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July 31, 1962 K. H. SCHMIDT 3,047,850

SONIC SPACE ALARM

Filed Aug. 12, 1959 2 Sheets-Sheet 1

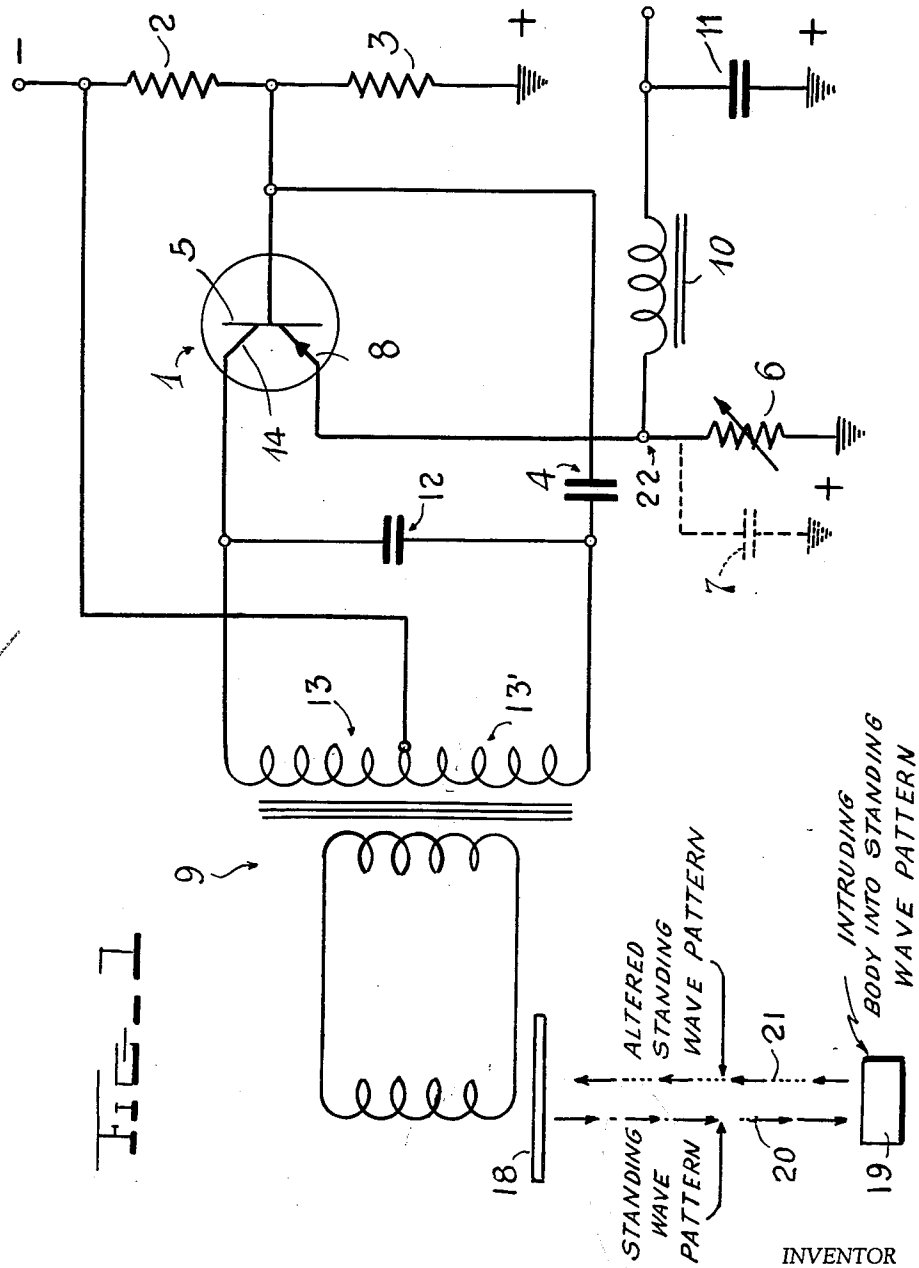


FIG. 1

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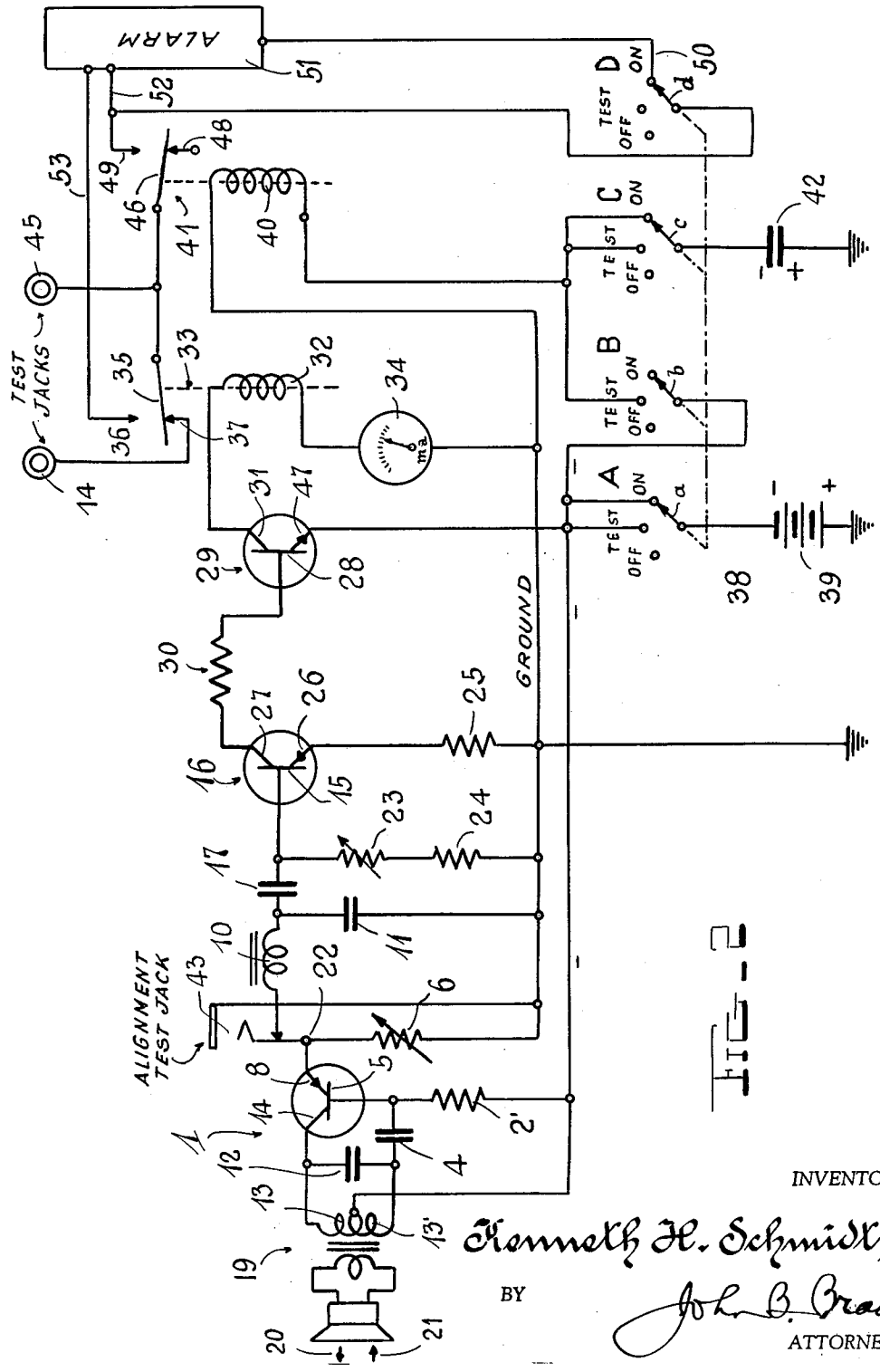


FIG. 2

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SONIC SPACE ALARM

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10 Claims. (Cl. 340—258)

My invention relates broadly to protective alarm systems and more particularly to a simplified construction of a sonic space alarm which utilizes the same circuits for setting up a standing wave pattern and for detecting variations in the standing wave pattern.

One of the objects of my invention is to provide a sonic space alarm in which only one speaker or transducer unit is utilized to assist in establishing a standing wave pattern and to accomplish the function of detection of standing wave variation which causes an alarm condition.

Another object of my invention is to provide a sonic space alarm system in which the sending and receiving sources are combined into a single circuit.

Another object of my invention is to provide a compact transistorized sonic space alarm which is portably self-contained, operating on battery power completely independent of line power.

Still another object of my invention is to provide a simplified circuit construction for a sonic space alarm which operates at a high sensitivity-stability ratio.

Other and further objects of my invention reside in the circuitry of my sonic space alarm as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

FIG. 1 is an electrical schematic circuit diagram of the oscillator circuit used in the sonic space alarm of my invention and particularly showing in schematic form the manner in which the speaker diaphragm sets up a standing wave pattern and also detects alterations in the standing wave pattern; and

FIG. 2 is an electrical schematic circuit diagram of the sonic space alarm of my invention.

My invention is directed to a construction of a new and simplified sonic space alarm which operates at a high sensitivity-stability ratio and utilizes a single transducer or speaker for setting up a standing wave pattern and for fulfilling the function of detection of standing wave variation. The sonic space alarm system of my invention sets up a standing wave pattern which is generated by an oscillator closely coupled to a speaker or transducer, the combination of which is tuned to a given frequency. The standing wave pattern is usually restricted to a confined area but does not necessarily have to be restricted to a confined area at sonic or ultrasonic frequencies. The speaker or transducer is of the type that gives very close coupling to air. Therefore, any change in the standing wave pattern, which is closely coupled with the speaker or transducer, varies the amplitude of the oscillator. The standing wave pattern can be changed or upset by various means, such as by an intruder entering the area covered by the standing wave pattern. Any variation in the amplitude of the oscillator caused by the upsetting of the wave pattern is further amplified and fed into a relay circuit which switches the system into an alarm condition.

The system will self-adjust to the existing physical characteristics of the area to be protected. However, after this initial self-adjustment, any variation, such as a person entering or moving about in the area, will alter the existing standing wave pattern, thus causing an alarm condition of the system. Any movement of a foreign object can cause an alteration either by absorption or

reflection of the standing wave pattern. This can be just the movement of a door opening or any action of an individual or object in the area.

The maximum transducer efficiency is maintained by operating the transducer at its natural resonance and utilizing the transducer as an intimate part of the negative resistance network. The intrusion information is picked off from this network at a point favoring the least loading. The derived signal is amplified through a simple low pass amplifier and applied to a high reliability relay/alarm. Due to the use of semi-conductors and the inherent high efficiency of the system, it is portable in the true sense of the word. The small power consumed by the system permits long term operation as a self contained unit if so desired.

Sonic space alarms are not new to the art, but other systems use two sources, one sending and one receiving, and this is not necessary in the system of my invention; nor is my system dependent upon Doppler effect. Those operating in the continuous wave category are conveniently analyzed in terms of the standing wave patterns set up by their respective systems.

If a pattern of standing waves is assumed for a given space system configuration, certain major factors can be cited as determining factors of system sensitivity.

These factors are as follows:

(A) The coupling coefficient between the transducer and the medium.
(B) The efficiency of the transducer.
(C) The load imposed on the transducer by the driving element.
(D) The load imposed on the transducer by the detecting circuit.

Factors (A) and (B) are determined to a large degree by the state of the transducer art and the medium into which the transducer must work. (In this case air). With reference to factor (B) it can be shown that operation of a transducer at resonance produces the highest possible efficiency, all other conditions being equal.

One purpose of this invention is to utilize the existing efficiency of the transducer with circuitry, such that this efficiency is not lost due to the loading factors ((C) and (D) above), thus maintaining the highest possible sensitivity versus stability.

Previous systems have attempted to make up for these losses by non-linear amplification and filtering of the derived signal. This ultimately leads to complex amplifiers, critical adjustments, and generally a loss in the sensitivity-stability ratio.

Bearing in mind the requirements imposed by the loading factors stated in (C) and (D) above, we may now analyze the subject invention in these terms.

Referring to the drawings in greater detail, in FIG. 1, I have shown a modified Hartley type oscillator of my invention which I utilize in my sonic alarm, employing a semi-conductor **1** as its negative resistance element. In conventional design, resistors **2** and **3** set the operating point. In FIG. 2 resistor **2'** designates the base bias resistor which sets the transistor operating point. Capacitor **4** completes the feedback circuit to the base **5** of the semiconductor. Resistor **6** would not be used in this type circuit except in the interest of decoupling in which case, capacitor **7** would be used, to place the emitter **8** at R.F. ground.

In this invention the emitter **8** is intentionally elevated above ground and capacitor **7** is not used. The resistor **6** serves a unique set of functions. First, it creates a high base impedance on the semi-conductor **1**, reducing the oscillator loading on the transducer **9**. Second, resistor **6** sets the oscillator circuit just above the threshold of oscillation, where it is most sensitive to the changes in its tank

circuit impedance. Not so apparent is the fact that the drop across resistor 6 is inverse feed-back, hence stabilizes this operating point. The (D) loading factor previously mentioned, that is, the load reflected on the transducer by the signal pick-off point is again solved by resistor 6. Since any impedance change in the transducer 9 will cause a direct current change in resistor 6. The change information can be removed through a simple low pass filter consisting of filter coil 10 and filter capacitor 11, without upsetting the rest of the circuit configuration in any way.

The oscillator tuned tank circuit consists of tank capacitor 12 connected across the inductance coils 13 and 13' of speaker or transducer 9, the tank circuit being connected to the collector 14 of the PNP type semi-conductor 1. The oscillator circuit in combination with the transducer 9 sets-up or establishes a standing wave field, indicated at 20, through transducer diaphragm or acoustical force producing means 18. Since the transducer coils 13 and 13' in the oscillator tank circuit are tuned to their natural resonance the transducer is thus operated at its maximum efficiency. An intruding body 19 entering the standing wave field 20 will thereby upset the wave pattern, causing an altered standing wave pattern, indicated at 21, which, when detected, by transducer diaphragm 18, causes an impedance change in the transducer which will change the resonant operating point of the oscillator tank circuit. When this occurs, as previously mentioned, a direct current change occurs across the non-inductive variable resistor 6 connected between emitter 8 and ground, so that the transducer is not loaded by the change information removed at signal pick-off point 22. Since emitter 8 is the point in the oscillator circuit which favors the least circuit loading, the current change information is conveyed from this point, signal pick-off point 22, to a relay amplifier circuit through filter coil 10 and filter capacitor 11 having one end thereof connected to ground.

The current change information is coupled from the output of the low pass filter to the base 15 of transistor amplifier 16 through coupling capacitor 17. Base bias resistors 23 and 24 connected between the base 15 and ground set the operating point of transistor 16 which is of the PNP type. Bias resistor 23 is adjustable so that the operating bias of transistor 16 may be changed, thus providing an alarm sensitivity adjustment in the relay amplifier circuit. Load resistor 25 is connected between the emitter 26 and ground and the transistor output information on collector 27 is coupled to the base 28 of NPN type transistor 29 through resistor 30. Transistor 29 is normally conducting close to cut-off so that the change information appearing on the base 28 of the relay coupling transistor 29 operates to cut-off the energizing current conveyed to one end of coil 32, of the normally energized alarm relay 33 from the collector 31. The other end of coil 32 is connected to ground through ammeter 34 provided in the circuit for checking proper operating conditions.

The change information signal from the output of transistor 29 deenergizes the coil 32 of alarm relay 33 causing the movable contactor 35 to move from normally closed stationary contact 37 to normally open stationary contact 36. When this occurs the external alarm circuit is completed, thus sounding an alarm.

Reference character 38 generally designates a three position function switch comprised of wafers A, B, C and D having movable switch contactors *a, b, c* and *d*, respectively, ganged together to move in unison. In the first switch position, designated OFF, wafers A, B, C and D have no connections. Thus the battery 39, which has its positive terminal grounded and its negative terminal connected to movable switch contactor *a*, is disconnected from the circuit and the alarm system is shut off. The switch is turned to this position during the daytime hours or while the protected area is being utilized.

In the second switch position, designated TEST, the battery 39 is connected to the oscillator and relay amplifier circuits, and movable contactor *b* through switch wafer A and its associated movable contactor *a*. Thus in the TEST position alarm relay 33 is normally in the energized state. The TEST position on wafer B and the TEST and ON positions on wafer C are all commonly connected with one end of the coil 40 of delay set relay 41, the other end of the coil being grounded. Thus in the second switch position delay set relay coil 40 is energized through wafer B and contactor *b*, and at the same time, time delay capacitor 42 connected intermediate movable contactor *c* and ground is charged through wafer C. In the energized state delay set relay movable contactor 46 is in electrical contact with stationary contact 48 which has no circuit connection. Wafer D of function switch 38 has no connection in the TEST position, hence, there is no possibility of sounding an external alarm in this switch position.

In the TEST position, the system can be calibrated and tested without sounding an alarm. The alignment test jack 43 is used to align the oscillator-detector circuit. Since the relays 33 and 41 make no sound when they operate I provide test jacks 44 and 45, respectively, connected to normally closed stationary contact 37 and the series circuit commonly connecting movable contactors 35 and 46 for determining the relay operation state. To set the alarm sensitivtiy, an ohmeter is connected between the test jacks 44 and 45 and observed in conjunction with the milliammeter 34 while the base bias resistor 23 is adjusted to produce the desired alarm sensitivity. The emitter 47 of transistor 29 is connected to the negative voltage bus and the bias resistor 23 is adjusted so that transistor 29 is in the normally conducting state so that coil 32 of relay 33 is normally energized. In the energized state the movable contactor 35 of relay 33 is in electrical contact with normally closed contact 37. Bias resistor 23 positions transistor 29 very close to cut-off so that any change information from the detector circuit will cut-off the transistor 29, thus deenergizing coil 32 and causing movable contactor 35 to move into electrical contact with normally open alarm control stationary contact 36.

The third position on the function switch 38 is the normal operating position designated ON. In this position my sonic alarm system is fully operational. The circuit functions are as follows:

(1) Wafer A maintains connection between the battery 39 and the oscillator and relay amplifier circuits.

(2) Wafer B disconnects the battery from delay set relay coil 40.

(3) Wafer C maintains the connection between time delay capacitor 42 and coil 40 of the delay set relay 41.

(4) Wafer D connects the stationary contact 49 of delay set relay 41 to the alarm connection circuit 50, thus connecting the external alarm 51 through the series contacts of relays 33 and 41.

Since time delay capacitor 42 is charged in the TEST position it is fully charged at the instant the function switch is switched to the ON position, thus relay coil 40 remains energized until capacitor 42 discharges through the coil 40 of the delay set relay to ground. This discharge time is approximately one minute, being dependent upon the resistance of the coil 40, the value of capacitor 42, and the dropout voltage of relay 41. The purpose of this delay in setting the relay to complete one part of the alarm circuit is to allow setting the alarm and leaving the area without triggering the external alarm circuit 51. When capacitor 42 discharges to the dropout voltage of relay 41 the movable contactor 46 thereof moves into electrical contact with stationary contact 49 which is connected to external alarm circuit 51 through circuits 50 and 52. Thus it can be seen from FIG. 2 that a connection between contact 36 and movable contactor 35 is all that is required to complete the series alarm closure circuits which extend from the alarm circuit 51, over circuit 53, through the contacts of relays 33 and 41 which

are connected in series, and then back to the alarm circuit **51** through circuits **52** and **50**.

The connection between contact **36** and movable contactor **35** is brought about by an intruding body upsetting or altering the standing wave field as previously set forth. The charge information from the detector circuit results in cutting off the normally conducting transistor **29** which causes normally energized relay coil **32** to be deenergized, thus causing movable contactor **35** to drop into electrical contact with stationary contact **36** to complete a short circuit across the input terminals to the alarm circuit **51**, thus actuating an alarm.

The external alarm circuit **51** is complete in itself. It contains its own batteries and alarm duration timing circuit. In operation, a momentary short across the input terminals of the external alarm, such as between circuits **50** and **53**, will energize the alarm and its associated timing circuit. The audio alarm continues until the internal timing circuit shuts it off. The timing circuit is preferably set for an approximate two minute interval. After being shut off, the external alarm circuit **51** remains silent until the input is again momentarily shorted, thus reenergizing the audio alarm and its timing circuit.

The sonic alarm of my invention can operate in both the audible frequency range and the inaudible frequency range, the frequency range of operation depending upon the individual alarm application. My preference is to operate my sonic alarm in the inaudible frequency range thus making the intrusion alarm application more realistic.

I can summarize the salient points of my invention by stating its advantages over other devices intended for space alarm applications, as follows:

(1) The simplicity of the circuit without sacrifice of reliability or sensitivity.

(2) The high inherent stability of operation point due to the combination of a transducer at resonance functioning as the main tank circuit of a unique semi-conductor oscillator.

(3) The availability of a single control summation point whose position in the circuit provides a non-loading signal pick-off.

I have constructed and tested the sonic space alarm of my invention and have found it very useful, practical, and stable while maintaining high sensitivity. It has proved to be an extremely reliable and accurate protective alarm system.

While I have described my invention in certain preferred embodiments I realize that modifications may be made and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A sonic space alarm wave pattern establishing and detecting system comprising a transducer carrying windings thereon, said transducer being of a type that gives very close coupling to air, a transistor oscillator having a tank circuit, said transistor oscillator having a collector, base and emitter, said tank circuit comprising a capacitor connected across the transducer windings, said tank circuit connected to the collector, a feed-back capacitor connecting said tank circuit to said base, said base connected to a power source through a bias resistor, said emitter providing a signal pick-off point, means connecting said signal pick-off point to ground, a low pass filter connected to said pick-off point and alarm circuit means interconnected to said low pass filter, said alarm circuit means being actuated in response to a predetermined change in amplitude of the signal at said signal pick-off point.

2. A sonic space alarm as set forth in claim 1 in which said means connecting said signal pick-off point to ground comprises a resistive element.

3. A sonic space alarm as set forth in claim 1 in which said means connecting said signal pick-off point to ground is a variable resistor.

4. A sonic space alarm as set forth in claim 1 in which said means connecting said signal pick-off point to ground is a non-inductive resistor.

5. A sonic space alarm as set forth in claim 1 in which said means connecting said signal pick-off point to ground is a non-inductive variable resistor.

6. A sonic space alarm system comprising a transducer of a type that gives very close coupling to air, said transducer including coils, and a transducer acoustical force producing means, said transducer acoustical force producing means coupled through coupling means to said transducer coils, a standing wave generating transistor oscillator having a collector, a base, an emitter and a tank circuit and including a transistor having a collector, an emitter and a base, said transducer coils in conjunction with a capacitance constituting said tank circuit, said tank circuit being connected to the oscillator collector member, said oscillator further having a signal pick-off point connected to the oscillator emitter, and alarm circuit means connected to said signal pick-off point, said alarm circuit means being responsive to the amplitude at said signal pick-off point.

7. A sonic space alarm standing wave establishing and detecting system comprising a transducer of the type that gives very close coupling to air, said transducer including coils and a transducer acoustical force producing means, a standing wave generating oscillator circuit, said oscillator circuit including a tank circuit, said coils being disposed in the tank circuit of said oscillator circuit, an oscillator signal pick-off point, said oscillator circuit being effective to cause said transducer acoustical force producing means to simultaneously establish a standing wave pattern and detect variations in the standing wave pattern, variations in said standing wave pattern causing changes in the impedance of said transducer coils whereby the amplitude of the signals at said signal pick-off point is varied, and signal amplitude responsive alarm means interconnected to said signal pick-off point.

8. A sonic space alarm system having a standing wave establishing oscillator circuit, a standing wave variation detection circuit, a transducer having an acoustical force producing means therein, said transducer being of a type that gives very close coupling to air, said oscillator circuit and said acoustical force producing means being effective to produce a steady state wave pattern, said steady state wave pattern being altered by the intrusion of a body into said pattern, a detection circuit, said acoustical force producing means being coupled with said oscillator circuit and said detection circuit and being effective to simultaneously establish said standing wave pattern and detect any variations in said standing wave pattern, and alarm circuit means responsive solely to changes in the amplitude of oscillations generated in said oscillator for providing an alarm upon the occurrence of a variation in said standing wave pattern.

9. A sonic space alarm system having a standing wave establishing oscillator circuit, a standing wave variation detection circuit, a transducer having an acoustical force producing means therein, said transducer being of a type that gives very close coupling to air, said oscillator circuit being effective to oscillate said acoustical force producing means at the natural resonant frequency of said acoustical force producing means, said oscillator circuit and said acoustical force producing means being effective to produce a steady state wave pattern, said steady state wave pattern being altered by the intrusion of a body into said pattern, said acoustical force producing means being coupled with said oscillator circuit and said detection circuit and being effective to simultaneously establish said standing wave pattern and detect any variations in said standing wave pattern, and alarm circuit means responsive solely to changes in the amplitude of oscillations generated in said oscillator for providing an

alarm upon the occurrence of a variation in said standing wave pattern.

10. A sonic space alarm comprising an oscillator circuit, a detection circuit, a speaker including a diaphragm and means including a coil for vibrating said diaphragm, said coil being connected in the tank circuit of said oscillator, said speaker being of a type that gives very close coupling to air, said oscillator circuit being effective to cause said speaker diaphragm to be vibrated at its resonant frequency whereby a steady state wave aptern is produced, said steady state wave pattern being altered by the intrusion of a body into said pattern, said detection circuit being coupled with said oscillator circuit and said speaker winding, said speaker being effective to simultaneously establish a steady state wave pattern and detect any variations in said wave pattern, and alarm circuit means responsive to changes in the oscillations generated by said oscillator for providing an alarm upon the occurrence of variations in said steady state wave pattern.

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