

Nov. 8, 1966

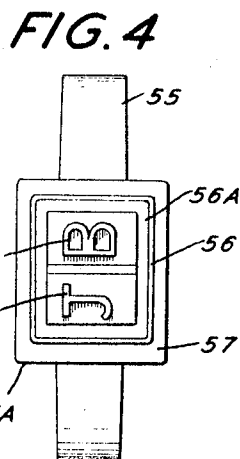
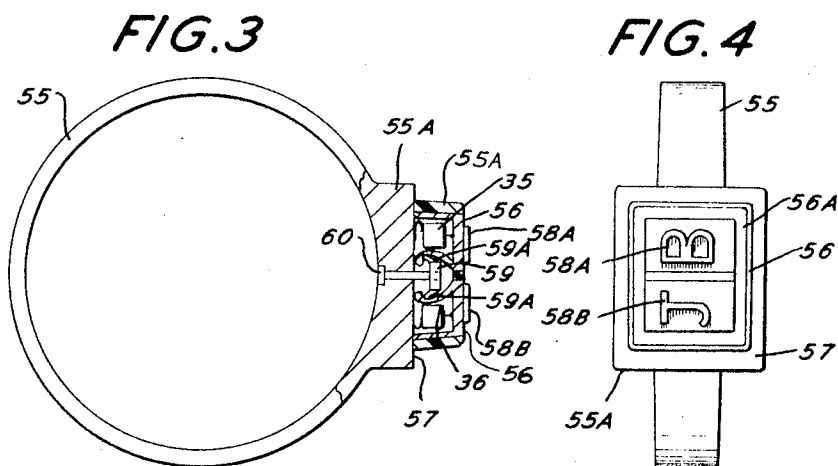
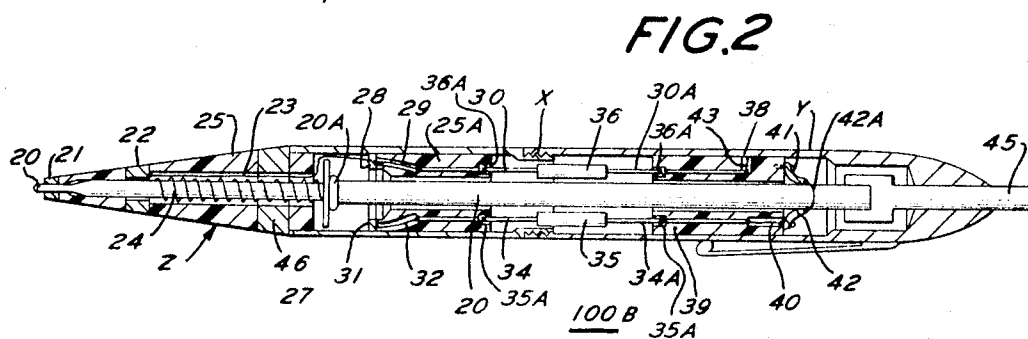
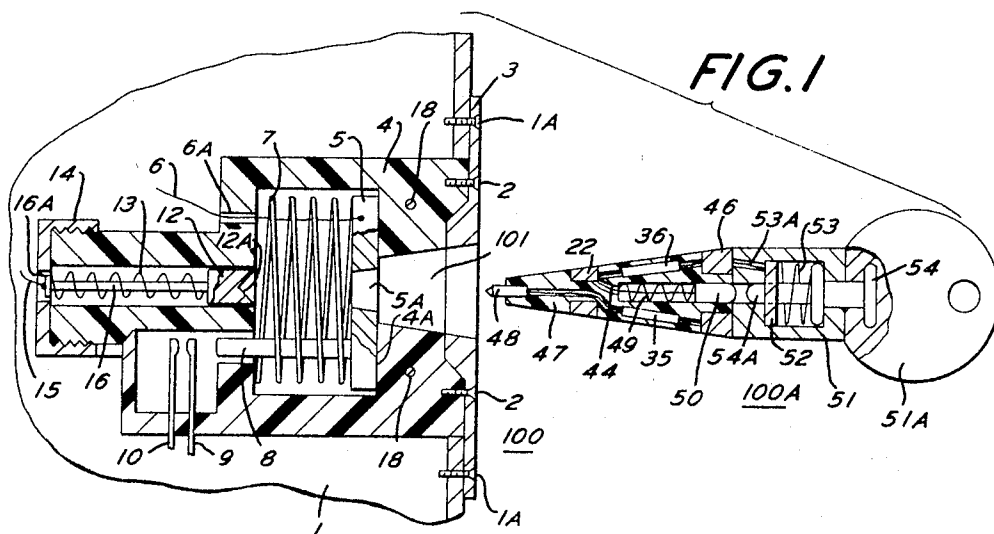
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3,283,550

ELECTRICAL LOCKING ARRANGEMENT

Filed May 25, 1964

3 Sheets-Sheet 1



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FIG. 5

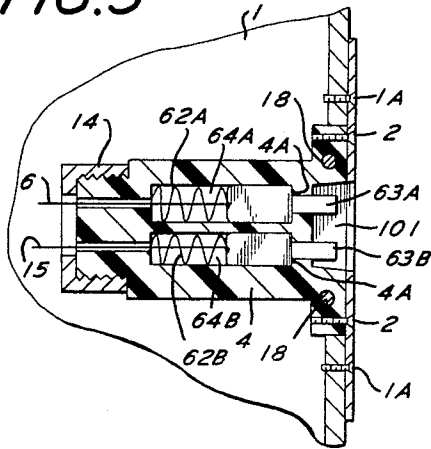


FIG. 6

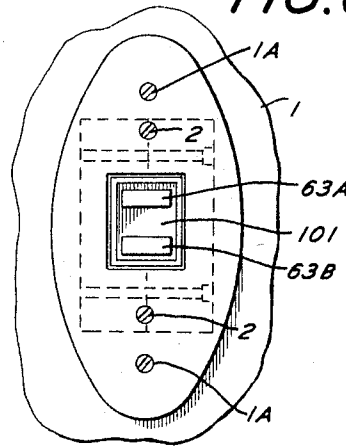


FIG. 8

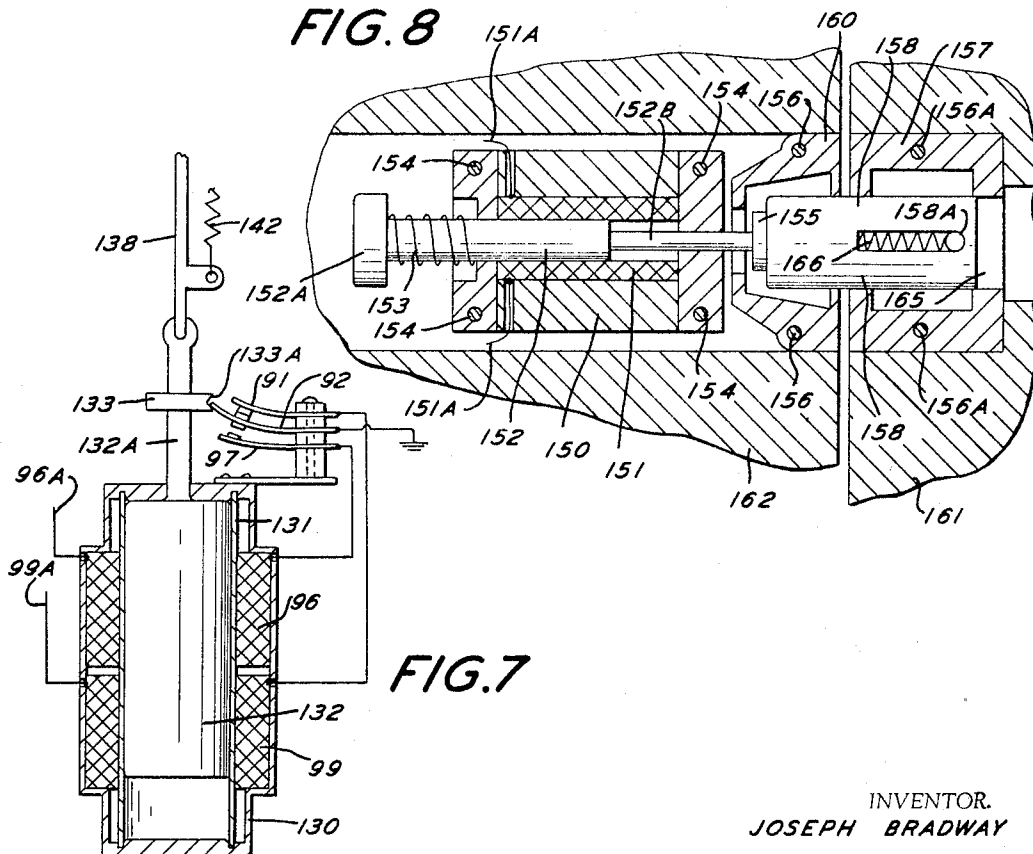


FIG. 7

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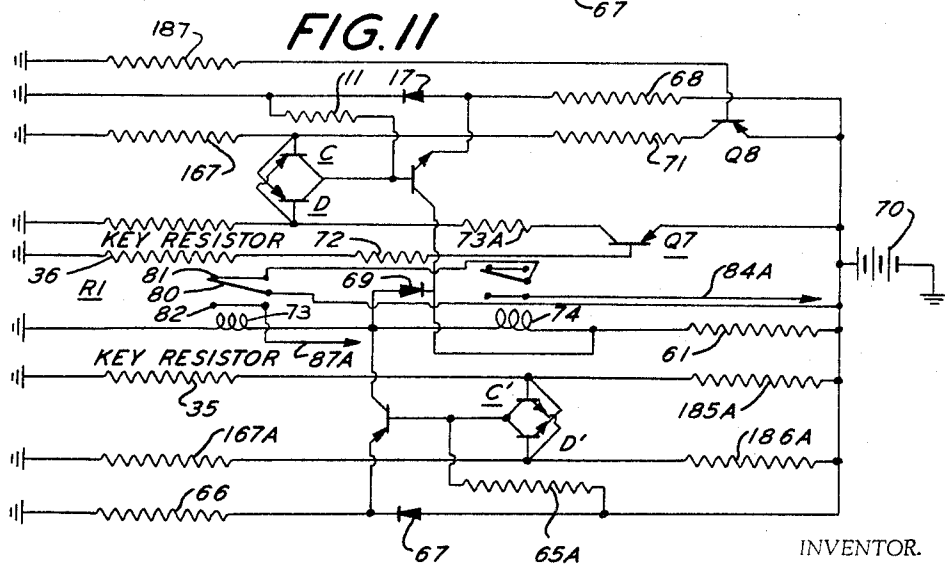
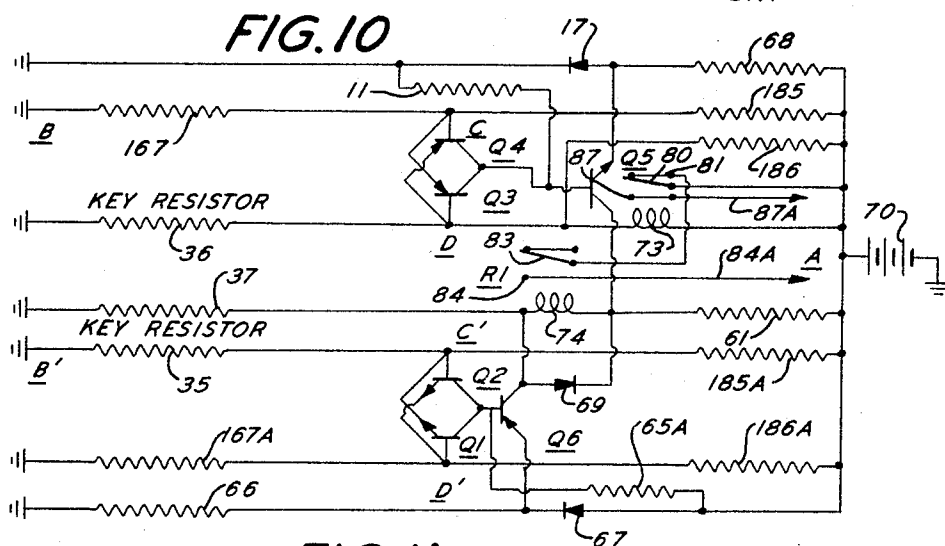
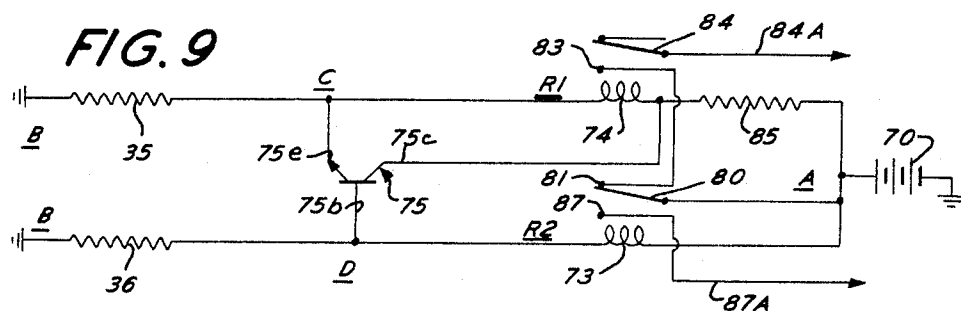
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ELECTRICAL LOCKING ARRANGEMENT

Filed May 25, 1964

3 Sheets-Sheet 3



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ELECTRICAL LOCKING ARRANGEMENT

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Filed May 25, 1964, Ser. No. 369,887

3 Claims. (Cl. 70—282)

The present invention relates to a new and improved apparatus for providing an electric locking arrangement. More particularly the present invention relates to a new and improved electric locking arrangement which can be operated only by a unique impedance keying device.

To operate the conventional locking arrangements in use today it is merely necessary to arrange the various sleeves and tumblers in the lock until they are properly aligned. Typically, the proper alignment is produced when the actual key having a specially grooved edge is inserted into the lock and turned. For additional security, these conventional locks merely provide a more complicated arrangement of the tumblers and sleeves so that more time is necessary before the lock can be picked or opened without the proper key.

Electric locks have also been made heretofore. These conventional electric locks are very similar to the mechanical variety and consist of a number of cams which use a plurality of microswitches that are actuated by the insertion of the key. That is, the high points of the key make mechanical contact with the microswitches to close the same and thereby energize the lock actuating mechanism of the electric lock. These locks can also be picked readily by juggling of the various microswitches such that they all close at one time.

Moreover, with all of the previously manufactured locks, either the conventional mechanical lock or the electric lock, it is possible to duplicate the key used for opening the lock by means of any standard key making machine. Thus, it can be seen that it is relatively easy for unauthorized duplicates of a key to be made.

On the other hand, the present invention does not use the ordinary type of key. Therefore, it is not possible to make a duplicate key on the standard key making machine, even if the actual key falls into unauthorized possession. By means of the present invention the key is provided with electric impedance elements. Upon insertion into the lock, the electric impedance elements contained in the key permit the lock actuating mechanism to be energized by completing the electric circuit. The electric impedance elements complete the electric circuit in a unique manner so that any other impedance or combination of electric impedances, as the case may be, will not open the electric lock. Previously proposed locking circuits using a key containing an impedance element were primarily designed for high voltages and if used with a low voltage source, such as automobile battery, would require highly sensitive and delicate relays, requiring careful and frequent adjustment. Variations in source voltage of such systems also cause operating difficulties. Such variations, and particularly decrease of the source voltage decrease the sensitivity of such circuits. The system of the present invention is particularly suitable for low voltage operation with components which do not require highly sensitive adjustments nor constant source voltage. The present invention accordingly has the advantages of a more rugged circuit capable of withstanding vibration and shock, with lower maintenance costs.

It is accordingly an object of the present invention to overcome the disadvantages of prior locking arrangements.

Another object of the present invention is to provide a new and improved electric locking arrangement using a unique impedance keying device.

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Another object of the present invention is to provide a new and improved electric locking arrangement using a keying device which cannot be duplicated by standard key making machines.

Another object of the present invention is to provide a new and improved electric locking arrangement using a plurality of switching means which are in either circuit-open or circuit-closed position and whose position can be varied in a desired manner by the insertion of the impedance keying device in the lock.

Another object of the present invention is to provide a new and improved impedance keying apparatus for use in an electric locking arrangement.

Another object of the present invention is to provide an electric locking arrangement using an impedance keying device including a plurality of resistances.

Another object of the invention is to provide an electric locking arrangement which is simple and uncomplicated.

Another object of this invention is to provide an electric locking arrangement which may be utilized on various types of vehicles, such as automobiles or the like.

Another object of the invention is to provide an electric locking arrangement which may be installed in or upon any device which it may be desired to lock and which is adapted to have an electrical power source associated therewith.

Another object of this invention is to provide an electric locking arrangement in which the control point may be located at a distance from the actual lock to provide additional security.

Another object of the present invention is to provide a locking circuit which operates on low voltage such as that available from an automobile battery but which provides the same order of sensitivity as higher voltage circuits.

Another object of the invention is to provide a circuit which will actuate for locking or unlocking even with a large increase or decrease in source voltage.

Another object of the invention is to provide a circuit which does not require the use of delicate or supersensitive relays.

Another object of the invention is to provide a circuit which will stand severe vibration and shock which would tend to render other circuits inoperative.

Another object of the invention is to provide a circuit which includes a key and a key receptacle which provides an easy target for insertion of the key and which preferably includes a shallow conical shaped key and receptacle.

Another object of the invention is to provide a key member which includes a shell having the impedance members therein, the impedance members being readily removable for replacement.

Another object of this invention is to provide an electric locking arrangement which is relatively low in cost both in terms of the manufacture thereof and the components therein.

Other objects and advantageous features of the invention will be apparent from the description and claims.

The nature and characteristic features of the invention will be more readily understood from the following description taken in connection with the accompanying drawings forming part thereof, in which;

FIGURE 1 is a vertical sectional view of an electric locking arrangement including the contacting portion and the associated keying member;

FIG. 2 is a vertical sectional view of another embodiment of the keying member;

FIG. 3 is a top view partly in elevation and partly in section of another embodiment of a keying member;

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FIG. 4 is an end view of the keying member shown in FIG. 3;

FIG. 5 is a vertical sectional view of the contacting portion of the electric locking arrangement which is activated by the keying member shown in FIGS. 3 and 4;

FIG. 6 is an end view of the contacting member shown in FIG. 5;

FIG. 7 is a side view, partly in section and partly in elevation of a schematic diagram of a solenoid which is used to control one application of the locking arrangement;

FIG. 8 is a side view, partly in section and partly in elevation of a schematic diagram of another solenoid which is used to control another application of the locking operation; and

FIGS. 9, 10 and 11 are schematic diagrams of circuits which control the operation of the locking and unlocking of the electric locking arrangement.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes can be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

Referring now to FIG. 1, the contacting portion or key slot mechanism 100 is shown adjacent to one embodiment of the associated keying mechanism 100A. As will be seen subsequently, the instant invention is not limited by the configuration of the slot arrangement or by the key configuration shown in FIG. 1. Thus, the locking mechanism 100 is shown attached, by means of bolts 1A, to a device 1, such as a door or the like, which is to be selectively locked. The locking mechanism 100 is arranged so that opening or slot 101 is exposed in order to receive the key member 100A. Bolts 2 pass through holes in the front plate 3 into threaded holes in the insulated casing 4. The plate 3 may preferably be manufactured of a metal or some other good electrical conductor which is non-corrosive and, in some cases, preferably chrome plated especially for appearance. Plate 3 will serve as a ground connection as will appear subsequently. Casing 4 encloses the inner components of the locking mechanism and may be any desired configuration as, for example, rectangular or cylindrical or the like, and is preferably manufactured of a dielectric material such as plastic, Bakelite or the like. Of course, a reasonably strong and durable type of material should be utilized. The copper collar 5 may comprise any configuration such as a ring or the like having a beveled hole 5A substantially in the center thereof. Coil spring 7 bears against the surface of the copper ring 5 such that the copper ring or collar 5 is normally maintained substantially adjacent to or even abutting the shoulder 4A of the casing 4. However, coil spring 7 permits ring 5 to be moved inwardly by the insertion of the key member 100A. Wire 6 which is connected to copper ring 5 and which passes through hole 6A in casing 4 is one connector lead from the contacting portion or keyhole which is connected to the control circuitry as will be described subsequently. Contact 12 consists of an electrically conductive material, for example a copper block or the like, which may include a groove or notch 12A therein, as desired, to provide a better seating arrangement for the key device. Contact 12, like collar 5, provides an electrical contact for the keying device and is connected via the conductive member 16 which may be an integral portion of the connector block 12, or in the alternative a rod which is attached thereto, to the contact button 16A at the end thereof to which is connected the connector wire 15. The contact assembly comprising block 12 and rod 16 is adapted to extend through the opening in the cap 14 when the key element is inserted. The coil spring 13, similar to coil spring 7, exerts sufficient force to normally maintain contact 12 in the position shown, but is resilient enough to permit the

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contact 12 to be moved by the keying device. The threaded cap 14 is utilized to hold the casing 4 together inasmuch as the casing 4 may be made in separate sections. Similarly, assembly screws 18 may also be utilized to hold the sections of casing 4 together.

Although it is not required, FIG. 1 shows additional components which may be utilized in certain applications such as automobile trunks or the like. This apparatus includes the rod 8 which is manufactured of a suitable dielectric or non-conductive material such as nylon or the like and which is attached to collar 5 by any suitable means or method. This rod is, of course, moved whenever collar 5 is moved. Contact terminals 9 and 10 are shown affixed in the casing 4 of the keyhole 100 as for example by being molded into the casing during manufacture thereof. These terminals are shown as being normally open terminals. However, when the keying device is inserted into the slot 100 such that the collar 5 is moved inwardly, rod 8 moves therewith and encounters contact terminal 9 such that this resilient terminal moves and contacts terminal 10. When the key is removed, the terminals 9 and 10 resume their original positions. It is to be understood, of course, that this apparatus is not required in all applications but is included herewith in the event that such a desired use is preferred.

The keying device 100A is, of course, only one embodiment of the types of keys which may be utilized with the contacting mechanism 100. The key 100A comprises a tapered substantially conical configuration. At the tapered end thereof, is a contact 48 which may be fabricated of copper or other suitable electrically conductive material. The contact 58 is imbedded in the dielectric material 47 which may be a suitable non-conductive plastic or the like. Connected to the contact 48 is one terminal of resistor 35. This resistor 35 may be any predetermined resistance value and may be as small as is physically possible, as for example a one-tenth watt resistor or a smaller resistor. Contact 48 and one terminal of resistor 35 may be actually joined together or a suitable conductor, such as a copper wire or the like, may be imbedded in the plastic 47 to form the connection. The other terminal of resistor 35 is connected to the annular band 46. This annular band 46 may comprise a ring of a suitable electrically conductive material, such as copper, which forms a ground connection and encircles the key perimeter. A similar conductive band 22 is connected to one terminal of resistor 36 which may be similar to resistor 35 in all respects even including the resistance values thereof. However, the resistance values of resistors 35 and 36 may vary considerably, depending upon the preferred design of the control circuit, as will appear subsequently. The other terminal of resistor 36 is also connected to the annular band 46. It will be noted that the configuration of the keying element 100A is so designed that when the key 100A is inserted into slot 101 of the keyhole 100, contact 48 of the key 100A engages contact 12 of the keyhole. At the same time, the outer surface of annular band 22 engages the inner surfaces of hole 5A, in collar 5, and the outer surface of annular band 46 engages the inner surface of the slot 101 which is included within the ground plate 3. Thus, electrical contact is made from wire 15 to ground plate 3 via conductor rod 16, contact 12, contact 48, resistor 35, and annular band 46. Similarly, electrical contact is made between connector wire 6 and ground plate 3 via collar 5, annular band 22, resistor 36 and annular band 46. Moreover, it will be seen that an electrical connection therefore exists between connector wire 6 and 15 respectively via the resistors 35 and 36 inter alia. With the proper resistors in the circuit, the electric lock arrangement will "open."

Also connected to annular band 22 is wire 44 which is connected to contact brush 50. Contact brush 50 is maintained in the extended position shown by means of

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the coil spring 49 which may also replace wire 44. Brush 50 is maintained in the extended position shown in order to facilitate contact with another member and yet is sufficiently resilient to be retracted when an opposing force is exerted. The wire or similar conductor 53A connects the annular ring 46 to the washer 52. Washer 52 may be any suitable electrically conductive material having a desired configuration, as for example a disc-like configuration. The disc or washer 52 is mounted such that the extension 54A of the plunger 54 slidably extends therethrough and preferably provides a reliable electrical contact between the washer and the plunger 54. However, the coil spring 53, which is utilized to normally maintain plunger 54 in the extended position shown, is also fabricated of electrically conductive material to assure good contact between washer 52 and plunger 54. Thus, when plunger 54 is depressed against the spring 53, contact is made between extension 54A and brush 50. This will cause a connection via wire 53A, or in the alternative, casing 51 if casing 51 is fabricated of an electrically conductive material, to annular band 46 such that resistor 36 is short circuited and is, effectively, out of the network. With this condition, the electric lock arrangement will "lock." Of course, when this operation is not desired, plunger 54 is released and coil spring 53 bears thereagainst such that plunger 54 extends out of the cavity shown and resides along the side of the key body 51A. The key body 51A as well as the casing 51 may be fabricated of an electrically conductive material such as aluminum or brass or the like to simulate a standard key body. In the alternative, the casing 51 and the key body 51A may be fabricated of an insulating material such as nylon, Duralon or other non-conductive synthetic plastic material in which case connection wire 53A is required.

Referring now to FIG. 2, there is shown another embodiment 100B of the keying device which will mate with the contacting mechanism 100 shown in FIG. 1 in order to operate the electrical locking arrangement. In FIG. 2, elements similar to those shown in FIG. 1 bear similar reference numerals. The keying device shown in FIG. 2 is shown in the form of a typical ball point pen which has a retractable point 20 and is operable as is well known in the art. Thus, by pressing upon the push button 45, the point 20 is ejected. By an additional pressure upon the push button 45, the ball point 20 is retracted. Detailed explanation of the operation of ball point pens is unnecessary as these are well known. Again, the ball point pen configuration, which need not however be limited to a ball point pen, per se, incorporates the tapered or substantially conical configuration as a portion thereof. This tapered portion is inserted into the slot 101 of the keyhole 100 shown in FIG. 1 in order to mate therewith and effect control operation over the associated lock. The cap of the pen which is indicated generally at Y and the barrel of the pen which is indicated generally at Z screw together at the threaded portion X as is typical of this type of device. The cap Y and body Z of the pen may be separated in order to make modifications or changes to the elements therein. The elements therein include, inter alia, resistors 35 and 36 which are similar to those described in FIG. 1 and the ball point pen refill 20. One end of the refill 20 engages the push button 45 while the other end (e.g., writing end) of the refill 20 passes through the bushing 21 at the tapered end of the ball point pen. The bushing 21 provides additional support to the end of the pen thereby minimizing the possibility of breakage thereof inasmuch as the ball point pen body may be fabricated of any suitable non-conductive material such as synthetic plastic or the like. The annular conductive rings 22 and 46 which are similar to those described relative to FIG. 1 are imbedded in the plastic body 25 of the ball point pen. The copper ring 22 is connected via wire 23 which is insulated to avoid spurious contact with other portions

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of the key, to contact terminal 28. Contact terminal 28 which may be any suitable type of contact, as, for example, a solder bead or the like attached to one end of the conductor 29. Conductor 29 is connected at the other end thereof by a suitable means to connector lead 30 of resistor 36. This connection may be effected by means of pin sockets 35A and 36A or the like in order to facilitate replaceability. That is, the conductor 29 may be connected to one end of a pin socket and the connector lead 30 inserted therein. In the alternative, the conductor 29 may be extended through the insulating material 25A and connected, as for example by soldering, to the connector lead 30. Other methods of mounting the resistors 36, and 35 as will be discussed subsequently, may be utilized without departing from the basic inventive concepts. The other connector lead 30A of resistor 36 may be inserted into pin sockets 36A or in the alternative may be connected by a wire 43 or the like to the pen casing 38. The pen casing 38 which is a cylindrical sleeve-like arrangement substantially encompassing the barrel of the ball point pen configuration, may be fabricated of an electrically conductive material such as aluminum or other suitable metal. The casing 38 which is connected to the annular band 46 provides a ground terminal along the length of the pen. Thus, it becomes obvious that the electrical insulating material 25A and 39 must be included within the embodiment disclosed.

The contact 31 which is similar to the contact 28 described above is connected to the casing 38, or ground, and to the connector lead 34 of resistor 35 via wire 32. Again, the connector lead 34 may be connected to wire 32 via a pin socket or other suitable means. Connector lead 34A of resistor 35 passes through the insulating material 39 and is connected to wire 40 by any suitable means, as for example pin sockets or the like. The wire 40 is connected to brushes 42 by any suitable means, as for example by means of screws 41 which affix the brushes 42 to the insulating material 39. Inasmuch as the pen is substantially cylindrical in configuration and the insulating material 25A and 39 comprise sleeve-like members therein, the brushes 42 may comprise a friction collar-like member which fits inside the casing 38 with a hole therethrough such that the pen refill 20 may slidably pass therethrough and engage the collar to maintain contact. In the alternative, the brushes 42 may be separate brushes which are connected together by a wire 42A. In any event, refill 20 makes electrical contact therewith.

Disc contact 27 may be any typical electrically conductive material, as for example copper, and have the configuration of a disc or washer-like member which fits within the casing 38 with a hole therein such that the refill 20 passes therethrough. The retracting spring 24 which normally forces the refill 20 back when released by pressure upon push button 45 also serves to maintain the disc contact 27 against the flange or bump 20A which is typically found in ball point pen refills. Disc contact 27, when the refill 20 is retracted, bears against contacts 28 and 31 causing an electrical short circuit therebetween.

In operation, the keying device of FIG. 2 is substantially similar to the keying device 100A shown in FIG. 1. That is, when the key 100B in the form of a ball point pen is inserted into the slot 101 in the contacting mechanism 100 shown in FIG. 1, with the refill or pen point 20 extended outwardly, the refill 20, which is a brass or other type of metal refill, engages contact block 12 and makes contact with wire 15 via rod 16. Additionally, annular ring 22 engages the slot 5A in the collar 5 such that electrical contact is effected between wire 6 and annular ring 22 via collar 5. The ground plate or plate 3 also makes contact with annular ring 46. The annular ring 46 is connected to casing 38 which is connected the connector lead 34 of resistor

35 via wire 32. The connector lead 34A of resistor 35 is connected to wire 15 via rod 16, contact 12, refill 20, brush 42 and wire 40. Briefly then, resistor 36 is connected between wire 15 and ground. Similarly, connector wire 6 is connected via collar 5 to annular ring 22 which is connected to contact 28 via wire 23. Contact 28 is connected via wire 29 to connector lead 30 of the resistor 36. Connector lead 30A of resistor 36 is connected to the casing 38 via wire 43. Therefore, resistor 36 is connected between wire 6 and ground.

In the alternative, insertion of the ball point pen key configuration 100B into slot 101 of the contacting mechanism 100 in FIG. 1 causes no electrical contact to be made with contact 12 and, therefore, no contact is made with wire 15. However, the retraction of the refill 20 permits coil spring 24 to urge disc contact 27 into contact with contacts 28 and 31. Since contact 31 is connected to ground via casing 38, and since disc 27 is an electrical conductor, contact 28 is similarly connected to ground. Thus it will be seen that there is no complete circuit for resistor 35 inasmuch as the refill 20 does not engage contact block 12 and, furthermore, resistor 36 is connected to ground at both terminals thereof. Therefore, resistors 35 and 36 are not incorporated into the electrical circuit, which is described below, when inserted into the keying mechanism 100 of FIG. 1.

Referring now to FIGS. 3 and 4, there is shown a side view partially in section, and a front view respectively, of a typical ring such as a finger ring or the like. The finger band 55 may be fabricated of gold, silver or any other suitable electrically conductive material. Gold or silver is suggested such that the finger ring may also have some ornamental utility. The ring includes the mounting base 55A to which the ornamentation 56 is affixed. The ornamentation 56 may be fabricated of any insulating material including precious stones or the like. Ornamentation 56 is, in fact, a hollow member in which are mounted the resistors 35 and 36 which are similar to the resistors described previously. On the face plate or front edge 56A of the ornamentation there are mounted electrically conductive members 58A and 58B. These members may be formed of any desirable design or, may be in the form of initials or the like. However, members 58A and 58B must be insulated one from the other. One connector lead of each of resistors 35 and 36 is connected to the initials or conductive members 58A and 58B, respectively. The other connector leads of resistors 35 and 36 are each connected to electrically conductive means. This electrically conductive means may, in a preferred embodiment, constitute the bottom of the ornamentation element 56. This electrically conductive bottom means is then placed in contact with the mounting portion 55A of ring band 55. As will be seen subsequently, the shoulders 57 of the mounting means 55A provide contact with the ground plate of the mating electrically locking mechanism. Of course, the latter named connector leads of resistors 35 and 36 may be connected directly to the mounting element 55A. However, the former description provides for greater ease in manufacturing and assembling the ring element. When the ornamentation element 56 is affixed to a ring mounting element 55A, the nut 59 with the flexible wings 59A attached thereto is engaged with bolt 60 which passes through a slot in the base element 55A. By tightening the bolt 60 such that the nut 59 is drawn downwardly, the wings 59A (which are inside the hollow ornamentation member) of the nut 59 tend to bend outwardly thereby applying and exerting additional force on the ornamentation member 56 which includes therein the resistors 35 and 36. This method of connection insures a rigid connection between the ring mounting element 55A and the ornamentation element 56.

Reference is now made concurrently to FIGS. 5 and 6 which show a side view, partially in section, and a front view of the contacting mechanism which mates with the

ring key shown in FIGS. 3 and 4. In these two figures, similar components bear similar reference numerals. In addition, components which are similar to those described in previous figures also bear similar reference numerals. Thus, the keyhole mechanism shown in FIG. 5, similar to the keyhole mechanism 100 of FIG. 1, which engages the ring key shown in FIGS. 3 and 4 is attached to a device 1, such as a door or the like which is to be locked. The mechanism is attached to the device 1 by means of bolts 1A. The slot 101 is exposed in order to receive the key ring described supra. The bolts 2 pass through the front plate 3 into threaded holes in the insulated case 4. The plate 3 which serves as a ground plate, should preferably be fabricated of a suitable metal or the like to provide a good electrical conductor. Again, the casing 4 which encompasses the inner components of the locking mechanism is fabricated of a suitable dielectric material such as plastic or the like. The casing 4 is typically fabricated in at least two sections. These sections are held together by means of the threaded end cap 14 and the assembly bolts 18. Coil springs 62A and 62B are mounted in the slots 64A and 64B respectively. These springs tend to urge the contacts 63A and 63B, respectively, forwardly such that the ends of the contacts extend into the opening 101. Shoulders on the contacts 63A and 63B abut against the shoulders 4A which are formed in the material of the casing 4 in order to contain the contacts. The wires 6 and 16 correspond to the connector wires 6 and 15 shown in FIGURE 1. Wire 6 is connected to contact 63A, for example, and wire 15 is connected to contact 63B.

In operation, the ring of FIGS. 3 and 4 has the ornamental piece inserted into the slot 101 of the contacting mechanism shown in FIGS. 5 and 6. This produces contact between the end of contact 63A and one of the contacting elements 58A or 58B. Also, the end of contact 63B is in electrical contact with the other one of the contacting elements. The insertion of the ring into the slot 101 forces the contacts 63A and 63B back against the pressure of springs 62A and 62B. The insulating element 56 is properly dimensioned such that the shoulders 57 (see FIGS. 3 and 4) abut against the ground plate 3. Therefore, a current path exists from wire 6 through contact 63A, through one of the contact elements 58A or 58B, through the associated resistor 35 or 36 to the ring mounting element 55A and thence through shoulder 57 to ground plate 3. Similarly, a current path exists from wire 15 through contact 63B, through the other contact 58A or 58B and the associated resistor to the shoulder 57 which is connected with ground plate 3. Thus, each of the resistors 35 and 36 completes the respective circuit from wires 6 and 15 to ground.

As will become apparent, if the control circuit which is associated with the locking mechanism is properly designed, critical tolerance limits may be imposed such that the circuit is operable only when proper resistances are connected into the circuit path. Thus for example, if one of resistors 35 and 36 is a high impedance and the other of resistors is a low impedance, the proper insertion of the ring of FIGS. 3 and 4 into the locking mechanism in FIGS. 5 and 6 will effect the proper operation of the control circuit and, therefore, activate the unlocking apparatus. On the other hand, however, the improper insertion of the rings, as for example in the reverse position, or the utilization of improper resistances will activate the control circuit whereby the locking apparatus will be activated.

Referring now to FIG. 7, there is shown a double action electrical solenoid which may be utilized to activate the actual locking mechanism in some applications, as, for example, automobile locks or the like. The solenoid comprises the coils 96 and 99. These coils encircle the sleeve 131 which may be fabricated of brass or copper. A plunger 132 which may comprise an iron bar or the like is disposed within the sleeve 131 and is free to move

axially within the sleeve. The solenoid coils 96 and 99 are encased within a housing 130 which may be fabricated of any suitable material such as steel or the like. Connected to or formed as an integral part of the plunger 132, is the rod 132A which extends from one end of the plunger. This rod 132A protrudes through a hole in the housing 130 and is connected at the other end by any suitable pivotal connection 132B, such as a hook-eye arrangement or the like, to the rod 138 which may be connected to the latching mechanism. The coil spring 142 is connected to the rod 138 by any suitable means as well as to an abutment (not shown). The coil spring 142 is designed to exert sufficient force to substantially balance the weight of the plunger 132. However, the coil spring 142 need not, in the preferred embodiment, apply sufficient force, in and of itself, to hold the plunger 132 in the upper position as shown. Affixed to the rod 132A is a cross contact control member 133 which may be of any suitable configuration, such as a collar which encircles the rod 132A or an additional rod which passes through the rod 132A. In a preferred embodiment, the contact control member 133 includes a notch 133A at one side thereof to facilitate the function thereof. The function of the contact control member 133 is to cause the actuation of the resilient (for example, leaf spring) contacts as shown and enclosed within any protective cover. Of these contacts, the central terminal 92 is connected to ground; terminal 91 is connected to one end of coil winding 99; and terminal 97 is connected to one end of coil winding 96. Thus, it is seen that when the plunger 132 is in the upper position, as shown, the contact lands of terminals 91 and 92 are in engagement. On the other hand, when the plunger 132 is in the lower position (not shown), the contact lands of terminals 92 and 97 are in engagement.

The operation of the double action solenoid shown in FIG. 7 is such that when one of the suitable keys described above is inserted into the associated contacting member or keyhole the circuit is completed whereby current is applied to either terminal 96A or terminal 99A and flows through the coil 96 or 99, respectively, to ground via the terminal contacts. For example, insertion of a proper key into the keyhole will cause current to flow from terminal 99A through coil 99, through terminal 91, to ground via terminal 92. Current flow in coil 99 will create a magnetic field which causes the plunger 132 to be drawn downwardly into the housing 130 thereby pulling the rod 138 which is attached to the latching mechanism thereby locking, or conversely unlocking, the latching mechanism as desired. In addition, the member 133 also moves downwardly carrying therewith the flexible terminal 92 such that contact between terminals 92 and 91 is broken and contact between terminals 92 and 97 is effected. Therefore, with the application of the proper key in the keyhole, current may be now passed from terminal 96A through coil 96, through terminal 97 to ground via terminal 92. The current flow through coil 96 to creates a magnetic force which causes the plunger 132 to move upwardly in the sleeve 131 within the housing 130. As the plunger 132 moves upwardly, the rod 138 is also moved upwardly thereby with the key in the keyhole in the proper manner to cause 132 assumes one of its two positions. As soon as the either locking or unlocking the latching mechanism as the case may be, whichever is the opposite to the effect of drawing plunger 132 downwardly. It will be seen that with the key in the keyhole in the proper manner to cause either locking or unlocking of the latching device, current passes through one of the coils 96 or 99 so that the plunger 132 assumes one of its two positions. As soon as the plunger moves sufficiently to cause member 133 to move terminal 92 such that contact is broken between the terminal 92 and either terminal 97 or terminal 91 as the case may be, the circuit is broken in this operation such that current flow through the effected coil is discontinued thereby avoiding any problem of overheating or the like.

In addition, the contact terminals are now so arranged such that the proper key must be inserted into the keyhole mechanism in a different manner for the opposite action to be effected by current flow through the other coil which is now in the circuit which is completed to ground. Thus, the solenoid can be either of two conditions with the electrical connection so arranged that the opposite condition may be easily effected by the proper insertion of the proper key into the keyhole.

Reference is now made to FIG. 8 which is a schematic diagram of another type of solenoid used in certain applications of the instant electrical locking arrangement. Whereas the solenoid shown in FIG. 7 is easily applicable to automobile door locks and the like, the solenoid shown in FIG. 8 is easily adaptable for locks which are used on building doors and the like. The casing 150 within which the solenoid elements are enclosed may be any suitable material and is shown as a laminated structure. The components are held together by the assembly bolts 154. The energizing coil 151 is mounted within the casing 150 and the plunger 152 passes therethrough. The plunger 152 includes an enlarged end 152A which prevents the plunger from passing completely through the solenoid casing 150. Likewise, the plunger includes a reduced portion 152B at the other end thereof which passes through an opening in the solenoid casing end which forms abutment shoulders therefor. A cap 155 is attached to one end of the reduced end portion 152B of plunger 152. Although the plunger 152 is preferably fabricated of material such as soft iron or the like, the cap 155 may be comprised of other suitably durable but relatively resilient material such as Duralon or the like. This cap 155 which may, in fact, be an integral portion of the plunger 152 or may be attached subsequent to the fabrication of plunger 152 is enlarged such that the plunger end 152B does not move into the housing 150 of the solenoid. The coil spring 153 provides a returning force which causes the plunger 152 to remain in the withdrawn position shown in FIG. 8. One portion of the latching mechanism, that is catch 160, which may be any conventional type of catch is affixed to wall 162 or the like by means of screws or bolts 156. Similarly, another portion of the latching mechanism, that is latch holder 157, is affixed to the door 161 or the like by means of screws 156A. The latch 158 is located in the latch holder 157. Stop 158A may be a pin or the like which protrudes through a substantially centrally located, elongated aperture in the latch 158. Stop 158A controls the extent of travel of the latch 158 as well as providing a guide, in conjunction with the slot 165, such that the latch 158 moves in proper alignment.

In describing the operation of the mechanism in FIG. 8, the door 161 is locked as shown. In order to unlock the door 161, the proper key must be inserted into the keyhole associated with the device to be unlocked. The insertion of the proper key into the keyhole closes the control circuit such that current is applied to coil 152 via the terminals 151A. This application of current to coil 152 creates a magnetic force which draws plunger 152 of the solenoid toward the right (as depicted) thereby inherently moving the rod 152B to which is attached the cap or latch moving member 155. This cap bears against the end of latch 158. As the plunger 152 moves towards the right, the latch 158 is moved towards the right against the spring 166. When the latch 158 moves beyond the catch 160, the latch 158 is disengaged and the door 161 is free to open. Conversely, when the improper key is inserted or when the proper key is removed or the like, current is not applied to coil 151 and coil spring 153 returns, or maintains, plunger 152 in the position shown in FIG. 8. Likewise, the coil spring 166 exerts sufficient pressure to move the latch 158 to the left such that latch 158 engages the catch 160 thereby locking the door 161. Thus, again, the latching mechanism is controlled by the application of the proper key member into the keyhole or contacting member.

FIGS. 9, 10 and 11 are schematic diagrams of control circuits which are utilized in this invention. Each of these circuits though similar in concept is somewhat different in configuration thereby providing different operational advantages. Referring now to FIG. 9 in particular, there is shown a transistor 75. This transistor is shown as an NPN transistor. However, it is to be understood that by suitable changes other types of transistors or other amplifiers may be utilized in the circuit. The emitter 75e is connected to one terminal of resistor 35. Another terminal of resistor 35 is connected to ground. The base 75b of the transistor is connected to one terminal of resistor 36. Another terminal of resistor 36 is connected to ground. Resistors 35 and 36 are the control resistors which are found in the keying device described above. The base 75b is also connected to one terminal of coil 73 of the relay R-2. Another terminal of coil 73 is connected to one terminal of potential source 70. Source 70 is shown as a battery but other types of sources may be utilized. Also connected to potential source 70 is one terminal of resistor 85. Another terminal of resistor 85 is connected to one terminal of coil 74 of relay R-1. Another terminal of coil 74 is connected to emitter 75e of the transistor. The collector 75c of the transistor is connected to the common terminal of coil 74 and resistor 85 such that the collector-emitter junction of the transistor is in parallel with coil 74. The contact 83 of relay R-1 is connected to one contact 81 of the relay R-2. The armature contact 84 of relay R-1 is connected via wire 84A to the external circuitry, for example a relay or the like, which is utilized in the unlocking operation. The armature contact 80 of relay R-2 is connected to source 70 and to the terminal of coil 73 which is connected to source 70. Contact 87 is connected to external circuitry via wire 87A which external circuitry controls the locking operation of the circuit.

Basically, the circuit shown in FIG. 9 may be considered to operate using the principles of a Wheatstone bridge. That is, coil 73 comprises arm A-D; coil 74 and resistor 85 comprise arm A-C; resistor 35 comprises arm C-B; and resistor 36 comprises arm B-D. Of course, resistors 35 and 36 are incorporated into the key which is inserted into a keyhole as described above. The potential source 70 is applied across the terminals A-B while the transistor amplifier 75 is connected between terminals C-D. In accordance with typical bridge operation, when the bridge is balanced, no current flows in transistor 75. Therefore, the circuit is initially balanced using the proper key resistors 35 and 36. Thus, whenever these proper resistors are inserted into the circuit (for example between ground and the respective terminals C and D), the bridge is properly balanced and no current flows in the transistor. Moreover, the current which exists in the bridge network, when balanced, is such that relay R-1 is activated and relay R-2 is not activated whereby the external circuitry connected to wire 84A is operated (and the lock unlocked) while the external circuitry connected to wire 87A is not operated. If, on the other hand, improper resistors are inserted into the circuit, the bridge is no longer balanced and the opposite relay operation obtains. For example, if an improper resistor is substituted for resistor 36 which improper resistor has a resistance which is less than the proper resistor, the potential drop thereacross is reduced such that the potential drop across the coil 73 is increased. This of course, provides a greater current flow through coil 73 such that the relay R-2 is activated and armature 80 contacts terminal 87 thereby closing the circuit with the external locking circuitry. Thus, if the lock in question was unlocked or open, the energization of coil 73 closes relay R-2 such that the lock is now closed. On the other hand, if the improper resistor substituted for resistor 36 has a resistance which is larger than the proper resistor, the potential at node D (i.e., the base 75b of the transistor) increases, thereby turning on

the transistor through the base-emitter junction. This current flow reduces the impedance of the collector-emitter junction such that coil 74 is effectively short circuited thereby preventing relay R-1 from being actuated. Similarly, if the resistor substituted for the resistor 35 has a resistance less than the prescribed value, transistor 75 is turned on thereby shunting coil 74. On the other hand, if resistor 35 is replaced by a resistor having a greater impedance than the critical value, there will be insufficient current flow through coil 74 and relay R-1 will not be activated.

Referring now to FIG. 10, there is shown a schematic diagram of another control circuit. This circuit is similar to the circuit shown in FIG. 9 but it employs two Wheatstone bridge networks each of which is bilaterally cross connected by transistor amplifiers. One of the bridge networks comprises resistor 185 as arm A-C; shunt resistor 186 in parallel with coil 73 (of relay R-2) as arm A-D; resistor 167 as arm B-C; and resistor 36 as arm B-D. Source 70, similar to the previously described source, is connected between nodes A and B. The PNP transistors Q-4 and Q-3 are connected between nodes C and D. Transistor Q-4 has the base thereof connected to node C and the emitter thereof connected to node D. Transistor Q-3 has the base thereof connected to node D and the emitter thereof connected to node C. The collectors of these transistors are connected together. The other bridge comprises resistor 185A as arm A-C'; resistor 186A as arm A-D'; resistor 35 as arm C'-B' (where nodes B and B' may both be ground potential); and resistor 167A as arm B'-D'. Again, source 70 is connected between nodes A and B'. Also, NPN transistors Q-1 and Q-2 are connected between nodes C' and D'. The base of transistor Q-1 is connected to node D' and the emitter thereof is connected to node C'. The base of transistor Q-2 is connected to node C' and the emitter thereof is connected to node D'. The collectors of transistors Q-1 and Q-2 are connected together. The collectors of transistors Q-4 and Q-3 are connected, via resistor 11, to ground. These collectors are also connected to the base of NPN transistor Q-5. The emitter of transistor Q-5 is connected to the anode of diode 17 and, via resistor 68, to source 70. The cathode of diode 17 is connected to ground. The collector of transistor Q-5 is connected to one terminal of coil 74 of relay R-1 and to the cathode of diode 69. The anode of diode 69 is connected to the collector of transistor Q-6 as is another terminal of coil 74. Thus, diode 69 is in parallel with coil 74 and provides selective shunting thereof. The parallel network of coil 74 and diode 69 has one terminal thereof connected to ground via resistor 37 and the other terminal thereof connected to source 70 via resistor 61. The base of transistor Q-6 is connected to the collectors of transistors Q-1 and Q-2 and, also, to source 70 via resistor 65A. The resistors 11 and 65A are preferably shunt resistors for temperature stabilization and function in conjunction with diodes 17 and 67 and resistors 66 and 68. This prevents abnormal conduction of current across emitter collector junction of transistors Q-5 and Q-6 as the temperature rises. The amount of shunting is determined by the characteristics of the transistors Q-5 and Q-6. The less the shunting the more sensitive the circuit. Silicon transistors require less shunting than germanium type and provide a more sensitive circuit. The emitter of transistor Q-6 is connected to ground via resistor 66 and to the cathode of diode 67. The anode of diode 67 is connected to source 70. Relays R-1 and R-2 are connected similar to those described as to FIG. 9. Thus, contact 84 is connected, via conductor 84A, to external circuitry which activates the unlock apparatus. The armature 83 (relay R-1) is connected to contact 81 of relay R-2, armature 80 is connected to source 70 and contact 87 is connected, via conductor 87A, to external circuitry which controls the lock apparatus.

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The circuit of FIG. 10 is more sensitive than the circuit shown in FIG. 9 since relay coil 74 current may be completely shunted instead of merely having the current flow therein reduced. The operation of these circuits is generally similar. For example, when resistors 35 and 36 are present in the circuit (by insertion of keys) both bridges are balanced. Therefore, transistors Q-1, Q-2, Q-3, and Q-4 do not conduct. Thus, transistors Q-5 and Q-6 cannot conduct and the only current through coil 74 is the current flow through resistor 61 which also flows through resistor 37. This causes the closing of contacts 83 and 84 of relay R-1. Also not enough current passes through relay coil 73 to actuate it so that contacts 80 and 81 of relay R-2 remain closed. This provides a current path from source 70, to contact 80, to contact 81, to contact 83, to contact 84, to wire 84A which goes to the unlock circuitry which includes activated solenoids thereby unlocking the door or the like.

If on the other hand, however, resistors 35 and 36 are normally absent, or have improper values, produce an unbalanced bridge circuit. Thus, if, for instance, the resistor which is substituted for the proper resistor 35 is less than the critical value, transistor Q-1 will conduct. On the other hand, if the substituted resistance is greater than the critical value, transistor Q-2 will conduct. The conduction of either of these transistors due to unbalance of the bridge tends to bias transistor Q-6. Resistor 65A shunts emitter base junction of transistor Q-6 to prevent excessive emitter base current and also acts to stabilize emitter to base leakage current when there is a rise in temperature. Similarly, transistor Q-3 or Q-4 conducts when resistor 36 is less than or greater than the critical value, respectively. The current from the collectors of transistors Q-3 or Q-4 when conducting due to unbalance of the bridge is applied to the base of transistor Q-5 to bias the transistor to conduction. Resistor 11 serves the same purpose in relation to transistor Q-5 as resistor 65A does to transistor Q-6. When transistors Q-5 and Q-6 are not conducting relay R-1 is energized and contacts 83 and 84 are closed. However, when transistor Q-5 is conducting due to resistor 36 being more or less than the critical value, relay coil 74 is at least partially shunted. That is, transistor Q-5 takes part of the current coming through resistor 61. This reduces the current passing through coil 74 whereby relay R-1 is not actuated. When transistor Q-6 conducts due to an improper resistor being substituted for resistor 35 current flows from source 70, through diode 67, across the emitter-collector junction of transistor Q-6, to negative end of coil 74, through resistor 37 to ground. When transistor Q-6 is conducting this tends to produce a positive potential at the end of coil 74 connected thereto. When transistor Q-5 is conducting a reduction in positive potential is produced at the other terminal of coil 74, i.e., the terminal connected to transistor Q-5. Thus, coil 74 acts as the center of a bridge in which transistor Q-6 represents one arm; transistor Q-5 another arm; resistor 61 another arm; and resistor 37 another arm. So long as the resistance across the emitter-collector junctions of transistors Q-5 and Q-6 are both about equal due to resistors 35 and 36 being more or less than their designated value, current will flow from source 70, through resistor 61, through transistor Q-5, and through diode 17 to ground, and also from source 70, through diode 67, through transistor Q-6, through resistor 37 to ground. However, no current will flow through coil 74 and the unlock circuitry will not be activated. If now the resistance of one of the transistors changes as for example by the excessive conduction thereof, the current therethrough transistor Q-5, for example, would then flow from source 70 through resistor 61, through transistor Q-5, through diode 17 to ground, and, also, from source 70, through diode 67, through transistor Q-6. There, the current divides with a portion of the current going through resistor 37 to ground and the remainder of the current passing through coil 74 in the

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reverse direction or from left to right as depicted through transistor Q-5 to ground. With any polarized relay, this reverse current will be ineffective regardless of its magnitude since the relay will not actuate in response to current in the reverse direction. But with a non-polarized relay the reverse current may become large enough to actuate the relay. To prevent this diode 69 is shunted across coil 74. Diode 69 does not effect forward current flow through coil 74 because of the high reverse resistance thereof. However, reverse current flow "sees" the low forward resistance of diode 69. Therefore, diode 69 shunts coil 74 thereby preventing any large amount of current from flowing therethrough thus preventing the spurious actuation of the unlock circuitry by reverse current. The diode thus tends to make a relay polarize. The diode 69 may be eliminated if polarized relay is used. Resistors 68 and 11 and diode 17 are temperature stabilizers for transistor Q-5. Resistors 65 and 66 and diode 67 are temperature stabilizers for transistor Q-6.

Reference is now made to the schematic circuit diagram shown in FIG. 11. This circuit is similar to the circuit shown in FIG. 10 with the exception that this circuit draws less current under quiescent conditions. Furthermore, transistors Q-7 and Q-8 replace resistors 186 and 185 respectively in the bridge network. Also resistor 36 provides the bias resistor connected to the base of transistor Q-7 instead of being an arm of bridge circuit as in previous circuits. Also, having relay R-1 positioned as shown, with this arrangement and using the keying member as in FIG. 2, the contacts 28 and 31 and disk 29 may be eliminated since as will be seen in FIG. 10 when the ink cartridge is drawn into the casing the contact containing resistor 35 is open circuited. This causes transistor Q-6 to conduct due to the unbalanced bridge. The resistor 36 however is properly inserted into the circuit and thus transistor Q-5 does not conduct as the bridge is balanced. Thus a small portion of current goes from positive of source 70 through resistor 61, through relay coil 74, through relay coil 73 to ground and a greater current passes from 70 through diode 67 across the emitter-collector junction of transistor Q-6 through relay coil 73 to ground. This increase in current would cause relay R-2 to activate closing contacts 80 and 82 thus activating the circuit which caused the locking means to engage.

When the key member is withdrawn or is not in contact with the receptacle, current flows from the positive of source 70, through resistor 61 across the emitter-collector junction of transistor Q-5, through diode 17 to ground, as when the resistor 36 is absent the bridge is unbalanced and transistor Q-5 conducts. Current also flows from source 70 through diode 67, across the emitter-collector junction of transistor Q-6, where the current divides with a large portion passing through diode 69, across transistor Q-5 through diode 17 to ground as this is the path of least resistance. A small portion of the current passes through relay coil 73 to ground. Insufficient current passes through the relay coil 73 to hold the relay R-2 in an activated state so that it is deactivated and contacts 80 and 82 disengage. Thus, resistor 36 continues to serve the purpose of controlling the resistance of one arm of the bridge. The base current controlled by resistor 36 controls the emitter-collector current of transistor Q-7, since this changes the emitter-collector junction resistance and amplifies the change in resistance of the bridge arm. A resistor could be used in place of transistor Q-8 if varying temperatures did not cause a change in the emitter-collector junction resistance of transistor Q-7. When transistor Q-8 is utilized its change in characteristics caused by temperature variations are the same as Q-7. Thus, a temperature change would effect both transistors at the same time changing their junction resistance by about the same amount. Therefore, the bridge remains balanced even under large temperature changes. Resistors 71 and 73A are used

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in conjunction with Q-8 and Q-7 to provide bridge arms. This makes the impedance of the arms of the bridge substantially equal. Resistor 72 is inserted in order to prevent excessive base current when resistor 36 is shorted. Resistor 187 is used to balance the base current flow of transistor Q-8 to that of transistor Q-7 when resistor 36 is inserted. Thus resistor 187 should equal the total resistance of resistors 36 and 72. It should be noted that transistors may be substituted for resistors 186A and 185A for greater sensitivity and permit a larger value for resistor 35. These transistors would be arranged the same as transistors Q-7 and Q-8 of the other bridge. Thus, it may be seen that the manufacturer has a choice of several control circuits for use with the locking device described. Each of these circuits is rendered operative to unlock a door or the like when the proper resistors are inserted by means of a key which is described. The insertion of improper resistors, or the lack of insertion of any resistors in the circuit, will render the circuit operative to lock said door or other device. More resistors similar to 35 and 36 may be utilized using a keying device with more contact surfaces for the utilization of these resistors to maintain a more complex and secure locking operation without deviating from the spirit of this invention.

From the foregoing description, it will be understood that various changes may be made in the form, construction and arrangement of the components, without departing from the scope of the invention, the forms hereinbefore described being merely preferred embodiments.

I claim:

1. In an electrical locking device comprising, a key, a keyhole and a control circuit, said control circuit connected to said keyhole and including a bridge-type network, said bridge-type network including arms thereof which are supplied by said key when inserted into said keyhole, said key having an elongated housing of generally cylindrical configuration with at least one tapered end, the smaller end of said tapered end incorporating a first contact, said housing incorporating a second contact, a third contact incorporated into the intermediate portion of said housing and between said first and second contacts, each of said first, second and third contacts being

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insulated from each other, a first precision resistor connected to said first and second contacts, a second precision resistor connected to said third and second contacts, said first and second precision resistors comprising the arms which are supplied to said bridge-type network.

2. The key as recited in claim 1 wherein said elongated housing comprises a ball point pen, and a metal encased ink cartridge in said housing, said cartridge comprising said first contact.

3. In an electrical locking device comprising, a key, a keyhole and a control circuit, said control circuit connected to said keyhole and including a bridge-type network, said bridge-type network including arms thereof which are supplied by said key when inserted into said keyhole, said key having an elongated housing of generally cylindrical configuration with at least one tapered end, the smaller end of said tapered end incorporating a first contact, said housing incorporating a second contact, a third contact incorporated into the intermediate portion of said housing and between said first and second contacts, each of said first, second and third contacts being insulated from each other, a first precision resistor connected to said first and second contacts, a second precision resistor connected to said third and second contacts, said first and second precision resistors comprising the arms which are supplied to said bridge-type network, said key having means for changing the value of the resistors of at least one of said resistors, thereby to provide selective locking and unlocking operation of said locking means.

References Cited by the Examiner

UNITED STATES PATENTS

1,743,730	1/1930	Rugg et al.	70—280 X
2,882,455	4/1959	Ferguson	70—277 X
3,029,345	4/1962	Douglas	70—277 X
3,134,254	5/1964	Richard	70—277

FOREIGN PATENTS

312,699	6/1919	Germany.
332,659	2/1921	Germany.

BOBBY R. GAY, Primary Examiner.