

[54] **INDUCTIVE REACTANCE PROXIMITY ALARM SYSTEM FOR BULKY MOVABLE OBJECTS**

[76] Inventor: **Hans A. Schirmer**, 20 Westside Ave., Bergenfield, N.J. 07621

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[51] Int. Cl. **G08b 13/22**

[58] Field of Search..... 340/280, 276, 274, 258 C, 340/63; 336/226, 180; 331/65

[56] **References Cited**

UNITED STATES PATENTS

3,129,415	4/1964	McKnight	340/258 C
3,183,411	5/1965	Palfi	340/258 C
3,192,517	6/1965	Werlin	340/280
3,284,082	11/1966	Isenberg et al.	340/280
3,332,863	7/1967	Woods	336/226
3,454,869	7/1969	Strauss et al.	340/280
3,611,345	10/1971	Pintell	340/280

3,764,971 10/1973 Brobeck..... 340/280

Primary Examiner—Glen R. Swann, III
Attorney, Agent, or Firm—Robert A. Maikis

[57] **ABSTRACT**

An alarm system for detecting removal of or tampering with trucks and other bulky movable objects is provided having an oscillator-supplied tuned circuit. The circuit has a remotely located sensing coil which is mounted on a metallic portion of the truck body and the tuned circuit is adjusted to a predetermined resonant or non-resonant operating condition. Removal of the sensing coil from the truck body detunes the circuit from the predetermined operating condition because of the change in inductive reactance of the coil and sounds an alarm signal to warn of the attempted removal. The system is operable with both magnetic and non-magnetic metallic materials and may also be employed to detect the opening of doors in buildings and truck bodies.

13 Claims, 7 Drawing Figures

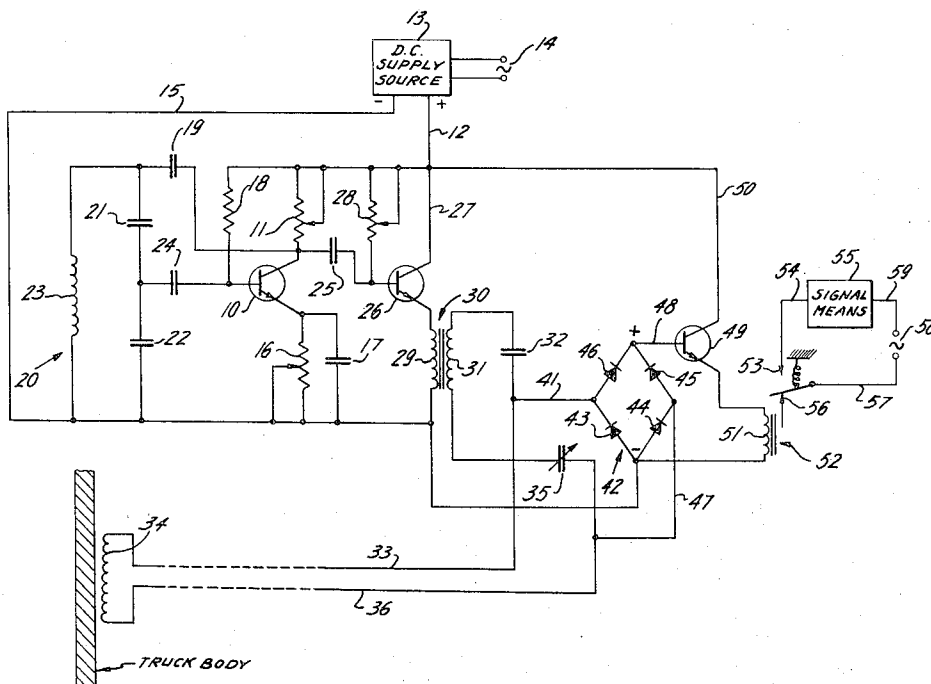


FIG. 1

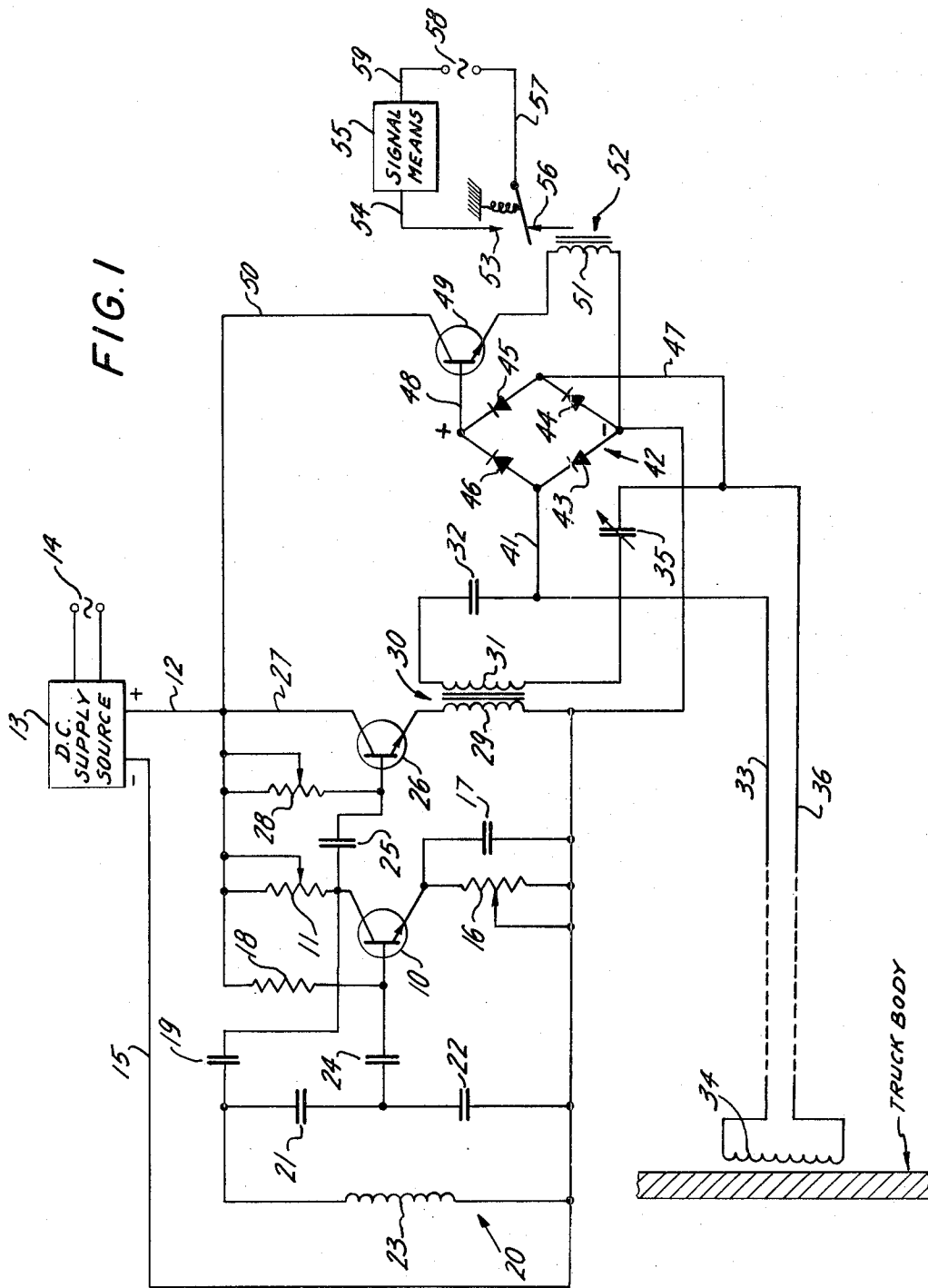


FIG. 2

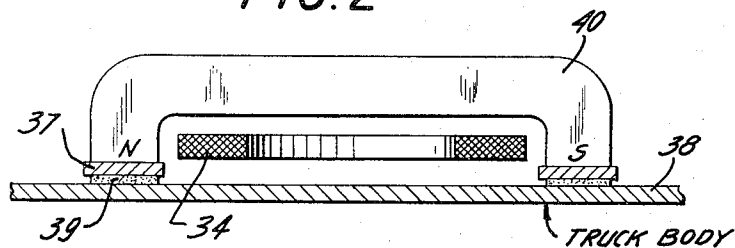


FIG. 6

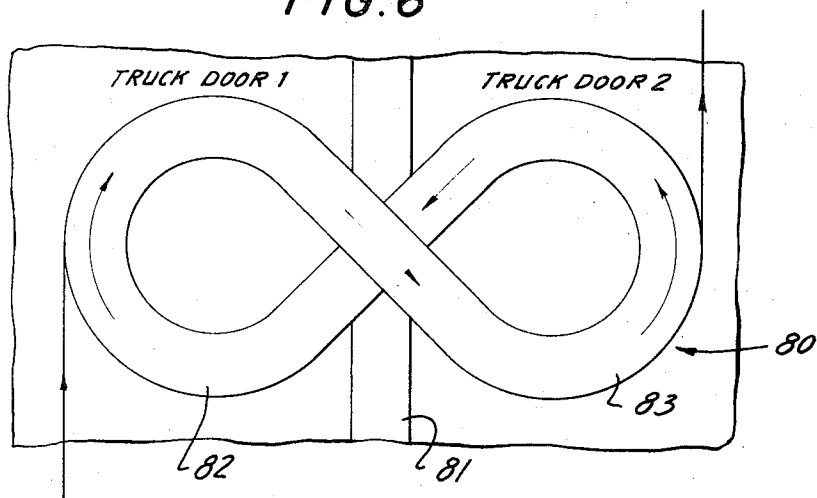


FIG. 7

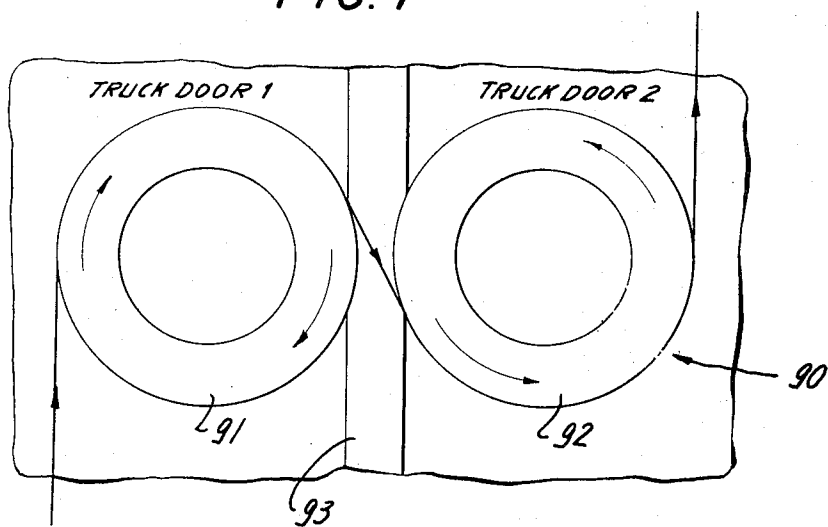


FIG. 3

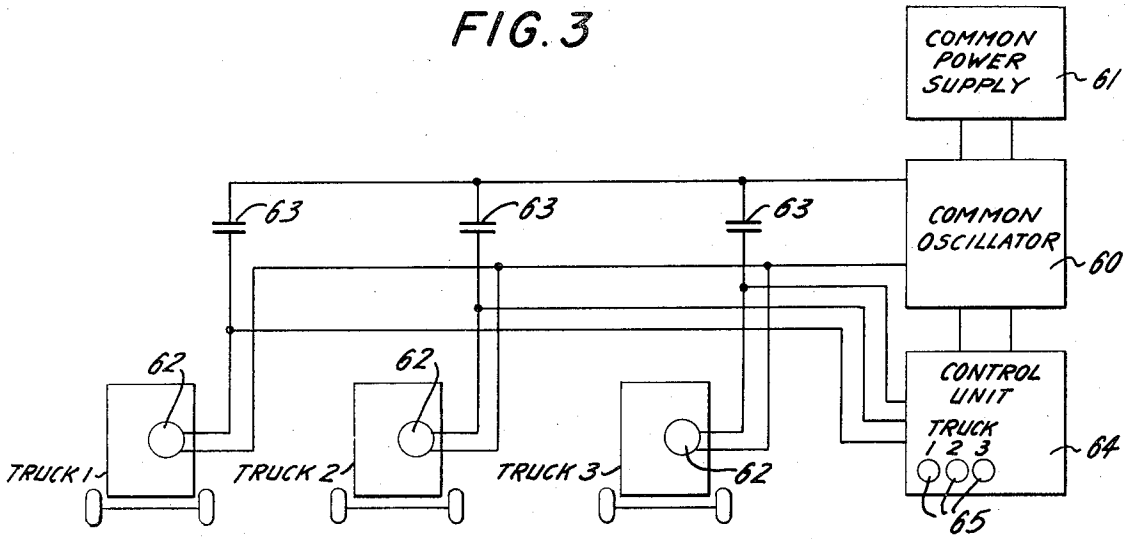


FIG. 5

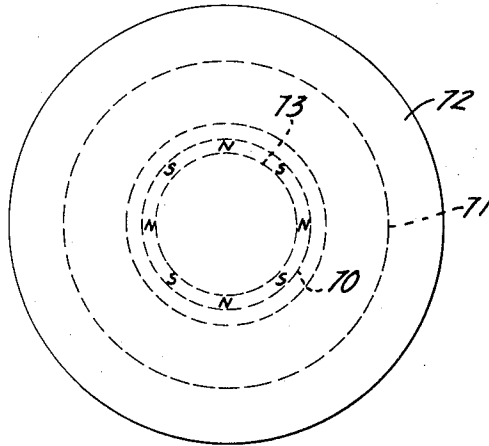
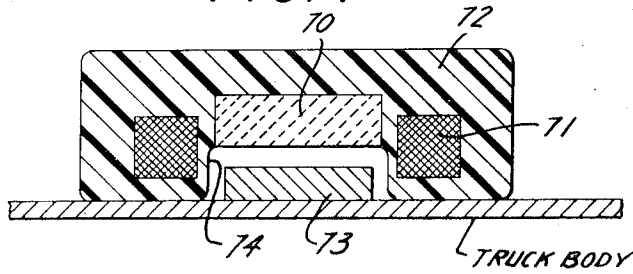


FIG. 4



INDUCTIVE REACTANCE PROXIMITY ALARM SYSTEM FOR BULKY MOVABLE OBJECTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to alarm and detection systems for the protection of property and, more particularly, to an alarm system for detecting the unauthorized removal or tampering with of bulky movable objects, such as office equipment, trucks and other vehicles. The system may also be used to detect the opening of doors in buildings, vehicles and equipment cabinets.

2. Description of the Prior Art

The present day increase in crimes pertaining to property, such as burglary and larceny, for example, coupled with greatly increased labor costs for guards and other security personnel have created a great demand for automatic alarm systems which will permit a single guard to protect property which is located over a wide area. A particular need for such systems exists in plants and offices where a number of bulky movable objects must be protected against theft and tampering. In industrial plants, for example, a number of trucks are often parked outside the plant and left unattended for periods of time while loading and unloading operations are performed. The trucks are often loaded and then left overnight until drivers report for work in the morning. The parked trucks should be protected not only against unauthorized removal from the plant premises, but also against the opening of doors in the vehicle to obtain access to the cargo stored therein. A suitable alarm system for protecting trucks should permit a single security guard to monitor a large number of parked vehicles and should be highly reliable and tamper-proof in operation. Additionally, it is highly desirable that such an alarm system be fail-safe in operation, so that interruptions to the power supply for the system will alert the guard. An alarm system of this type may also be employed to protect other bulky, movable objects in plants and offices such as safes, computers, and other valuable office equipment which is subject to theft and unauthorized removal.

Prior art solutions to the aforementioned problems have taken a variety of forms. For example, electric switches have been attached to safes and other objects and connected to audible or visual alarm signals in a central location, so that removal of the switch from the protected object causes the switch to be operated and an alarm to be sounded. Obviously, systems of this type are easily defeated, since thin sheets of material could be slid between the switch and the surface of the protected body to prevent the switch from operating when it is removed from the body. Systems of this type are also subject to failure when the switch contacts become dirty with prolonged periods of use. Intruder alarm systems have been developed which make use of a capacitor sensing arrangement wherein the physical presence of an intruder in the vicinity of the capacitor sensor causes an alarm signal to be sounded. Systems of this type are unsuited for the protection of trucks and other bulky movable objects, because the need for such protection very often exists during the very hours when the plant or office in which the system is used is filled with workers, so that the presence of authorized personnel in the vicinity of the protected equipment could trip the alarm. It may also be noted that suitable alarm systems

for the protection of trucks and other bulky movable objects should be easily installed without requiring extensive modifications of the truck bodies or the other objects to be protected.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an alarm system for detecting the removal or tampering with of bulky movable objects which is virtually tamper-proof and highly reliable in operation.

It is a further object of this invention to provide an alarm system for trucks and other bulky movable objects which is easily installed and fail-safe in operation.

It is a still further object of this invention to provide an alarm system for trucks and other bulky movable objects which not only warns against unauthorized removal of the truck but also against the unauthorized opening of cargo areas.

It is an additional object of this invention to provide an alarm system for trucks and other bulky movable objects which is especially suited for the monitoring of a large number of trucks or other protected objects by a single security guard.

It is a further object of this invention to provide an alarm system for trucks and other movable objects which is of compact size and weight and which is relatively inexpensive to manufacture and maintain.

Briefly, the alarm system of the present invention comprises tuneable circuit means which are coupled to oscillator means for energization thereby. The tuneable circuit means include inductive sensing coil means which are adapted to be mounted on a metallic portion of the object to be protected, so that the proximity of the coil means to the metallic portion of the object determines the inductive reactance of the coil means. The tuneable circuit means also comprise tuning means for tuning the circuit means to a predetermined resonant or non-resonant operating condition with the coil means mounted on the object, so that removal of the coil means from the object causes the inductive reactance of the coil means to change and the circuit means to be detuned. Mounting means are provided for removably mounting the sensing coil means on the metallic portion of the object to be protected. Detector means are coupled to the tuneable circuit means for producing an output signal in response to a change in the inductive reactance of the coil means and alarm signal means are coupled to the detector means to produce an alarm signal in response to the detector means output signal. A plurality of tuneable circuit means with separate sensing coil means may be energized by a common oscillator, so that a plurality of trucks, doors or other movable objects may be individually monitored at a single location. Mounting means for mounting the sensing coil means on the body to be protected are provided for both magnetic and non-magnetic metallic bodies. Sensing coil means having different configurations are provided for certain applications wherein a coil of a larger area may be desirable, such as detecting the opening of cargo doors in trucks and other objects, for example.

The nature of the invention and other objects and additional advantages thereof will be more readily understood by those skilled in the art after consideration of the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a circuit diagram of an alarm system constructed in accordance with the teachings of the present invention;

FIG. 2 is a side elevational view, partly in section, of the sensing coil and mounting arrangement therefor of the alarm system of FIG. 1 showing the sensing coil attached to a truck body;

FIG. 3 is a schematic circuit diagram showing the alarm system of the invention monitoring a plurality of trucks;

FIG. 4 is a full sectional view of a different mounting arrangement for the sensing coil which utilizes a ceramic magnet;

FIG. 5 is a top plan view of the sensing coil and mounting arrangement therefor shown in FIG. 4 of the drawings;

FIG. 6 is a schematic diagram of an alternate form of sensing coil having a "figure 8" winding configuration; and

FIG. 7 is a schematic diagram of still another form of sensing coil which utilizes two serially-connected coils.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now to FIG. 1 of the drawings, there is shown an alarm system constructed in accordance with the teachings of the present invention. The alarm system is shown as comprising a transistor 10 of the NPN type which is connected in a common emitter configuration. The collector of the transistor 10 is connected through an adjustable collector supply resistor 11 to the positive output lead 12 of a D.C. supply source 13. The D.C. supply source 13 may comprise a battery of suitable voltage or may, as illustrated, comprise a rectifier which is energized from an A.C. voltage supply source 14. The negative output lead 15 of the D.C. supply source 13 is connected to the emitter of the transistor 10 through a biasing network consisting of an adjustable resistance 16 and a shunt capacitor 17. A base bias resistor 18 is connected between the base of the transistor 10 and the positive output 12 of the D.C. supply source 13, so that the D.C. supply source provides both the collector supply voltage and the base bias. Resistor 16 and capacitor 17 function in the usual manner to provide additional base bias without introducing objectionable A.C. degeneration. The output of transistor 10 appearing at the collector is connected through a coupling capacitor 19 to a tuned circuit 20 consisting of serially-connected capacitors 21 and 22 and a shunt inductance or coil 23. The circuit junction of the serially-connected capacitors 21 and 22 is coupled by a capacitor 24 to the base of transistor 10, so that the transistor is caused to function as an oscillator having an output frequency determined by the circuit parameters of the tuned circuit 20.

The output of the transistor-oscillator 10 which appears at its collector is coupled by a capacitor 25 to the base of a transistor 26 of the NPN type which is connected in an emitter follower circuit. The collector of transistor 26 is connected by a lead 27 to the positive output 12 of the D.C. supply source 13, while the base of the transistor 26 is connected through an adjustable base bias resistor 28 to the same positive output 12 of

the supply source so that the lower bias potential required for transistor operation is obtained. The emitter of transistor 26 is coupled to the negative output 15 of the D.C. supply source 13 through the primary winding 29 of an output transformer 30. The transformer 30 is provided with a secondary winding 31 which has one end thereof coupled by a coupling capacitor 32 and a long lead 33 to one end of a remotely-located sensing coil 34. The other end of the transformer secondary winding 31 is coupled by an adjustable tuning capacitor 35 and a long lead 36 to the other end of the sensing coil 34. The sensing coil 34 is located in proximity to the truck body or other movable object which is to be protected by the alarm system of the invention, so that the inductance of the sensing coil depends upon its proximity to the body to be protected.

A suitable arrangement for mounting the sensing coil 34 on the truck body is shown in FIG. 2 of the drawings. As seen in FIG. 2, a thin annular member or ring 37 of steel, iron or other magnetic material is affixed to the truck body 38 by a double-sided adhesive tape 39. The method of mounting the ring 37 on the truck body 38 may be varied to suit particular applications and the double-sided adhesive tape illustrated may be replaced by cement, screws or rivets, for example. The sensing coil 34 is preferably wound as a relatively thin annular coil or "pancake" coil which has an outside diameter somewhat less than the inner diameter of the ring 37 so that the coil may be placed in proximity to the truck body 38. The sensing coil 34 may be secured by any convenient means (not shown) to the inner portion of a C-shaped permanent magnet 40 which has a length between pole pieces corresponding to the diameter of the ring 37. By virtue of this arrangement, the sensing coil 34 is held in place in proximity to the truck body by the magnetic attraction exerted between the poles of the permanent magnet 40 and the ring 37 of magnetic material. This arrangement facilitates the installation and removal of the sensing coil on the object to be protected. It may be noted that the ring 37 and the ring securing means 39 may be dispensed with when the truck body 38 is fabricated of a magnetic material, such as steel or iron, for example, since the permanent magnet 40 will then hold the sensing coil 34 in place by the magnetic attraction between the magnet and the truck body. The ring 37 and ring securing means 39 may be utilized when the truck body is fabricated of a non-magnetic, metallic material, such as aluminium, for example.

Referring again to FIG. 1 of the drawings, it may be seen that one end of the sensing coil 34 is connected by long lead 33 and a lead 41 to one A.C. input terminal of a "bridge" type rectifier circuit 42 formed by diodes 43, 44, 45 and 46, while the other end of the sensing coil 34 is connected by long lead 36 and a lead 47 to the other A.C. input terminal of the rectifier circuit 42. The positive D.C. output terminal of the rectifier 42 is connected by a lead 48 to the base element of a NPN transistor 49 which is connected in an emitter-follower configuration. The collector supply potential for the transistor 49 is obtained by means of a lead 50 which connects the collector element of the transistor to the positive output 12 of the D.C. supply source 13. The emitter element of transistor 49 is coupled through the control winding 51 of a relay 52 to the negative D.C. output terminal of the rectifier 42, so that the signal applied to the transistor 49 is the rectified A.C. voltage

appearing across the sensing coil 34. The relay 52 is provided with a fixed contact 53 which is connected by a lead 54 to one side of an alarm signal means 55 and a movable contact 56 which is connected by a lead 57 to one side of an A.C. voltage supply source 58. The other side of the A.C. voltage supply source 58 is connected by a lead 59 to the other side of the alarm signal means 55. For reasons which will be explained hereinafter, the movable relay contact 56 is spring biased into making contact with fixed contact 53, so that the electric circuit through the alarm signal means 55 is normally closed unless the control winding 51 of the relay 52 is energized. The alarm signal means 55 may comprise an audible signal means, such as a buzzer or bell, for example, or a visual signal, such as a light, or any desired combination of audible or visual signals.

In operation, transistor 10 of the alarm system of the invention functions as an oscillator to provide an A.C. signal of substantially constant frequency which is applied to the primary winding 29 of transformer 30 through the transistor 26. Since the transistor 26 is connected in an emitter-follower configuration, the output from this circuit remains substantially constant over a wide range of load changes, so that multiple tuned circuits and sensing coils may be supplied from a single oscillator. The voltage appearing across secondary winding 31 of transformer 30 is applied to a tuneable circuit consisting of capacitor 32, sensing coil 34 and tuning capacitor 35. When the sensing coil 34 is in place in proximity to the truck body, the series circuit formed by coil 34 and capacitors 32 and 35 may be tuned to resonance by means of the variable capacitor 35, so that a maximum current will flow through the circuit and a maximum reactive voltage drop will appear across the sensing coil 34. The maximum voltage drop across the sensing coil 34 will produce a maximum A.C. applied voltage to the bridge rectifier 42, so that a maximum D.C. current will flow through the control winding 51 of relay 52 and the series circuit through the alarm signal means 55 will be opened, thereby deactivating the alarm. Should the truck to which the sensing coil is affixed be disconnected from the system by driving the truck away from the designated area or by manually removing the sensing coil 34 from the truck body, the inductance and, consequently, the inductive reactance of the sensing coil 34 will be changed, with the result that the tuned circuit will become detuned and the voltage appearing across the sensing coil 34 will be decreased. The decrease in voltage across the sensing coil 34 will reduce the D.C. current flowing in the winding 51 of relay 52, so that the movable contact 56 will be moved to its normally-closed position in contact with fixed contact 53, thereby causing the alarm signal means 55 to be energized by the A.C. supply source 58 and the alarm sounded.

Should the long leads 33 and 36 coupling the sensing coil 34 to the main portion of the alarm system be cut, or the coil 34 itself be opened or otherwise tampered with, the alarm will be sounded, since the tuneable circuit will detune and the current through the relay winding 51 decrease, thereby closing the alarm signal circuit. The alarm system of the invention permits all of the components of the system, with the exception of the sensing coil 34 and the long leads 33 and 36, to be located in a protected location within the plant or other building. Since the only exposed portion of the system

is the sensing coil 34 and the leads 33 and 36, any tampering with the coil or cutting of the long leads will immediately sound the alarm. The system has also been designed to be fail-safe, since a failure of the A.C. supply source 14 will cause the current flowing through the relay winding 51 to fall to zero, thereby closing the circuit through the alarm signal means 55. In this regard, it may be noted that it would be preferable to provide an independent power supply for alarm signal means 55, so that a failure of A.C. supply service to the plant will not prevent the alarm signal means from being energized. To this end, the alarm signal means 55 may be designed to operate on direct current and the A.C. supply source 58 may be replaced by a battery or other suitable independent electric supply source.

When the sensing coil 34 is located in proximity to a truck body formed of a magnetic metallic material, such as steel or iron, for example, the change in inductive reactance of the coil caused by movement of the coil away from the truck body will be substantial. When the truck body is formed of a non-magnetic metallic material, such as aluminum, for example, the movement of the sensing coil away from the truck body will also cause a variation in the inductive reactance of the coil because the aluminum of the truck body is an electrically conductive material and eddy currents will be induced in the aluminum by the A.C. voltage in the coil. The presence of the induced currents in the aluminum truck body will then produce a small, but definite change in the overall inductive reactance of the sensing coil, so that the removal of the sensing coil from the truck body will still serve to sound the alarm. Consequently, the alarm system of the invention may be used with both magnetic and non-magnetic metallic truck bodies.

The foregoing description of the operation of the alarm system of the invention is based upon the assumption that the tuneable circuit formed by the sensing coil 34 and capacitors 32 and 35 is tuned to a resonant operating condition when the coil is mounted on the truck body, so that removal of the coil from the body detunes the circuit to a non-resonant condition. It is believed apparent that the alarm system would also operate if the tuneable circuit was tuned to a resonant operating condition before the sensing coil is mounted on the truck body, so that the circuit is shifted to a non-resonant operating condition when the coil is mounted on the truck body. In this situation, the current in the series tuneable circuit would increase rather than decrease when the sensing coil is removed from the truck body, whereby the current in the control winding 51 of the relay 52 would also increase with the result that the alarm signal means would not be energized. Accordingly, for this mode of operation, the relay contacts should be biased to a normally-open position, so that the increase in current through the relay winding caused by the removal of the sensing coil from the truck body causes the relay contacts to close, thereby energizing the alarm signal means. The same effect may also be produced by suitably biasing the transistor 49 to provide for a decrease in the current through the relay control winding 51 when the voltage applied to the base element of the transistor from the rectifier 42 is increased. Accordingly, the alarm system of the invention may be operated when the tuneable circuit is tuned to either a resonant or a non-resonant operating

condition with the sensing coil mounted on the truck body.

Referring now to FIG. 3 of the drawings, it may be seen that the alarm system of the invention permits a single oscillator and power supply to monitor a plurality of trucks or other movable objects. As seen in FIG. 3, a common oscillator 60 is supplied with a single power supply 61 and the voltage output of the oscillator is applied to the parallel-connected sensing coils 62 of a plurality of parked trucks through coupling capacitors 63. In this arrangement, the common power supply 61 would be the D.C. supply source 13 shown in FIG. 1 of the drawings, while the common oscillator 60 would comprise the transistors 10 and 26 and associated circuitry shown in the arrangement of FIG. 1. The capacitors 63 and the sensing coils 62 would respectively correspond to the capacitor 32 and the sensing coil 34 shown in the circuit of FIG. 1 of the drawings. Since the transistor 26 in the circuit of FIG. 1 of the drawings is connected in an emitter-follower circuit, it serves as a buffer amplifier to provide an output which is constant over a fairly wide range of load changes. Consequently, the oscillator circuit of FIG. 1 is ideally suited to supply a plurality of parallel-connected tuneable circuits. In the arrangement of FIG. 3, individual tuning capacitors 35, rectifiers 42, output transistors 49, relays 52, and alarm signal means 55 would be located in a central control unit 64, so that each of the plurality of trucks being monitored would have its own detector and alarm circuit. For example, the alarm signal means 55 shown in FIG. 1 of the drawings would become a plurality of separate panel indicator lamps 65 as illustrated in the arrangement of FIG. 3 of the drawings and could be utilized with an audible alarm, such as a buzzer or bell, for example, to provide the necessary warning and identification of the vehicle being tampered with or removed. In practice, the individual tuneable circuits associated with each of the sensing coils 62 shown in the arrangement of FIG. 3 would be individually tuned by the variable capacitor associated with that circuit. By virtue of this arrangement, trucks having both magnetic and non-magnetic metallic bodies may be accommodated by a single common oscillator and power supply.

An alternate arrangement for mounting the sensing coil 34 of the alarm system of the invention on a truck body is shown in FIGS. 4 and 5 of the drawings. In this arrangement, a cylindrical permanent magnet 70 is concentrically disposed within an annular sensing coil 71 and the resulting assembly is encapsulated in an Epoxy resin material 72. The permanent magnet 70 may conveniently comprise a ceramic magnet which is formed of an electrically non-conductive material, so that eddy current losses in the permanent magnet structure are eliminated. The use of a ceramic magnetic material and the resultant elimination of eddy current losses permit the permanent magnet to be located within the annular sensing coil 71 to produce the small compact assembly shown. As seen in FIG. 5 of the drawings, the cylindrical permanent magnet 70 may be magnetized with radially-disposed pole pairs to increase the holding power of the magnet. When the truck body is formed of a magnetic material, such as steel or iron, for example, the structure as described thus far will hold the sensing coil 71 securely in place against the truck body. When the truck body is fabricated of a non-magnetic metallic material, such as alu-

minum, for example, the permanent magnet 70 will not be attracted to the truck body. In this case, a magnetized ceramic disc 73 may be mounted on the truck body by any convenient means (not shown), such as cementing, screws or riveting, for example, so that a magnetic attraction exists between the ceramic disc 73 and the permanent magnet 70 which will hold the encapsulated sensing coil 71 in place. In order to receive the ceramic disc, the encapsulation 72 may be conveniently formed with a centrally-disposed depression 74 as illustrated. If desired, the magnetized ceramic disc 73 may be replaced by a small steel washer without creating a substantial eddy current loss and materially affecting the functioning of the system. The mounting arrangement shown in FIGS. 4 and 5 of the drawings produces a sensing coil arrangement having small size and low weight and reduces the cost of the system through the elimination of the relatively expensive C-shaped permanent magnet utilized in the arrangement of FIG. 2 of the drawings.

From the foregoing description of the alarm system of the invention, it is believed apparent that the system will not only function to prevent the removal of a truck from a designated location but may also be used to sense the unauthorized opening of a door on the truck body. When the door on the truck body is of the hinged type, the sensing coil may be affixed to the truck body in a position where it straddles the small opening between the edge of the door and the door frame, so that when the door is opened, the change in magnetic path through a magnetic truck body or the decrease in eddy current area on a non-magnetic truck body causes the inductive reactance of the coil to change, thereby sounding the alarm. When the truck body contains a pair of adjacent, hinged doors, the diameter of the sensing coil should be increased to a point where the coil is able to overlap both doors. In some applications, because of the spacing between the doors, this may result in a sensing coil having an excessively large diameter. It is also possible to employ two separate sensing coils with separate associated tuneable circuits, so that the opening of either door will sound the alarm. This solution, however, is expensive because two circuits must be provided for each truck. The sensing coil arrangement shown in FIG. 6 of the drawings provides a coil which is capable of covering a large surface area of the body to be protected. In this arrangement, the sensing coil 80 is wound with a "figure 8" configuration, so that the coil is long and narrow. The coil is so placed that it straddles a pair of truck doors consisting of truck door 1 and truck door 2 which are separated by a sash strip or frame 81. The "figure 8" configuration produces two coil sections 82 and 83 which are then respectively located in proximity to truck door 1 and truck door 2, so that the opening of either door sounds the alarm signal.

Another arrangement for the sensing coil which facilitates the coil being used with truck bodies having a pair of hinged doors is shown in FIG. 7 of the drawings. In this arrangement, the sensing coil 90 consists of a first annular sensing coil 91 and a second annular sensing coil 92 which are spaced a distance apart. The winding of coil 91 is connected in series circuit with the winding of coil 92, so that a variation in inductance of either coil will cause a detuning of the tuneable circuit associated with the pair of coils. Sensing coil 91 is located in proximity to truck door 1 and is arranged to

straddle the opening between truck door 1 and the truck frame or strip 93 which separates the doors, while sensing coil 92 is located in proximity to truck door 2 and is arranged to straddle the opening between truck door 2 and the door frame 93, so that the opening of either truck door will vary the total inductance of the serially-connected sensing coils, thereby detuning the tuned circuit and sounding the alarm signal.

It is believed apparent that many changes could be made in the construction and described uses of the foregoing alarm system and many seemingly different embodiments of the invention could be constructed without departing from the scope thereof. For example, the series-tuned circuit energized by the secondary winding 31 of the transformer 30 in FIG. 1 of the drawings could be replaced by a suitably designed parallel-tuned circuit and the detector and alarm circuits modified in a known manner to accommodate the resulting change in resonance characteristics. It is also believed apparent that the alarm system of the invention may be used to prevent the removal or tampering with of movable bulky objects other than truck bodies. For example, safes and other valuable office and laboratory equipment could be protected through the use of the present alarm system. The alarm system of the invention may also be used to protect and monitor interior and exterior doors in buildings, since the sensing coil means may be mounted on the door in such manner that the tuneable circuit means is detuned when the door is opened. In this case, the door itself would be considered to be the movable object to be protected. When the door, truck body or other movable object to be protected is entirely fabricated of a non-metallic material, such as wood or a plastic, for example, a metallic plate can be affixed to the object and the sensing coil means mounted on the plate, so that removal of the sensing coil means from the plate produces a suitable change in the inductive reactance of the coil means. By virtue of this arrangement, the alarm system of the invention is made suitable for use with virtually all movable objects having at least a metallic portion. Accordingly, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An alarm system for protecting movable objects having at least a metallic portion comprising oscillator means in a protected location remote from the object to be protected; tuneable circuit means coupled to said oscillator means for energization thereby, said circuit means having movable inductive sensing coil means adapted to be mounted on the metallic portion of the movable object to be protected, so that the proximity of said coil means to the metallic portion of the object determines the inductive reactance of the coil means, and tuning means in said protected location for tuning said circuit means to a predetermined resonant or non-resonant operating condition with said coil means mounted on the metallic portion of the object, so that removal of the coil means from the metallic portion of the object causes the inductive reactance of the coil means to change and said circuit means to be detuned;

mounting means for removably mounting said sensing coil means on the metallic portion of the object to be protected;

detector means in said protected location coupled to said tuneable circuit means for producing an output signal in response to a change in the inductive reactance of said coil means; and alarm signal means in said protected location coupled to said detector means for producing an alarm signal in response to said detector means output signal.

2. An alarm system as claimed in claim 1 wherein said tuneable circuit means is a series circuit tuned to a resonant operating condition, and said detector means is coupled across said sensing coil means and responsive to the voltage thereacross.
3. An alarm system as claimed in claim 2 wherein said detector means comprises a bridge rectifier circuit having the input thereof coupled across said sensing coil means, an electrical energy source, and relay means having the control winding thereof coupled to the output of said rectifier circuit for energization thereby and normally-closed relay contact means for coupling said alarm signal means to said electrical energy source whenever the output of the rectifier circuit falls below a predetermined level.
4. An alarm system as claimed in claim 1 wherein said mounting means comprises a permanent magnet, and means for securing said sensing coil means to said permanent magnet.
5. An alarm system as claimed in claim 4 wherein said permanent magnet is a C-shaped permanent magnet having a recessed portion between the pole pieces thereof and, said sensing coil means is disposed within the recessed portion of said C-shaped magnet.
6. An alarm system as claimed in claim 4 wherein said sensing coil means comprises an annular sensing coil, said permanent magnet comprises a ceramic permanent magnet disposed within said annular sensing coil, and said means for securing the sensing coil means to the permanent magnet comprises a potting compound encapsulating said sensing coil and said permanent magnet.
7. An alarm system as claimed in claim 5 wherein said mounting means further comprises a ring of magnetic material having a diameter substantially the same as the distance between the pole pieces of said C-shaped permanent magnet for magnetically engaging said C-shaped magnet when the sensing coil means is to be mounted on the metallic portion of the object to be protected, and means for securing said ring to the metallic portion of the object to be protected.
8. An alarm system as claimed in claim 6 wherein said mounting means further comprises a disc of magnetic material removably disposed within said annular sensing coil and adapted to magnetically engage said ceramic permanent magnet when the sensing coil is to be mounted on the object to be protected, and

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means for securing said disc to the metallic portion of the object to be protected.

9. An alarm system as claimed in claim 8 wherein said disc of magnetic material comprises a ceramic permanent magnet.

10. An alarm system as claimed in claim 1 wherein the object to be protected has at least one hinged door thereon having at least a metallic portion adjacent the metallic portion of the remainder of the protected object, and

said mounting means is adapted to mount said sensing coil means in a position wherein the sensing coil means overlaps at least the metallic portion of the door and the metallic portion of the remainder of the protected object.

11. An alarm system as claimed in claim 10 wherein said sensing coil means comprises a sensing coil having a FIG. 8 winding configuration.

12. An alarm system as claimed in claim 10 wherein said sensing coil means comprises a pair of spaced-apart annular sensing coils having the windings thereof connected in series circuit.

13. An alarm system for protecting a plurality of movable objects each having at least a metallic portion comprising

an oscillator circuit in a protected location remote from the objects to be protected;

a plurality of tuneable circuit means coupled to said oscillator circuit for energization thereby, each of said tuneable circuit means being associated with a different one of the objects to be protected and having

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movable inductive sensing coil means adapted to be mounted on the metallic portion of the object to be protected associated therewith, so that the proximity of said coil means to the metallic portion of that object determines the inductive reactance of the coil means, and

tuning means in said protected location for tuning said circuit means to a predetermined resonant or non-resonant operating condition with said coil means mounted on the metallic portion of the protected object associated therewith, so that removal of the coil means from the metallic portion of the object causes the inductive reactance of the coil means to change and said circuit means to be detuned;

a plurality of mounting means for removably mounting said plurality of sensing coil means on the metallic portion of the bodies to be protected;

a plurality of detector means in said protected location, each of said detector means being associated with a different one of said plurality of tuneable circuit means and being coupled to the tuneable circuit means associated therewith for producing an output signal in response to a change in the inductive reactance of the coil means associated therewith; and

a plurality of alarm signal means in said protected location, each of said alarm signal means being coupled to a different one of said plurality of detector means and being operable to produce an alarm signal in response to the output signal of the detector means associated therewith.

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