

Dec. 27, 1949

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2,492,180

RINGING ARRANGEMENT FOR ELECTRONIC SWITCHING SYSTEMS

Filed April 26, 1947

3 Sheets-Sheet 1

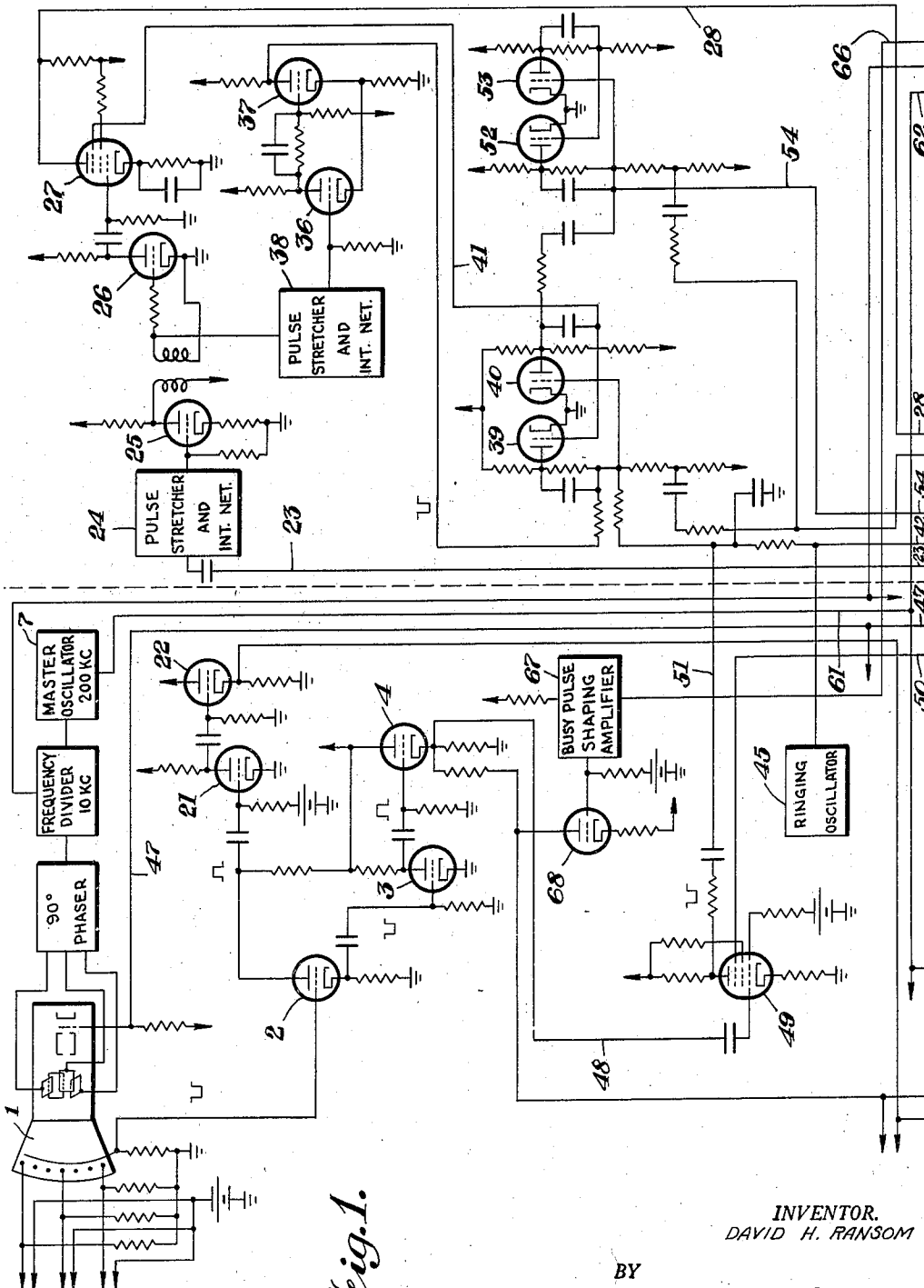


Fig. 1.

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3 Sheets-Sheet 2

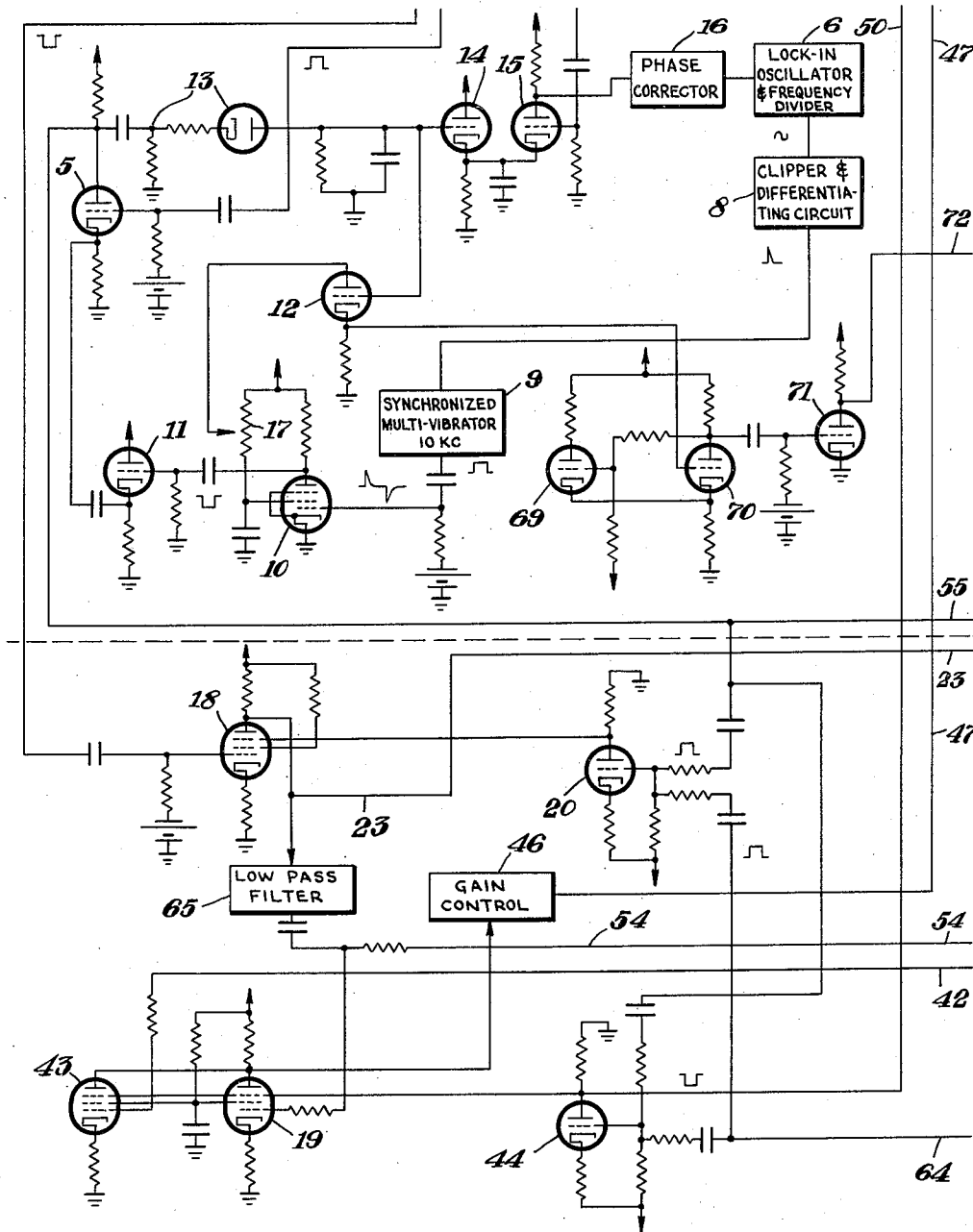


Fig. 2.

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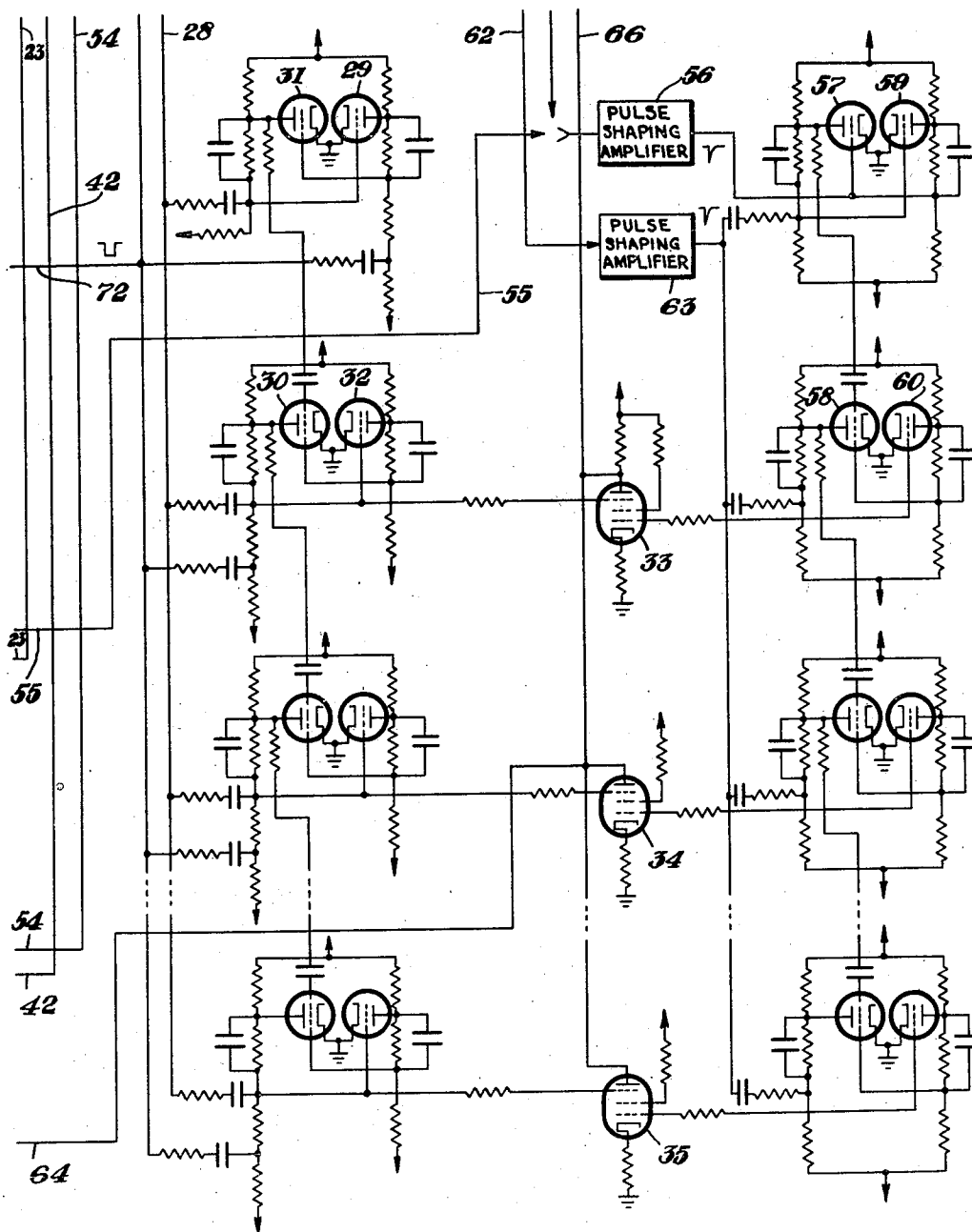


Fig. 3.

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2,492,180

RINGING ARRANGEMENT FOR ELECTRONIC SWITCHING SYSTEMS

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Application April 26, 1947, Serial No. 744,112

12 Claims. (Cl. 179—18)

1

This invention relates to new and useful improvements in telecommunication systems, and more particularly to electronically controlled systems of the type disclosed in my application, Serial No. 643,285, filed January 25, 1946.

It is the object of the present invention to provide a completely electronically controlled ringing arrangement for telephone systems of the above type.

The nature of the invention will more clearly appear from the appended claims and the following detailed description of an embodiment thereof. The drawings show diagrammatically as much of a telephone system as is necessary for an understanding of the invention.

Fig. 1 shows part of a subscriber's line circuit and the central exchange equipment common to a group of subscribers' lines, as well as the central exchange dial pulse responsive and ringing control equipment.

Fig. 2 illustrates the line finder and the talking circuit associated with a link, and

Fig. 3, the register and called line selector provided for a link.

When a subscriber desires to initiate a call, the operation of the switch-hook at his station places a negative potential on the dynode of the calling line in distributor 1. This will cause the flow of electrons from the dynode to the anode whenever the dynode is scanned by the cathode ray beam of the distributor 1. The negative pulse from the anode is fed to a cathode follower and inverter 2 whose cathode output is fed to a clipper amplifier 3. The amplifier 3 is biased to draw current normally whereby each negative pulse will drive it beyond cut-off, clipping any variation due to transmitter modulations or dial pulses. The plate output of tube 3 is fed to a cathode follower 4 whose cathode is connected to the grids of all line finder gate tubes 5. The line finder gate tubes are normally biased far enough beyond cut-off so that the incoming signal will not affect their plate output.

A lock-in oscillator 6 in each line finder operates at a frequency slightly less than the rate of dynode scanning controlled by a 200-kc. master oscillator 7. The output of lock-in oscillator 6 is divided to a frequency of approximately 50 kc. and is passed through a clipper amplifier and differentiating network 8 to a multivibrator 9 arranged to synchronize at 10 kc. The output of the multivibrator 9 is differentiated in the grid circuit of a clipper tube 10. The constants and bias of this tube are adjusted to form a short,

2

square wave of approximately five micro-seconds' duration in the plate circuit of the tube from the leading edge of the differentiated pulse and to suppress the trailing edge. The resulting negative pulse is passed through a cathode follower 11 to the cathode of the line finder gate tube 5. The amplitude of this pulse is adjusted by a delayed gain tube 12 so that normally the line finder gate 5 remains cut-off. Neither signal will drive the line finder gate 5 beyond cut-off to conduction.

The frequency of the line finder lock-in oscillator 6 being slightly less than that of the master oscillator 7, these two pulses applied to the line finder gate 5 will drift in time until they occur simultaneously, whereupon gate will be opened to pass a signal on its plate to the integrating net and rectifier 13. A gate control tube 14 will be driven to cut-off after a few pulses, permitting a lock-in gate 15 to pass a signal from the master oscillator 7 through a phase corrector 16 to the lock-in oscillator 6, synchronizing the latter.

A portion of the rectifier output of the line finder gate is fed to the grid of the delayed gain tube 12 which will be driven beyond cut-off after a few pulses. Since the plate resistor 17 of the delayed gain tube is connected with the screen and clipper amplifier 10, the screen voltage of the latter will rise and increase the amplitude of the pedestal pulse which is applied to the cathode of the line finder gate 5 whose grid will thus be driven positive by the incoming pulse from the common circuit, and clipping by grid current will occur. The signal amplitude of the incoming pulse will then be insufficient to affect the line finder gate in any other link.

The plate output of the line finder gate 5 is used to control the speech gates 18 and 19. 18 is normally biased to cut-off on its suppressor grid by the voltage drop in the plate resistor of a gate control tube 20. The negative pulse from the line finder gate 5 drives the grid of tube 20 beyond cut-off, putting the suppressor grid of the input gate 18 at ground potential, permitting the passing of signals that arrive on the control grid of input gate 18.

It is assumed that speech and dial pulses will modulate the line signals at twenty-five percent and the clipping action of tube 3 will cut off modulated portions so that a uniform signal will be available for the line finder circuit. However, a clipper tube 21 is biased so that only the modulated portion of the positive pulses from the plate of inverter 2 will appear in its plate circuit and

3

in the cathode follower 22. The output of the latter is fed over conductor 23 to the control grids of the input gate tubes 18 of all the links.

Normally the dial pulse circuit receives a series of negative pulses from the input gate 18 which are interrupted by each dial pulse. The positive pulses appearing in the plate circuit of the input gate 18 are passed over a conductor 23, through a pulse stretching and integrating network 24, to the grid of an amplifier 25, and the amplified low frequency dial pulses thus produced are shaped in an amplifier and clipper tube 26 to form square wave pulses which are, in turn, differentiated in the network connected with the grid circuit of a dial gate tube 27. This gate tube is biased so that the leading edge of the differentiated pulse will be suppressed and the trailing edge passed as a negative pulse over conductor 28 to the register circuits.

The register circuits are conventional Eccles-Jordan trigger circuits connected to form a strip count. Initially, the right-hand tube 29 of the No. 0 register and the left-hand tube 30 of the No. 1 register and of all subsequent registers are conducting. The first negative pulse will transfer conduction in the No. 0 register from triode 29 to triode 31. The latter, in turn, will put a negative pulse from its plate to transfer conduction in the No. 1 register from tube 30 to tube 32. The next pulse will repeat this sequence of operation in the No. 1 and No. 2 registers. After a series of pulses one register will remain conducting on its right-hand side which will bias the suppressor grid of the time channel gate tubes 33, 34, etc. 35 associated with this register, so that signals may be passed from the control grid thereof.

Referring now to the dial pulse circuit the leading edge of the first pulse will cause a flip-flop circuit, comprising tubes 36 and 37, to transfer conduction from 37 to 36. This condition will be maintained throughout the series of pulses by the potential built up in a pulse stretcher and integrating network 38 connected with the grid of tube 36.

At the end of the series of pulses, 37 will again become conductive, sending a negative pulse to the ringing gate control flip-flop circuit comprising tubes 39 and 40. Normally 39 is conducting, biasing over a conductor 41 and suppressor grid of the dial gate 27 to pass signals. The negative pulse at the end of the series of pulses will flip conduction to 40 and apply a biasing potential over conductor 42 to the control grid of a ringing gate 43. The suppressor grid of the ringing gate will be biased by the negative pulse output of gate control 44 which, under the control of the time channel gate, is operated to pass signals during the called time channel, permitting, in turn, through the agency of gate 43 to pass ringing signals during this period from a ringing oscillator 45, over the conductor 42, the gate 43, a gain control circuit 46, conductor 47, to the grid of the distributor 1. This signal will actuate a cold cathode gas relay at the called station to operate a visual or audible signal.

When the called subscriber answers, pulses are generated on the common anode of the distributor tube 1 during the called line period and are passed by the cathode follower 2, clipper 3 and output cathode follower 4, over conductor 48, to the control grid of a trip gate 49. The suppressor grid of 49 is connected over conductor 50 with the plate output of talking gate control 44. If the negative pulse thus applied to the suppressor

4

grid of trip gate 49 occurs at the same time as the positive pulse which is applied to its control grid over 48, then the trip gate will send a negative pulse over conductor 51 to the ringing gate control to flip conduction back to tube 39. This will cut off the ringing gate 43 and flip conduction in a talking gate control flip-flop circuit from a triode 52 to a triode 53. A pulse is now applied over conductor 54 to the control grid of talking output gate control 19 and will bias it to conduction.

The line selecting circuit (Fig. 3) counts the difference pulses set in the register on a counting circuit, synchronizing on each count with a pulse from the line finder gate 5 over conductor 55 and a pulse shaping amplifier 56. Normally the left-hand tubes of the counters, i. e. tubes 57, 58, etc., are conducting, and the synchronizing negative pulse will flip conduction to the right-hand tubes of the counters, such as 59, 60, etc. Negative pulses derived at five micro-second intervals from the master oscillator 7 in the common circuit are passed over conductors 61, 62 through a pulse shaping amplifier 63, and are fed to the grids of all the right-hand counters 59, 60, etc. The next pulse after the synchronizing pulse will transfer conduction in the No. 0 counter from 59 to 57, whereupon a negative pulse is sent from the plate of 57 to the grid of 58 in the No. 1 counter, flipping conduction to 60. Each successive pulse will flip a counter so as to make the right-hand tube conducting until all the counters are operated, the final pulse of the series restoring the circuit to normal. Thus, for the period of a count corresponding to the operated register, the grid of the gate tube for the pair will be made positive and the pulse will be fed to the gate control tubes by the associated time channel gate over conductor 64 to the control grids of the gate control tubes 44 and 20 in parallel. For example, if the No. 1 register is conducting on its right-hand tubes 32, then the positive bias on it is transferred to the suppressor grid to the No. 1 time channel gate 33, so that when in the No. 1 counter conduction is flipped to the right-hand tube 58, a negative pulse will be generated on the plate of 33 and passed, as above stated, over the conductor 64 to the control grids of 20 and 44.

The circuit is now ready to pass speech signals from the appropriate dynode of distributor 1 to cathode follower and inverter 2, clipper 21, cathode follower 22, conductor 23 and the control grid of input gate 18. This gate is opened by pulses from the gate control 20 which is opened not only by pulses applied thereto by the time channel gate 33 when the beam of the distributor 1 engages the dynode of the called line, but also by pulses applied thereto from the output circuit of line finder gate 5 when the beam of the distributor 1 sweeps over the dynode of the calling line. The signal from the plate of input gate 18 is fed over a low pass filter 65 where it is converted to the original speech and, thence, to the control grid of the output gate 19. The output gate is opened by the signal from the line selector circuit conveyed thereto via gate control 44 and corresponding, therefore, to the time period of the called line. The plate of the gate control 19 is connected as the plate of the ringing gate 43 over gain control 46 and conductor 47 with the grid of the distributor 1 as the beam sweeps the called line where it is passed through a low pass filter to the called subscriber's telephone set.

Speech in the opposite direction passes through

the same path, except that the timing of the input gate 18 is under the control of the line selecting circuit (Fig. 3) and the output gate 19 is under the control of the line finder circuit. Since there is a feedback path in this circuit to each terminal, the gain control circuit 46 is provided to insure that the gain around the system will always be less than unity.

The called line cannot be selected by a line finder when the receiver is removed from the hook of the telephone set at the called station, because the pulses from the operated time channel gate 33, 34, etc. are fed over a conductor 66 and a busy pulse shaping amplifier 67 to the grid of a busy gate 68. This tube will place a negative pulse on the grids of all the line finders which will neutralize the positive line pulse.

When the calling subscribed hangs up, the circuit releases under the control of the delayed gain tube 12 through the agency of a release control flip-flop circuit comprising triodes 69 and 70 and a release tube 71. At the start of the call, the delayed gain tube 12 is driven to cut-off, lowering the potential on the control grid of 70. This will transfer conduction from 69 to 70, sending a negative pulse to 71 which is biased beyond cut-off and has, therefore, no effect. When, however, the line finder releases, then 69 in the release control circuit again becomes conductive and sends a positive pulse to 71 which transmits a negative pulse over conductor 72 to restore the operated register and the dial gate control to normal.

The circuit is now ready for the next call.

What I claim is:

1. In a communication system, a plurality of lines, an electronic means common to said lines and having a plurality of electrodes in which the lines terminate, a control grid, and means for cyclically sweeping with an electron beam the electrodes to establish connection therewith, a signal repeater having an output connected with said control grid to vary therethrough the intensity of the beam in accordance with signals, a source of signaling potentials, timing means for applying to the repeater signals originating on calling and called lines when the beam of said electronic means sweeps over their terminals, and timing means for applying to the repeater signals from said source when the beam of said electronic means sweeps over the called line terminal.

2. The system according to claim 1, and in which the electronic means comprises a cathode ray tube.

3. The system according to claim 1, in which the signal repeater comprises two discharge tubes having input and output circuits, means for effectively associating the input circuit of one tube with the electrodes of the calling and called lines when they are swept by the beam, means for associating the input circuit of the other tube with said source when the terminal of the called line is swept by the beam, and means for effectively associating the output circuits of both tubes with the control grid when the beam sweeps the electrodes of the calling and called lines.

4. The system according to claim 1, a plurality of signal repeaters, each having a source of signaling potentials, means operative upon the initiation of a call for taking into use one of said repeaters, means for disconnecting the source from the repeater when the called line answers, and means for releasing the repeater taken into use upon the termination of the call.

5. In a communication system, a plurality of lines, electronic means having means for moving

a beam of electrons, a control grid for the beam and a plurality of electrodes in which said lines terminate, means for operating said electronic means continuously and cyclically to sweep said terminals with its beam, a plurality of normally inactive links, a signal input tube and pairs of signal output tubes in each link, input, output and control circuits for the tubes, a source of signaling potentials in each link, means operative upon the initiation of a call on a line for selecting a link, means for operating the control circuit of the first output tube in the selected link when the beam sweeps the electrode in which the called line terminates and ineffective at all other times, means for operating the control circuits to render effective the input and the second output tube in the selected link when the beam sweeps the electrodes in which the calling and called lines terminate and ineffective at all other times, a connection from the output of the input tube to the input of the second output tube, means for associating the input of the input tube with the electrodes in which the calling and called lines terminate when they are swept by the beam, means for associating the input of the first output tube with said source when the called line terminal is swept by the beam, and means for connecting the output of both output tubes with the control grid when the electrodes of the calling and called lines are swept by the beam.

6. The system according to claim 5, in which each link has a normally inactive line finder gate tube and called time channel selector gate, means for actuating said line finder gate tube upon the initiation of a call, means for operating the line finder gate tube to convey signals from the calling and called lines to the signal input tube whenever the electron beam sweeps over the terminating electrodes thereof, and means for operating the selector gate tube to convey signals to both output tubes when the electron beam sweeps over the terminating electrode of the called line.

7. A system for interconnecting two channels of different time displacement for two-way energy transfer between said channels, comprising a first means for receiving energy from either channel, a second means for applying energy to either channel, means for transferring energy from said first to the second means, selectively operable means for producing a time displacement of the energy received from one channel equal to the difference in time displacement between said channels, line finder means responsive to energy received from a channel, a source of signaling potential associated with said selectively operable means, a third means for transferring energy from said source to said second means, means jointly controlled by said line finder and selectively operable means for alternately operating said first means under the control of both channels, and means controlled by said selectively operable means for effecting energy transfer from said source under the control of one channel.

8. The system according to claim 7, and in which said first, second and third means are normally ineffective vacuum tubes, means jointly controlled by the line finder and selectively operable means for alternately rendering the first and second tubes effective, and means controlled by the selectively operable means for rendering the third tube effective.

9. A telephone system for interconnecting calling with called channels of different time displacement for two-way speech over said chan-

7

nels, comprising a speech input tube for receiving energy from the calling and called channel, a speech output tube for applying energy to the calling and called channel, a source of signaling potential, a signal output tube operated by said source, a connection for operating the speech output tube in accordance with the operation of the input tube, selectively operable means for producing a time displacement of the energy received from one channel equal to the difference in time displacement between said calling and called channels, line finder means responsive to energy received from a channel, means jointly controlled by said line finder and selectively operable means for alternately rendering effective said input and signal output means, and means controlled by the selectively operable means for rendering effective the signal output tube only during the called channel.

10. The system according to claim 9, and means controlled over the called channel for rendering ineffective the signal output tube.

11. In a telephone exchange system, a cathode ray tube having a control grid and a plurality of dynodes, means for continuously rotating the beam of said tube successively to engage said dynodes, a telephone line connected with each dynode, a speech input, a speech output and a ringing gate tube each having a cathode, an anode, a control grid and a suppressor grid, the three gate tubes being common to all telephone lines, a connection from the control grid of the cathode ray tube to the anodes of the output and ringing gate tubes, gain control means in said connection to keep the total gain around the system at less than unity, a connection for applying potentials to the control grid of the input gate tube through the dynodes of the calling and the called line, two triodes common to said lines, one for applying potentials to the suppressor grid of the input and the other for applying potentials to the suppressor grids of the output and ringing

8

gate tubes, a line finder gate tube common to said lines controlled by energy applied to the dynodes, a multiple connection from the output of the line finder gate tube to the grids of said triodes, a connection from the plate of the input to the control grid of the output gate tube, a low pass filter in the last-mentioned connection, a line selecting circuit comprising register and counter tubes variably operable in accordance with the designation of the called line, a ringing oscillator associated with said line selecting circuit and connected with the control grid of the ringing gate, time channel gate tubes controlled by the counters, and means operable upon the actuation of any time channel gate tube for applying a potential to the multiple connection to the grids of the triodes.

12. In a telephone system, a plurality of lines, electronic switching means for establishing a two-way talking connection between a calling and a called line, electronic distributor means common to said lines for establishing time channels during which the switching means becomes effective for a connection, electronic ringing means associated with the switching means and common to said lines, electronic means common to said lines for rendering the ringing means effective upon the selection of the called line, and electronic tripping means common to said lines for the ringing means operated when the called line answers.

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