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Jersey City, N.J.

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[54] **VAULT PROTECTION SYSTEM**
 10 Claims, 7 Drawing Figs.

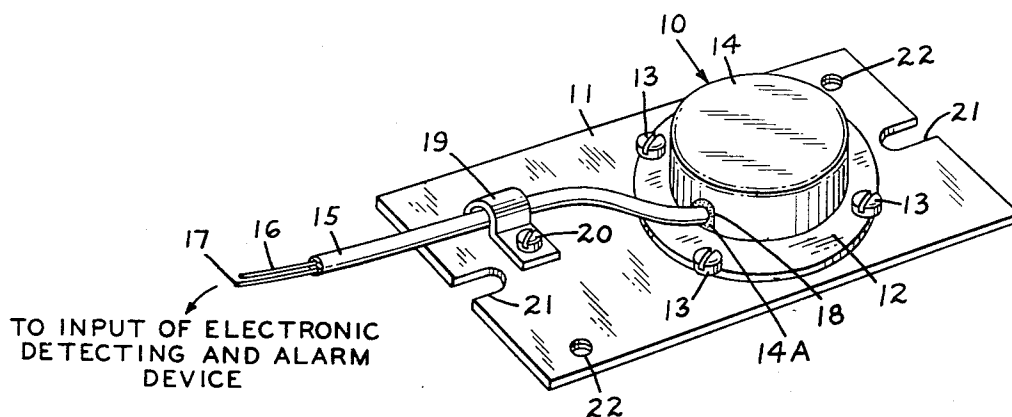
[52] U.S. Cl. 340/261,
 179/115.5, 109/38
 [51] Int. Cl. G08b 13/16
 [50] Field of Search 340/261,
 273; 179/110.1, 113, 114, 115, 115.5; 109/38, 42

[56] **References Cited**

UNITED STATES PATENTS

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ABSTRACT: An electrical protection system of the acoustic type for bank vaults and like structures which provides means for collecting the sound from numerous points whereby adequate protection is provided for vaults of building block construction at far less expense than is possible under the prior art. The invention also permits operation at higher sensitivity levels while maintaining normal stability when used in conjunction with vaults of monolithic construction.



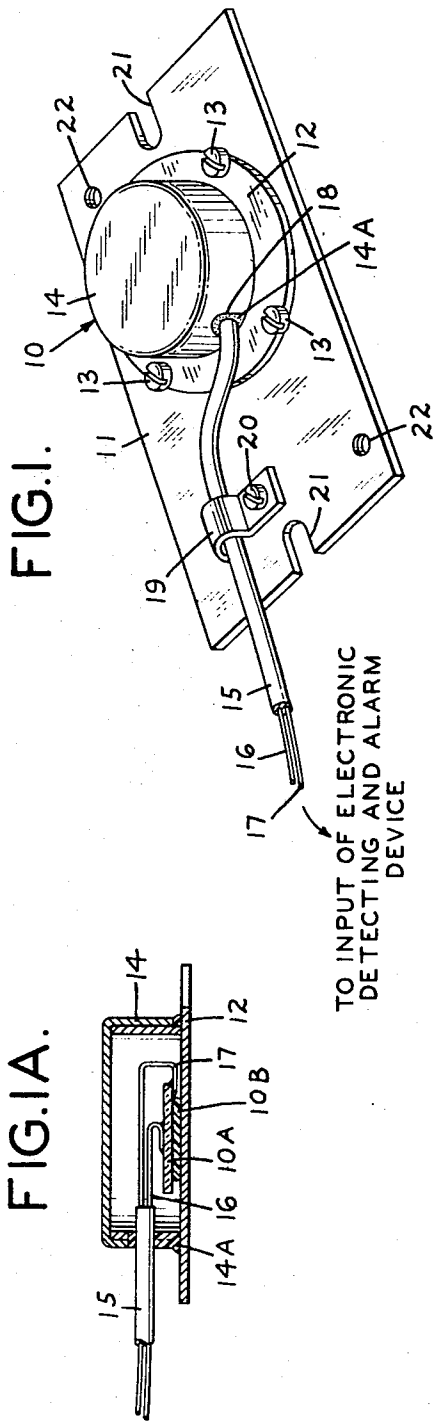


FIG. 1A.

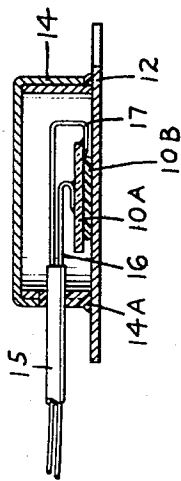


FIG. 2.

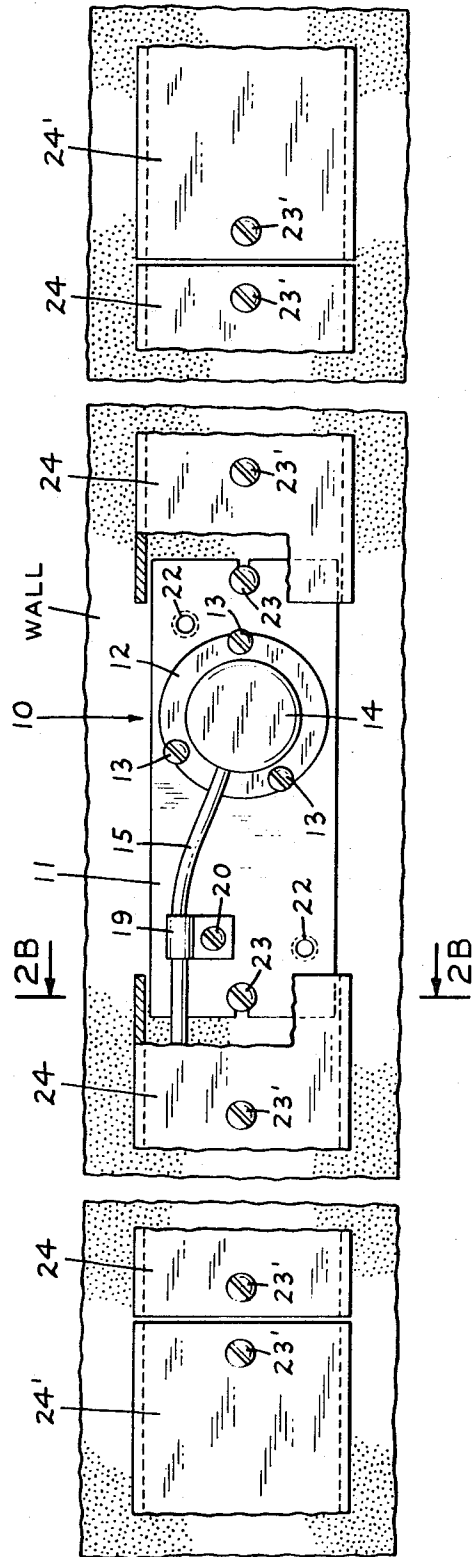


FIG. 2A.

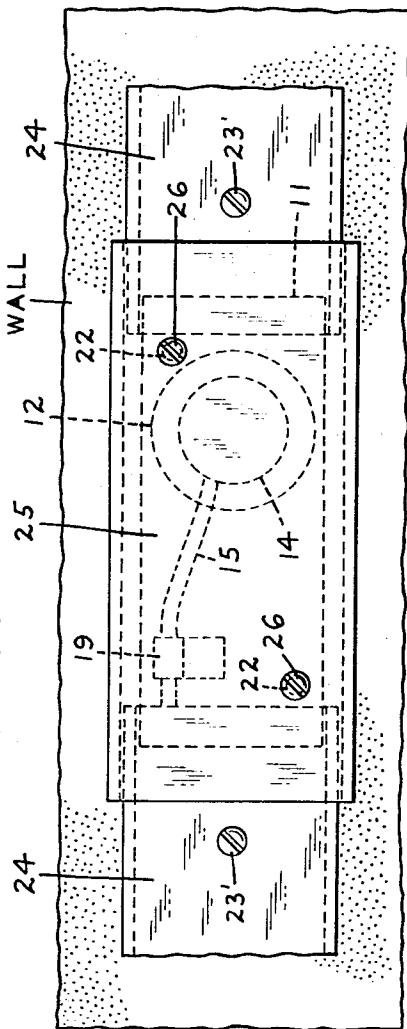


FIG. 2B.

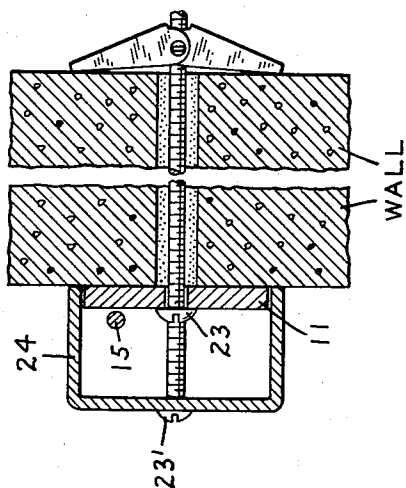
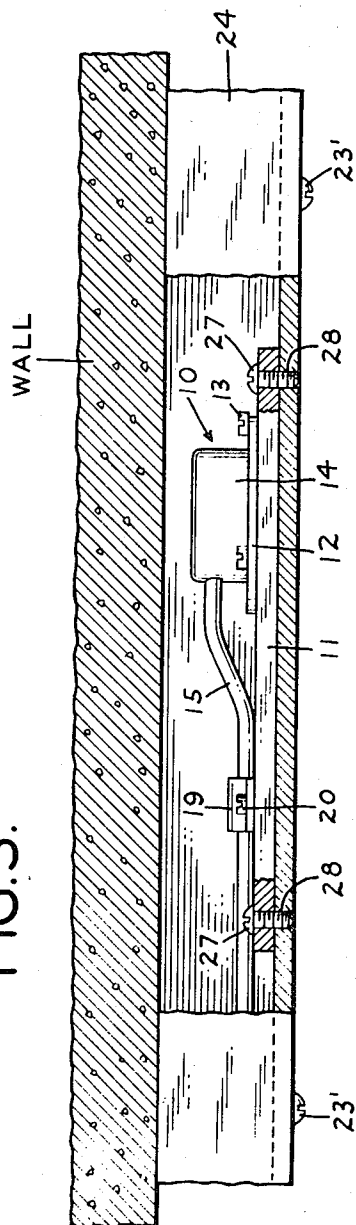
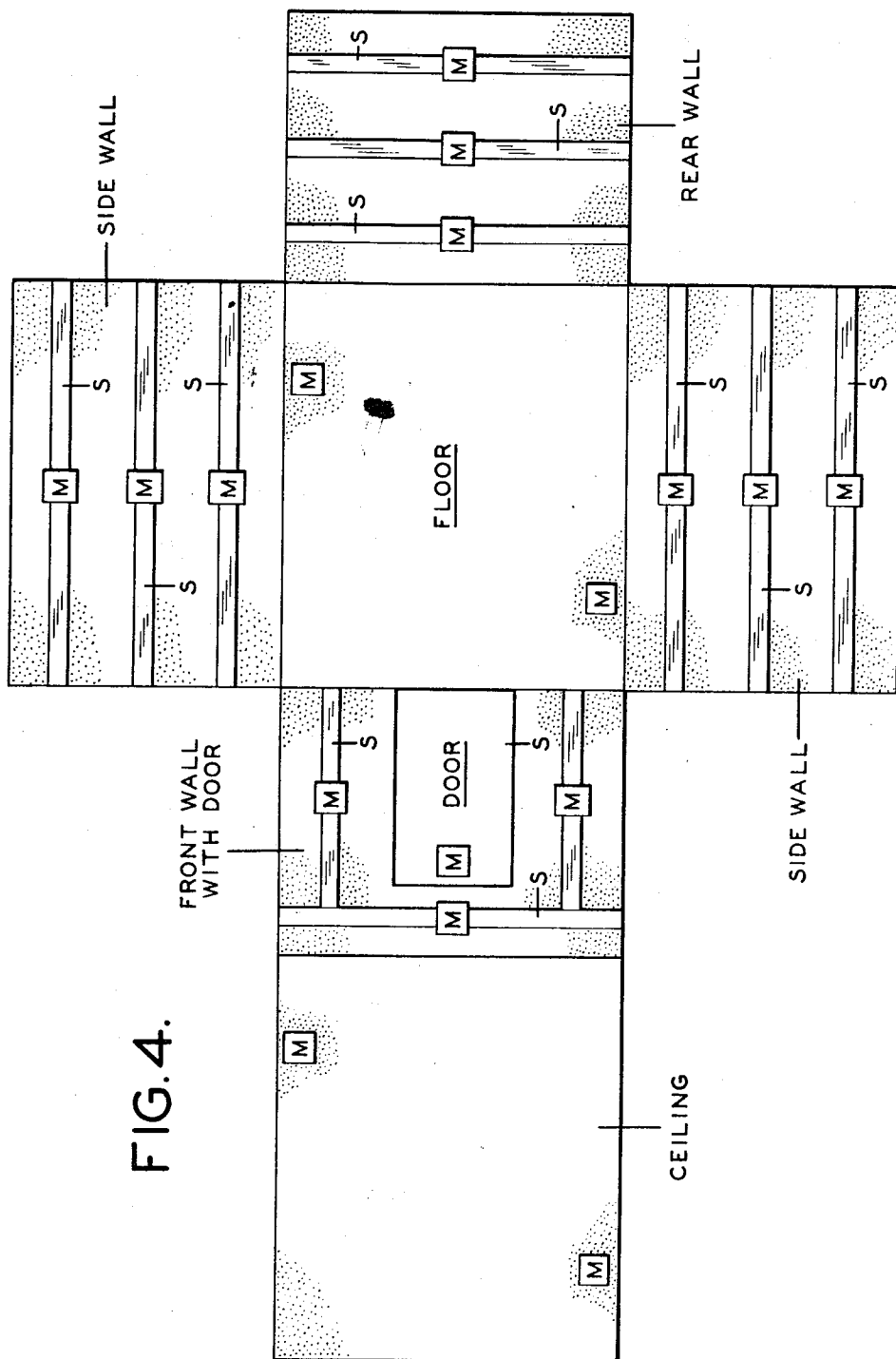


FIG. 3.





VAULT PROTECTION SYSTEM

BACKGROUND OF THE INVENTION

Electrical protection systems of the acoustic type have been employed for many years to give warning of attempts by unauthorized persons to break into bank vaults and similar enclosures employed for the safekeeping of valuable merchandise such as furs.

Such systems rely upon the ability of one or more microphones located within the protected structure to respond to the noises produced in the course of an attack upon the structure and to produce an electrical signal, e.g., a voltage, which, by means of appropriate electronic apparatus, may be amplified and employed to provide a suitable warning signal at selected remote locations that the protected area is under attack. An early example of such a system is found in U.S. Pat. No. 1,192,312 issued July 25, 1916, to R.M. Hopkins and J. F. D. Hoge.

The noises produced during an attack depend primarily upon the nature of the tools employed for the purpose and these have varied widely as more and more sophisticated tools and techniques have become generally available. Thus, for instance, the simple sledge hammer attack of years past may now be replaced by the use of a portable core drill with diamond cutters or a hydraulic jack may be employed to push down a portion of the vault wall. In the case of vaults constructed of building blocks joined together with mortar, the attack may consist of the scraping away of the mortar with a pointed tool.

The noises produced during an attack upon a vault are transmitted both through the air and through the material of the vault walls, floor and ceiling. The earlier vault protection system, of which the previously mentioned U.S. Pat. No. 1,192,312 is representative, depended primarily upon the detection of airborne sounds. More recently, however, it has been found that superior performance is obtained from protection systems designed to respond primarily to the sound energy within the vault structure itself because this mode of operation greatly inhibits the incidence of false alarms caused by adjacent but innocuous sources of loud noises such as jet aircraft and heavy vehicular traffic. An example of such a system is found in U.S. Pat. No. 3,134,970 issued May 26, 1964 to L. H. Kelly and A. C. LaMartina, Jr.

It is evident that protection systems designed to respond to the noises within the vault structure are most satisfactorily applied to monolithic vaults, i.e., vaults constructed of poured concrete, as continuous material provides the best sound transmission path. Even so, vaults thus constructed must have occasional discontinuities in the form of expansion joints which interrupt the sound transmission paths and require the installation of additional microphones to ensure adequate protection. The additional installation expense of a few extra microphones is not of critical importance in the case of monolithic vaults. But when the vault is constructed of preformed building blocks mortared together, the presence of so many discontinuities in the structure makes the cost of providing enough microphones to ensure adequate protection for the entire structure a very serious economic problem.

The principal object of the present invention therefore has been the provision of a novel and improved acoustic protection system for vaults and like structures which overcomes certain disadvantages of the prior art.

More particularly, it has been an object of the invention to provide a protection system for vaults of block construction that is both economic to install and reliable in operation.

In protection systems of all types for both fire and burglar alarm purposes, it is necessary to strike a workable balance between sensitivity and stability. Almost regardless of the phenomenon being monitored, be it noise, heat or electrical signals, there are available today sensing devices of such sensitivity as to make possible the detection of very small occurrences of the phenomenon of interest. Unfortunately, it is equally true that it is rare that the phenomenon can be ob-

served against an absolutely neutral background. Almost always there will be present extraneous ambient conditions which so closely resemble the desired phenomenon that the detecting device will respond thereto and produce an unwanted or false signal. It is now customary to speak of this problem broadly as the "signal-to-noise ratio" and strenuous efforts are being made in all the technical disciplines to improve thereon. When the ratio is poor, the incidence of false signals is high and the systems therefore lacks stability.

Obviously the "signal-to-noise ratio" is important in the protection of vaults against attack and much research has been done to determine the particular characteristics of the noises produced by genuine attacks so that innocuous sounds may be discarded by techniques involving frequency, amplitude and time duration discrimination. Any measures that will improve the "signal-to-noise ratio" will permit operation of the protection system at a higher sensitivity while holding the stability of the system at an acceptable level and therefore result in improved protection for the vault.

Accordingly, it has been another object of the invention to provide a vault protection system having improved sensitivity-stability characteristics.

Other and further objects, features and advantages of the invention will be apparent from the following description of the invention.

SUMMARY OF THE INVENTION

The invention comprises the provision of specific means for the collection of attack noises existing within a vault structure and the efficient transmission thereof to one or more microphones of a vault protection system. The microphones of the protection system are connected to metallic strips which are in turn connected to the interior surfaces of the vault to be protected by suitable anchoring fasteners. Each fastener serves as a sound collecting point for noises within the structure and transfers that noise to the metallic strip whereby it is effectively and efficiently transmitted to the microphones. The low cost of the fasteners and metal stripping as contrasted to the expense of providing enough microphones to adequately protect a block-constructed vault makes possible the protection of such vaults at reasonable expense. Furthermore, the plurality of sound collection points coupled with a highly efficient means of transmitting sound to the microphones results in the receipt of a stronger signal under attack conditions and an improved "signal-to-noise ratio" whereby the protection system may be operated at a higher sensitivity level than would otherwise be possible at a given stability rating.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail with reference to the appended drawings in which:

FIG. 1 is a perspective view of a contact microphone and mounting plate suitable for use in the system of the invention; FIG. 1A is a cross-sectional view of the microphone of FIG. 1;

FIG. 2 is a cutaway front view illustrating an embodiment of the invention in which the microphones and strips are installed on a wall of a vault;

FIG. 2A is a front view of a completed microphone installation in the embodiment of FIG. 2;

FIG. 2B is a cross-sectional view taken along the line 2B-2B of FIG. 2;

FIG. 3 is a cross-sectional view of an alternate arrangement for installing microphones and strips on a wall of a vault; and

FIG. 4 is a diagram indicating a typical approximate spacing and layout of the microphones employed to protect a typical vault.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is shown a microphone 10 secured to a mounting plate 11. A microphone suitable for the purposes of the present invention may be of the contact type,

which might, for example, be responsive to a frequency range of about 7,000 to 50,000 cycles per second. The microphone may comprise an aluminum disk 12 approximately 1 1/4 inches in diameter, about 3/64 inch thick and provided with three radial slots to receive mounting screws 13 which serve the microphone 10 to the mounting plate 11.

As shown in FIG. 1A, a ceramic composition transducer element 10A, which is desirably of the lead zirconate titanate type, is adhesively affixed to the top surface of disk 12 by an electrically insulating adhesive 10B, e.g., an epoxy cement, which will transmit vibrations from the disk to the transducer element. An aluminum housing 14 which may be three-eighths inch high and seven-eighths inch in diameter is affixed to the top surface of disk 12, e.g., by an epoxy adhesive 14A. A shielded cable 15 having conductors 16 and 17 connected to the respective terminals of the transducer element is brought out through a slot 18 provided in housing 14. The spaces between the cable 15 and slot 18 as well as the joint between housing 14 and disk 12 are filled with the epoxy cement to form a watertight assembly.

The mounting plate 11 may be conveniently formed from one-eighth inch thick steel strip and is provided with a clamp 19, held by screw 20, to secure the cable 15. The mounting plate is also provided with a pair of slots 21 located at the opposite ends thereof and a pair of tapped holes 22, located adjacent each slot, whose purpose will be made apparent hereinafter.

Microphone 10 may be connected in parallel with the other microphones of the protective system via the conductors 16 and 17 and thence to the input of a suitable electronic detecting and alarm device which may be of the type described in the previously mentioned U.S. Pat. No. 3,134,970 wherein the detected sounds of an attack upon a protected vault are converted into a suitable warning signal. Each of the microphones should be mounted so as to be in close vibratory contact with a wall of the structure being protected. That is to say, the physical coupling between the wall and a microphone should readily transmit sound energy from the wall to the microphone.

It will be evident from the foregoing that the general import of the present invention is to provide sound collecting means and transmission paths so that more economical and efficient use may be made of the microphone unit described above or of similar microphone units. Those skilled in the art will recognize that the basic components for accomplishing this end as described hereinafter may be combined in a variety of combinations and configurations and that the following embodiments of the invention are intended as illustrative of the invention rather than as limitations thereof.

One arrangement for mounting the microphone units is shown in FIGS. 2 and 2A. Referring first to FIG. 2, the mounting plate 11 which is held in intimate contact with microphone 10 by the mounting screws 13 is firmly secured to the surface of the vault wall by two screw fasteners 23 acting in the slots 21 of the mounting plate 11.

Careful choice must be made of the type of fastener to be employed at 23 and all other locations where connection is made to the surface of the protected structure because these elements are the primary means whereby sounds are transferred from the structure to the transmission paths to the microphone. Therefore the lead (or plastic) type of expansion plug should be avoided because the soft material will impede the transfer of sound. Best results are obtained through the use of expansion shields made of a harder metal such as malleable iron. In the case of hollow walls, steel toggle (butterfly) bolts may be successfully employed.

Immediately adjacent each end of the mounting plate 11 there are installed steel channel (U shaped) members 24 whose length is determined by the requirements of the particular installation and the ease of shipping and handling the material. Ten foot sections have been found to be generally most convenient. These members 24 are carefully fastened, with the hollow side toward the wall, by fasteners 23' which have the same sound transmission characteristics of the

fasteners 23 employed with mounting plate 11. If necessary, additional channel members 24' are butted to the channel members 24 to complete the desired length of run. It should be noted that no particular effort need be made to obtain an intimate, metal-to-metal joining between channel members 24 and 24' or between channel member 24 and mounting plate 11 other than to present a neat appearance. The reasons therefor are that upon a wall of normally rough texture, such a joining is virtually impossible and it is not necessary as it has been found that sound energy is adequately transmitted via the wall between adjacent fasteners wherever joints occur. Thus the path for sounds from channels 24' is via the end fastener 23' thereof, the wall to the adjacent end fastener 23' of channel 24, thence to the other end fastener of channel 24, the wall again to fastener 23 of mounting plate 11 and therethrough to the microphone 10. As a practical example, if the mounting plate 11 were 1 1/4 inches in width, the channel member 24 might conveniently have an inside dimension of 1 5/16 inches. The joints between channel members 24 and 24' might range from actual contact at a point to a gap of perhaps 1/32 inch.

To finish off the installation for a neat appearance and to provide a degree of mechanical protection for the microphone 10, a cover 25 may be provided as shown in FIG. 2A. Cover 25 has been omitted from FIG. 2. The cover 25 is easily constructed of a short length of channel material whose inside dimensions are just sufficient to fit over the channels 24 and is held in position by two screws 26 which engage the tapped holes 22 in mounting plate 11. The cover 25 is not a part of the sound transmission path.

The sound conducting strip need not necessarily be of channel shape as equally satisfactory sound transmission would be obtained from other shapes, e.g., strips of rectangular cross section. It is, however, important that a hard metal be employed since the softer materials, e.g., aluminum, do not possess as good sound transmitting characteristics. The channel shape is generally considered the most satisfactory as the cable 15 is concealed for better appearance and is also protected from mechanical damage. Ordinary steel conduit, so long as it is properly anchored to the vault wall so as to receive sound energy therefrom, can be used in the invention. In such case the conduit serves as the sound transmission path to the microphones and the fasteners which attach the conduit to the wall serve as the sound collecting points.

An alternate form of installation which eliminates the need for the covers 25 is shown in FIG. 3. Here the microphone and mounting plate unit are secured to the inside of the channel member 24 by means of two screws 27 acting in the slots 21 of mounting plate 11 and engaged with tapped holes 28 provided in channel member 24. The channel member 24 is secured to the wall, open side in, by fasteners 23' as described in connection with FIG. 2. In this way the microphone will be in close vibratory contact with the wall through the channel member 24 and fasteners 23'.

The overall layout and spacing of the microphones is of course dictated by the requirements of the particular installation and it is seldom that two are ever alike. Nevertheless there are several basic rules, as follows, which should be observed to provide adequate protection for a building block construction vault.

1. The strips carrying the detectors (microphones) should not be spaced at greater than 3 foot intervals.

2. The upper and lower microphone strips should not be spaced more than 1 1/2 feet from the ceiling and floor, respectively.

3. The spacing between detectors on any strip should not exceed 20 feet.

4. The strip should be fastened to the wall at intervals not exceeding 3 feet.

5. The spacing between detectors on the floor and ceiling should not exceed 20 feet.

A typical installation will now be described in conjunction with FIG. 4 which is a folded out diagram of a block construc-

tion vault measuring 20 feet in length by 16 feet in width and 9 feet high. The microphones are indicated by M and the microphone strips by S. As indicated, on three of the walls, the microphone strips S are located 1½ feet from the floor and ceiling and a third strip is added therebetween to maintain the desired 3 foot spacing between strips. The strips need not be installed horizontally as shown since a vertical pattern may be more convenient in some cases, as for instance on the front wall on either side of the door. It should be noted that an extra microphone is mounted on the door frame for additional security. The microphones on the other three walls are shown mounted vertically one above the other primarily for convenience in making the installation. A staggered pattern may be used to equal advantage provided that the spacing between detectors on each strip does not exceed about 20 feet. At the corners of the vault, the stripping may be bent into a right angle although it will usually be more convenient to simply start a new strip.

As the floor and ceiling walls will usually be of poured concrete and thus monolithic in nature, stripping will not ordinarily be required; it being only necessary not to exceed the limitation of 20 feet between detectors. The floor and ceiling wall microphones should be flushed into a recess cut in the concrete and then grouted with a suitable cement such as an epoxy adhesive. It will be noted in FIG. 4 that the floor and ceiling microphones are located near the walls. The reason therefor is to avoid the need for running the cable across the exposed surface to a centrally located microphone. In the case of very large vaults, so doing would be unavoidable to maintain the desired 20 foot spacing.

While the invention has been described in connection with specific embodiments thereof and in specific configurations, various modifications thereof will occur to those skilled in the art without departing from the spirit and scope of the of as set forth in the appended claims.

What is claimed is:

1. An electrical protection system for detecting physical attacks on vaults and like structures constructed of building blocks of the type wherein a sensor responsive to vibrations in the structure activates an electronic detecting and alarm device wherein the improvement comprises:

- a. a plurality of elongated, metallic, vibratory energy collecting and transmitting strips each disposed in close physical contact with a respective portion of an interior surface of a select wall of the structure, each strip being made of a hard metal having a better vibratory energy conductance than the walls of the structure;
- b. at least one vibration sensitive microphone mounted in close vibratory contact with both the interior surface of the select wall and the strips and being arranged to produce an electrical signal voltage in response to detection of vibrations transferred thereto along all axes from the select wall and the strips;
- c. vibration transmitting mounting means mounting the strips on the interior surface of the select wall, the mounting means including individual metallic attaching elements spaced apart along the strips, penetrating the select wall and contacting the strips to transfer vibrations along all axes from the select wall the the strips; and
- d. means for supplying the electrical signal voltage from each of the microphones to the electronic detecting and alarm device.

2. An electronic protection system for vaults and like structures subject to physical attacks, comprising:

- a. a plurality of vibration sensitive microphones mounted in close vibratory contact with the walls of the structure at spaced apart positions on the interior surfaces of the walls, each of the microphones being capable of producing an electrical signal voltage in response to detection of vibrations transferred thereto along all axes from the walls of the structure;
- b. means for separately collecting vibratory energy along all axes from numerous spaced apart positions on the interi-

or surfaces of the walls and for transmitting the collected vibratory energy from selected groups of the positions to selected corresponding ones of the microphones, the collected vibratory energy from the positions in each of the selected groups being transmitted as a unit to the selected corresponding microphone along an individual transmission path having a sonic energy conductance much greater than the conductance of the walls; and

c. means for detecting the electrical signal voltage output of one or more of the microphones as an alarm signal indication of an attack on a wall of the structure.

3. The method of protecting vaults and like structures subject to physical attacks, comprising the steps of:

- a. positioning a plurality of vibration sensitive microphones in close vibratory contact with the walls of said structure at spaced apart positions on the interior surfaces of said walls, each of said microphones being arranged to produce an electrical signal voltage in response to detection of vibrations transferred thereto along all axes from the walls of said structure;
- b. separately collecting vibratory energy along all axes from numerous spaced-apart positions on the interior surfaces of said walls;
- c. transmitting said collected vibratory energy from selected groups of said positions to selected corresponding ones of said microphones, said collected vibratory energy from the positions in each of said groups being transmitted as a unit to the corresponding microphone along an individual transmission path having a sonic energy conductance much greater than the conductance of said walls; and
- d. detecting the electrical signal voltage output of one or more of said microphones as an alarm signal indication of an attack on a wall of said structure.

4. An electrical protection system for detecting physical attacks on vaults and like structures having walls subject to physical attack, comprising:

- a. an electronic detecting and alarm device;
- b. a plurality of vibration-sensitive microphones each mounted in close physical contact with the interior surface of a wall of said structure such that vibrations of said wall surface along all axes are physically transmitted to each of said microphones and each of said microphones being arranged to produce an electrical signal voltage in response to detection of vibrations transferred thereto from the interior surface of a wall of said structure;
- c. a plurality of elongated metallic vibratory energy transmitting strips each extending along and in close proximity to a respective portion of a wall surface of said structure and each being in close vibratory contact with select ones of said microphones to aid in collecting and transmitting vibratory energy arising in said respective portion of a wall surface to said select ones of said microphones;
- d. means including individual metallic mounting elements each penetrating a select strip and a wall of said structure for mounting each of said strips on said respective portion of a wall surface such that vibrations of said wall surface along all axes are transmitted to each strip; and
- e. means for supplying the electrical signal voltage from each of said microphones to said electronic detecting and alarm device.

5. An electrical protection system as set forth in claim 1 in which said microphones are responsive to a frequency range of about 7,000 to 50,000 cycles per second.

6. An electrical protection system as set forth in claim 1 in which said individual mounting elements are spaced along said strips at spacings not exceeding about 3 feet.

7. An electrical protection system as set forth in claim 1 in which said microphones are mounted on respective sound transmitting metal plates and in which each of said metal plates is attached to a wall of said structure by sound transmitting metallic fastening elements capable of transmitting vibrators in said wall along all axes to said plates.

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8. An electrical protection system as set forth in claim 1 in which said strips are steel channels having the open sides thereof facing the adjacent structure wall.

9. An electrical protection system as set forth in claim 1 in which at least some of said microphones are mounted directly on respective ones of said strips.

10. An electrical protection system as set forth in claim 1 in

which some of said strips are mounted horizontally on each vertical wall of said structure, the strips on each of said vertical walls being disposed generally parallel to each other, the strips nearest the ceiling and floor of said structure being spaced not more than about 1½ feet from the adjacent ceiling and floor, respectively.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,618,062 Dated November 2, 1971

Inventor(s) Charles D. Ott

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 57 - "preformed" should be -- pre-formed --;

Col. 2, line 9 - "systems" should be -- system --;

Col. 3, line 5 - "serve" should be -- secure --;

Col. 5, line 35 - after "the" (second occurrence) insert
-- invention --;

Col. 5, line 35 - delete "of" (second occurrence);

Col. 5, line 61 - "the" second occurrence should be -- to --;

Col. 6, line 64 - "1" should be -- 4 --;

Col. 6, line 67 - "1" should be -- 4 --;

Col. 6, line 70 - "1" should be -- 4 --;

Col. 7, line 1 - "1" should be -- 4 --;

Col. 7, line 4 - "1" should be -- 4 --;

Col. 7, line 7 - "1" should be -- 4 --.

Signed and sealed this 27th day of June 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.

Attesting Officer

ROBERT GOTTSCHALK

Commissioner of Patents