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Aug. 5, 1930. R. M. HOPKINS ET AL. 1,772,422

BANK VAULT ALARM SYSTEM

Filed Dec. 24, 1925 2 Sheets-Sheet 1

See 1,867,834

Sound Foil Timer Heat

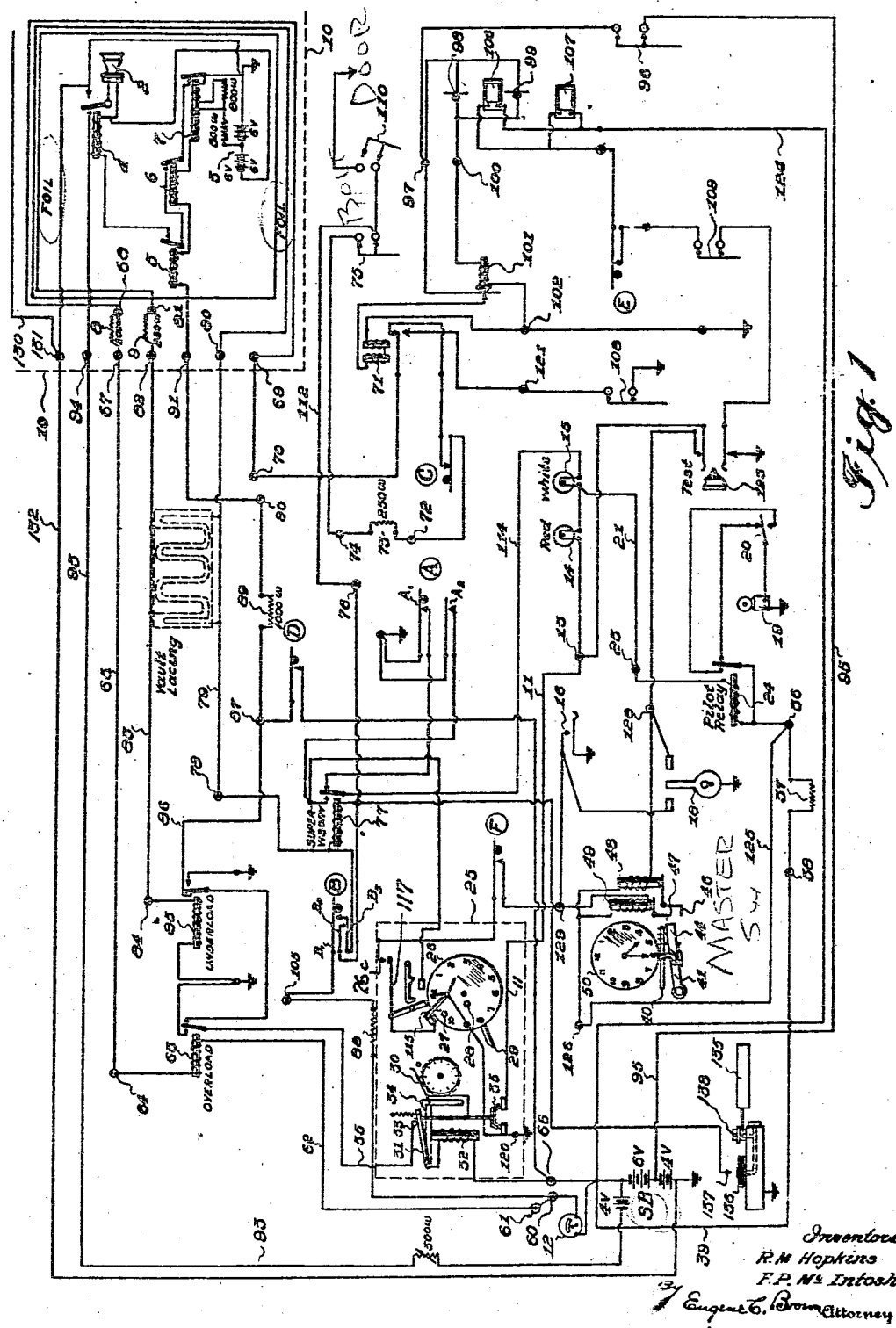


Fig. 1

Inventors
R. M. Hopkins
F. P. McIntosh
By Eugene G. Brown Attorney

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BANK VAULT ALARM SYSTEM

Filed Dec. 24, 1925 2 Sheets-Sheet 2

Fig. 2

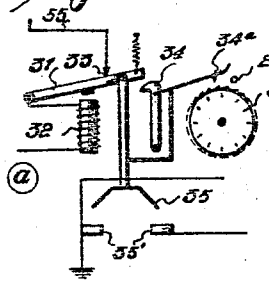


Fig. 3

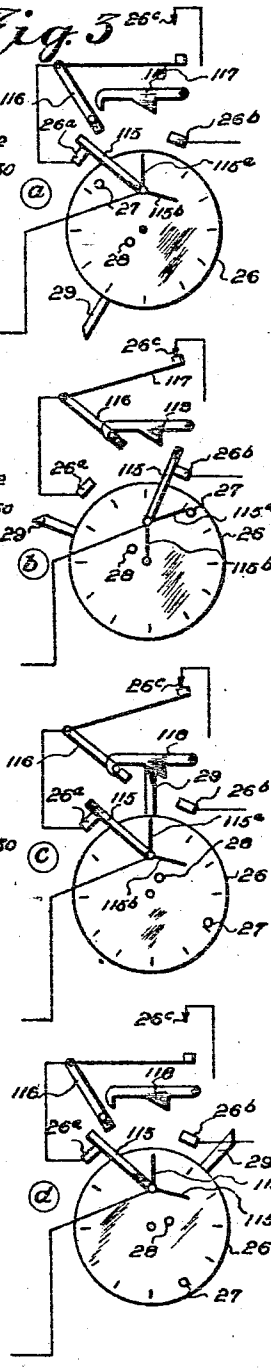
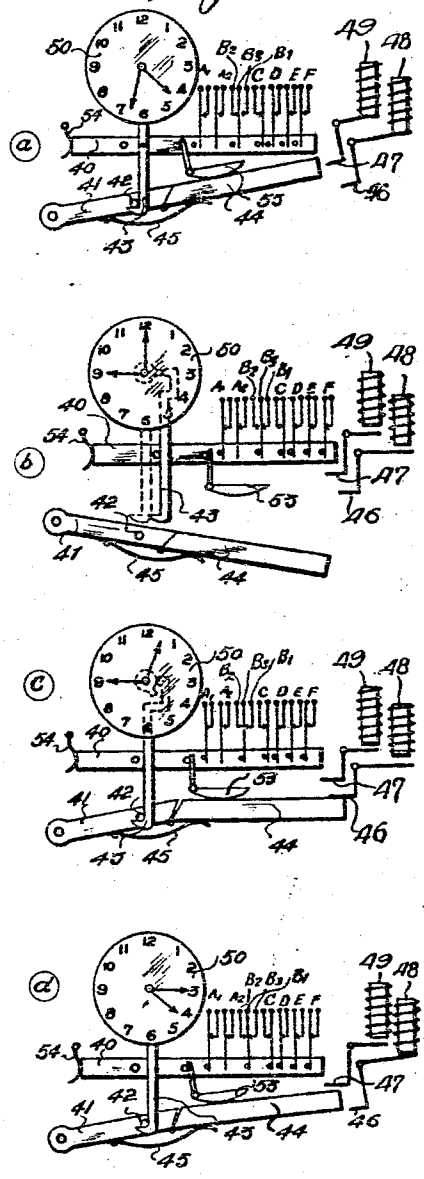


Fig. 4



Inventors

R. M. Hopkins

F. C. Mc Intosh

By Eugene A. Brown

Attorney

Patented Aug. 5, 1930 1,772,422

UNITED STATES PATENT OFFICE

RICHARD M. HOPKINS, OF RUTHERFORD, NEW JERSEY, AND FREDERICK P. McINTOSH, OF NEW YORK, N. Y., ASSIGNORS TO AMERICAN DISTRICT TELEGRAPH COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY

BANK-VAULT ALARM SYSTEM

Application filed December 24, 1925. Serial No. 77,546.

This invention relates generally to alarm systems or detection systems and particularly to systems for the protection of bank vaults and the like from burglary.

One purpose of our invention is to provide an equipment which is exceedingly sensitive to sound vibrations produced inside the protected premises or to shocks applied to the vault or parts thereof from the outside. We also provide means for detecting any sudden or undue increase in temperature within the vault or protected premises. An indication of an abnormal condition due to one of said causes is given by an audible signaling device located outside of the building and by a combination visible and audible signal device located inside the building or at any desired location.

A further purpose of our invention is to provide means for automatically cutting off the external signaling device during the unprotected period covering the business hours of a bank and yet maintaining the electrical equipment under constant supervision so that a warning signal will be given by signal devices located inside of the building in case of any tampering with the circuits. Other objects will appear from the description which follows:—

In the accompanying drawings which we shall refer to in the following detailed account, Figure 1 is a diagrammatic illustration of the circuits and equipment of one embodiment of our invention; Figs. 2, 3 and 4, illustrate the different positions of the respective clock-actuated devices for controlling the automatic functions of the system.

The several structural features of the equipment will first be described, after which we will set forth the operation of the complete system.

The outside signaling device

A motor-driven siren 2 together with a source of current and a set of control relays and resistances is enclosed in a protected housing which is usually fastened to the wall of the building at an inaccessible place. The source of current may be a twelve volt battery 3, tapped to give potentials of six and twelve volts, the latter potential being used to operate the siren. The six volt potential is used in a protecting circuit between the vault or other protected premises and the housing as hereinafter explained.

The relay 4 is of the heavy duty type, equipped with heavy contacts, and is used for closing the circuit between the battery and the siren. The relays 5, 6 and 7 are connected in series in one of the circuits leading from the housing to the equipment inside the vault, or protected premises. The operating circuit for the heavy duty relay 4 is connected in series through the contacts of the relays 5, 6 and 7. The armature of relay 5 is normally in retracted position, being attracted only upon the occurrence of an abnormal current.

The resistances 8 and 9 are connected respectively in two protection circuits for the housing, extending between the housing and the equipment inside the vault or protected premises.

The housing indicated by the dotted line 10, consists of a very strong cabinet or box which may be constructed of heavy gauge sheet iron, cast aluminum or other suitable material and having the open front closed by a door. The sides are perforated to permit the sound from the siren to be heard. The inside walls are protected as usual by plate glass having strips of metal foil attached to the inner surfaces of the glass, the strips of foil being connected in series with one of the resistances 8 or 9 in one of the protection circuits referred to above. A number of tamper springs may also be located as usual inside the housing, being connected to the other protection circuit previously referred to in such manner that they will ground this particular circuit if it is disturbed.

The control box

The various switches used for controlling the operation of certain parts of the equipment during the opening and closing periods together with certain indicating apparatus are included in a box which is located in a convenient place outside of the vault or protected premises. This control box contains

a milliammeter 12, a red lamp 14, a white lamp 15, a test key or switch 123, an advance closing switch 16, and a two-way lock-controlled switch 18. A vibrating bell 19 is also included in this control equipment and may or may not be mounted within the box. A two-way switch 20 for the bell is mounted within the box. By means of the milliammeter, bell and lamps, the condition of the system and apparatus may be determined at all times.

The forty-day clock-controlled switch

Located inside of the vault or protected premises is a clock movement and associated switch mechanism contained in a separate box or housing indicated by the dotted rectangle 25. The clock may conveniently be a forty-day clock, and is provided with a rotating twenty-four hour disk or dial 26 adapted to actuate a plurality of contact arms; and a rotating one-hour disk or dial 30 associated with an engaging pawl and with an adjustable device to constitute a variable time element; and a magnet operated switch controlled by said variable time element.

The pins or projecting elements on the twenty-four hour dial 26 are employed to control certain functions of the equipment during the closing period. The pins or projecting elements 27, 28 and 29 may be set at various positions around the dial but always in such positions that the dial will carry them past a given point in the same sequence.

The first pin to pass the given point operates a set of contacts in a circuit for the white lamp 15 in the control box. This operation is usually set to occur at approximately one-half hour before closing time. This signal, given by the white lamp, becomes a warning that it is time to prepare for the closing of the bank vault.

The first operating pin also causes the closing of a second set of contacts which establishes another circuit to be closed later. At the end of the one-half hour warning period, the second pin 28, on the dial releases the set of contacts closed by the first pin, operates a set of contacts in the circuit previously established by the operation of the first pin, and if all of the other preliminary operations have been performed, the master switch, to be described later, moves to its closed period position, breaking the circiut for the warning signal and applies the protection to the vault or other protected premises. The third pin 29 on the dial, follows the second pin at approximately a one-hour interval. This pin opens the circuit originally established by the first arm and this part of the clock mechanism then passes out of commission until the corresponding closing period of the following day.

The magnet operated switch 31 is associated with the alarm signaling devices. The winding or coil of the actuating magnet 32 is connected directly in a control circuit leading to the siren housing. The switch arm 31 is operatively associated with the variable time element device and engaging pawl associated with the dial 30.

The control circuit through the magnet 32 to the siren housing passes through the switch arm 31, which carries the armature of the magnet, so that the attraction of the armature breaks the circuit through the magnet. The switch arm 31 is locked or latched in operated position by the latch 34 and remains in locked position until released by the time element associated with the dial 30 and the duration of this locked period depends upon the setting of the time element device which may be varied from one to fifteen minutes. There is another set of contacts 35 associated with the switch arm 31 and which contacts are closed when the magnet 32 is energized. These contacts are also controlled by the time element device and in closing they establish a circuit for the red lamp 14 in the control box.

The master switch

The master switch is enclosed in a separate case or housing and includes six sets of contacts controlled by a single lever 40, a master lever in two parts pivotally connected, one part 41 being provided with a projecting pin 42 by means of which it may be lifted and which projecting pin is also adapted to be engaged by a catch 43, the other part 44 of the lever being hinged to the manually operated part and pressed upwardly by a spring 45 in such a manner that it tends to move upwardly into alinement with the part 41.

Two stop members 46 and 47 are interposed in the path of the lever part 44 in such positions that they will engage the lever in succession and each will hold it against further movement until withdrawn by the respective magnets 48 and 49.

The spring operated part 44 of the master lever is adapted to engage and move the contact controlling bar 40, by means of the pivoted bell crank 53. A clock movement of the elapsed time type, indicated at 50, and adapted to be set for any period up to seventy-two hours is associated with the latch 43, in such a manner that when the clock is wound, the contact controlling bar 40 is moved slightly to the left by the latch, the latter being moved by the clock into such a position that it will engage the projecting pin 42 on the master lever, but when the clock has run down to zero, the latch will be moved to the right allowing the master lever to fall by gravity to non-operated position. The master switch in its operation and release applies and removes the protection on the vault. It also sets up various other cir-

cuit combinations required during the opening and closing periods and in addition controls certain functions of the reciprocal control features of the system.

The master switch is semi-manual in character. It is manual to the extent that the clock movement must be wound before the latch will function to engage and hold the lifting pin on the lever. It is electro-mechanical to the extent that the stop pins in the path of the spring-operated part of the master lever must be withdrawn by their respective electromagnets before this part of the lever and the contact controlling bar can move to their extreme operated positions.

It then becomes mechanical in character to the extent that the release and return of the master lever to its extreme non-operated position depends on the running down of the clock movement to zero.

The contacts of this switch are so arranged in relation to their controlling lever and the master lever that different circuit combinations are established in the various positions of the master lever. For example, certain combinations are established when the master lever is in its extreme non-operated position, others when this lever is moved into engagement with the first stop pin in its path and still other combinations when the lever finally moves to its extreme operated position. These circuits will be described later under a different heading.

This switch is to be located inside the vault or protected premises.

The combination relay receiver and phonet-alarm relay unit

This unit is mounted in a separate housing and includes a 1000 ohm relay of the McCulloh type, having an armature with a front and back contact, and a relay receiver which comprises a telephone type receiver with the addition of a set of contacts consisting of the diaphragm and an adjustable flexible member adapted to co-operate with it to control a local circuit.

This apparatus is to be located inside the vault or protected premises indicated by the dotted enclosure 25^a.

The bolt contacts

These contacts comprise circuit controlling devices or switches operated by the locking bolts of the vault doors.

The door switch

This comprises a set of contacts arranged to be operated by the vault door in such a manner that a circuit is closed through them when the door is opened and broken when the door is closed.

The sound detector sets

Each of these comprises a sensitive microphone and a sounding device mounted in a housing and arranged to be located on the ceiling inside the vault. These microphones are connected in a circuit which includes a battery and the relay receiver previously described. The relations between the microphones and the relay receiver are such that any sounds produced inside the vault or any shocks applied to the vault or parts thereof from the outside will be picked up or detected by the microphones and transmitted to the relay receiver, where they produce an alarm condition in the system as will be described later.

The sounding devices associated with the microphone are similar to single stroke buzzers; they are used to set up sound disturbances in the microphones as a means of testing the condition of the equipment before applying the protection.

The system and equipment are so arranged that the protection can not be applied according to schedule unless the sound detecting devices perform the functions assigned to them.

The relays, resistances and terminals

These are arranged in a small compact unit to be located inside the vault or protected premises and enclosed in a common housing.

There are four relays in this unit, an overload and an underload relay connected serially in the main protection circuit during the closed period, a supervisory and a pilot relay for controlling respectively the lamp signals and the bell located in the control box outside the vault or protected premises.

There are four resistances in this unit and they are introduced into the circuit at various places and for various purposes as will be described.

There are thirty terminals in this unit and they are arranged in one group at a convenient place and means for connecting the circuits of the various elements of the system together.

The battery

A fourteen volt storage battery is employed with taps taken off at various points to supply current at four, ten and fourteen volts.

The four volt potential is used to supply current to the sound detectors, relay receiver and phonetalarm units. The ten volt potential is used to supply current for the protection circuits, and the signaling apparatus and operating circuits.

The fourteen volt potential is used as a source of current supply for charging the battery located in the housing for the outside alarm device.

Operation of the system

Before describing the various circuit com-

binations established during the operating phases involved in the application and removal of the protection, a brief summary of the operations will be given.

Applying the protection (setting the alarm)

The clock movement associated with the master switch indicated at 50, is first wound for a run corresponding to the number of hours intervening between the time of winding and the next opening time. This time interval may be any period up to seventy-two hours.

As previously described, this operation causes the latch 43 and the contact controlling bar 40 to move slightly to the left so that the latch will be in a position to interlock with and hold the lifting pin on the master lever.

The master lever is then lifted manually until the spring-operated portion 44 engages the stop pin 46 in its path. This pin will prevent further movement of this part of the lever but movement of the other part 41 should be continued until the pin 42 is caught by the hook of the latch 43, as indicated in Fig. 4c.

The two parts of the lever are now separated and the coupling spring 45 between the two parts is under tension tending to pull them into alinement but the stop pin 46 intervenes and prevents it.

The forty day clock 26 is now wound and the three pins, 27, 28 and 29, carried by the dial are set as close together as possible with the pin 27 to the right, and the center of the middle pin 28 in line with the indication on the dial corresponding to the closing time. The position of the clock face may be adjusted in relation to the time indicating points so that the correct time is indicated.

As the closing time approaches and when the forty day clock operates the first or warning contacts, the white lamp 15 in the control box will light and the bell 19 will ring. The bell switch 20 is operated to stop the ringing of the bell but the lamp 15 continues to burn.

The vault doors should then be closed and the bolts thrown to the locked position. The test switch in the control box must next be operated to energize the sounders associated with the microphones and, if the equipment is in proper operating condition, an alarm condition will be established; the first stop pin 46 in the path of the master switch lever will be withdrawn by the magnet 48 and the red light 14, in the control box will be operated. The pivoted part 44 of the master lever will move forward past the first stop pin and will engage the second stop pin 47.

At the end of a definite period, depending upon the setting of the time element device of the forty day clock, the red lamp will go out but the white lamp will continue to burn.

When the forty day clock dial indicates the time corresponding to the closing time the second pin 28 on the dial 26 closes its contacts. This completes a circuit for the electromagnet 49 associated with the second stop pin 47 in the path of the master switch lever. This pin is withdrawn and the lever advances to its extreme operated position indicated at Figure 4a. This operation applies the protection to the vault and the white lamp goes out, indicating that the alarm is set. The bell, however, will start to ring again, but is stopped by moving the lever arm of the bell switch 20 to the opposite contact.

Removing the protection (opening the vault)

The clock 50 associated with the master switch runs down just at the end of the protected period and at that instant releases the latch 43, allowing the master lever to fall to its lowest non-operated position. As a result of this operation, the protection is removed from the vault. The contact sliding controlling bar 40 is permitted to move to the right, thereby closing one of the contacts which closes a circuit through the white lamp 15 and through the bell 19. The bell may be stopped by shifting the position of the switch arm 20. The light is an opening signal, indicating that the vault protection has been removed and that the vault doors may be opened.

The opening of the vault doors closes a circuit at door contacts 110 for the supervisory relay and the latter closes an alternative circuit for the white lamp through a set of contacts A_2 of the master switch which are only closed when the master lever is in its lowest position. The white lamp, therefore, remains lighted.

Upon then winding the clock 50 and raising the lever part 41 of the master switch until the pin 42 is engaged by the latch 43, the contact controlling lever will be moved slightly to the left, as previously described, thereby separating a pair of contacts which breaks the circuit through the white lamp. It will be noted that the raising of the lever of the master switch extinguishes the white lamp but the lever cannot be latched in its raised position until the clock has been wound to thereby cause the latch 43 to move back into locking position.

The alarm is now set for the day period in readiness for the warning signal to be given by the forty-day clock at the approach of closing time. If, however, for any reason it is desired to close the vaults and set the alarm ahead of the regular closing time, the operations would be as follows:—

Advance closing

The vault doors are closed and the bolts are thrown to locked position. This operation breaks the circuit for the supervisory relay at 110. Its armature is released and closes a circuit through its back contact and through

contact A_1 of the master switch to light the white lamp which now operates as a supervisory signal. The microphones in the vault are tested by operating the test key 123 or switch 16 in the control box and, as previously described, the first stop pin 46 will be withdrawn by the magnet 48 and the red light 14 in the control box will be lighted. The pivoted part 44 of the master lever will move upwardly against the second stop pin 47.

In view of the fact, however, that we are now closing up ahead of the regular time the contact pins on the forty day clock will not now be in such positions that they can perform their closing functions. It is for this reason that the advance closing key or switch 16 is provided as a part of the equipment in the control box.

If the equipment is in proper operating condition, the red lamp will be operated and will continue in operation until released by the time element device in the forty day clock, at the end of the alarm period, as indicated by the red lamp and after the lamp has gone out. Upon operating the advance closing key or switch 16 in the control box, which corresponds to the action of the second pin 28 on the forty-day clock, the magnet 49 is energized, removing the stop pin 47 and allowing the spring-actuated part 44 of the master switch lever to move upward to closed period position 4^a. The white signal lamp is thereby extinguished, indicating that the vault is closed and the alarm is set.

Circuits

Before tracing the circuits in detail, certain conventions and notations on the drawings will be explained.

The letters "A" to "F" enclosed by circles refer to individual groups of contacts forming a part of the master switch. These groups are indicated in the four positions of the switch in Fig. 4, merely by a series of spring contacts which are not intended to show the actual arrangement of the contacts as they are indicated in Fig. 1. These groups of contacts are operated by a set of pins carried by the contact controlling bar 44. These pins are indicated in Fig. 1 by solid black dots.

In the lower right hand corner of Fig. 1, four bolt contacts are shown. These contacts are made up in the form of a switch and are operated by the bolts of the vault door, being so arranged that the contacts are closed when the door is closed and the bolts are thrown to the locked position.

A door switch is indicated at the right end of Fig. 1 near the center. This switch is of the same type of construction as the bolt contacts and is mounted on the door frame in such position that it will be operated and released when the door is opened and closed, the contacts being closed when the door is open and vice versa.

Fig. 1 shows the circuit conditions existing during the closed or protected period. During this period a number of separate and distinct circuits are established as follows:—

Protection circuit

This circuit may be traced as follows: from grounded battery SB of 10 volts, through the milliammeter 12 to terminal 61, through conductor 62 and the winding of over-load relay 63 to terminal 64, through conductor 65 to terminal 67, inside the siren housing 10, through resistance 8 to terminal 68, through the wiring inside the housing to terminal 69, to terminal 70, to the armature of relay 71, through the upper contact, through master switch contact "C", to terminal 72, through resistance 73 to terminal 74, through bolt contact 75 to terminal 76, through contacts B_2 and B_3 of master switch group "B", to terminal 78, over lacing wire 79, to terminal 80 inside the siren housing, through the tinfoil to terminal 81, through resistance 9 to terminal 82, over lacing wire 83, to terminal 84, through under-load relay 85 to ground.

Alarm control circuit

From grounded battery SB of 10 volts to terminal 66, through the magnet winding 32 through armature 31 and back contact 33 to the armature of over-load relay 63, through its back contact to armature of under-load relay 85, through its front contact and conductor 86 to terminal 87, through resistance 89 to terminal 90, to terminal 91 inside of siren housing, through the winding of relays 5 and 6, through one winding of relay 7, through the 800-ohm resistance, and through the second winding of relay 7 to ground. There is also another circuit established here from grounded 6 volt battery through the 300-ohm and 800-ohm resistances and the second winding of relay 7 to ground.

Relays 6 and 7 are energized and in their operated condition establish a circuit for relay 4 from grounded 12 volt battery through the winding of relay 4, the back contact of relay 5, and the front contacts of relays 6 and 7 to ground.

Charging circuit for housing battery

The 12 volt storage battery 3 in the siren housing is charged from the 14 volt storage battery SB, the latter being maintained in charged condition from the lighting mains or other source. Relay 4 is energized and at its front contact establishes a charging circuit for the battery 3 in the housing as follows:—from 14 volt grounded battery SB, over the charging wire 93, to terminal 94 inside the siren housing, through the front contact and armature of relay 4, through the

siren to the 12 volt battery 3, and through the battery to ground.

Sound detector circuit

From 4 volt grounded battery, through conductor 95, bolt contact 96, to terminal 97. Here the circuit divides, one branch leading through the two microphone detectors 98 and 99 in multiple, to terminal 100, through the winding of the telephone receiver relay 101, to terminal 102, and to ground. The other branch leading from terminal 97, through the contacts of the telephone receiver relay 101, through the winding of relay 71, to terminal 102 to ground.

Alarm conditions

During the closed or vault protected period, an attack causing any disturbance of the sound detectors 98 and 99 will disturb the contacts of the sensitive telephone receiver relay 101 which in turn will re-act on relay 71. This relay will release its armature which will accomplish two things; 1st, break the protection circuit at the front contact and thereby release the underload relay 85, and 2nd, ground the end of the protection circuit leading to the over-load relay 63 and thereby energize this relay.

The under-load relay 85 in its release will break the alarm control circuit through conductor 86 leading to the siren housing. Relay 6 in the housing will release and break the circuit of relay 4. Relay 4 will release and close a circuit at its back contact from 12 volt battery 3 through the siren, and back to the other side of the battery. The siren will operate and give the alarm signal.

The over-load relay 63 will close its front contact which will complete a circuit as follows:—from ground through the relay front contact, to the back contact 33, and armature 31, through the magnet coil 32 to terminal 66, and through the 10 volt battery SB to ground. The magnet 32 will operate and will separate armature 31 from contact 33, as indicated in Fig. 2b. Although the circuit through the magnet is broken, the armature will be held down by the latch 34 of the time element device of the forty day clock, thereby breaking the current supply circuit for the relays in the siren housing, thus causing the siren to sound. The siren will continue to operate until the time element device of the clock restores contact between the armature and contact 33. It will be noted that although the opening of the protection circuit may be only momentary and that although the over-load and under-load relays may immediately return to their normal conditions, the time element of the clock will hold the alarm control circuit open and cause the siren to continue in operation for a length of time previously determined by the setting of the time element device. The time element device is illustrated conventionally in Fig. 2. The parts are normally in the position shown in Fig. 2a. When the magnet is energized, the armature 31 is attracted and locked by the latch 34 as shown in Fig. 2b. Simultaneously the pawl 34a pivoted to the latch drops into engagement with the peripheral teeth of the dial 30 of the forty day clock movement. As the pawl is gradually pulled by the dial, the projecting end of the pawl lever rides over the adjustable pin 22 until it lifts the pawl out of engagement with the teeth on the dial, as indicated in Fig. 2c and the parts then move back to normal position shown in Fig. 2a. The position of the pin may be adjusted so that the latch will hold the armature down for the length of time the siren should ring. This is usually from three to fifteen minutes.

The magnet 32, in addition to breaking the alarm control circuit, also causes the closing of contacts 35′ of the switch member 35 operatively connected to it as indicated in Fig. 2b. This establishes a circuit for the red lamp 14 in the control box as follows: from ground, through the contacts of switch 35 and conductor 11, to terminal 13, through the red lamp 14, and conductor 21, to terminal 23, through the winding of the pilot relay 24, to terminal 36, through resistance 37 to terminal 38, through conductor 39, and through the 10 volt battery SB to ground.

The red lamp is thereby lighted and the pilot relay 24 is energized. This relay closes a circuit from ground and 10 volt battery SB, through resistance 37 to terminal 36, through the armature and front contact of the pilot relay 24, the contacts of the bell switch 20, through the pilot bell 19, to ground.

The red lamp will continue to burn and the bell will ring until its circuit is broken at contacts of switch 35 by the release of the time element device of the clock as above described.

Morning—Opening period

When the master-switch clock 50 has run down to zero which is the opening time, the latch 43 for the master lever is released and the lever itself drops to its lowest position, as indicated at Fig. 4b. When this happens a number of circuit changes take place as follows:—

Contacts A_1 and A_2 of the master switch group "A" close. This completes a circuit for the white lamp 15 from grounded 10 volt battery SB, through conductor 39, to terminal 38, through resistance 37, to terminal 36, through the winding of the pilot relay 24 to the terminal 23, through conductor 21, to the white lamp 15, through the lamp to the armature of the supervisory relay 77, through its back contact and contacts A_1 to ground.

The pilot relay causes the bell to ring and

it is stopped by throwing the switch 20 over to its alternate contact.

Spring contact arm B_1 of master switch group "B" makes contact with contact spring B_3 and breaks the connection between springs B_2 and B_3. This removes a short circuit from around the winding of the supervisory relay 77 and completes an alternate circuit for the under-load relay 85 as follows: from the grounded 10 volt battery SB, through the milliammeter 12 to terminal 60, through resistance 88 to terminal 105, through spring B_1 and contact B_3 to terminal 78, over lacing wire 79 to terminal 80 inside the siren housing, through the tinfoil to terminal 81, through resistance 9 to terminal 82, over lacing wire 83 to terminal 84, and through the winding of the under-load relay 85 to ground. The under-load relay is thus energized and held in its operated position.

Spring contacts "C" of the master-switch are moved by a pin on the control lever 40 and break contact, thereby opening the protective circuit leading back to the over-load relay 63.

Springs "D" of the master-switch are moved to closed position and complete a short circuit or by-pass around the contacts of the over-load and under-load relays and the armature 31 and contact 33 of the magnet 32. This by-pass provides a means of supplying current for the alarm control circuit to the siren housing during the day or open period of the vault and preventing the operation of the siren during that time.

Contacts "E" of the master-switch are moved to closed position and complete a link in the circuit for the sounders or buzzers 106 and 107 associated with the detectors 98 and 99, to be described later.

Contacts "F" of the master-switch are moved to closed position and establish a part of another circuit to be described later.

The lighting of the white lamp and the ringing of the pilot bell indicate to the vault attendant that the protection has been removed from the vault and that the doors may be opened.

The bolts are now thrown and the doors are opened. Bolt contact 75, breaks the protection circuit. Bolt contact 108 disconnects the ground from the back contact of relay 71. Bolt contact 96 breaks the battery circuit for the detectors 98 and 99 and for the winding of relay 71. This relay is now de-energized, and its armature moves from the front contact to the back contact. Bolt contact 109 breaks a portion of the circuit for the buzzers 106 and 107.

When the vault door is opened, the door switch 110 closes its contacts and completes a circuit for the supervisory relay 77 as follows: from ground, through the door switch and conductor 112 to terminal 76, through the winding of supervisory relay 77, to contact group "B," through contacts B_3 and B_1 to terminal 105, through resistance 88 to terminal 60, through the milliammeter 12 and 10 volt battery SB to ground.

The supervisory relay 77 is energized, and completes an alternate circuit at its front contact for the white lamp 15 as follows: from grounded 10 volt battery SB, through conductor 39 and resistance 37, the winding of the pilot relay 24 to terminal 23, through the white lamp 15 and conductor 114, to the armature of the supervisory relays 77, through its front contact, and spring A_2 of the master-switch to ground. The vault is now open but the white lamp continues to burn.

The vault attendant now enters the vault and winds the master-switch clock 50 for a run corresponding to the elapsed time between the present opening and the next opening time. This operation releases the latch 43 and the sliding bar 40, associated with clock movement, allowing the latch to move into such position that it will engage the pin 42 on the master lever when it is raised from the position in Fig. 4[b] to the position in Fig. 4[c].

The lever is then raised until the pin is engaged by the hook of the latch and the spring operated member 44 of the lever moves into engagement with the lower stop pin 46 in its path where it is held against further movement.

In the movement of the spring-operated portion 44 of the master lever, the operating pin on the control bar 40 associated with the "A" group of springs, moves away from the A_2 spring, permitting these springs to separate and break the circuit for the white lamp 15. The extinguishment of the lamp indicates to the attendant that proper conditions have been established for the day or open period.

The break in the circuit for the white lamp at contacts A_2 also breaks the circuit for the pilot relay 24. Its armature falls against its back contact and establishes a circuit for the pilot bell 19. The ringing may be stopped by returning the contact lever of switch 20 to its original position, as shown in the drawing.

Day period—Vault open

During the day period the protection is removed from the vault, that is, the sound detectors 98 and 99 are out of commission and the control of the alarm circuit to the siren housing has been transferred from the over-load and under-load relays to contacts "D" of the master switch as previously described.

The foil in the housing is in circuit with the under-load relay 85 and hence is under constant supervision during this day period.

A potential is maintained through the

over-load relay 63 on the wiring inside the siren housing to which the usual tamper springs are connected.

Under these conditions a break in the tin-foil will cause the release of the under-load relay and the operation or release of a tamper spring in the siren housing will cause the over-load relay to operate.

Either relay under such conditions will ground the battery circuit through the magnet 32 causing the magnet to operate and close the contacts of switch 35, thereby completing the circuit for the red lamp 14, which will light, and indicate an alarm or trouble condition.

The pilot relay 24 will also operate and in turn cause the bell 19 to ring. The ringing of the bell may be stopped by shifting the lever of the bell switch 20 as previously described, but the lamp will continue to burn as long as the trouble exists.

After the trouble has been cleared, the lamp will continue to burn until the contacts of switch 35 have been broken by the time element device of the clock. As soon as the lamp goes out, the pilot relay 24 will be de-energized, causing the bell to ring again until stopped by means of the bell switch 20.

Closing period

As the closing time approaches and usually about thirty minutes before the actual time has arrived the first pin 27 on the forty day clock dial will move the switch arm 115 to the right from the position shown in Fig. 3^a to the position shown in Fig. 3^b. The switch arm will then engage contact 26^b. In swinging over, the arm pushed the lever 116, until it was locked by the latch 118, and the spring arm 117 engaged the contact 26^c, thereby completing a circuit for the white lamp 15 and for the pilot relay 24. Hence the lamp will light and the bell 19 will ring to give a warning signal that the closing time is approaching. The circuit is as follows: from ground to terminal 120, through switch arm 115 and contact 26^b to the front contact of supervisory relay 77, through the relay armature and conductor 114 to the white lamp 15, to terminal 23, through pilot relay 24, resistance 37, conductor 39 and the 10 volt battery SB to ground.

When everything is in readiness the vault door is closed and the bolts are thrown to the locked position. As the door is closed the door switch 110 opens and breaks the ground connection for the supervisory relay 77. The relay is de-energized and in releasing its armature breaks the circuit for the white lamp from the clock switch just described but at its back contact an alternate circuit for the lamp is closed as follows: from grounded 10 volt battery SB through conductor 39 the pilot relay winding 24 to the white lamp 15 to the armature of the supervisory relay 77, through the back contact of the relay and the contact A_1 of the master switch to ground.

The vault door is closed and locked, but the white lamp continues to burn, which indicates that there is still no protection.

Bolt contact 75 closes one break in the protection circuit; and bolt contact 96 closes the circuit from the 4 volt portion of battery SB through conductor 95 to the detectors 98 and 99 and relay 71. The relay attracts its armature and closes another break in the protection circuit.

Bolt contact 108 closes a circuit from ground through terminal 121 to the back contact of relay 71.

Bolt contact 109 closes one break in the circuit for the sounders or buzzers associated with the detectors.

The protection equipment, that is the detectors, 98 and 99, is now tested by pressing the test key 123. This operation closes two circuits, one from ground through the lower set of contacts on the test key, through bolt contact 109, through contacts "E" of the master switch, through the two sounders 106 and 107 in parallel, through conductor 124 and the 10 volt grounded battery SB to ground.

The other circuit leads from the 10 volt grounded battery SB through conductor 39 and resistance 37, to terminal 36, through conductor 125 to terminal 126, through the first stop magnet 48 associated with the first stop pin 46 in the path of the master switch operating lever, to terminal 128, through the upper contacts of the test key 123, to terminal 13, through conductor 11, and through the contacts of switch 35 of the forty day clock timing element to ground.

The sound waves from the buzzers 106 and 107 disturb the microphone detectors 98 and 99, and this affects the receiver relay 101, causing its contacts to chatter or vibrate and this in turn causes the relay 71 to release its armature, which moves from its front and closes against it back contact. This completes a circuit for the over-load relay 63 as follows: from ground through bolt contact 108, through the back contact and armature of relay 71 to terminal 70, thence to terminal 69 inside the siren housing to terminal 68, through resistance 8 to terminal 67 inside the housing, through conductor 65, to terminal 64, through the overload relay winding 63 and conductor 62 to terminal 61, through the milliammeter 12 and through 10 volt battery SB, to ground. The overload relay 63 is energized and at its front contact closes a circuit for the magnet 32. The solenoid operates and closes the contacts of switch 35, thereby completing the circuit previously described as leading through the test key 123 and the first stop magnet 48, and in addition closes the circuit for the red lamp 14.

The lighting of the red lamp indicates to the attendant that the microphone detectors and other protection equipment are in proper operating condition.

Both red and white lamps are now lighted. The red lamp will continue to burn until the time element device of the forty day clock releases the contacts of switch 35. As just stated, the contacts of switch 35 complete the circuit for the first stop magnet 48 of the master switch. This magnet therefore operates to withdraw the first stop pin 46 from the path of the master switch lever. The spring 45 connecting the parts of the lever, moves the pivoted lever part 44 upwardly into engagement with the second stop pin 47. The movement is not sufficient, however, to make any change in the contact springs.

As soon as the time element device of the clock releases the armature 34, the circuit for the red lamp breaks at the contacts of switch 35, and the red lamp is extinguished.

As soon as the forty day clock 26 indicates the exact closing time, the second pin 28 on the dial 26 strikes the lower arm 115^b projecting from the pivot of switch arm 115, and causes arm 115 to move to the left from the position in Fig. 3^b to that in Fig. 3^c. This operation moves the switch arm 115 against contact 26^a and thereby closes a circuit for the second stop magnet 49 associated with the master switch as follows: from ground to terminal 120, through switch arm 115, contact 26 spring arm 117, contact 26^c, through master switch contacts "F", to terminal 129, through the winding of the second stop magnet 49 to terminal 126 through conductor 125, to terminal 36, through resistance 37, conductor 39 and 10 volt battery SB, to ground. Magnet 49 withdraws the second stop pin 47 out of the path of the master switch operating lever and spring 45 moves the lever part 44 upwardly into its extreme operated position, from the position shown in Fig. 4^d to that in Fig. 4^a. This is the closed period position and the circuits are now the same as shown in Fig. 1.

In moving from the position in Fig. 4^d to that in Fig. 4^a, the master switch makes a number of changes in the circuit conditions as follows:—

Contact A_2 breaks the circuit for the white lamp, and for the pilot relay. This causes the bell to ring and it is stopped by the bell switch. The extinguishment of the lamp indicates to the attendant that the protection is applied and that the alarm is set.

Contacts "B" operate as follows: The main spring B_1 breaks the contact with B_3 and opens the circuit previously established for supplying current to the under-load relay during the open period. Contacts B_2 and B_3 close and short circuit the winding of the supervisory relay.

Contacts "C" close and connect the two ends of the protection circuit in series with the over-load and under-load relays.

Contacts "D" break and open the by-pass circuit around the contacts of the magnet 32 and the under-load and over-load relays. This transfers the control of the alarm control circuit leading to the siren housing, back to the over-load and under-load relays.

Contacts "E" open and break the circuit for the sounders or buzzers associated with the microphonic sound detectors.

Contacts "F" open and break the circuit for the second stage magnet 49.

The vault is now closed and the alarm set for the night period. After a predetermined time, usually one hour after the second pin 28 on the dial of the forty day clock has closed the circuit for the second stage magnet 49, the third pin or arm 29 on the dial 26 strikes the latch dog 118, and releases the lever arm 116, permitting the contact spring 117 to drop away from contact 26^c, the parts moving from the position shown in Fig. 3^c to the position shown in Fig. 3^d. This clock has no further functions to perform until the next closing time, unless there should be an alarm, the clock then performing the function of controlling the time limit device.

Advance closing

If for any reason it is desirable to close the vault and set the alarm in advance of the regular closing time the operations would be as follows:—

Close the door and lock it by throwing the bolts. There will be no warning signal in this case. However, as soon as the door is closed the door switch 110 will open and break the circuit for the supervisory relay. The relay will release and close a circuit for the white lamp 15 through its back contact and contacts A_1 of the master switch. The lamp will now operate as a supervisory signal.

Test the detectors by means of the test key as previously described. If the detectors and associated apparatus are in proper condition the red lamp will light and the first stage pin 47 will be moved out of the way of the master switch lever by the magnet 48. At the end of the time limit, as controlled by the forty day clock, the red lamp will go out but the white lamp will remain lighted. After the red lamp goes out, the advance closing switch is operated which completes a circuit to energize the second stage magnet 49, which thereupon withdraws the second pin 47 from the path of the master switch lever. The master switch moves upwardly to its extreme operated position shown in Fig. 4^a and the closed period circuits are established. The white lamp is thereby extinguished, thus indicating to the attendant that the alarm has been set for the closed period.

If for any reason the microphone sound detectors and the associated apparatus should not function properly on test and the alarm can not be set by this means, we have provided a lock-controlled emergency switch which may be used to control the operation of the first and second stage magnets for withdrawing the stop pins 46 and 47 from the path of the master switch lever.

This switch is shown at 18 in Fig. 1 and is so constructed that when the proper key is inserted and the lever is moved to the right a circuit is closed to ground for the first stage magnet 48 and when the lever is moved to the left a similar circuit is closed to ground for the second stage magnet 49.

This allows the master switch to advance to the closed period position, establish all the circuits for this period, set the alarm, and although the detectors may not be in the condition they should be to function properly, the protection circuit will be established through the bolt contact 75 and any attempt to enter the vault by way of the door will cause a break at this point or a ground at the door switch and will result in an alarm signal.

Heat actuated alarm

The metal body or casing of the siren housing, indicated by the line 130, is grounded at 131 to the ground wire 132 so that any attempt to cut through the casing will ground the foil circuit and disturb the protection circuit, thereby sounding the alarm.

We also provide means for sounding the alarm in case heat is applied, as for instance, if an attempt is made to cut through the vault door by means of an oxy-acetylene torch. A thermostatically controlled contact device is located within the vault comprising a tank 135 connected by a small tube with a metal sylphon bellows 136. Any sudden or undue rise in temperature causes the air in the tank to expand, causing the bellows to expand and engage the contact 137, thereby establishing a ground to the protection circuit and causing the siren to operate in the manner previously described. Any slow expansion due to a rise in temperature resulting from atmosphere changes will merely escape through a minute duct or bleed hole 138 and will not affect the bellows.

Reciprocal control system

One of the underlying principles of this invention is the necessity for cooperative action between the automatic operations and the manual operations required of the attendant. Certain operations take place automatically, then certain manual operations must be performed before the system can function. These manual operations must be performed in proper sequence and the supervisory features of the system will then respond with an indication as to such performance.

Starting now with the alarm in the closed period condition: The lamp signals in the control box are all clear indicating that the alarm is set.

When the opening time arrives, the master switch is released by the clock, the white lamp burns and the pilot bell rings.

The bell may be stopped by operating the bell switch but the lamp will not go out until the vault has been opened, the master switch clock re-wound, and the master lever raised and caught by the latch bar. Winding the clock alone will not suffice, raising the lever will put out the light but the clock must be wound before the lever can be latched and held.

In closing the vault, the action of the door switch and the supervisory relay cause the white lamp and bell to operate again. The bell can be stopped as before, but the lamp can not be put out now without setting the alarm. If the vault is left unprotected, the white lamp will continue to burn and to indicate the unprotected position. The pilot bell is never out of commission but is always on guard ready to indicate a changed condition in the lamp circuits.

We claim:—

1. An alarm system, comprising a protection circuit including conductors extending through the walls of a protected structure and including the coils of overload and underload relays, an electromagnetically actuated alarm device and an operating circuit therefor, an alarm control circuit including the armatures of said relays, and the coils of relays controlling said operating circuit of the alarm device, a normally closed sound detector circuit including sound responsive devices operating to modifiy the electrical resistance therethrough and a relay, said detector circuit relay having contacts included in said protection circuit and a timing device included in said alarm control circuit and operating upon a changed electrical condition in said circuit to open the circuit for a predetermined time.

2. An alarm system, comprising a protection circuit including conductors extending through the walls of a protected structure and including the coils of overload and underload relays, an electromagnetically actuated alarm device and an operating circuit therefor, an alarm control circuit including the armatures of said relays. and the coils of relays controlling said operating circuit of the alarm device, a normally closed sound detector circuit including sound responsive devices operating to modifiy the electrical resistance therethrough, and means including a relay in said last mentioned circuit operating when deenergized to open the circuit

through said underload relay and ground the circuit through said overload relay.

3. In an alarm system, a protection circuit including the coils of overload and underload relays, an alarm, an alarm control circuit including the armatures and contacts of said relays, relays in said alarm control circuit controlling the operation of said alarm, a detector relay having its armature in the protection circuit and operating when deenergized to open the protection circuit thereby deenergizing said underload relay and thereafter grounding the circuit to thereby actuate said overload relay and causing the relays in the alarm control circuit to actuate said alarm, sound responsive devices, and a sound detector circuit including said detector relay and said sound devices.

In testimony whereof, we affix our signatures.

RICHARD M. HOPKINS.
FREDERICK P. McINTOSH.