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Johnston et al.

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[45] Nov. 13, 1973

[54] MAGNETIC PULSE GENERATOR

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

[22] Filed: **July 14, 1972**

[21] Appl. No.: **271,877**

[52] **U.S. Cl.**..... **340/224,** 310/14, 340/274
[51] **Int. Cl.**..... **H02k 41/00,** G08b 13/08
[58] **Field of Search**..... 340/224; 325/185; 331/65, 185; 310/15, 14, 23

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Primary Examiner—Donald J. Yusko
Attorney—F. H. Henson et al.

[57] **ABSTRACT**

The invention pertains to an improved design of a magnetic pulse generator which renders the pulse generator reliable and suitable for use in a concealed manner in an intrusion alarm system. The combination of the magnetic pulse generator which consists of a magnet which is movable with respect to a pickup coil wound about a pole piece in response to movement of a monitored object such as a door or window, and a transmitter circuit in a single package provides a compact intrusion alarm device. A change in magnetic flux resulting from rapid movement of the pole piece relative to the magnet in response to movement of the monitored object produces an output signal which is subsequently amplified and transmitted by the transmitter circuit to a remote mounted alarm indicating circuit.

12 Claims, 10 Drawing Figures

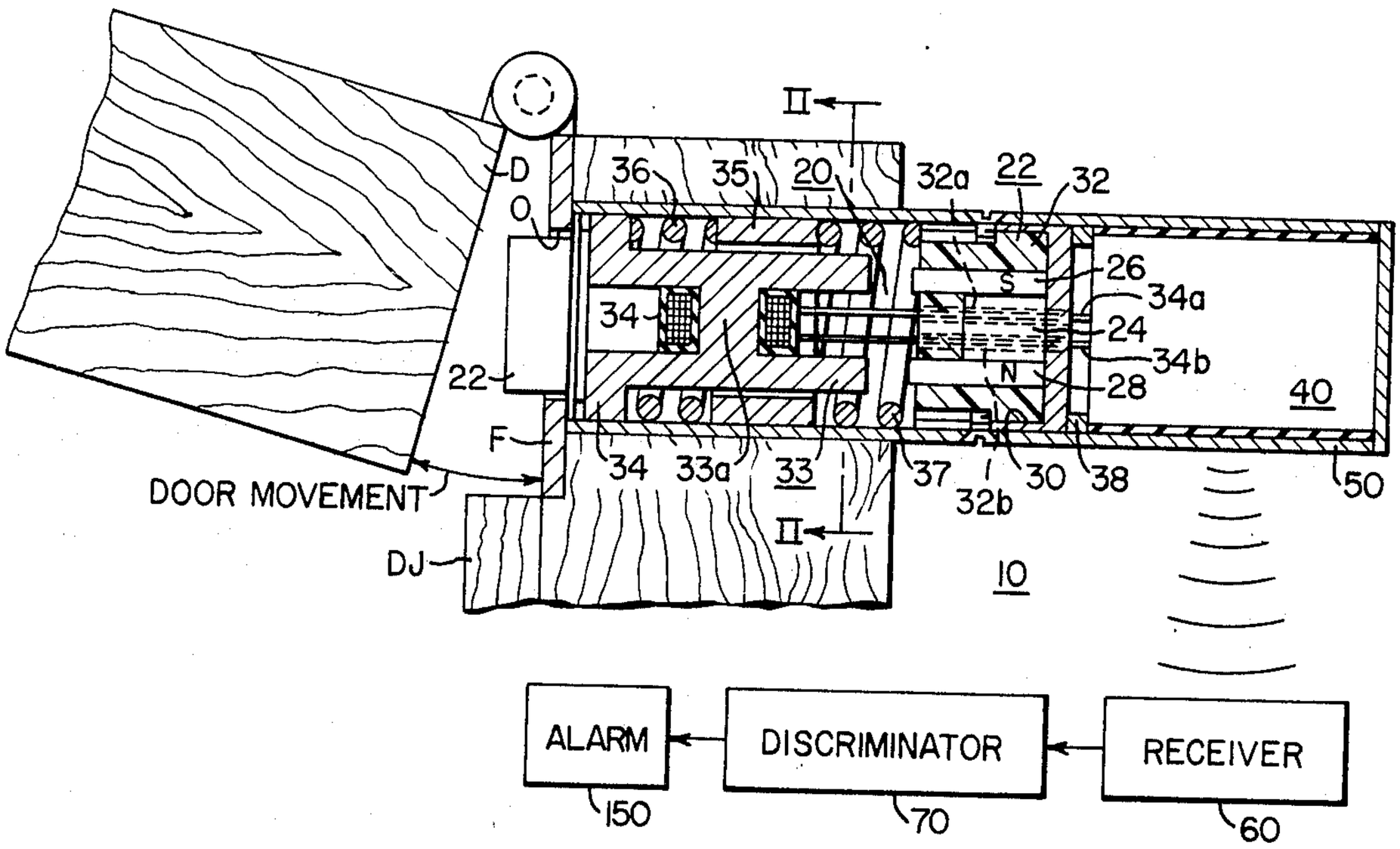


FIG.1

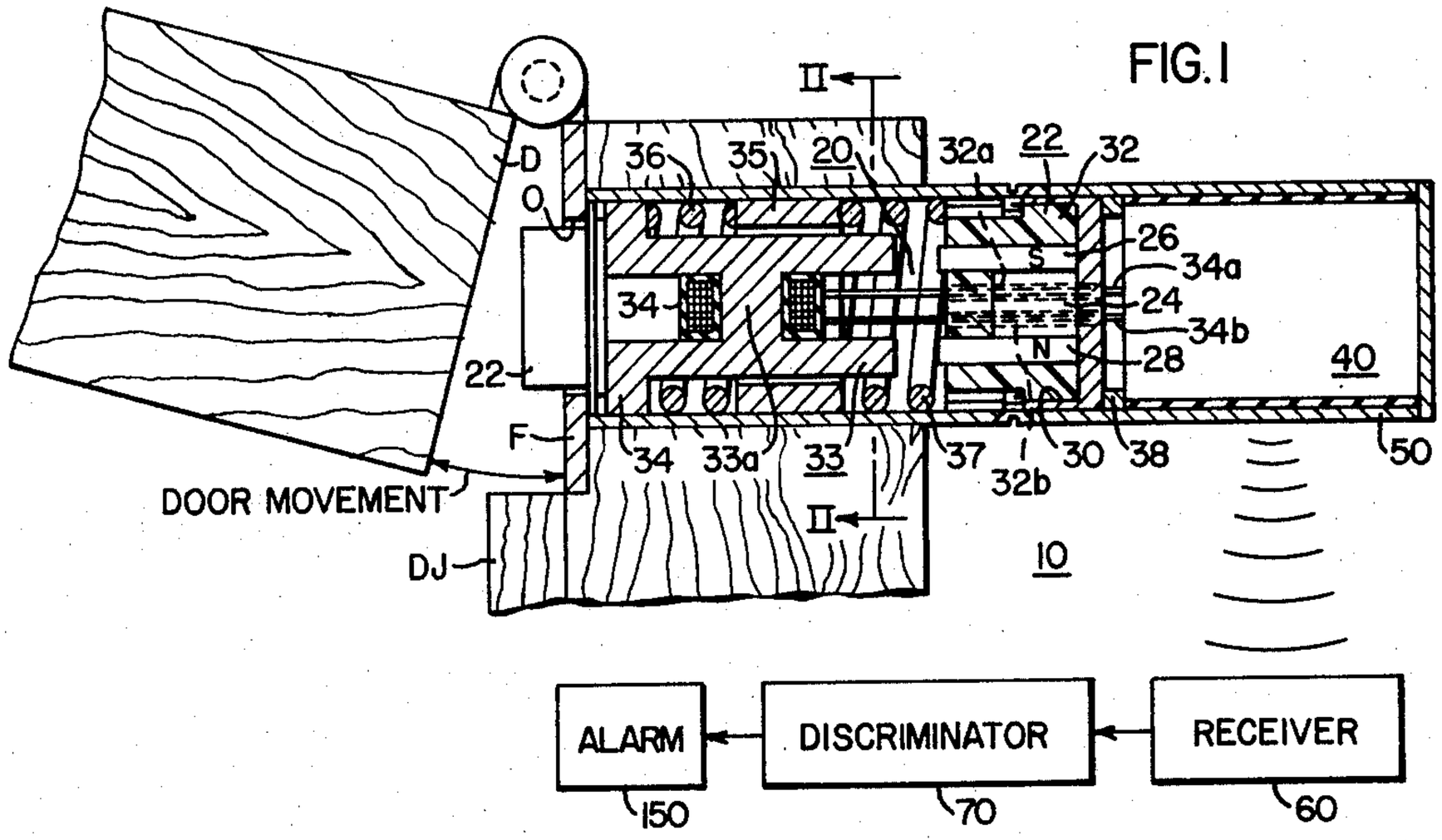
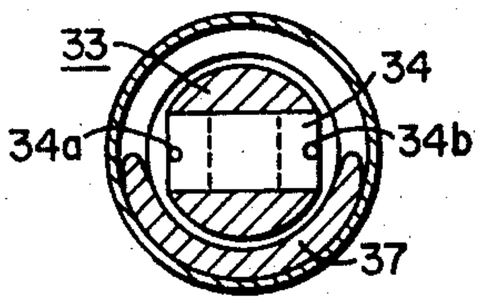


FIG.2



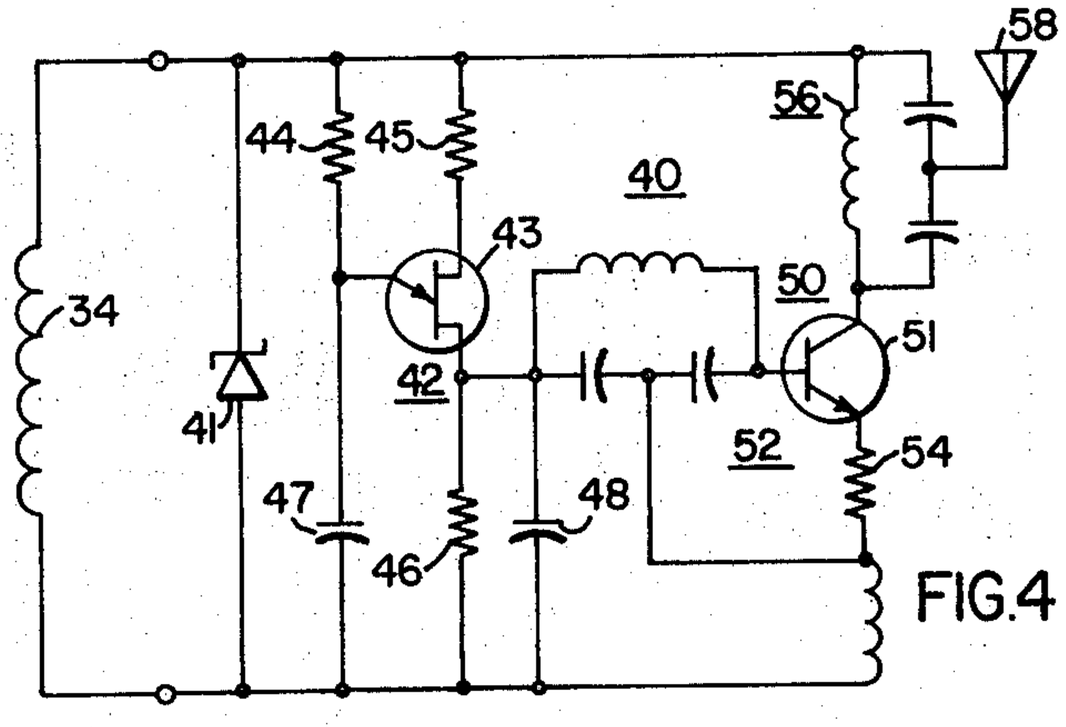


FIG.4

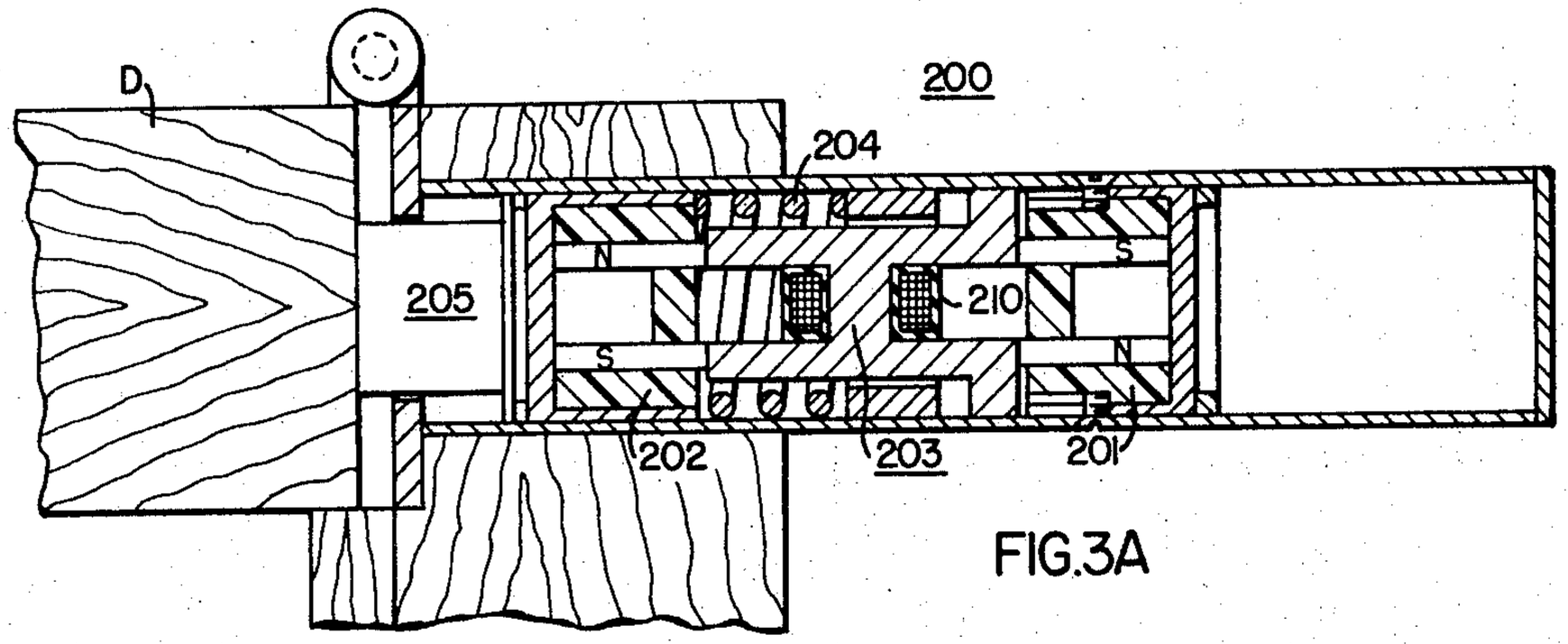


FIG.3A

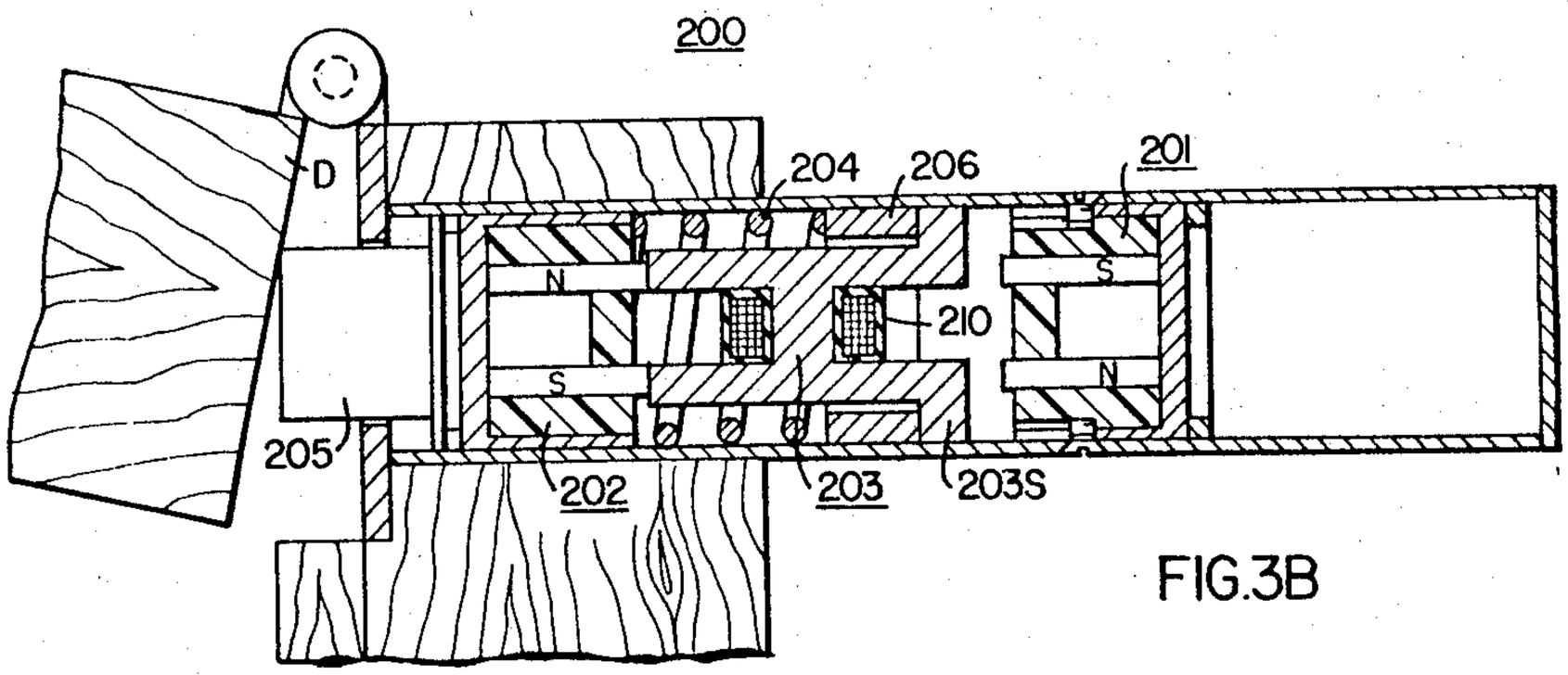


FIG.3B

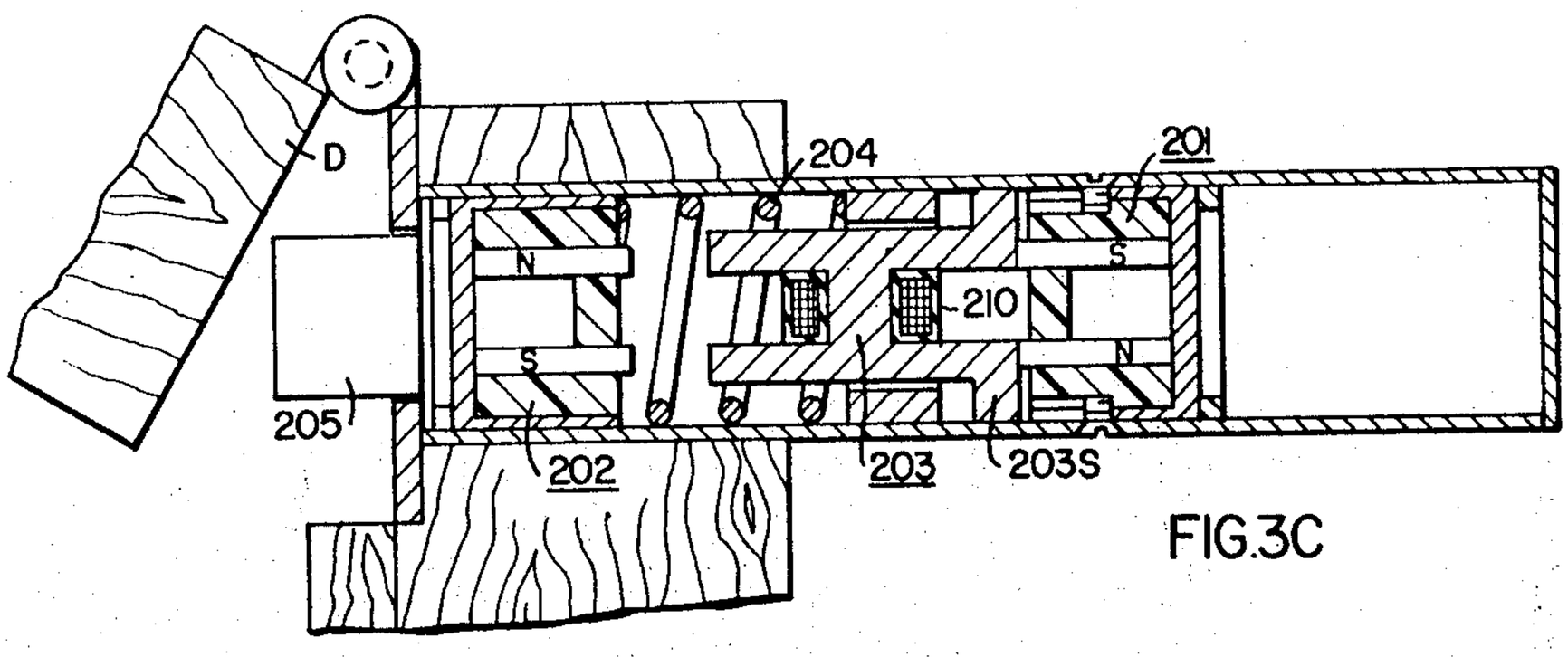


FIG.3C

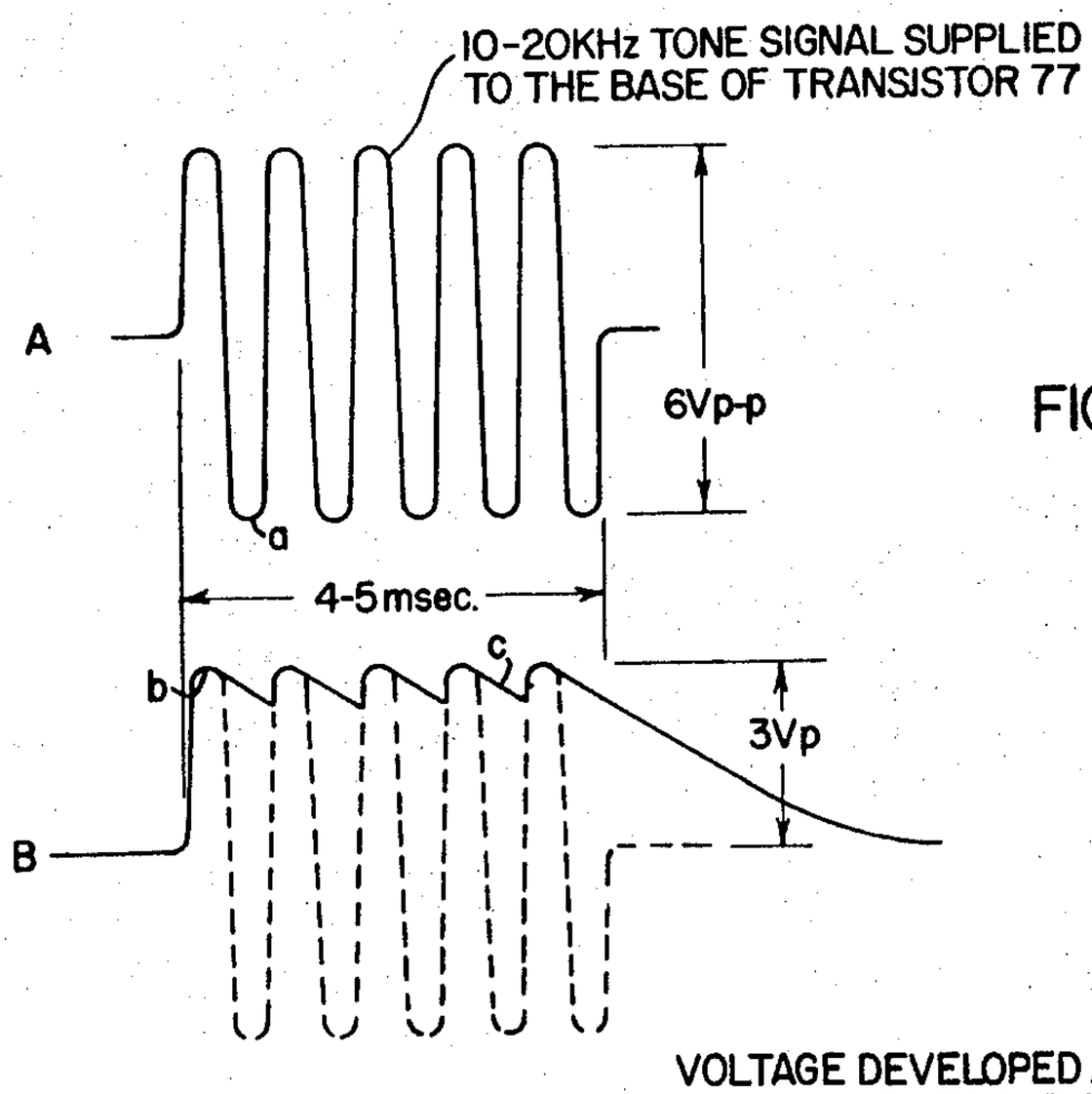


FIG.6

VOLTAGE DEVELOPED AT JUNCTION
OF RESISTOR 79 AND CAPACITOR 80

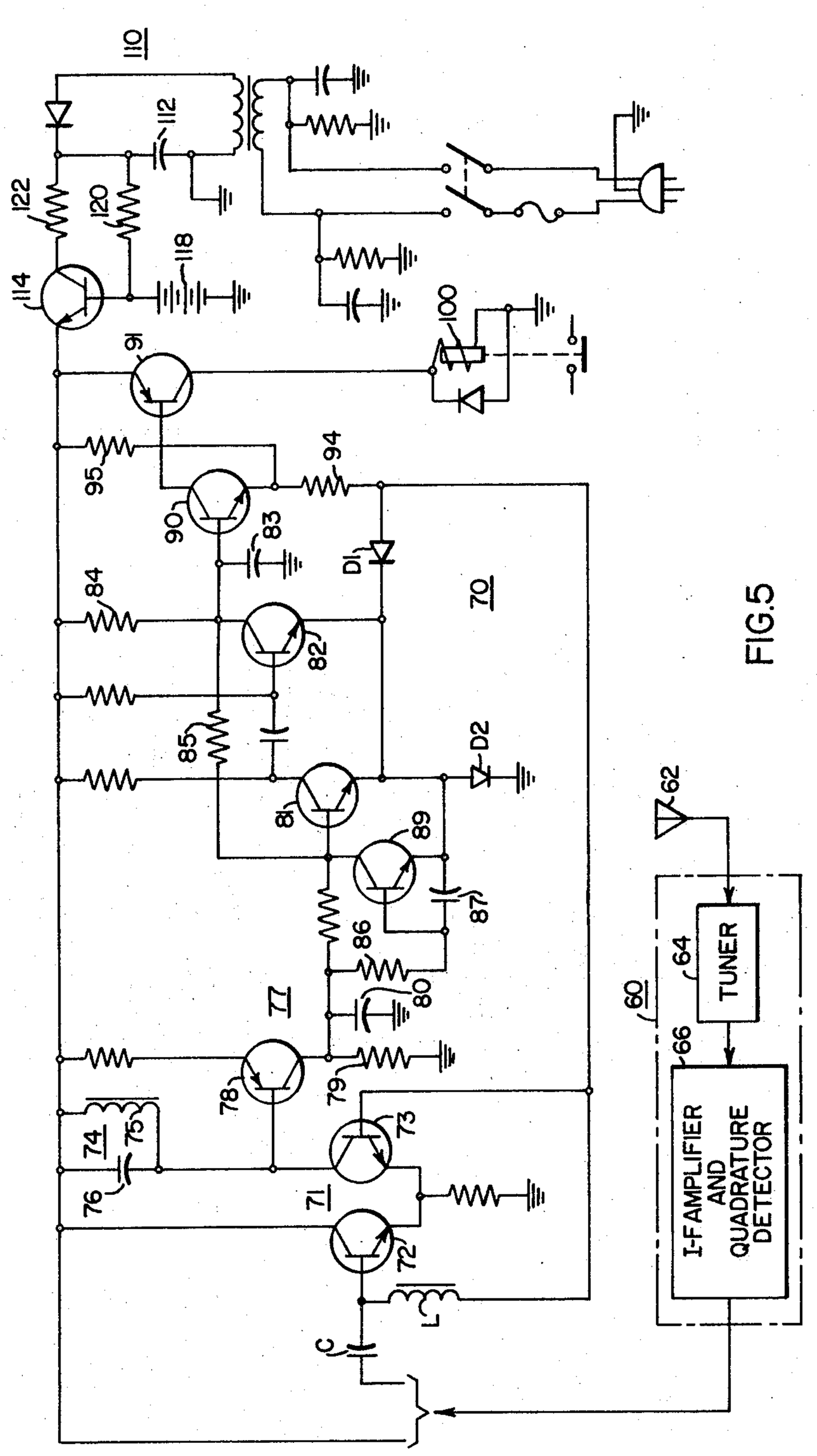

112
122
120
118
114
100
91
95
94
90
83
D1
84
82
70
85
D2
81
89
87
86
80
77
78
79
74
75
76
73
71
72
62
60
64
TUNER
66
I-F AMPLIFIER AND QUADRATURE DETECTOR

FIG.5

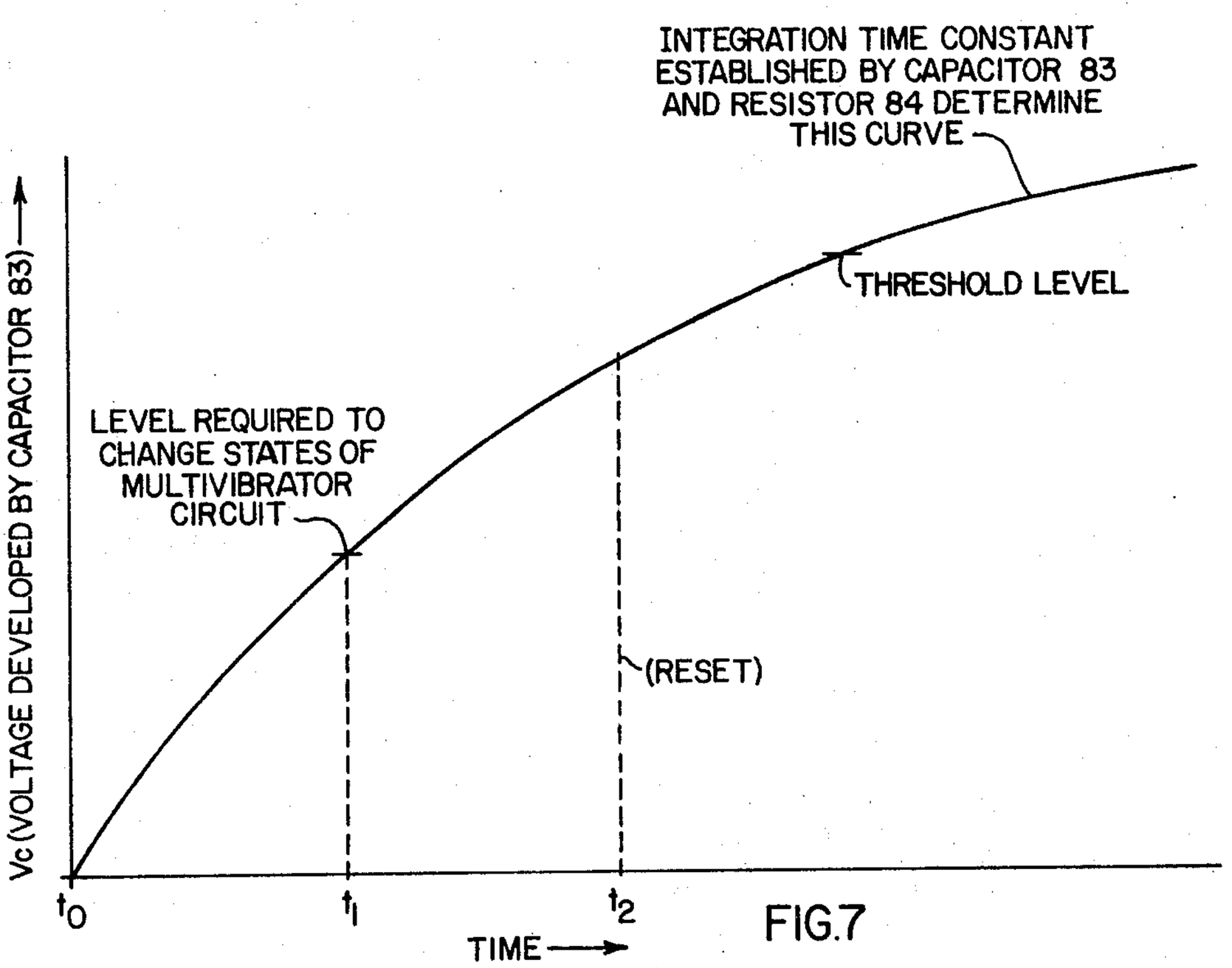

INTEGRATION TIME CONSTANT ESTABLISHED BY CAPACITOR 83 AND RESISTOR 84 DETERMINE THIS CURVE
THRESHOLD LEVEL
LEVEL REQUIRED TO CHANGE STATES OF MULTIVIBRATOR CIRCUIT
(RESET)
Vc (VOLTAGE DEVELOPED BY CAPACITOR 83)
t_0
t_1
t_2
TIME

FIG.7

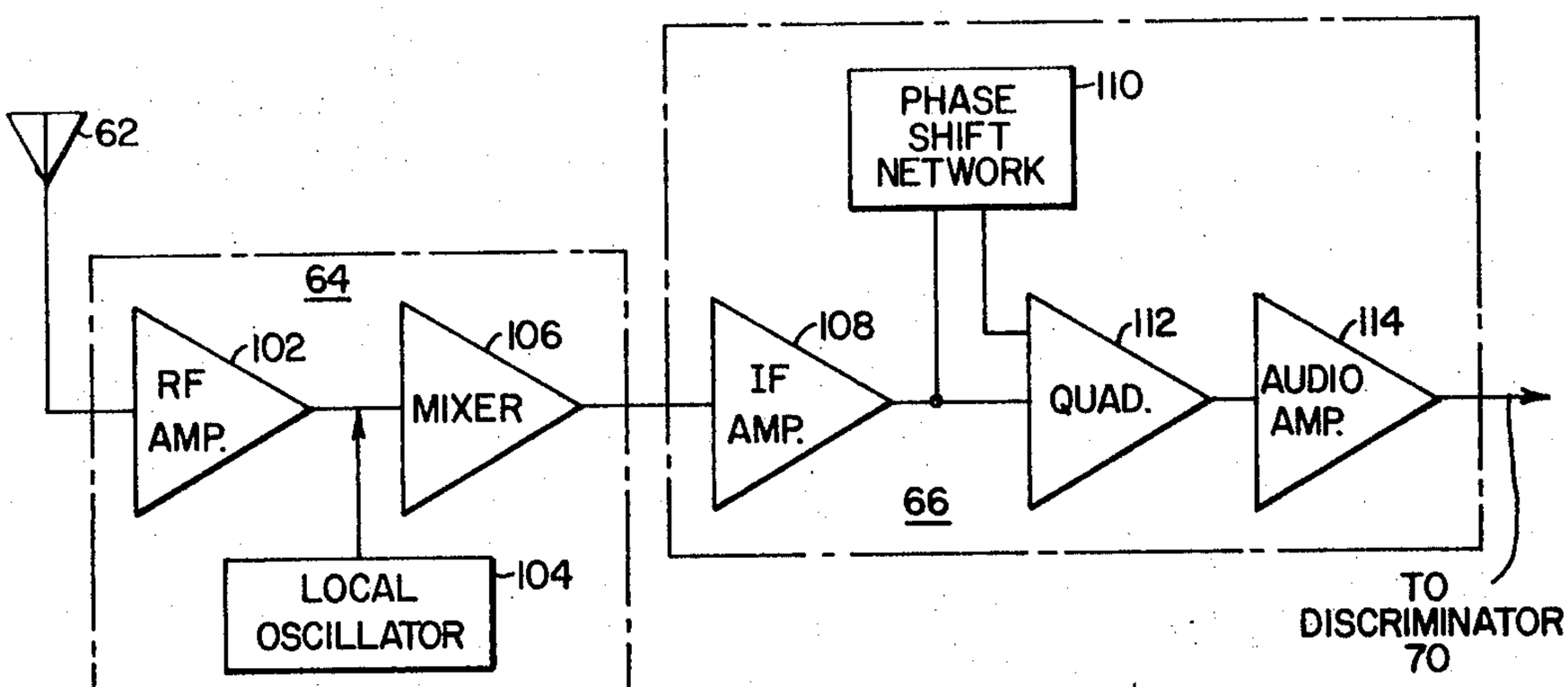

62
64
RF AMP.
102
MIXER
106
LOCAL OSCILLATOR
104
PHASE SHIFT NETWORK
110
IF AMP.
108
QUAD.
112
AUDIO AMP.
114
66
TO DISCRIMINATOR 70

FIG.8

MAGNETIC PULSE GENERATOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to the following co-filed copending applications all of which are assigned to the assignee of the present invention:

Ser. No. 271,879 (filed July 14, 1972), Title Self-Powered Wireless Intrusion Alarm (W.E. 43,126), Ser. No. 271,880 (filed July 14, 1972), Title Transmitter Circuit (W.E. 43,128), and Ser. No. 271,878 (filed July 14, 1972), Title Receiver-Discriminator Circuit (W.E. 43,849).

BACKGROUND OF THE INVENTION

Security systems for protecting homes and businesses are becoming increasingly popular due to the increase in vandalism and thefts. The commonly used protective system involves the wiring of doors and windows in such a manner that an unauthorized opening of a door or window activates an electric circuit which in turn produces an alarm. The conventional system requires extensive wiring and specially designed switching devices making a conventional security system susceptible to tampering and failure as well as rendering the costs prohibitive. The magnetic pulse generator, or induction generator, is a commercially available product which has found application in the national space program as a device for firing explosive squibs. The state-of-the-art magnetic pulse generator is described in Design News, May 10, 1967, page 204. This product is a product of the Suprel Division of Globe Industries, Inc., Dayton, Ohio.

The commercially available magnetic pulse generators, while adequately satisfying the requirements for nonsecurity applications do not lend themselves directly for use in security systems where it is essential that security intrusion devices be concealed from view.

SUMMARY OF THE INVENTION

The intrusion alarm detection system described herein with reference to the drawings includes one embodiment of a magnetic pulse generator including a spring loaded pole piece-coil assembly for latching with a magnet to set the magnetic pulse generator in a latched condition while the pole piece is maintained in physical contact with the magnet. Upon release of the force maintaining physical contact between the pole piece and the magnet-coil assembly the latched combination is permitted to move in unison within a housing in response to spring biasing by the first spring which movement causes compression of a second spring. This movement is continued until the compression forces developed by the second spring exceeds the holding force of the magnet at which time the magnet is rapidly accelerated away from the pole piece with the resulting collapsing magnetic field producing a pulse.

The pulse produced by this collapsing magnetic field is supplied to a transmitter circuit consisting of a voltage regulator, tone modulator and a modulated oscillator. The transmitter circuit in turn develops and transmits an output pulse having a width which is determined by the magnetic pulse generator. The transmitter circuit is simultaneously frequency modulated by a tone and keyed by a pulse of known width to reduce the probability of alarm response to an erroneous signal. The transmitted pulse is subsequently detected by a remotely located receiver circuit which in turn develops an output signal for initiating an alarm indication in response to a transmitted pulse indicative of intrusion of a secured area.

The receiver circuit consists of a radio receiver having a detector and a discriminator circuit driven from the detector. The discriminator circuitry is driven from the detector of the radio circuit and responds to the signal from that point by selectively amplifying the desired tone frequency, detecting the pulse duration or width of that tone and producing the alarm indication output signal if the detector output signal satisfies predermined requirements. The discriminator circuit employs a monostable circuit with a built-in latching delay circuit to reject narrow pulse width signals. The discriminator circuit also utilizes an integrator circuit and a switch to reset the monostable circuit in the event the pulse width of the detector signal is too long.

The invention will become more readily apparent from the following exemplary description in connection with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram sectioned schematic illustration of an intrusion alarm protection system;

FIG. **2** is a section I—I of the magnetic pulse generator of FIG. **1**;

FIGS. **3A**, **3B** and **3C** represent an alternate embodiment of the magnetic pulse generator of FIG. **1**;

FIG. **4** is an electrical schematic illustration of the transmitter circuit of the embodiment of FIG. **1**;

FIG. **5** is a schematic illustration of the discriminator circuit of the embodiment of FIG. **1**;

FIGS. **6** and **7** are waveform illustrations of the operation of the discriminator circuit of FIG. **5**; and

FIG. **8** is a block diagram schematic embodiment of the receiver circuit of FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1** there is illustrated an intrusion detection device **10** comprising a magnetic pulse generator **20** and a transmitter circuit **40** integrally packaged in a cylindrical housing **50.** The intrusion detection device **10** is concealed within a doorjamb DJ by a mounting flange F with an actuator rod **22** extending through an aperture **0** in the flange F for contacting the door D during the opening and closing action of the door D. The closing of the door D causes the magnetic pulse generator **20** to be transferred from an unlatched condition as illustrated in the drawings to a latched condition whereupon subsequent opening of the door will cause the magnetic pulse generator to return to the unlatched condition resulting in the collapse of the magnetic field and the generation of a pulse to which transmitter circuit **40** responds by transmitting an output signal to the receiver circuit **60** of the intrusion detection device **10.** The receiver circuit **60** supplies a signal to discriminator circuit **70** which interrogates the received signal and transmits an alarm actuating signal to the alarm circuit **150** when the received signal reflects predetermined characteristics.

STRUCTURE AND OPERATION OF THE MAGNETIC PULSE GENERATOR

The magnetic pulse generator **10** is comprised of a

magnet assembly **22** consisting of a permanent magnet **24** having a north and south pole as indicated, and soft iron extnsion elements **26** and **28.** The combination of the permanent magnet **24** and the soft iron elements **26** and **28** are secured within cylindrical container **30** by potting material **32** in a position to assure protrusion of the elements **26** and **28** beyond the potting compound. The cylindrical assembly **30** is slidably positioned within the intrusion detection device housing **50.** An iron circuit represented by the soft iron member **33** having a coil element **34** wound thereabout is slidably positioned within housing **50** in operable alignment with the north and south pole extension elements **26** and **28.** The alignment of the soft iron member **33** is provided by the shoulder portion **34** which is slidably positioned relative to the inner wall surface of the housing **50** and the elongated body portion which is slidably inserted through an aperture in a stationary collar **36.** In the unlatched condition the soft iron member **33** is maintained in contact with the actuating rod **22** by a spring element **36** acting between the stationary collar **36** and the shoulder **35** of the member **33.** The coil element **34** is wrapped around a transition portion **33A** of the soft iron member **33** as illustrated in the sectioned view along section line I—I as illustrated in FIG. **2.** The wires **34A** and **34B** extending from the coil **34** pass through passages **32A** and **32B** respectively provided in the potting material **32** and are terminated in the transmitter circuit **40.** In the unlatched condition disclosed in FIG. **1** a second spring element **37** assumes its free length which is slightly less than the space between the stationary collar **35** and the potted magnet assembly **22.** The free length of spring element **37** is sufficient however to prevent contact between the magnet extension elements **26** and **28** and the soft iron member **33** as a result of any sliding motion of the potted magnet assembly in response to vibrations.

The movement of the door D to a closed position applies a force to the actuator arm **22** which in turn causes movement of the soft iron member **33** against the spring element **36** which, in the illustrated embodiment, is assumed to apply **15** pounds compression between the shoulder **34** and the stationary collar **35** in the unlatched condition causing further compression of the spring element **36** until a movement of the member **33** results in physical contact between the magnet extension elements **26** and **28** and the soft iron member **33** thus producing a latched condition. In the latched condition the soft iron member **33** acts as a magnetic shunt between the poles of the magnet **24** and provides a magnetic flux path between the elements **26** and **28.** This latched condition is maintained while the door D is in a closed position. In the embodiment described, wherein spring element **36** is designed to provide 15 pounds compression in the unlatched condition, a suitable latching force for the magnet **24** is considered to be approximately 13 pounds. In the latched condition the spring element **36** is compressed to a point where it exerts approximately 45 pounds force between the shoulder **34** of the member **33** and the stationary collar **35.** During the latched condition the spring element **37** is maintained at its free length. The path of the magnetic flux developed in the latched condition can be traced from the north pole N of the permanent magnet **24** through the soft iron extension element **26** and the soft iron member **33** through the transition portion **33A** and ultimately to the south pole S of the magnet **24** through the extension element **28.**

When the door D is opened thus removing the force from the actuating rod **22** the **45** pounds of resorting force exerted by the spring element **36** initiates movement of the magnetic pulse generator **20** and the potted magnet assembly **22** in a latched condition toward the flange F. The potted magnet assembly **22** continues to move within the housing **50** until the distance between the potted magnet assembly **22** and the stationary collar **35** has been reduced to the free length of the spring element **37.** The force developed by the spring **36** continues to move the latched combination of the soft iron member **33** and the magnetic coil assembly **22** in unison thus resulting in compression of the spring element **37.** The compression of the spring element **37** continues until the force developed by the spring element **37** between the stationary collar **35** and the potted magnetic coil assembly **22** exceeds the holding force of 13 pounds supplied by the magnet **24.** At the moment the force exerted by the spring **37** exceeds the holding force of the magnet, the potted magnet assembly **22** is separated from the soft iron member **33** and accelerated away from the pole piece by the spring element **37.** The rapid acceleration of the magnetic coil assembly **22** from the soft iron member **33** to a rest position against stop **38** breaks the magnetic circuit and the flux linking the coil **34** decays rapidly from a saturation level to a zero level thus producing an output voltage pulse which is transmitted to transmitter circuit **40** by the coil leads **34A** and **34B.** The separation operation thus described renders the pulse magnitude independent of the rate at which the door is opened in that the rate of acceleration of the potted magnet assembly **22** from the soft iron member **33** is determined by the action of the spring **37** and not the rate at which the actuator arm **22** is controlled by the movement of the door D. This feature can be more clearly understood if it is considered in the prior art the potted magnet assembly **22** is stationary and not permitted to slide within the housing **50** in which case the separation of the pole piece from the magnet would be determined solely by the force developed by the spring **36.** In this situation it is apparent that if the door was opened at a very slow rate thus allowing the spring **36** to move the pole piece ever so slowly from the latched condition with the magnet assembly, the slow separation of the pole piece from the magnet would produce only a very slight electrical pulse the magnitude of which could very well go undetected. It is apparent that the requirements for slidable movement between various surfaces of the components described above would dictate to some extent the materials chosen. A coating of a material such as nylon or Teflon would be suitable. It is likewise apparent that the rate of separation of the potted magnet coil assembly from the pole piece and the magnitude of the pulse thereby generated are parameters which can be controlled by the design of the springs and the magnets.

The width of the electrical pulse is determined by a number of factors including the number of turns of the coil **34.** The more turns the greater the inductance and the larger the pulse width. This parameter in addition to spring and magnetic design are controlled to produce a predetermined pulse width in order to assure accurate signal discrimination by the discriminator circuit **70.**

An alternate embodiment of the magnetic pulse generator is illustrated in FIGS. 3A, 3B and 3C. In this embodiment a single spring element and two magnet assemblies are utilized. The voltage generated by this design is essentially double in the voltage of the design of FIG. 1.

Referring to FIG. 3A there is illustrated a magnetic pulse generator **200** comprised of a pair of magnet assemblies **201** and **202** and a single soft iron member **203** wherein the magnetic pulse generator is in a latched condition. The actuator rod **205** responds to the closed position of the door D by forcing magnet assembly **202** against spring element **204** establishing a latched condition between the magnetic assembly **202** and the soft iron member **203** and further causes the soft iron member **203** to make contact and latch with the stationary magnet assembly **201.** The force exerted by the spring element **204** in the latched condition will be assumed to be approximately 45 pounds. When the door D is moved from its closed position to an open position thus releasing the latching force established by the actuator rod **205** as shown in FIG. **3B**, the spring element **204** operates against a fixed collar **206** to move the latched combination of the magnet assembly **202** and the soft iron member **203** toward the door D in unison. The movement of the latched combination of the magnetic assembly **202** and the soft iron member **203** in response to the spring element **204** breaks contact between the magnet assembly **201** and the soft iron member **203** and continues movement of the latched combination towards the door until contact is made between the shoulder **203S** of the soft iron member **203** with the stationary collar **206.** With the movement of the soft iron member **203** terminated by the contact between the shoulder **203S** and the stationary collar **206,** the spring element **204** functions to exert sufficient force to break contact between the magnet assembly **202** and the soft iron member **203** and rapidly accelerates the magnet assembly **202** away from the soft iron member **203** causing a rapid collapse of the magnetic flux linking the coil **210** of the soft iron member **203.** This collapse initiates the power generation sequence of the magnetic pulse generator **200.**

As the flux collapses a corresponding voltage is produced at the terminals of the coil leads **210***a* and **210***b* which are connected to the transmitter circuit **212.** The voltage produced is represented by the following relationship:

$$V = N\ (d\phi/dt)$$

where N is a number of turns of the coil **210** and $d\phi/dt$ is the rate of change of magnetic flux.

The change in the flux linkage caused by the rapid separation of the magnet assembly **202** from the soft iron member **203** is aided by the action of magnet **201.** The attraction of magnet assembly **201** on the soft iron member **203** following separation of the magnetic assembly **202** from the soft iron member **203** causes a reverse motion of the soft iron member **203** towards the magnet assembly **201.** The orientation of the magnet of the magnet assembly **201** is such that the direction of flux linkage is opposite to that established between the magnet assembly **202** and the soft iron member **203.** The acceleration of the soft iron member **203** towards the magnet assembly **201** results in an increase of the flux level in the coil **210** to its saturation level in a direction opposite to the change in flux manifested by the acceleration of the magnet assembly **202** away from the soft iron member **203.** This opposite polarity change in flux has the effect of increasing the $d\phi/dt$ term in the above voltage equation by a factor of **2** thus essentially doubling the energy output from the magnetic pulse generator **200** in response to the opening of the door D. The final position of the components of the magnetic generator assembly **200** in the quiescent, unlatched condition is illustrated in FIG. **3C.** The soft iron member **203** is latched or mated with the magnet assembly **201** and the spring element **204** is extended to its free length.

TRANSMITTER CIRCUIT OPERATION

While there are numerous state-of-the-art circuit arrangements available to implement the operation of the transmitter circuit **40** such as that illustrated in the co-filed U.S. Pat. application Ser. No. (W.E. Case 43,126), entitled "Self-Powered Wireless Intrusion Alarm" there is illustrated in FIG. **4** a detailed schematic of a preferred technique for implementing the transmitter circuit **40.** The transmitter circuit **40** consisting of a voltage regulator comprised of Zener diode **41,** an audio frequency oscillator circuit **42** and an RF oscillator circuit **50** is powered by the pulse modulated output pulse produced by the magnetic pulse generator **20** of FIG. **1.** The Zener diode **41** is driven by a series impedance consisting solely of the inductance and the resistance of the coil **34** of the coil **34** of the magnetic pulse generator **20.** The magnetic pulse generator **20** is therefore employed as a current generator rather than a voltage generator. The Zener diode **41** functions to conduct the reverse current from the magnetic pulse generator **20** thus protecting the remaining transmittr circuitry from the application of reverse voltage and furthermore eliminating the need of an additional diode for rectification. The absence of a storage capacitor across the coil **34** insures that the pulse width of the signal transmitted by antenna **58** of the transmitter circuit **40** will be the same width as the pulse developed by the magnetic pulse generator **20.**

The audio frequency oscillator circuit **42** consists of a unijunction transistor **43** and its associated resistors **44, 45** and **46** and timing capacitor **47.** An additional capacitor **48** is used to integrate the narrow output signal developed by the audio frequency oscillator circuit **42** in order to concentrate the modulating energy at a predetermined frequency to which the receiver circuit **60** of FIG. **1** is responsive.

The RF oscillator circuit **50** utilizes a transistor **51** having a base *b*, emitter *e* and collector *c* in a Colpitts configuration. The conventional base circuit **52** for the Colpitts configuration, which consists of inductance L, and capacitors **C1** and **C2,** is tuned to one-half of the desired output frequency, i.e., the oscillator is operated as a doubler, to minimize detuning resulting from changes in the output circuit loading. Capacitor **48,** which integrates the modulating signal from the audio frequency oscillator circuit **42,** also functions as an RF bypass for the base tuned circuit **52.** Negative feedback in the RF oscillator circuit **50** which is provided between the output and input by a resistor **54,** improves the stability and minimizes amplitude modulation thus providing greater transmitter circuit output power. The primary function of the signal produced by the audio frequency oscillator circuit **42** is to vary the voltage between the base *b* and collector *c* of the transistor **51** in

order to frequency modulate the carrier frequency of the RF oscillator circuit **50** at a predetermined frequency over a duration corresponding to the pulse width of the signal produced by the magnetic pulse generator **20.** This is accomplished due to the voltage dependence of the collectorbase junction capacitance. Direct coupling is employed between the audio frequency oscillator circuit **42** and the RF oscillator circuit **50** such that the DC level at the output of the unijunction transistor **43** tends to decrease with an increase of temperature which in turn tends to compensate for the thermal voltage drift between the base *b* and emitter *e* of the transistor **51.** An additional tuned circuit **56** is included in the collector circuit of the transistor **51** and functions to select the desired harmonic, typically the second. The second provides more power than higher order harmonics. The antenna **58** is connected to a capacitive tap on the tuned circuit **56** to provide impedance matching between the transistor output impedance, which is high, and the low impedance of the antenna.

The transmission by antenna **58** of an RF carrier which is frequency modulated at a particular audio tone frequency developed by audio frequency oscillator circuit **42** which exhibits a pulse width characteristic determined by the operation of the magnetic pulse generator, provides coded signal for analysis by receiver circuit **60** and discriminator circuit **70.** This coding minimizes false indications of the operation of the magnetic pulse generator **20** by the alarm circuit **150.**

RECEIVER-DISCRIMINATOR CIRCUIT OPERATION

There is illustrated schematically in FIG. **5** a preferred embodiment of a discriminator circuit **70** which is responsive to output signals provided by a commercially available radio receiver circuit **60** which includes an amplifier and a demodulator for receiving the FM modulated sine-wave generated by the transmitter circuit.

The receiver circuit **60** includes antenna **62,** FM tuner circuit **64** and IF amplifier and quadrature detector **66.** The tuner circuit **64** functions to detect the frequency of received signals corresponding to the predetermined frequency, i.e., 88–108 mHz, established by the transmitter circuit **40** and convert it to a more convenient frequency, i.e., 10.7 mHz, which is subsequently selectively amplified by IF amplifier and quadrature detector **66.**

A more detailed schematic representation of the receiver circuit **60** is illustrated in FIG. **8.** The FM tuner circuit **64** includes an RF amplifier **102** which selectively amplifies the transmitted frequency and rejects interfering signals. The output of a local oscillator **104** is mixed with the output of RF amplifier **102** in mixer circuit **106** resulting in an output signal at a lower frequency typically 10.7 mHz. This operation is generally known as superhetrodyning which provides improved sensitivity and selectively while reducing receiver oscillator radiation and adjacent channel interference.

The resulting lower or intermediate, frequency signal is then selectively amplified by the IF amplifier **108** of circuit **66.** A portion of the amplified output of IF amplifier **108** is phase shifted by 90° by phase shift network **110** and thus put in quadrature with itself in quadrature detector **112.** Audio amplifier **114** provides differential amplification of the output of quadrature detector **112** and supplies an output signal to discriminator circuit **70** exhibiting the predermined frequency and pulse width information impressed on the carrier frequency in the transmitter circuit **40.**

The FM tuner operation of circuit **64** can be satisfied by the Heathkit FM Tuner Model 110–30 while the IF amplifier and quadrature detector can be implemented through the use of Fairchild Semiconductor circuit μ A754. The discriminator circuit **70** responds to the pulse signal developed by the receiver circuit **60** by selectively amplifying the predetermined tone frequency of the signal, detecting the duration, i.e., pulse width, of the pulse signal and transmitting an alarm actuation signal to the alarm circuit **150** if the pulse signal produced by the receiver circuit **60** satisfies the predetermined frequency and pulse width characteristics.

The pulse signal developed by the receiver circuit **60** is coupled to a limiter stage **71** by means of an L-C network comprised of inductor L and capacitor C. The L-C network provides both frequency selectivity to permit selection of single frequency from a spectrum and impedance transformation by matching impedance for efficient power transfer. The limiter circuit **71** is of a symmetrical type including coupled transistors **72** and **73** which drive a parallel resonant circuit **74** consisting of inductor **75** and capacitor **76** to provide additional discriminator circuit selectivity.

The function of the L-C network in combination with the limiter circuit **71** and the parallel resonant circuit **74** is to respond selectively to the predetermined frequency established by the audio frequency oscillator circuit **42** of the transmitter circuit **40** of FIG. **4.**

In the absence of a signal from receiver circuit **60** which exhibits the predetermined frequency, no signal will be supplied from limiter circuit **71** for pulse width discrimination by the remainder of discriminator circuit **70.**

The frequency discrimination having thus been completed, if the signal processed through the limiter circuit **71** and parallel resonant circuit **74** exhibits the predetermined frequency it is applied to a class C amplifier stage **77** comprised of transistor **78** which functions to provide envelope detection. The operation of the transistor amplifier **77** in the class C mode rather than the class B mode provides the desirable advantage of rendering the amplifier stage insensitive to erroneous low amplitude signals. The high frequency tone signal, i.e., typically **10** to **20** kilohertz, developed by the limiter circuit **71** and the parallel resonant circuit **74** and subsequently supplied to the base electrode of the transistor **78** is illustrated in waveform A of FIG. **6.** The transistor **78** in the amplifier configuration illustrated turns on at the negative excursions a of the waveform A of FIG. **6** thus developing an output signal which when applied to the parallel combination of resistor **79** and capacitor **80** produces an envelope waveform at the junction of resistor **79** and capacitor **80** of a form illustrated in waveform B of FIG. **6.** During the on conduction of transistor **78** the capacitor **80** develops a voltage at the junction corresponding to the peak voltage *b* of waveform B and retains essentially this voltage signal during the negative swing of the waveform as illustrated in waveform A due to the high resistance paths provided by resistor **79** and resistor **81.** Resistor **79** is typically a 22 kilo-ohm resistor whereas resistor **81** is typically a 1 megaohm resistor. The slight decay in voltage resulting during the negative swing of the waveform A is

recovered at the following positive peak of waveform A thus producing the envelope waveform C of waveform B which represents essentially the envelope or outline of the tone signal supplied to the base of transistor **78.**

The envelope signal represented in waveform B of FIG. **6** is in the form of a pulse and is subsequently applied to trigger a multivibrator circuit herein represented as a monostable circuit comprised of transistors **81** and **82.** In the normal mode of operation of a monostable circuit the input pulse supplied to the base *b* of transistor **81** would produce an output signal in the monostable circuit at the collector *c* of transistor **82** which is subsequently applied to the first stage of the two transistor stage switch comprised of transistors **90** and **91.** However, the addition of capacitor **83** which functions as an integrator, at the output of the monostable circuit provides a built-in delay in changing states of the monostable circuit. The minimum pulse duration requirement is established by the capacitor-resistor combination comprised of capacitor **83** and resistor **84.** A trigger pulse supplied to transistor **81** having a width less than the predetermined width will fail to develop a voltage signal sufficient to provide feedback through resistor **85** for changing the state of the monostable circuit and for actuating transistors **90** and **91.**

The pulse signal supplied as a trigger pulse to the base *b* of transistor **81** is also supplied to a second resistor-capacitor combination comprised of resistor **86** and capacitor **87** which is connected to switching transistor **89.** The resistor-capacitor combination of resistor **86** and capacitor **87** serves to establish a maximum signal duration criteria for the input pulse signal for which actuation of the two stage transistor switch circuit **90** is permitted. The capacitor **87,** which functions as an integrator, is connected between the base *b* and emitter *e* of the switching transistor **89** in order to produce a faster turn on the switching transistor **89** without effecting the delay time established by resistor **86** and capacitor **87.** The switching transistor **89** functions as a reset switch for resetting the monostable circuit in response to an input pulse having a duration exceeding the maximum duration criteria established by resistor **86** and capacitor **87.** The capacitor **83** establishes a delay which is sufficient to permit reset of the monostable circuit by transistor **89** before developing a voltage sufficient to overcome the threshold level established by resistors **94** and **95** and diodes **D1** and **D2** to actuate the two stage transistor output switching circuit **90** and activate output circuit **100.**

The graphical representation of the voltage developed across capacitor **83,** V*c*, versus time is illustrated in FIG. **7.** Pulse signals supplied as trigger pulses to the multivibrator circuit of duration less than t_1, fail to change the state of the multivibrator and fail to develop a voltage sufficient to exceed that required to actuate switch circuit **90.** Trigger pulses of a width t_2 or greater, while causing a change of state of the multivibarator circuit, will produce a reset of the multivibrator circuit at a time prior to the development of level capacitor voltage V*c*, sufficient to actuate the switch circuit **90.**

Thus, the output switch circuit **90** remains off unless the monostable circuit is triggered by an input pulse having a duration or width within the minimum and maximum limits prescribed by the resistor-capacitor networks. Upon the occurrence of an input pulse having a duration within the prescribed minimum and maximum limits the capacitor **83** develops a signal sufficient to overcome the threshold level and actuate switch circuit **90** which remains in an on state thus actuating output circuit **100,** herein represented by the relay circuit **102,** until a feedback signal resets the monostable circuit. The monostable circuit could be converted into a bistable multivibrator circuit should it be desirable to maintain the output switch circuit **90** in a conductive state until it is manually reset.

The discriminator circuit **70** further includes an AC-battery power supply which serves to provide power to both the receiver circuit **60** and the discriminator circuit **70.** The power supply consists of a transformer operated half-wave rectifier circuit **110** having a capacitor filter **112** which is connected to a voltage regulator circuit consisting of a series regulator transistor **114** and a battery **118** which functions as a reference voltage source for the series regulator transistor **114** during normal AC power conditions. Due to the transistor operation of regulator **114** the battery does not supply load current during normal AC power conditions. In addition, to functioning as a reference voltage source for the series regulator transistor **114** the battery **118** functions to supply load current to the load consisting of receiver circuit **60** and discriminator circuit **70** through the base-emitter junction of the transistor **114** in the event of a main power failure causing loss of AC input power. The battery is maintained at full charge by a trickle current through resistor **120** which is independent of the load current. The use of the battery **118** for the reference voltage source eliminates the traditional use of the Zener diode for the same purpose. The changeover to battery operation in the event of AC power loss is fully automatic and results in no significant change in supply voltage or impedance. The resistor **122** provides three functions: it serves as a parasitic suppressor; it limits the dissipation of transistor **114;** and it limits the excess battery drain in the event of failure of filter capacitor **112.**

What is claimed is:

1. In a magnetic pulse generator apparatus, the combination of, a housing, a magnet assembly means having a north and south pole slidably positioned within said housing, magnetic shunt means slidably positioned within said housing in alignment with said magnet assembly means, actuator means adapted to respond to a reset force by providing a contact between said magnet assembly means and said magnetic shunt means to establish magnetic coupling therebetween, said magnetic shunt means completing a magnetic circuit between said north and south poles of said magnet assembly means to provide a magnetic flux path therebetween, said magnetic shunt means further including coil means operatively associated therewith, first means for moving the magnetically coupled combination of said magnet assembly means and magnetic shunt means within said housing in a first direction in the absence of said reset force, second means for decoupling the magnetically coupled magnet assembly means and magnetic shunt means after predetermined movement of said magnetically coupled combination by said first means and producing rapid separation of said magnet assembly means and said magnetic shunt means thus producing a change in magnetic flux, said coil means responding to said change in magnetic flux by developing in electrical signal pulse.

2. A magnetic pulse generator apparatus as claimed in claim 1 wherein said magnetic shunt means comprises a soft iron element for shunting said north and south poles when said magnet assembly means and magnetic shunt means are magnetically coupled, said coil means being wound about said soft iron element.

3. A magnetic pulse generator apparatus as claimed in claim 1 wherein said actuator means includes a rod member extending through an aperture in said housing and contacting said magnetic shunt means to slidably move said magnetic shunt means into magnetic coupling contact with said magnet assembly means in response to said reset force.

4. A magnetic pulse generator apparatus as claimed in claim 3 wherein said first and second means are spring members.

5. A magnetic pulse generator apparatus as claimed in claim 1 further including a transmitter circuit positioned within said housing and operatively connected to said coil means, said transmitter circuit responding to said electrical signal pulse by transmitting a signal of a predetermined frequency content and exhibiting a pulse width corresponding to the pulse width of said electrical signal pulse.

6. A magnetic pulse generator apparatus as claimed in claim 1 wherein the pulse of the electrical pulse signal developed by said coil means is a function of the inductance of said coil means.

7. A magnetic pulse generator apparatus as claimed in claim 5 further including a receiver means remotely positioned for responding to the signal transmitted by said transmitter circuit means by producing an output signal corresponding thereto, and discriminator circuit means operatively connected to said receiver circuit means for analyzing the frequency content and the pulse width of the signal produced by said receiver circuit means and generating an output signal when said frequency content and pulse width correspond to predetermined values.

8. A magnetic pulse generator apparatus as claimed in claim 4 wherein said first spring member is compressed in response to the presence of said reset force, said first spring member causing the magnetically coupled combination of said magnet assembly means and said magnetic shunt means in a first direction following termination of said reset force, said second spring member being in operative contact with said magnetically coupled combination is compressed by movement of said magnetically coupled combination in said first direction until the force developed by said second spring member under compression exceeds the force of said magnetic coupling at which time said second spring decouples said magnet assembly means and said magnetic shunt means and produces rapid separation of said magnet assembly means and said magnetic shunt means.

9. A magnetic pulse generator apparatus as claimed in claim 8 further including a stationary spring support member, said first spring member acting between said stationary spring support member and said magnetic shunt means, said second spring member acting between said stationary spring support and said magnet assembly means.

10. A magnetic pulse generator apparatus as claimed in claim 8 wherein the rate of separation of said magnet assembly means and said magnetic shunt means is a function of the design of said second spring member.

11. In a magnetic pulse generator apparatus, the combination of, a tubular housing, first magnet assembly means having a north and south pole fixedly positioned within said tubular housing, a second magnet assembly means having north and south poles slidably positioned within said tubular housing, magnetic shunt means including a coil element associated therewith slidably positioned within said tubular housing intermediate said first and second magnet assembly means and aligned with said first and second magnet assembly means to provide a magnetic circuit between the north and south poles of the respective magnet assembly means when brought in contact therewith, said contact providing a magnetic flux path between said north and south poles, actuator means slidably positioned within said tubular housing and adapted to respond to a reset force by moving said second magnet assembly means in a first direction for contacting said magnetic shunt means and establishing magnetically coupling between said second magnet means and said magnetic shunt means to complete the magnetic circuit therebetween, bias means in operative contact with said second magnet assembly means for developing a force opposing the movement of said second magnet assembly means in said first direction in response to said reset force, said opposing force increasing with the continued movement of said second magnet assembly means in said first direction, said bias means responding to the absence of said reset force by moving said magnetically coupled combination of said second magnet assembly means and said magnetic shunt means in the opposite direction, means for limiting the movement of said magnetic shunt eans in said opposite direction and causing separation of said second magnet assembly means from said magnetic shunt means, said bias means providing a rapid acceleration of said second magnet assembly means from said magnetic shunt means producing a rapid change in magnetic flux, said coil means responding to said rapid change in magnetic flux by developing a first electrical output pulse, said first magnet assembly means magnetically attracting said magnetic shunt means following separation of said magnetic shunt means from said second magnet assembly means, said attraction causing rapid movement of said magnetic shunt means in said first direction to produce contact and magnetic coupling between said magnetic shunt means and said first magnet assembly means, said magnetic shunt means completing the magnetic circuit between the north and south poles of said first magnet assembly means, said rapid acceleration of said magnetic shunt means towards said first magnet assembly means producing a rapid change in magnetic flux therebetween, said coil means responding to said rapid change in magnetic flux by developing a second electrical output pulse.

12. In a magnetic pulse generator apparatus as claimed in claim 11 wherein the orientation of the north and south poles of said first and second magnet assembly means are such that the sum of the first and second electrical output pulses exceeds the value of the individual first and second electrical output pulses.

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