generating a wave of stepped formation. In the instant case I utilize the principles of such a generator to deliver a single negative impulse after the lapse of two seconds, or when 1,000 cycles of the 500-cycle wave have been utilized for modulating the transmitter 103. The tubes 164 and 165 thus operate to open the circuit of the multi-

vibrator, blocking the space path in the control tube 128. The mode of operation is as follows:

Capacitor 172 is shunted directly across the anode and cathode of tube 164. Similarly, capacitor 173 is shunted directly across the anode and cathode of tube 165. Capacitors 172 and 173, therefore, have a common terminal which is connected between the cathode of tube 164 and the anode of tube 165. This common terminal is also connected through a biasing source 176 and a resistor 177 to a tap 140 on grid resistor 138 of tube 128, and thence through the cathode resistor 136 to ground, assuming that contacts 150 and 152 are closed by the depression of key 127. Since one electrode of capacitor 173 is also connected through resistors 175, 136, 138, 177, and source 176 to the other electrode of this capacitor, it will be understood that an initial charge equivalent to the voltage of source 176 will be maintained at the outset of operation. Also at the outset capacitor 172 will possess no charge because of the presence of a shunting resistor 178 of very high ohmic value. The voltage of the source 176 is preferably made slightly less than the minimum voltage drop across tube 165 when it is ionized.

The impulses of 5-cycle frequency delivered to the grid of tube 164 in combination with the time constant value of capacitor 172 and the resistor 174 will cause tube 164 to be ignited and extinguished cyclically. The proper adjustment of the grid bias voltage from source 168 will stabilize this action. With each successive moment of ignition a charge will be transferred from capacitor 172 to capacitor 173 until the voltage on capacitor 173 reaches the break-down voltage across the discharge space in tube 165. The adjustment of grid bias voltage in tube 165 by means of the elements 169, 170, and 171 can be made such that exactly 10 impulses delivered by successive discharges in tube 164 will produce ionization in tube 165. At this moment the drop of potential on the anode of tube 165 will be reflected in a negative impulse through source 176 and resistor 177 such that the grid 132 in tube 128 will be biased to cut-off. No subsequent impulses can then be delivered by the multi-vibrator tube 102.

While accurate timing and counting of the 500-cycle impulses is obtained in the manner aforesaid, the operator, with the aid of a watch, may readily determine how long he should hold down his key 127 in order to effect delivery of the full number of these impulses. Any slight holding of key 127 beyond the necessary time will have no effect so long as it is not held beyond the period for recovery of a neutral bias on grid 132 in tube 128.

Other counting devices may, of course, be provided in place of that which is shown in Fig. 1 but without departing from the spirit of the invention. It seems sufficient, therefore, to illustrate the operativeness of my apparatus in the manner set forth without showing modifications.

After the total vote has been registered, it is necessary to restore the respondent stations to a non-transmitting condition. This is done by removing the 38 kc. frequency by which the oscillator 117 was modulating the output from the transmitter 103 during the vote counting process. Also, when the votes registered on the counters 141 have been compiled, the vote counters should be restored to normal, or to a zero indicating position. This last step may be suitably accomplished by electrical means, if desired, and

in a way well within the scope of an ordinary engineer. Hence, I have shown a counter re-set key 143 connected to a direct current source 145 and connected also to a branched circuit 147 for re-setting all of the counters 141 simultaneously.

Referring now to Fig. 2, which shows an assembly of different units to be employed at a respondent station, I have indicated a transmitting and receiving antenna 201, to which are connected a filter 203 for passing a 400 mc. frequency, and a filter 205 for passing a 450 mc. frequency. Incoming signals collected by the antenna 201 and fed through the filter 205 are utilized in a radio frequency amplifier and converter 207, the output from which may, for example, be considered a 50 mc. intermediate frequency. An oscillator 235 and frequency multiplier 237 may be used to furnish the 400 mc. frequency necessary for heterodyning with the 450 mc. incoming carrier wave. The heterodyned output may then be amplified by the unit 209 and limited by the unit 211, and then fed through a discriminator 213, assuming that the signals are frequency-modulated.

In order to inform each respondent as to the nature of the question on which he is asked to register his vote, audible signals may be produced in the loud-speaker 215, or facsimile recordings may be made by a unit 217. The voter will be informed by any suitable means as to the method of obtaining the question on which to vote. He will then operate a switch 219 for connecting either the loud-speaker or the facsimile recorder to his radio receiving apparatus.

Connection is made between the discriminator 213 and the switch 219 through a low frequency amplifier 221, a pair of relay contacts 223a and a direct current source of operating potential 225, which is assumed to be required for operating either the loud-speaker 215 or the facsimile recorder 217.

After the voter has been informed on the question which is up for voting, he is prepared to register his vote, as for example, by depressing one of five voting keys 227. These keys are individual to the different votes which he may select for registration. They are, therefore, labeled correspondingly to the labels on the vote counters 141 at the central station. In other words, the keys are labeled respectively "Emphatically yes," "yes," "No opinion," "No," and "Emphatically no."

Provision is made for causing the respondent station to transmit a signal having the significance of "No vote" when none of the keys 227 is depressed. This no-vote signal may be characterized by a tone frequency of 24,000 cycles emanating from a tone generator 233. When none of the keys 227 is depressed a grounding circuit can be traced from the tone generator 233 through normally closed contact pairs *e* which are associated with each of the keys 227. The depression of any key opens one of these contact pairs *e* and breaks the grounding circuit from the tone generator 233, thereby disabling the same. Simultaneously, the depression of any key 227 closes a contact pair *f* and establishes a grounding circuit to a selected one of the tone generators 228 to 232 inclusive. The tones generated by the units 228 to 233 inclusive corresponds with the frequencies for which the central station filters 129, 131, 133, 135, 137, and 139 are tuned.

An advantage to be derived from the transmission of a "No vote" signal is that the operative-

ness of all the respondent stations can be accounted for, even when voters fail to register their votes by reason of absence or otherwise. Failure to receive any signal from a given respondent station might furnish the clue for an investigation and possible servicing of that station.

The depression of a voting key 227 does no more than condition one of the tone generators 228 to 233 for modulating the respondent station transmitter. This respondent station transmitter must be controlled by the central station so that signals will be sent in rapid succession by different ones of the respondent stations. The respondent station transmitter and its mode of operation will now be described.

A 5 mc. oscillation generator 235 is employed commonly for transmitting and receiving purposes. The output is, therefore, fed to a frequency multiplier 237, which delivers a 400 mc. output for heterodyning with the 450 mc. input frequency for the R. F. amplifier and converter 207. The frequency multiplier 237 also delivers a carrier wave of 400 mc. to the transmitting modulator 241. The modulator 241 has an input circuit for applying to the carrier wave impulses which are derived from any one of the tone generators 228 to 233. These impulses are then fed to the modulator through a wave shaping amplifier 281. The modulated carrier wave is then fed to a power amplifier 243, the output from which goes through filter 203 and is radiated by the antenna 201.

In describing Fig. 1, it was explained how a 38 kc modulating wave derived from the oscillator 117 could be employed for conditioning the respondent stations to transmit their votes. This 38 kc. wave is, therefore, received by each respondent station receiving apparatus and fed through a 38 kc. filter amplifier 245. The output from the unit 245 may be utilized by an electronic relay 247 of any suitable type. These relays are well-known in the art and need not be here described. They are capable of delivering a steady output current from a source 249 to a relay 223 as long as the incoming 38 kc. frequency persists. Relay 223 may, therefore, be energized while registering all of the votes of the different respondent stations. During the vote collecting period the contacts 223a will be opened for disabling the loudspeaker 215, or the facsimile recorder 217, depending upon which one of these last two units was in connection with the receiver through the switch 219.

Relay 223 has contacts 223b which close when the relay is energized, for establishing a circuit from ground through a power supply unit 251 to the apparatus which is to be rendered effective while transmitting the different votes of each respondent station. Thus, a circuit will be closed through conductor 253 to the power amplifier 243 for rendering the same operative. For the sake of simplicity, this power amplifier 243 is indicated as having a ground connection so that its operative and inoperative conditions may be determined by the closing and opening of the switch contacts 223b. The unilateral conductor 252 may serve to prevent a power drain out of the high potential side of the supply unit 251 when the contacts 223b are open.

The supply unit 251 may also be used as a source of power for the tone generators 228 to 233 inclusive and for any other apparatus which functions only during the period of registering votes. The conductor 255 connected to one of the positive terminals of the source 251 indi-

cates generally the means for feeding suitable operating potential to the tone generators. Conductor 257 feeds a positive potential directly to a relay 259. Since the tone generators, as well as the relay 259, have ground connections, it will be seen that all of these units are rendered and maintained operative as long as contacts 223b are kept closed by the energization of relay 223, that is, during the reception of the 38 kc. control frequency.

Relay 259, when energized, establishes a high-impedance circuit through resistor 269, through its own armature 261, and thence through the winding of a magnet 263. A re-set plate 265 associated with all of the voting keys 227 is connected to and operated by the armature of magnet 263. The winding of relay 263 is connected to a capacitor 267 and thence to ground.

When relay 259 is actuated, the current passing through magnet 263 is limited by the high impedance resistor 269 so that the armature 271 of magnet 263 will not be pulled up. In other words, the magnetization of magnet 263 will be insufficient to overcome the restraint produced by spring 273 connected to the key re-set plate 265. During the time when relay 259 is energized, however, the capacitor 267 will become fully charged. At the termination of the voting period relay 259 will be released, thereby closing a circuit of low impedance through the winding of magnet 263 and through the capacitor 267. The discharge of this capacitor, although momentary, will be sufficient to pull up the armature 271, thus releasing a depressed voting key 227 and restoring it to its normal position. The key re-set plate 265 is preferably designed in accordance with well-known practice in the adding machine art.

The successive registration of votes by the different respondent stations will now be explained. Each respondent station must be selected in a definite order by means of low frequency signals such as determined by a train of 500-cycle waves emanating from the central station when the start key 127 is depressed. I, therefore, preferably provide a counter or timer responsive to square-wave impulses of the 500 cycle frequency for causing each respondent station to transmit the vote during a very brief period, say $\frac{1}{1000}$ of a second. The fraction $\frac{1}{1000}$ is used to designate the marking period in contrast with a similar spacing period of the 500-cycle square wave. During the spacing periods transmission from all respondent stations is silenced; that is, their carriers are unmodulated. The 500-cycle filter 275 at the respondent station delivers a control signal through a wave shaper 276 to a counting selector labelled 277 in Figure 2. This selector will presently be described in full detail by reference to Figure 3. First, however, it is necessary to explain that when it operates it causes an electronic keyer 279 to function for controlling the power amplifier 243 so that a very brief signal lasting, say for not more than $\frac{1}{1000}$ of a second, will be transmitted by each respondent station sequentially under the control of its selected tone generator in the group 228 to 233.

The output circuits from the tone generators are connected in parallel to a control circuit for a wave-shaping amplifier 281 which feeds suitably shaped signalling waves to the modulator 241 by which the power amplifier 243 is modulated.

Referring now to Figure 3, I show a preferred

form of apparatus (all comprehended in the unit 277 of Figure 2) for selecting the different respondent stations sequentially. The apparatus comprises a plurality of cathode ray tubes arranged to count incoming cyclic impulses and to deliver a single output impulse when a specified number of incoming impulses has arrived at a given respondent station. The 500 cycle wave from filter 275 (Figure 2) is fed through wave shaper 276 to an amplifier 392 (Figure 3) having two output circuits, one of which is utilized in partially controlling the release of electrons by the electron guns in the several cathode ray tubes 307, 343, and 344.

Output energy from amplifier 392 is also fed to a frequency divider 398 and thence to an amplifier 301. This amplifier has two output circuits, one for producing two-phase deflecting circuit potentials to be applied to the deflecting coils 303 and 305 of the cathode ray tube 307. The frequency divider 398 preferably has a 10 to 1 ratio between its input and output frequencies. Thus, a 50-cycle wave is fed across transformer 309 which has a secondary in circuit with the vertical deflecting coils 305. At two points in this circuit ground connections are indicated. In order to produce a phase displacement of 90° in the currents which traverse the horizontal coils 303, a phase displacing network consisting of capacitor 311 and impedance 313 is employed. As is well-known, such a phase displacing network may be suitably designed to produce quadrature phase displacement between the currents traversing the coils 303 and 305 respectively, and thus to provide rotary scanning of the electron beam.

The cathode ray tube 307 comprises a cathode 315, a control electrode 317, a focusing anode 319, a target anode 321, and a second target anode 323. Anode 321 is here shown as a broken ring subtending an arc of $\frac{1}{10}$ of a circle, or 324°. Anode 323 subtends substantially an arc of 36° or $\frac{1}{10}$ of a circle. The two anodes 321 and 323 are connected by means of impedances 325 and 327 respectively to the positive terminal of a suitable direct current source. The negative terminal of this source is preferably grounded, and so is the cathode 315 of the tube.

Rotary scanning of the electron beam in the cathode ray tube 307 is thus provided by the two-phase currents derived from the transformer 309 and the phase displacing network 311, 313. As the beam rotates, it will, for $\frac{1}{10}$ of one revolution, traverse the anode 321, and for $\frac{1}{10}$ of a revolution, it will traverse the anode 323. The arrival time of the beam at the center of the anode 323 is determined by the orientation of this anode with respect to the axes of the deflecting coils 303 and 305, and is adjusted in accordance with the units digit of the call number for a given station. When anode 323 is impacted by electrons, a negative impulse is impressed across capacitor 329, which blocks the current otherwise normally flowing in discharge tube 331. This discharge tube possesses the usual electrodes, of which the control grid and cathode are interconnected by a grid leak resistor 333, while the anode is fed with positive potential from any suitable source across an impedance 335. When the discharge tube 331 is blocked, the rise of potential on its anode produces an impulse across capacitor 337 for actuating an amplifier 339, thereby to emit a control signal which is fed to the electronic keyer 279 (Figure 2). This keyer, as has been explained, conditions the power amplifier 243 momentarily

so that one of the tone generators of the group 228 to 233 inclusive may be effective in transmitting a voting signal.

During the persistence of the 500-cycle wave train applied to amplifier 392, the frequency divider 398 continues to function. The 50-cycle output from amplifier 301 also persists and delivers suitable potentials to the deflecting coils 303 and 305. In order to render the hundreds and tens digits of a station's calling number effective, the emission in tube 307 is restricted to a brief period which comprehends only 10 cycles of the 500-cycle wave. Furthermore, the electron stream flows only during ten positive half-cycles of this wave. During this time the electron beam will be directed toward nine different portions of the anode 321 and some portion of the anode 323. During 990 of the cycles of the 500-cycle wave the electron beam will be blocked by a blocking bias derived from source 396. This is true because the blocking bias is so set that it will be overcome only when control impulses are applied to the control electrode 317 across capacitors 310 and 397 simultaneously. I will now explain the manner of overcoming this blocking bias in order to produce the one effective impulse for selection of the respondent station, which impulse is initiated by a negative charge on the anode 323, for producing a surge impulse across capacitor 329, thereby to block the discharge in tube 331. The blocking of tube 331 causes a positive impulse to be fed across capacitor 337 to amplifier 339.

A frequency divider 345 is controlled by output current from the amplifier 301. This divider preferably has a 10 to 1 ratio between input and output frequencies. The output frequency of 5 cycles is amplified by the unit 347 which also has two output circuits. One such output circuit includes the primary of a transformer 349 occupying the same position with relation to cathode ray tube 343 and its deflecting circuits as is obtained by the transformer 309 and the deflecting circuits of cathode ray tube 307. In other words, transformer 349 feeds current of one phase to the vertical deflecting coils 351 and thence to ground. The phase displacing network consisting of capacitor 353 and impedance 355 causes current of quadrature phase to be fed to the horizontal deflecting coils 357 and thence to ground.

Each of the cathode ray tubes 343 and 344 is similar in construction to that of cathode ray tube 307. The electron gun elements need not, therefore, be described in detail. Furthermore, the same construction of anode electrodes exists in the different cathode ray tubes, and these need no further description. In cathode ray tube 343, however, the 324°-anode is labelled 359, while the 36°-anode segment is labelled 361. Correspondingly, in cathode ray tube 344, I have labelled the larger anode 363 and the smaller one 365. Vertical deflecting coils for tube 344 are labelled 367 and the horizontal deflecting coils 369.

One of the two output circuits from amplifier 347 feeds a 5-cycle current to a frequency divider 371 which also has a ratio of 10 to 1 between its input and output frequencies, thus delivering a frequency of .5 cycle per second to amplifier 373. This amplifier has an output transformer 375 across which the .5-cycle current is fed to a phase-splitting network 354, 356, and thence to the vertical and horizontal deflecting coils 367 and 369.

From the foregoing description of the amplifiers 392, 301, 347 and 373 and their interconnections through frequency dividers 398, 345 and 371 it will be seen that the beams in the three cathode ray tubes are rotated at different velocities corresponding to gears having 10 to 1 ratios therebetween. The maximum scanning velocity of 50 revolutions per second is obtained in tube 307; in tube 343 the velocity is 5 revolutions per second; and in tube 344 the velocity is $\frac{1}{2}$ revolution per second.

Tube 343 has an output circuit from its anode 361 and through impedance 378 to the positive side of an anode potential source. The anode 359 is connected to the same source through impedance 380. The scanning velocity in tube 343 is such that ten marking impulses of the 500-cycle wave are caused to traverse capacitor 314 and to discharge electrons from the gun while the beam is aimed once at the anode 361. During each scanning revolution 90 marking impulses are suppressed or rendered ineffectual by aiming the beam at the anode 359. When the beam is effective a negative surge across capacitor 391 blocks tube 393, thus delivering ten impulses through resistor 395 and across capacitor 397 for aiding in the release of electrons by control electrode 317 in tube 307.

Only one out of ten scanning revolutions of the beam in tube 343 is rendered effective in accordance with the preceding paragraph. The other scanings are suppressed by the biasing source 318 during the absence of control impulses to be derived from the action of tubes 344 and 383.

Tube 344 has an output circuit from its anode 365 and through impedance 377 to the positive side of an anode potential source. The anode 363 is connected to the same source through impedance 379. Impulses derived from the impact of 100 electronic puffs or clouds against anode 365 traverse the capacitor 391 for controlling a discharge tube 383 thereby to repeatedly block the same. The anode potential rises in this tube when it is blocked, due to the presence of a load resistor 385 in its connection to an anode potential source. Positive impulses, 100 in succession at the 500-cycle rate, are impressed across capacitor 387 for controlling the electrode 389 in cathode ray tube 343. At these instants simultaneous impulses across capacitor 314 cause the electron stream in tube 343 to be released while it is deflected rotatively just once. During the remainder of the time of transmission of the 500-cycle wave train preceding and/or following the reception of these 100 marking impulses the beam in cathode ray tube 344 is directed ineffectually against the anode 363, so that the emission in tube 343 becomes blocked.

The fundamentals of my counting system as set forth in the paragraphs immediately preceding may be extended, if desired, to a system wherein additional cathode ray tubes would be employed to permit counting up to a number having four or more digits. Alternatively, the arc subtended by the selecting anode segments 323, 361 and 365 might be reduced in degrees, and at the same time the ratio between input and output frequencies of the frequency dividers 398, 345 and 371 would be of higher order so that the scanning velocities in the several cathode ray tubes would bear higher ratios one to another. Thus, a higher order of selectivity would be obtainable without the use of additional apparatus components.

I previously mentioned that in order to select each respondent station for operation in a predetermined sequence, it is arranged for the cathode ray tubes 344, 343, and 307 to be rotatively adjusted on their respective axes thereby to place their effective anode segments 365, 361 and 323 in suitable angular relation to the vertical and horizontal axes of the deflecting coils which are associated with these tubes. The mere act of rotating the cathode ray tubes in this manner enables me to adjust each electronic counter at a given respondent station so that it will be caused to deliver a single control signal across the capacitor 337 and thence through amplifier 339 to the electronic keyer at an instant corresponding to its orderly position in the entire series of respondent stations. When the 500-cycle frequency is initiated by the central station a sufficient number of marking impulses in the train is caused to be transmitted so that each of the respondent stations will pick up its particular individual controlling impulse in the entire train, and the different respondent stations will send out their voting signals successively and in a predetermined order.

The equivalent of counting gears may be readily understood as provided by the association of the three cathode ray tubes 344, 343 and 307, in accordance with the foregoing description. In order to illustrate more specifically how an individual respondent station is to be selected at a particular instant when its count of half-cycles is reached in the train of 500-cycle waves, the operation of the circuit arrangement shown in Fig. 3 will now be recapitulated.

The 500-cycle input wave is limited to 999 marking impulses which are applied to amplifier 392 and utilized across transformer 394 for opposing the cut-off biases of sources 396, 318 and 324 so that control electrodes 317, 389 and 390 will stand only slightly below the cut-off threshold in the presence of these marking impulses. Scanning of the electron beams in tubes 307, 343 and 344 take place to the number of 100 revolutions, 10 revolutions and one revolution respectively. Selection of the time when, or the single impulse by which, the electronic keyer 279 is actuated depends upon the coincidence of a marking impulse and the blocking of the two tubes 383 and 393. This moment is, therefore, determined by the respective orientations of the anodes 365, 361 and 323.

In place of the counting device and selector shown and described with reference to Fig. 3 it is apparent that synchronous clock mechanisms might be provided for the purpose of initiating a control impulse applicable to each keyer 279. A single dot impulse sent out by the central station and suitably tone modulated for being passed by filter 275, would then be sufficient for simultaneously starting all clocks at the several respondent stations. Each separate clock would then be provided with a circuit closer operable after it had run for a predetermined time interval. In this way the different respondent stations would be caused to transmit their vote signals successively. Then, after the counting of the votes had been completed, a suitable resetting signal would serve to restore all clocks to a zero point and to disconnect them from the local source by which they would be driven. This adaptation of synchronous clocks to the needs of my system has not been illustrated, since any one skilled in the art would understand how to put

together the essential elements, in view of this description.

To those skilled in the art, various modifications of my invention will suggest themselves, in view of the foregoing description of the embodiment which I prefer.

I claim:

1. A plurality of separated radio voting stations each having selectively pre-settable vote designating means and each having a transmitter arranged to emit a signal characterized in accordance with the setting of said means, a central station receptive of said signals when center cast, means at said central station for broadcasting initiatory signals to said voting stations, and means at said voting stations responsive to said initiatory signals for producing a sequential operation of their respective transmitters.

2. A voting system comprising a central station adapted to send and to receive radio signals, a plurality of voting stations each adapted to receive and to send radio signals, selective means at each voting station for designating a vote signal to be centercast, and means at each voting station operable in response to an initiatory signal broadcast from the central station to all the voting stations simultaneously for causing the vote signals to be centercast in a predetermined time sequence.

3. A voting system in accordance with claim 2 and including means at said central station responsive to the reception of said vote signals for counting the votes of like designation.

4. A voting system in accordance with claim 2 and including at least one source of modulating waves at each voting station arranged to distinctively characterize each vote signal as to its designation.

5. A voting system in accordance with claim 2 and including at each voting station a plurality of wave generators for modulating the radio signals which are centercast, each generator having a distinctive frequency appropriate to a different vote designation.

6. A radio voting system comprising a central two-way radio station, including a plurality of vote registering units, a plurality of two-way respondent stations, vote-storage means manually settable at each respondent station, means at said central station for broadcasting a predetermined number of vote gathering impulses, receiving means at each respondent station responsive to said impulses for selecting an appropriate moment in which to transmit a vote-signal, transmitting means at each respondent station rendered operative by said receiving means in such manner that different respondent stations send out their vote signals in succession and in a predetermined sequence, each under control of its vote storage means, and radio receiving means at said central station for translating said vote signals into control impulses applicable to said vote registering units.

7. In a radio voting system in which voters at separated stations are enabled to express their opinions by pre-setting a vote-designating radio wave modulator, the method of transmitting, receiving and counting vote signals of different designations which comprises, storing a vote at each station where its modulator is to be pre-set, simultaneously conditioning all said stations to transmit radio waves, causing each station to operate in succession to transmit its vote signal during a brief time interval exclusive to itself, causing each vote signal to be characterized in

accordance with the pre-setting of its modulator, receiving all of said vote signals at a central station, and separately counting the vote signals of different designations.

8. The method as set forth in claim 7 and including the steps of transmitting, receiving and separately counting signals from any of said separated stations at which the vote-designating modulator fails to be pre-set.

9. A plurality of separated radio voting stations each having pre-settable vote designating means, radio transmitting and receiving apparatus at each said station, a device at each station selectively operable by said vote designating means for generating a relatively low frequency which is characteristic of a vote signal, and station selector means operable by a wave of predetermined frequency passed through said receiving apparatus at each station for causing the transmission of each vote signal to take place during a time interval exclusively assigned to each station, whereby the different vote signals are transmitted in a predetermined sequence.

10. The combination according to claim 9 and including a central station having a transmitter arranged to broadcast said wave of predetermined frequency during the aggregate voting time of the several voting stations.

11. The combination according to claim 9 and including a central station having a receiver arranged to accept all the vote signals as successively transmitted, and means for separately accumulating the votes of different designations.

12. A device for sequentially keying different ones of a plurality of separated radio transmitters, comprising a radio receiver adjacent each transmitter, a common source of timing impulses propagated at the rate at which successive transmitters are to be keyed, impulse counters operable by said timing impulses, each counter being arranged to single out one impulse from a series, a different impulse being appropriate to the keying of each transmitter, and means for causing each transmitter to emit a signal of predetermined characteristic when it is keyed.

13. A device according to claim 12 wherein each said counter comprises a set of cyclically operable counting units, each arranged to count the different digits of a number.

14. A voting system comprising a central station having means to transmit a limited series of vote initiating signals, radio receiving means at said station responsive to vote signals so initiated at a plurality of voting stations, a settable means at each voting station for designating a voter's vote, a plurality of wave generators at each voting station, each generator being selectable to the exclusion of the others, and by said settable means, for modulating one of said vote signals, each generator having a distinctive frequency appropriate to a different vote designation, and a radio transmitter at each voting station the output from which is arranged to be modulated by one of said wave generators at a particular moment individual to each voting station, whereby a series of vote signals is centercast from the different voting stations in the order in which they respectively become responsive to said vote-initiating signals.

15. A voting system comprising a plurality of separated and sequentially operable radio voting stations, each having a pre-settable vote designating means and a transmitter arranged to emit a high frequency signal of brief duration modulated at a tone frequency which is significant of

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the vote to be cast by said vote designating means, a plurality of tone generators one of which signifies "No vote", and others of which signify a voter's opinion when individually selected by the setting of said vote designating means, and central-station-controlled means for causing the vote signals, so modulated by a single generator at each voting station, to be centercast from the different voting stations in a predetermined order.

16. A voting system in accordance with claim 15 and including means for causing a "No vote" signal to be transmitted by each voting station at which said vote designating means fails to be set to register the voter's opinion.

17. In a voting system, a plurality of separated vote-signal transmitters each having a carrier wave source, selectively pre-settable means for causing the carrier wave of each transmitter to be modulated characteristically in accordance with a voter's option, thereby to emit a vote-signal, a central station having means for so controlling the operation of said transmitters that their transmitting times are mutually exclusive, and central station also having means for receiving and segregating vote-signals of like character into appropriate groups, and means thereat for separately counting the segregated vote-signals of each group.

18. In a voting system, a central station having a carrier-wave receiver and a plurality of filters for classifying modulated carrier wave signals according to their voting significance, means providing sequential transmission of vote signals each constituting a distinctive modulation of a predetermined carrier wave and each emanating from a different source, and means for separately counting the vote signals which are passed by each of said filters.

19. In a voting system, a central station and a plurality of outlying voting stations, radio transmitting and receiving equipment at each of said stations, means for causing the transmitting equipment of the central station to radiate a time signal, means at each voting station responsive to said time signal as detected by its receiving equipment for selecting a time interval exclusive to itself during which its transmitting equipment shall be caused to emit a vote signal, keying means at each voting station for characterizing a vote signal to be transmitted as one of at least three alternative voting choices, means for modulating a carrier wave under control of said keying means at each voting station, and during said exclusive time intervals, thereby to deliver a succession of vote signals to the receiving equipment of said central station, a plurality of vote signal registers sufficient for separately registering the votes of said alternative choices, and means for actuating said registers selectively under control of the characterized vote signals as detected by the receiving equipment of said central station.

20. In a vote system according to claim 19, the elements therein recited in combination with means providing sequential transmission of vote signals from said voting stations in a predetermined order.

21. In a voting system, a central station having vote-signal initiating means and vote registering means, a plurality of separated voting stations having means responsive to initiating signals broadcast from the central station under control of said initiating means, selective means at each voting station for characterizing vote signals to

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be centercast therefrom, and a centercasting transmitter at each voting station arranged to emit a vote signal characterized by said selective means and timed in accordance with the response to said initiating signals, said voting signals being effective to control said registering means at the central station.

22. In a voting system, a central station having vote classifying and vote integrating means, radio broadcasting facilities at said station for inviting voters at a plurality of outlying voting stations to give a voting response to a predetermined question, means for so controlling said facilities as to radiate a train of counting pulses to which selective responses are made in different voting stations successively, selective means at each voting station for designating the class of vote to be cast, radio centercasting facilities successively operable at the different voting stations under control of said selective means for causing designated vote signals to be transmitted to said central station, whereat the respective votes are classified and integrated, and means at each voting station for timing the transmission of its vote signal in accordance with the selective response it makes to said train of counting pulses.

23. A system according to claim 22 in which said centercasting facilities include a plurality of vote-characterizing tone generators at each voting station.

24. In combination, a plurality of separated transmitters, each having an individual power supply, selectively presettable voting means individual to each transmitter for determining the character of vote signals to be emitted therefrom, means in each transmitter subject to control by said voting means for causing its carrier wave to be modulated as a characterized vote signal, and means providing sequential operation of said transmitters whereby their vote signals are emitted at mutually exclusive times, as modulated output energy from each said individual power supply.

25. In combination, a plurality of separated radiant energy transmitters, selectively presettable means individual to each transmitter for determining the character of signals to be emitted therefrom, a timing pulse counting selector associated with each said transmitter and controlled from a central station, means controlled by the respective selectors at each transmitter for providing sequential operation of said transmitters, said counting selector being arranged and adapted to reserve to each transmitter a signaling moment exclusive to itself, and centralized means responsive to signals initiated by each of said transmitters all operating over a predetermined radiant energy channel for registering the number of such signals as are of like character.

26. A device for initiating a sequential operation of different ones of a plurality of separated radio transmitters, comprising a radio receiver adjacent each transmitter, a common time signal source arranged and adapted to radiate one signal impulse at a predetermined moment, means including a time delay device connected with each of said separated radio transmitters, and differently operable in response to the reception of said time signal by each said radio receiver adjacent thereto, for initiating the operation of the several transmitters sequentially, and means for causing each transmitter to emit a selectively chosen signal of predetermined characteristic at

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a moment exclusively assigned to itself by its connected time delay device.

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