Dec. 27, 1949 J. P. LEKAS 2,492,160

MULTITONE KEYER

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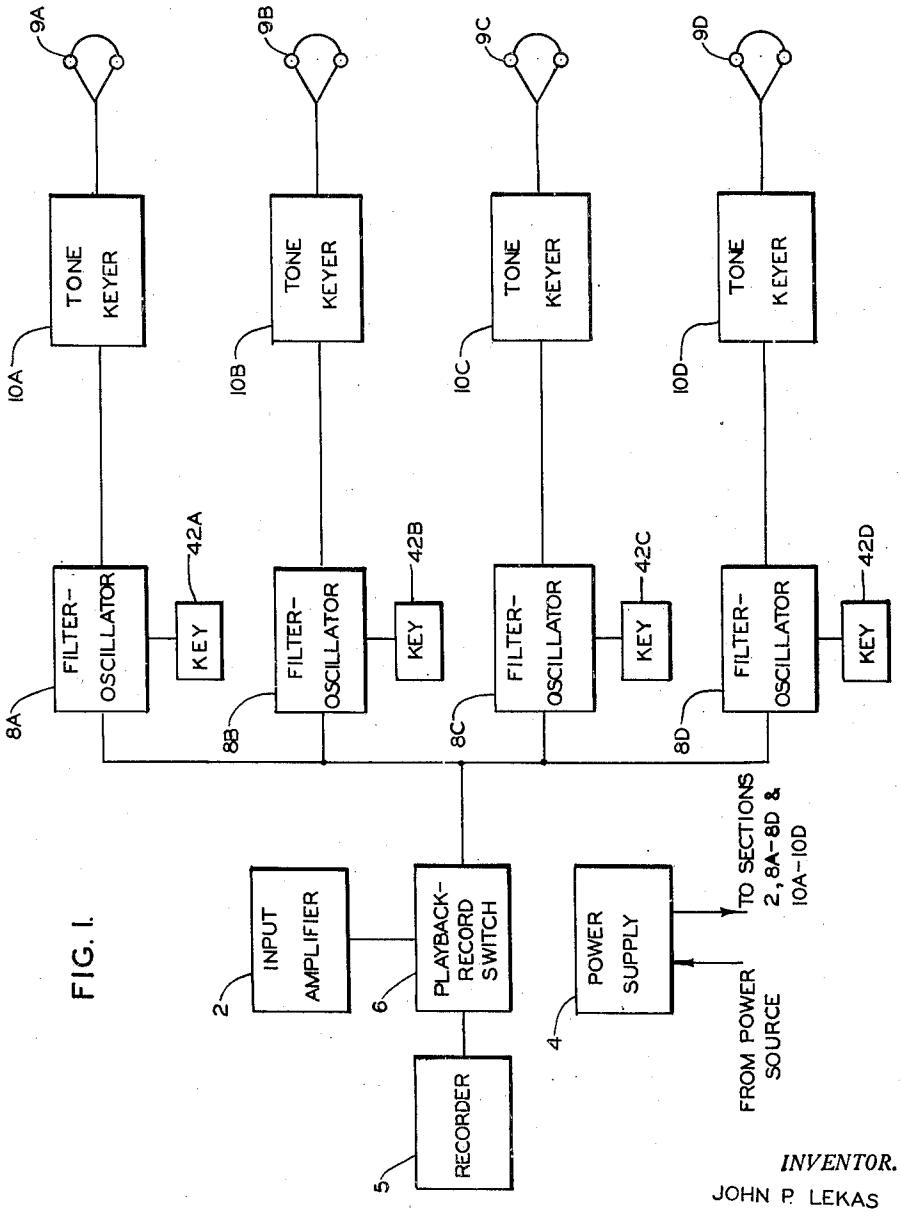


FIG. 1.

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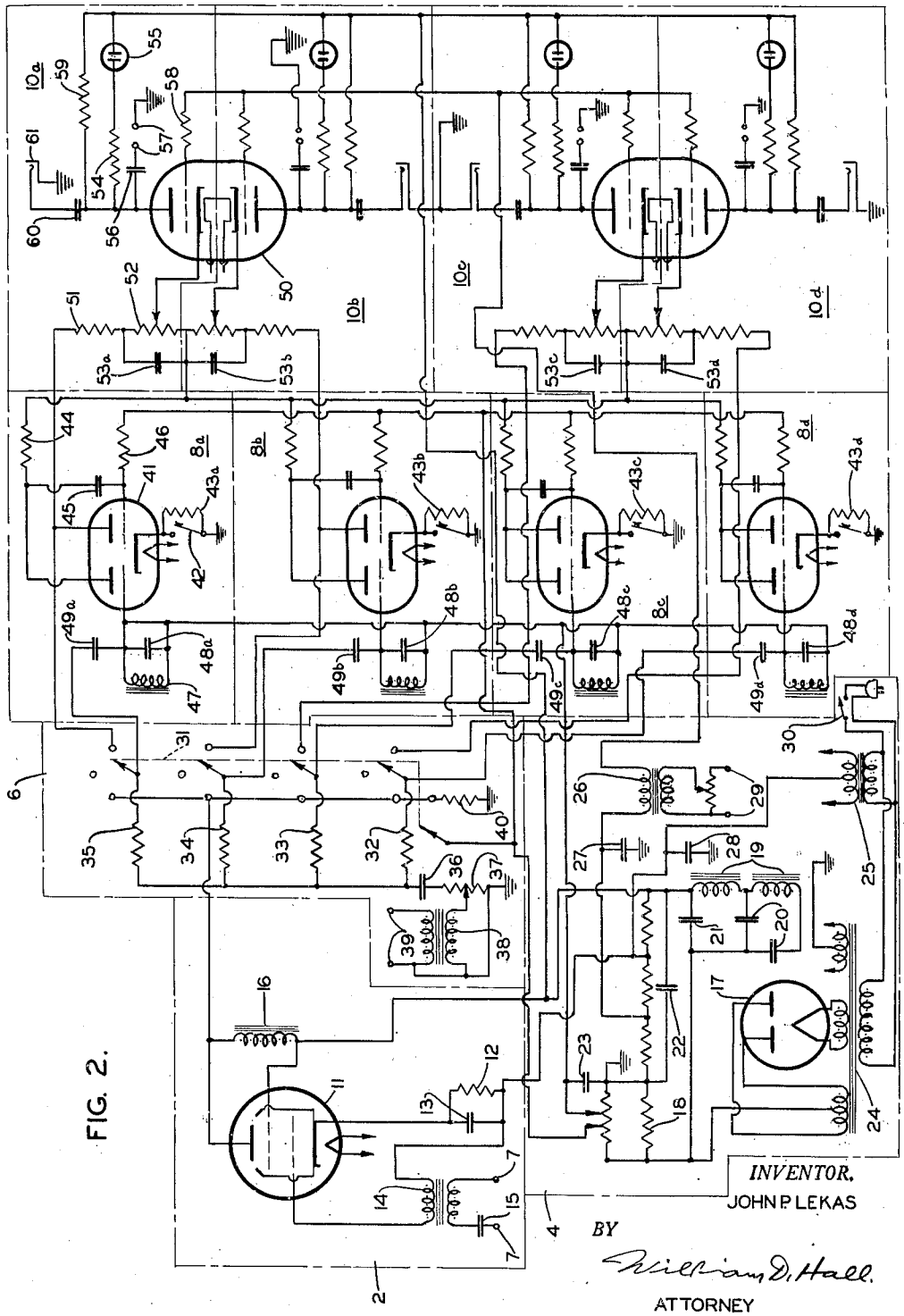


FIG. 2.

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MULTITONE KEYER

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1 Claim. (Cl. 178—115)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a multi-tone keyer utilizing a plurality of audio-frequency channels. Heretofore in giving students code tests, it has been customary to have each student operate a key which was part of a circuit including a recording machine and a record, the student's record being subsequently played back and his performance graded. This required a complete system including a key, amplifier, recorder, record, etc., for each student. It is desirable from the point of view of economy of operation and initial cost as well in the interests of compactness to use a single recorder and record to receive the signals from a plurality of keys.

In accordance with the present invention a large number of students, four to eight or more, may operate separate keys and through the use of tone monitors and filter-oscillators a single recording machine and record will register the individual key signals simultaneously on the same record.

Accordingly, it is an object of this invention to provide means whereby various channels will be recorded simultaneously by a single machine on one record.

A further object is to record intelligence, music, etc., through the use of two or more carrier bands on a single recording medium and to replay simultaneously over one circuit or separately over two or more circuits.

A further object of this invention is to provide a playback booster circuit.

These and other objects of the invention will be apparent in the specification and claim and in the appended drawings in which:

Figure 1 represents a block diagram of the multi-tone keyer; and

Figure 2 is a schematic circuit of the keyer blocked in accordance with the diagram of Figure 1.

In Figure 1, 2 designates the input amplifier for amplifying signals coming into the multi-tone keyer filter sections from the recorder 5. It consists of a single amplifier pentode tube and suitable components and will be described in detail below. 4 designates the power supply for providing operating voltages and currents to all sections of the multi-tone keyer except block 6 and consists of a rectifier tube and suitable filters and transformers. Playback record switch 6 is a five-pole three-position switch and functions

2

to change the circuit from a tuned amplifying system to an oscillator system and vice versa. Filter-oscillator sections 8*a*, 8*b*, 8*c*, and 8*d* each comprise a double triode tube so arranged that in the recording position of the playback-recording switch the section functions as a Franklin oscillator generating a specific frequency and in the playback position of the playback record switch each acts as a tuned amplifier which filters out and separates the specific frequency it previously generated. The tone monitoring sections 10*a*, 10*b*, 10*c*, and 10*d* cause incoming and outgoing frequencies present in the filter-oscillator sections to become audible in earphones 9*a*, 9*b*, 9*c*, and 9*d*. This is accomplished by one-half a double triode tube which turns on and off an external tone in exact synchronism with the filtered or generated frequency appearing in the filter-oscillator section preceding it. Each tone-monitoring section also includes earphone jacks, a neon lamp for visual indication of keying, and components suitable to the operation of the section as a monitoring device.

In Figure 2 the input amplifier 2 includes a standard beam pentode 11 or equivalent used to amplify incoming signals from the recorder which are fed to the amplifier through terminals 7. The input circuit includes a coupling capacitor 15 and step-up audio transformer 14. Resistor 12 enables the tube 11 to operate as a class "A" amplifier and by-passing capacitor 13 supplies a path for the alternating components of the tube cathode current. A coupling choke 16 connects this tube to the playback-record switch 6. Power is supplied from a conventional power supply 4 which utilizes, for convenience, a full wave rectifying tube 17 which may be of the mercury vapor type. A voltage divider network 18 supplies operating potentials to the various sections, the rectifier including chokes 19 and capacitors 20 and 21 as well as filter capacitors 22, 23, 27, and 28. A transformer 24 provides both plate voltage and heater current to the power supply; a separate transformer 25 supplies filament voltage for the keying section of the multi-tone keyer. A step-up transformer 26 receives an 850 cycle tone signal through terminals 29 and supplies voltage at this frequency to the headphones 9*a*, 9*b*, 9*c*, and 9*d* (Fig. 1) through keying blocks 10*a*, 10*b*, 10*c* and 10*d*, respectively.

The playback-record switch 6 includes a five-pole three-position switch 31 connected as shown. In playback position the output of block 2 is fed into blocks 8*a*, 8*b*, 8*c*, and 8*d* and the tubes 41 in these blocks are connected as tuned-voltage am-

plifiers for filtering out the recorded frequencies.

When the switch is in center position the entire keyer is inoperative. When the switch is in the right or record position the tubes in blocks 8*a*, 8*b*, 8*c*, and 8*d* are connected as oscillators and their outputs are mixed through resistors 32, 33, 34, and 35, and pass through capacitor 36 which blocks off the direct current in the output, and through potentiometer 37 which acts as an output voltage control into a step-down audio transformer 38 whose output terminals 39 connect to the recorder input. Resistor 40 lowers the operating bias on the tubes in block 8*a*, 8*b*, 8*c*, and 8*d* so that they will oscillate more readily. This resistor is removed from the circuit in the playback position of the switch.

Each of sections 8*b*, 8*c*, and 8*d* are identical to section 8*a* with the exception of capacitors 48 and 49 and resistor 43. Capacitors 49*b*, 49*c*, and 49*d* have increasing capacitance as compared to capacitor 49*a*. Capacitors 48*b*, 48*c*, and 48*d* have increasing capacitance as compared with 49*a* so that the circuits 8*a*, 8*b*, 8*c*, and 8*d* are tuned to successively lower frequencies. Resistors 43*b*, 43*c*, and 43*d* are increasingly lower as compared with resistor 43*a*. In a four-circuit arrangement as shown these frequencies may be as follows: 8*a*—2,750 cycles; 8*b*—2,250 cycles; 8*c*—1,750 cycles; and 8*d*—1,250 cycles.

The tone keying sections 10*a*, 10*b*, 10*c*, and 10*d* each include one-half of a double triode 50 having a separate cathode for each triode. A coupling resistor 51 connects to a potentiometer 52 for controlling the voltage on the cathode of triode 50, and a condenser 53 by-passes the alternating component of the plate current of the preceding filter-oscillator tube. 54 is a plate coupling resistor for the triode, the neon lamp 55 in series with this resistor giving a visual indication of the keying.

A capacitor 56 couples the earphones, to be connected at terminals 57, to the triode section of the tube. A corresponding capacitor 60 permits coupling through jack 61, of monitoring earphones, not shown. A resistor 58 acts as the grid coupling resistor through which the 850 cycle tone signal passes. When the second half of double triode 41 which forms part of block 8*a*, is drawing current due to a signal on its grid, its plate current is fed through plate coupling resistor 51 and the direct-current component of its plate current develops a voltage across 52. This voltage is applied to the cathode of one-half of double-triode tube 50 cancelling the negative bias supplied by voltage divider 18 in power supply block 4 and permitting the tone voltage impressed on the grid of the tube by transformer 26 through resistor 58 to be amplified by the tube and heard in the earphones. Resistor 59 connects across neon lamp 55 allowing the voltage to leak off the neon lamp when only cutoff current is flowing through the triode, thereby preventing random flickering at those periods when the lamp should have been dark. Blocks 10*b*, 10*c*, and 10*d* are identical to block 10*a* except that capacitors 53*b*, 53*c*, and 53*d* are of greater capacity than capacitor 53*a* to provide by-passing of alternating current components at progressively lower frequencies and each block is connected to its corresponding filter oscillator block 8*b*, 8*c*, and 8*d* respectively.

In operation when switch 6 is in the record position each of the four twin triode tubes 41 is connected in a form of cascade oscillator circuit with a parallel resonant circuit as the grid impedance in the first triode section of each tube. Thus, when oscillating each tube generates a frequency or channel which depends on the resonant frequency of the particular resonant circuit in its grid circuit. The second triode section of each tube 41 is used to invert the phase of voltage supplied to it by the plate of the first section so that sustained oscillation results. In the four channel multi-tone keyer, four resonant circuits are used, one in the grid circuit of the first triode section of each double triode and each is tuned to a different frequency—1,250, 1,750, 2,250, and 2,750 cycles per second as previously stated. The oscillations are started and stopped, that is, they are keyed by grounding the cathodes through keys 42. The four generated frequencies are tapped off by high resistances connected to the plate of the second triode section of each tube 41. At their other ends these resistors are connected to a potentiometer through a blocking capacitor. In this way, the four frequencies are mixed into a common output which is supplied to the recorder and impressed on the record. The blocking capacitor is used to keep the plate supply voltage from grounding. However, the generated frequencies are too high for ready hearing, therefore an auxiliary 850 cycle tone supplied through terminals 29 is used so that students can conveniently monitor their own sending. This tone is applied through a volume control such as a potentiometer across terminals 29 into audio transformer 26 and from there to the four sections of two additional twin triode tubes 50 in sections 10*a*, 10*b*, 10*c*, and 10*d*. The plate current of each of the four preceding tubes 41 is caused to flow through the cathode potentiometer 52 of a corresponding section in tubes 50 in such a way that it will drop the bias of tube 50 and cause the 850 cycle tone on the grid to be heard in the headset which is coupled to the plate through a capacitor 56. However, when the preceding section 8 is not drawing current, that is when tube 41 is not oscillating, there is a negative voltage drop across the cathode potentiometer of the corresponding section 10 and the bias on the grid is of high negative value which cuts off the plate voltage of this section and does not allow the 850 cycle tone to be heard. Thus, the 850 cycle tone in the plate circuit of the monitoring tubes follows accurately the generation of the higher frequencies which are actually recorded and affords a pleasing monitoring note which is easy to copy. The by-pass capacitor across each cathode potentiometer by-passes the alternating component of the plate current and keeps it from modulating the 850 cycle monitoring tone.

After the record has been made it is played back with switch 6 in playback position. In this position tubes 41 are connected as two stage tuned voltage amplifiers with the parallel resonant circuits still across the grids of the first triode sections of these tubes. Each resonant circuit now selects its own previous frequency, that is, the one previously generated and passes it on to its own tube 41. The second triode section of each tube 41 now functions as the second stage of the same stage amplifier and its plate current passes through the corresponding cathode potentiometer of each of sections 10*a*, 10*b*, 10*c*, and 10*d*. This causes tube 50 to function exactly as during the record connection so that it is now monitoring the signal coming in from the recorder. In this way, the 850 cycle tone follows accurately the keying of the particular channel as it was record-

ed. Also in the playback position tube 11 is inserted in the circuit as an impedance coupled amplifier to boost the output of the recorder during the playback period. The output of the recorder feeds in through terminals 7 and transformer 14 into the grid of tube 11 which amplifies the signal and passes it through switch 6 from which it goes to the first section of twin triodes 41 and behaves as described above. Tube 11 is idle during the record period and may draw plate and filament current but remains disconnected otherwise. The recording level is adjusted by the use of the output potentiometer on the keyer. Either automatic or handkeying may be used with this keyer since it will follow any speed. The only precaution to be taken is to insure that the key is closed during the playback period so that the high cathode to ground resistance 43 is shorted. Conventional receiver type tubes may be used throughout the circuit. Thus, tube 17 may be a type 83 tube; tube 11 may be a type 6L6; tubes 41 may be type 6SC7 and tubes 50 may be type 6F8G or equivalent. If preferred each of twin triodes 41 and 50 may be replaced with two separate triodes. Chokes 47 may be of the iron dust core loading coil type used in telephone work. While resistances 52 are shown as potentiometers they can be replaced by plain resistors of equivalent value with the cathode lead tied to the junction of the cathode resistor and the plate resistor.

In the four channel keyer given by way of example a width of only 1500 cycles is used. As the recorder can handle a considerably wider band and since the channels can be placed much closer together than shown in the example, eight or ten channel keyers are entirely practical within the teachings of this invention.

It is also possible to use this keyer in such a way that several practice code tests may be recorded at different speeds each occupying its own band or channel. If a magnetic recorder is used and the tape or wire is made long enough such a unit will provide a compact means of furnishing a dozen or more code speeds simultaneously for several hours without interruption and is ideal for use in code schools, thereby replacing a dozen

or more bulky, expensive and noisy keyers of the usual type.

It is also possible to utilize this keyer in radio intercepting units for recording received signals or for recording several data simultaneously such as meteorological observation signals transmitted at various frequencies.

While only a single modification of the present invention has been shown it may take various forms and embodiments all of which are readily apparent to one skilled in the art and it is not intended that the invention should be limited except in accordance with the appended claim.

I claim:

A multi-tone keyer including a plurality of oscillators each producing a different audio frequency, each of said oscillators comprising a tuned circuit, a controllable discharge device, and a switch, said switch connecting said tuned circuit to said controllable discharge device as an oscillator in a first position and as a tuned filter in a second position keying means to actuate each of said oscillators, a recorder connected to said oscillators through said switch in said first position for simultaneously recording the outputs of the oscillators, means for playing back the recorded signals, said last named means connected through said switch in said second position to each of said tuned filters for separating the reproduced signals into their original audio frequencies, an independent source of audio frequency signals, and means associated with said tuned filters, responsive to said audio frequencies for controlling the independent audio frequency signals in accordance with said audio frequencies.

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