

Nov. 19, 1963

R. A. BOENNING ETAL
CONTACT SWITCH DEVICE

3,111,608

Filed Feb. 27, 1961

2 Sheets-Sheet 1

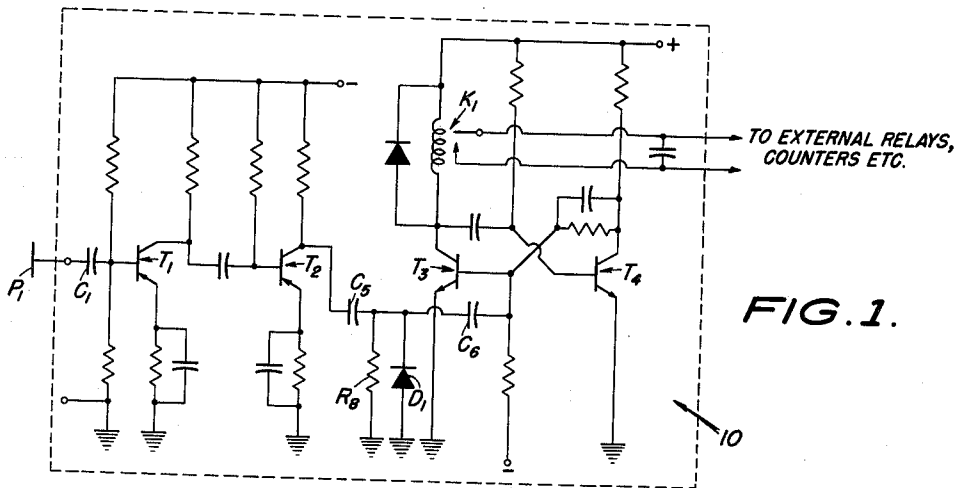


FIG. 1.

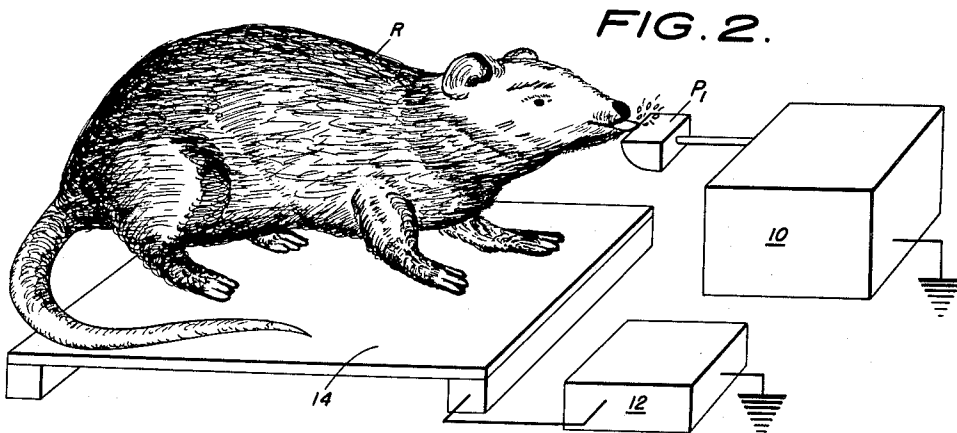


FIG. 2.

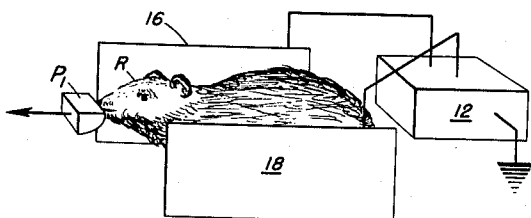


FIG. 3.

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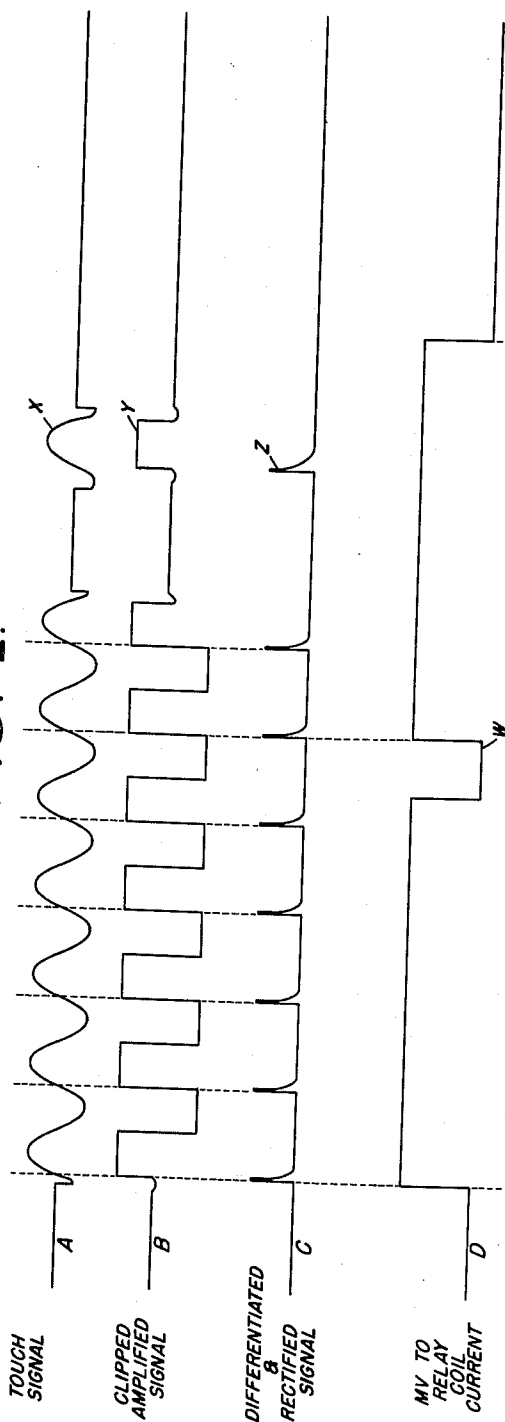
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FIG. 4.



RELAY K_1
ARMATURE
&
OUTPUT

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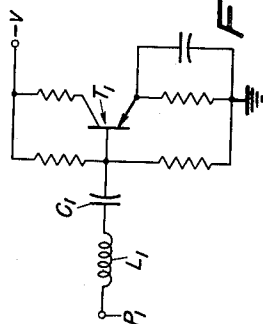
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TO T_2 OF
CONTACT SWITCH
AMPLIFIER

FIG. 5.

TO
SENSORY
PLATE

FIG. 6.



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CONTACT SWITCH DEVICE

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10 Claims. (Cl. 317-146)

This invention relates generally to electric circuit makers, and more particularly it pertains to a touch responsive switch apparatus.

In psychological and biological research, it is frequently desirable to use a touch or contact response switch device to operate counters, kymographs and other recording equipment. In industry, it is of advantage to cause electrical devices to turn on or off by similar light touch or even proximity effect.

An example of the use of an electronic contact switch is in the studies of fluid consumatory behavior of animals or in research on taste sensitivities or preferences for various solutions. A switch of this type permits the recording of every lap of the tongue of the animal as well as the frequency and distribution of the laps.

Because the driving signal is an alternating current, the net ionization is zero, with the taste perception being unaltered. Corresponding usage of such an electronic contact switch device in industry would be for package counting, burglar alarms, door bell or elevator "signal buttons" and the like.

A true touch responsive switch requires no effort to manipulate, and, in addition, no sensation of its functioning is perceptible to the operating organism.

Accordingly, it is an object of this present invention to provide a contact switch arrangement for imperceptibly closing an electric circuit.

Another object of this invention is to provide a non-reactive touch counting system.

And another object of this invention is to provide a touch or proximity operated circuit closing device which makes definite, rapid circuitry closure for each touch or approach thereof, however indefinite.

And still another object of this invention is to provide a touch switch device which will not overload and which can be set to ignore indefinite trains of triggering associated with a positive touch.

And still another object of this invention is to provide a switch device which will be frequency-selective.

These and other objects and attendant advantages of this invention will become more readily apparent and understood from the following detailed specification and accompanying drawings in which:

FIG. 1 is a schematic diagram of an electrical contact switch device incorporating features of the present invention;

FIG. 2 is a schematic perspective of a laboratory setup employing the novel contact switch device of FIG. 1;

FIG. 3 is a schematic perspective of a modification of the laboratory setup shown in FIG. 2;

FIG. 4 is a time phase diagram of the operation of the electrical control switch device of FIG. 1;

FIG. 5 is a schematic diagram of an emitter follower front end stage for increasing the input impedance of the amplifier of the contact switch device of FIG. 1, for proximity operation; and

FIG. 6 is a schematic diagram of a series resonant circuit added to the first stage for frequency selective operation.

Referring now to the details of the drawings, the contact switch device illustrated in the electrical circuit of FIG. 1 is designated generally by reference numeral 10. This contact switch device 10 consists basically of a cas-

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cade amplifier arrangement formed of two common emitter connected transistors T_1 and T_2 and a monostable multivibrator consisting of two transistors T_3 and T_4 . A relay K_1 provides for the external circuitry closure.

As will be further described and illustrated in FIGS. 1 and 4, the touch signal or trigger consists of an impulse of sinusoidal wave form, for example, a signal of 8,000 cycles per second which is applied by the animal to contact P_1 of any desired type.

A short connection is made therefrom to a capacitor C_1 and thence to the base of the transistor T_1 . The amplified output of transistor T_1 , the touch signal A of FIG. 4 is, in turn, applied to the base of the transistor T_2 which is biased such that clipping occurs at a low input amplitude.

The output of transistor T_2 is then a square wave, shown as the clipped amplified signal B in FIG. 4, which is passed through a differentiating network consisting of a capacitor C_5 and a resistor R_8 to produce sharp positive and negative spikes. The negative spikes are removed by a semi-conductor diode D_1 , leaving a differentiated and rectified output signal C which consists of a series of positive trigger pulses, one for each positive square wave loop, with the number of signal pulses being determined by the duration of the touch contact response itself.

The trigger signal pulses are then applied to the multivibrator transistors T_3 and T_4 through a coupling capacitor C_6 . The time constant of the multivibrator which, as previously pointed out, consists of transistors T_3 and T_4 , is adjusted such that conduction is transferred from transistor T_4 to transistor T_3 for a period of approximately 450 microseconds, in the example, so that each fifth trigger pulse of the differentiated and rectified output signal C will retrigger the circuit.

As a result, the relay K_1 in the collector circuit of the transistor T_3 is energized for approximately 90% of the switching cycle with no current flowing through it for the remaining 10% (as shown by signal W in the wave form D of FIG. 4). Because of the mechanical inertia of the armature of the relay K_1 and the electrical inertia of its coil, the relay K_1 cannot follow the very short off period and it remains closed as shown in its operation cycle E as long as trigger pulses of the differentiated and rectified signal C are supplied. Consequently, the relay K_1 closes on the first trigger pulse and it opens and remains open after the last of a consistent group, with each relay operation corresponding to one complete "on-off" contact. Depending on the type of relay used, contacts by the tongue of the animal R, on the contact P, in excess of 25 per second can be reliably followed by the relay K_1 .

The driving signal for the system is supplied by an oscillator 12, shown in FIGS. 2 and 3, having a low impedance output. This driving signal may be applied directly to a ground-isolated metal floor 14 upon which the animal R stands and makes electrical contact therewith as shown in FIG. 2, or to spaced metal plates 16 and 18, as shown in FIG. 3, between which the animal R stands. If the resistance of a rat is estimated at 100,000 ohms, a signal applied directly to the floor 14 need have only a magnitude of approximately 0.2 volt to reliably trigger the multivibrator in the prototype apparatus. A higher voltage is needed, which can be found by trial and error, where the signal is applied by spaced plates 16 and 18 as mentioned above in connection with FIG. 3.

The use of a multivibrator time constant of approximately 450 microseconds, in the prototype apparatus, insures freedom from response to stray transients X (as shown in the curve of the touch signal A) that may find their way into the circuit, as shown in FIG. 4, since a transient is not periodic and therefore cannot trigger the multivibrator for the number of cycles sufficient to activate the relay K_1 even though it produces a clipped signal

and a differentiated pulse Y and Z in waveforms B and C, respectively. Also, because of the low power requirements of the transistorized contact switch device 10, the operation is extremely economical for long time operation and completely eliminates problems due to heat generation.

A relay K₁ is typically used to switch another (external) relay having multiple contacts with high current ratings in order to operate counters, stepping switches and other circuit elements as desired.

The addition of an emitter follower stage as shown in FIG. 5, ahead of the first stage as illustrated in FIG. 1 permits proximity operation. When the animal R of FIG. 2, for example, nears the sensory plate shown in FIG. 5, the operating signal is capacitively coupled to the base of the transistor T₁ of FIG. 5, which, in turn, couples the signal, at low impedance, to the base of transistor T₁ of FIG. 1, through the capacitor C₁ to effect operation as previously described.

The addition of a frequency selective circuit, consisting of inductor L₁ and capacitor C₁ of FIG. 6, ahead of the first stage of FIG. 1, permits frequency selective operation. Two or more contact switch devices, consisting of the circuits of FIG. 2 and FIG. 6 as stated may be connected to a common point, P₁ of FIG. 6, the common point connected, in turn, to oscillators, the frequencies of which match the resonant frequencies of the tuned circuits. If an oscillator is then switched on, the contact switch device with the series resonant circuits resonant at the oscillator frequency will be triggered and operation will be as previously described.

This frequency selective device can be utilized, for example, to activate electrical circuits, by means of relay K₁, in response to programming signals coded with respect to frequency.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A contact switch apparatus responsive to the presence of an object to operate a pair of spaced contacts, comprising, means to supply an alternating current signal, amplifying means to convert said alternating current signal to a square wave output signal, said amplifying means being electrically connected to said means to supply an alternating current signal by the presence of said object and said square wave output signal being representative of the duration of the presence of said object as well as being indicative of its presence per se, means for converting said square wave output signal to unidirectional pulses, means for providing a substantially constant duration current pulse from said unidirectional pulses, and means for utilizing said substantially constant duration current pulse to actuate said pair of spaced contacts.

2. A contact switch apparatus responsive to the presence of an object to operate a pair of spaced contacts, comprising, means including an oscillator to supply an alternating current signal, amplifying means to convert said alternating current signal to a square wave output signal, said amplifying means being electrically connected to said oscillator by the presence of said object and said square wave output signal being representative of the duration of the presence of said object as well as being indicative of its presence per se, means to convert said square wave output signal to unidirectional trigger pulses, means for providing a substantially constant dura-

tion current pulse from said trigger pulses, and means for utilizing said substantially constant duration current pulse to actuate said pair of spaced contacts.

3. A contact switch apparatus responsive to the presence of an object to operate a pair of spaced contacts, comprising, means including an oscillator to supply an alternating current signal, amplifying means to convert said alternating current signal to a square wave output signal, said amplifying means being electrically connected to said oscillator by the presence of said object and said square wave output signal being representative of the duration of the presence of said object as well as being indicative of its presence per se, means to convert said square wave output signal to unidirectional trigger pulses, means responsive to a predetermined number of said trigger pulses to provide a constant duration current pulse therefrom, said last mentioned means being re-triggered by trigger pulses which exceed said predetermined number thereof to provide subsequent constant duration current pulses, means including a relay responsive to said constant duration current pulses to actuate said pair of spaced contacts.

4. A contact switch apparatus responsive to the presence of an object to operate a pair of spaced contacts, comprising, means including an oscillator to supply an alternating current signal, amplifying means to convert said alternating current signal to a square wave output signal, said amplifying means being electrically connected to said oscillator by the presence of said object and said square wave output signal being representative of the duration of the presence of said object as well as being indicative of its presence per se, means to convert said square wave output signal to unidirectional trigger pulses, means responsive to a predetermined number of said trigger pulses to provide a constant duration current pulse therefrom, said last mentioned means being re-triggered by trigger pulses which exceed said predetermined number thereof to provide subsequent constant duration current pulses separated from each other by a momentary current stoppage, means including a relay responsive to said constant duration current pulses to actuate said pair of spaced contacts, said relay having sufficient inertia to remain substantially unaffected by said momentary current stoppage.

5. The contact switch apparatus of claim 4 wherein said means responsive to a predetermined number of said trigger pulses has a time constant to thereby be unaffected by trigger pulses resulting from transient output signals from said oscillator.

6. The contact switch apparatus of claim 4 wherein said object is electrically conductive.

7. The contact switch apparatus of claim 4 wherein the alternating current signal supplied by said oscillator is of low impedance.

8. A contact switch apparatus as recited in claim 4, wherein said unidirectional pulses are regularly spaced.

9. A contact switch apparatus as recited in claim 4, and additionally a device for changing the input impedance of said unidirectional pulse providing means.

10. A contact switch apparatus as recited in claim 4, and additionally circuit means for rendering said unidirectional pulse providing means frequency selective.

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