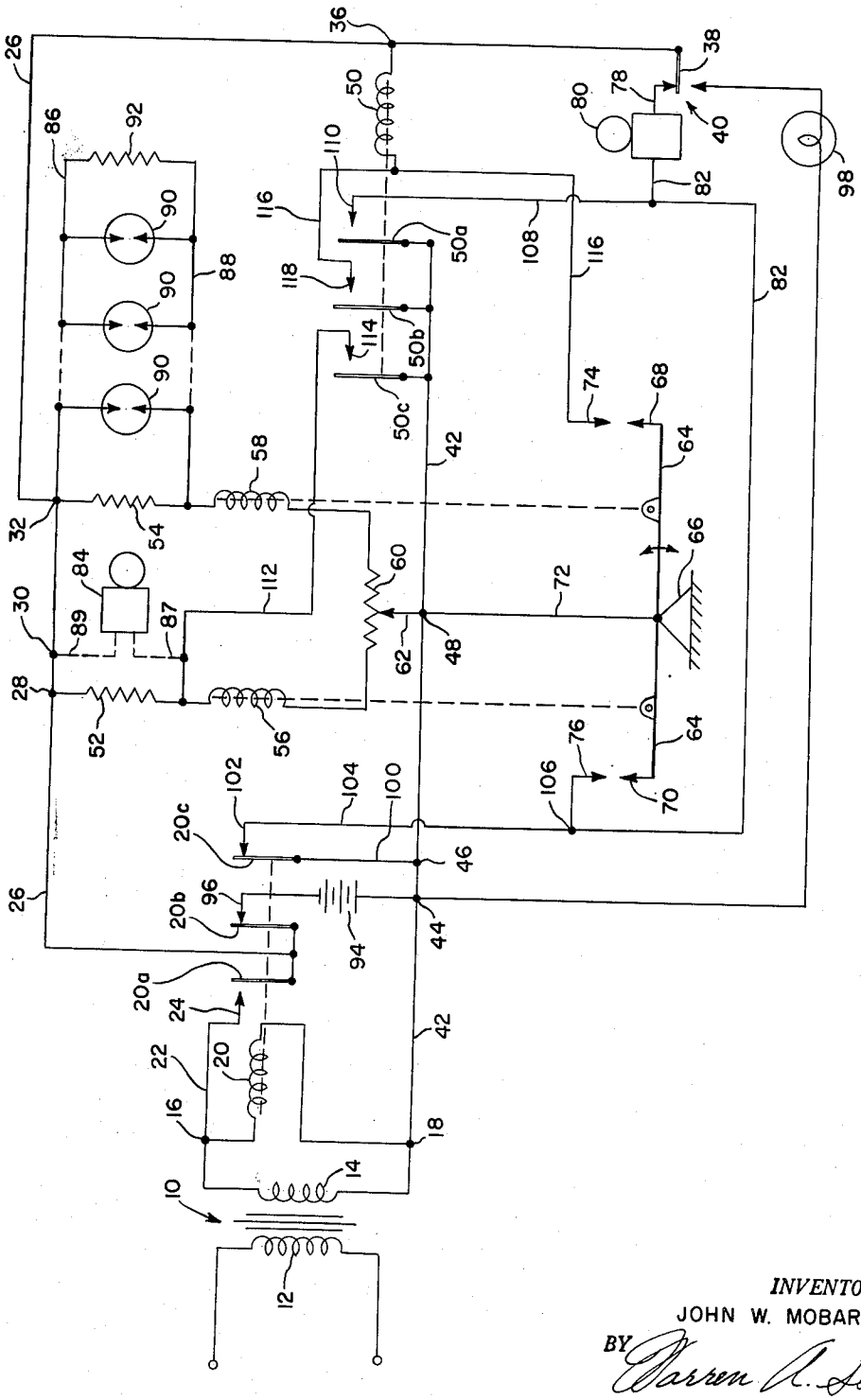
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SUPERVISED CONDITION DETECTION AND ALARM APPARATUS

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SUPERVISED CONDITION DETECTION AND ALARM APPARATUS

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This invention relates generally to electrical signaling systems and more specifically to electrical alarm circuits which are responsive to the occurrence of a dangerous condition to advise supervisory personnel of this condition. Apparatus of this general type may be used in fire, burglary, or any other application where it is desired to notify personnel in time for them to take precautionary measures.

In applications where human life is at stake, it is an absolute requirement that the signaling system employed be highly reliable. Because of this reliability requirement, the systems disclosed in the prior art tend to be quite complex and expensive thereby pricing this system out of the reach of the average home owner. The alarm circuit of the present invention is relatively simple in form and quite inexpensive. Notwithstanding these advantages, no sacrifice is made in the reliability requirements deemed to be so necessary.

The alarm system of my invention is arranged to provide an audible and/or visual indication upon occurrence of a dangerous condition to which it is responsive. As mentioned above, this may, for example, be an over temperature produced by a fire, or any other occurrence where it is desirable to notify supervisory personnel such that appropriate action may be taken. Additionally, provision is made in my alarm system to give an indication, either audible or visual, to supervisory personnel in the event that a fault such as a short circuit or open circuit has occurred somewhere in the system. Furthermore, there is provided in my system a self-contained auxiliary source of power which becomes operative to maintain the system in a standby condition in the event of a power failure, and to cause the alarm to sound in the event that the dangerous condition arises during the interval that the power has failed.

Included in my signaling system is a differential relay having switch means associated therewith. When the circuit is in its standby condition, the switch means are in a first position in which both the main alarm and the fault indicator are inoperative. Upon the occurrence of the dangerous condition, the balance condition of this relay is disturbed so as to cause the switch means associated therewith to be moved to a second or alarm position thereby allowing current to flow through said main alarm causing it to operate. Furthermore, the circuits are designed such that a fault occurring in the system is effective to cause an unbalance of the relay such that its associated switch means is moved to still a third position in which the fault indicating alarm is energized.

It is accordingly an object of the present invention to provide an improved means for giving an alarm at a central location upon the actuation of distributed detector means, and also to provide means whereby a break or short circuit fault in the system may be signaled.

It is another object of my invention to provide an alarm system which is both reliable and inexpensive.

Still another object of my invention is to provide an alarm system which remains operative even when a failure of this main source of power has occurred.

Still other objects of the present invention will be hereinafter pointed out in the accompanying specification and claims and shown in the drawing which by way of

illustration shows the preferred embodiment of the invention.

Referring now to the schematic diagram shown in the drawing, there is illustrated a transformer **10** having a primary winding **12** and a secondary winding **14**. Primary winding **12** is adapted to be connected to a convenient source of alternating current potential, such as a 120 volt 60 cycle source. Transformer **10** is effective to step down this voltage to a value suitable for use with the alarm. For example, the voltage appearing across terminals **16** and **18** of the secondary winding **14** may be approximately 15 volts. Connected between the terminals **16** and **18**, i.e., directly across the secondary winding **14** is a power failure relay **20** which operates a plurality of contact arms **20***a*, **20***b*, and **20***c*. The operation of the power failure relay **20** will be described more fully hereinbelow, but for now it is sufficient to say that in the event of a power failure the power failure relay and its associated contacts are operative to switch an auxiliary source of power into the circuit and to sound a trouble alarm which will indicate this fault to the occupant of the premises where the apparatus is installed.

Continuing now with a description of the circuit layout, a conductor **22** connects the secondary winding terminal **16** to a contact **24** of the power failure relay **20**. A conductor **26** connects the switch arms **20***a* and **20***b* to the junctions **28**, **30**, **32**, and **36** and to the switch arm **38** of a single pole double throw manual silencing switch **40**. A conductor **42** is used to connect the secondary winding terminal **18** to the junctions **44**, **46** and **48** and to the switch arms **50***a*, **50***b*, and **50***c* of an alarm relay **50**. Connected between the junctions **28** and **32** on conductor **26** and the junction **48** on conductor **42** is a balance circuit comprising a pair of current limiting resistors **52** and **54**, the two coils **56** and **58** of a balanced relay, and a balancing potentiometer **60**.

When normal line voltage is applied to the primary winding **12** of transformer **10**, the power failure relay **20** is energized thereby completing a circuit path which may be traced through conductor **22**, contact **24**, switch arm **20***a* and conductor **26** to the junction **28**. At junction **28**, the current divides with approximately one-half of the total current flowing through the resistor **52**, the balanced relay coil **56** and a portion of the balancing potentiometer to the junction **48** and the other half of the current flowing through a resistor **54**, relay coil **58** and the other portion of the balancing potentiometer to junction **48**. At junction **48** the current again combines and flows through the conductor **42** back to the secondary winding terminal **18**. Equality of current flow through the two coils of the balanced relay is obtained by initially adjusting the position of the wiper arm **62** of the balancing potentiometer **60**.

The balanced relay coils **56** and **58** are arranged to operate a common armature **64**. Armature **64** is shown as being rotatably mounted with respect to a pivot or fulcrum **66**. The armature **64** is provided with a pair of contacts **68** and **70** located on opposite sides of the fulcrum **66**. When the signaling circuit of this invention is in its standby condition, i.e., the condition which exists when the system is free from faults and no danger-out condition is present, the armature **64** is in the position illustrated. When the balance circuit becomes unbalanced due either to the occurrence of a dangerous condition or due to a system fault the armature **64** is rotated either in the counterclockwise direction or the clockwise direction about fulcrum **66** depending upon which of the balanced relay coils **56** or **58** receives a greater portion of the current. Because a conductor **72** connects the armature **64** to the junction **48** which, in turn, is connected by means of conductor **42** to the sec-

ondary winding terminal **18**, a counterclockwise rotation of the armature **64** is effective to complete a circuit which may be traced from the secondary winding terminal **16** through conductor **22**, contact **24**, switch arm **20***a*, conductor **26**, the alarm relay **50**, and a contact **74** which is arranged to mate with contact **68**. In a similar manner, a clockwise rotation of the armature **64** about fulcrum **66** completes the circuit between contact **70** and contact **76** so that a current can flow through the conductors **22**, **26**, the switch arm **38** of single pole double throw switch **40**, a conductor **78**, a fault indicating alarm **80**, a conductor **82**, through the armature **64** and the conductor **72**, and conductor **42** back to the secondary winding terminal **18**. The current flowing through this last mentioned path is effective to energize the fault alarm **80**.

Connected directly in parallel with the resistor **52** in the balanced circuit is a main alarm **84**. Connected directly in parallel with the resistor **54**, i.e., between the conductors **86** and **88**, are a plurality of detector means **90** and a termination or end of line resistor **92**. The conductors **86** and **88** pass through the areas of the premises to be protected and one or more detector means **90** is provided for each separate area. Detectors **90** are illustrated as being of the normally open contact type which when exposed to a dangerous condition become closed.

In order to supply energy to the circuit in the event of a failure of the line voltage, a battery source **94** is connected between the junction **44** on conductor **42** and a contact **96** which cooperates with the power failure relay switch arm **20***b*. The potential appearing at the junction **32** is normally applied through the conductor **26** and the single pole double throw manual silencing switch **40** to the fault alarm **80**. When the switch is thrown from the position shown to its opposite position, a lamp **98** is inserted in the circuit between the junctions **36** and **44**.

In completing the description of the circuit arrangement, a conductor **100** connects the junction **46** on conductor **42** to the switch arm **20***c* of the power failure relay. Contact **102** which is associated with the switch arm **20***c* is connected by means of a conductor **104** to a junction **106** which is the common point between the conductor **82** and a conductor **108**. Conductor **108** connects the junction **106** to a contact **110** which cooperates with the switch arm **50***a* of the alarm relay **50**. A conductor **112** is used to connect a contact **114**, which is associated with the switch arm **50***c*, to one side of the main alarm **84**. Also shown in the drawing is a conductor **116** which connects one side of the alarm relay **50** to the balanced relay contact **74** and to a contact **118** which is associated with the switch arm **50***b* of the alarm relay.

Now that the circuit layout and various connections have been described in some detail, a description of the circuit operation will be presented.

Operation

As mentioned earlier, the purpose of the signaling system shown in the drawing is to sound an alarm whenever a condition arises to which one or more of the detector means **90** is responsive, and to operate a fault indicator in the event that one or more of the circuit connections which run throughout the building becomes either opened or shorted. When initially placed in operation, the circuit is balanced by varying the position of the wiper arm **62** of the potentiometer **60** such that the magnetic force produced as a result of the current flowing through the balanced relay coil **56** is exactly counteracted by the magnetic force produced by the current flowing through the balanced relay coil **58**. When these forces are balanced, the armature **64** is in the position shown such that the switch means **68** and **70** is in its normal first or standby position, as illustrated. If the current flowing through the balanced relay coil **56** decreases or the current flowing through the balanced relay coil **58** increases from that which exists when the system is in balance, the armature members **64** will rotate counterclockwise about the fulcrum **66** such that electrical continuity is established between the contacts **68** and **74**. When the armature **64** has been rotated in the counterclockwise direction such that contacts **68** and **74** are closed and contacts **70** and **76** are open, the circuit is said to be in its second or alarm position. Either an increase in the current flowing through the balanced relay coil **56** or a decrease in the current flowing through the balanced relay coil **58** causes the armature member **64** to rotate clockwise about the fulcrum **66** thereby causing contacts **70** and **76** to close and contacts **68** and **74** to open. Under this condition, the switch means is said to be in its third or fault position.

When a source of line voltage is connected to the primary winding **12** of transformer **10**, a voltage is developed across secondary winding terminals **16** and **18** which is sufficient to energize the power failure relay **20**. Energization of relay **20** causes electrical continuity to be established between the switch arm **20***a* and contact **24** and breaks the circuit between the switch arms **20***b* and **20***c* and their respective contacts **96** and **102**. With electrical continuity established between contact **24** and switch arm **20***a*, a current path may be traced from the secondary winding terminal **16** through conductor **22** through the now closed switch contact **24**, the conductor **26**, to the junctions **28** and **32**. At junction **28** a portion of the current which normally flows in the conductor **26** divides and passes through the resistor **52** and the main alarm **84** which is in parallel with resistor **52**, through the balanced relay coil **56**, and through the balancing potentiometer wiper arm **62** to junction **48**. Likewise, at junction **32** a portion of the normal line current flowing in conductor **26** divides so that a fraction of the total current flows through the resistor **54** and the balance relay coil **58** and through the portion of the balancing potentiometer **60** to the right of the wiper arm **62** to a junction **48**. Also, a supervisory current flows through the detector lines **86** and **88** and the end of line resistor **92**. In the absence of a dangerous condition or system fault, the wiper arm **62** of the balancing potentiometer **60** can be set such that the currents flowing through the balanced relay coils **56** and **58** are substantially equal thereby producing equal magnetic forces on the armature **64** of the balanced relay. From junction **48** the current is returned to the secondary winding terminal **18** by way of conductor **42**. With the coils **56** and **58** exerting approximately equal forces on the armature member **64**, the circuit is in the standby condition and both the fault alarm **80** and the main alarm **84** are silent. Should a dangerous condition break out somewhere in the area being supervised, the normally open detector **90** responds to this dangerous condition by closing its contacts thereby shorting out the resistors **54** and **92**. With these resistors shorted out, there is an increase in the amount of current which flows through the balanced relay coil **58** such that the coil **58** produces a greater magnetic force on the armature **64** than does the coil **56**. As a result, the armature **64** is rotated in the counterclockwise direction so as to establish electrical continuity between the contacts **68** and **74**. As mentioned previously, this is the alarm position for the balanced relay armature. With contacts **68** and **74** closed, a circuit path may be traced from the secondary winding terminal **16** through conductors **22** and **26** to the junction **36**. From junction **36** the current flows through the alarm relay coil **50** through the conductor **116** and the now closed contacts **68** and **74**, through the conductive armature **64** and the conductor **72** to junction **48**. The current which flows through the relay coil **50** is returned from junction **48** to the secondary winding terminal **18** through conductor **42**. The current flowing through the relay coil **50** causes a magnetic force to be produced which causes the contact arms **50***a*, **50***b* and **50***c* to close against their respective

contacts **110**, **118** and **114**. The closure of the switch arm **50***b* against its associated contact **118** causes the alarm relay coil **50** to be locked in its energized position. The closure of the switch arm **50***c* against its associated contact **114** is effective to connect the main alarm **84** directly across the output of the secondary winding **14** so that sufficient current can now flow therethrough allowing it to sound. The closure of the alarm relay contact **50***a* against its associated contact **110** establishes a current path from the junction **36**, through conductor **26** and the single pole double throw silencing switch **40**, through conductor **78** and the fault alarm **80**, through conductors **82** and **108** to the conductor **42** which is connected to the secondary winding terminal **18**. This current causes the fault alarm to sound. Once the occupant of the building hears the main alarm he knows that a dangerous condition exists.

Since the lines **86** and **88** and the lines **87** and **89** connecting the main alarm **84** to the control panel are strung throughout the building, most building codes require that these lines be supervised so that the occupant will be advised of a break in these lines. Assuming that a break does occur in either line **86** or **88**, the end of line resistor **92** would be disconnected so that it would no longer be in parallel with the resistor **54**. The equivalent resistance in series with the balanced relay coil **58** therefore increases. As a result, less current now flows through the balanced relay coil **58** so that the magnetic force produced by this coil is outweighed by the magnetic force produced by the balanced relay coil **56**. The armature member **64** therefore rotates in a clockwise direction about the fulcrum **66** causing electrical continuity to be established between the contacts **70** and **76**. Since the contacts **68** and **74** are open when the armature **64** is in its third or fault position the alarm relay coil **50** remains deenergized. A current path may be traced, however, from the secondary winding terminal **16** through conductors **22** and **26**, through the silencing switch **40**, through conductor **78** and the fault alarm **80**, through conductor **82** and the now closed contacts **70** and **76**, through the armature **64** and conductor **72**, back to the secondary winding terminal **18** by way of conductor **42**. It can be seen, then, that the fault alarm **80** is, under these circumstances, connected directly across the secondary winding of the transformer **10**. Sufficient current therefore flows through the fault alarm to cause it to sound. Should the sound from the fault alarm become objectionable to the occupant, once he has been advised that a fault exists he may silence this alarm by reversing the position of the switch arm **38** of the manual silencing switch **40** so as to connect the fault indicating lamp **98** directly across the secondary winding **14**.

In a similar manner, if a fault should occur in the form of a short circuiting of the main alarm **84** the amount of current flowing through the balanced relay coil **56** will exceed that flowing through the balanced relay coil **58** again producing a clockwise rotation of the armature **64**. As explained previously, this completes a circuit through the fault indicator **80** which will advise the occupant that a fault exists in the system so that he may take appropriate measures to correct the situation.

Still another fault which may occur is that the lines connecting the main alarm into the circuit may become open. Under this condition, the effective impedance in series with the balance relay coil **56** increases such that a greater magnetic force is applied to the armature **64** by the balanced relay coil **58** than is applied by the balanced relay coil **56**. Armature member **64** therefore rotates counterclockwise to close the contacts **68** and **74**. This is the same as the alarm condition previously described. As already mentioned, when contacts **68** and **74** close a current flows through the alarm relay **50** by way of conductors **22**, **26**, **116**, **72**, and **42**. With the alarm relay **50** energized its associated contacts **50***a*, **50***b* and **50***c* are pulled in. The closing of the contact **50***a* against its associated contact **110** completes a circuit to connect the fault alarm **80** directly across the output of the transformer **10**. The closure of the contact arm **50***c* across its associated contact **114** would cause the main alarm **84** to ring, but since the fault which has been assumed is an open in the main alarm line, the main alarm **84** remains silent.

In the event of a power failure, no voltage will be induced in the secondary winding **14** of the transformer **10** so that the power failure relay **20** will become deenergized. With the power failure relay coil **20** deenergized its associated contact arms **20***a*, **20***b* and **20***c* will assume the position illustrated in the drawing. When contact arm **20***b* closes against its associated contact **96** the auxiliary energy source **94** is connected between the junction **44** and conductor **42** and the conductor **26**. Current therefore can flow from the positive terminal of the source **94** through the conductor **26** to the junctions **28** and **32**. As before, the current divides at these two points such that when no dangerous condition or fault (other than a power failure) exists, substantially equal currents will flow through the balanced relay coils **56** and **58** and through each half of the balancing potentiometer **60** and through conductor **42** back to the negative terminal of source **94**. The armature **64** of the balanced relay therefore remains in its first or standby position. However, since the contact arm **20***c* of the power failure relay is now closed against its associated contact **102** a circuit path may be traced from the junction **32** through conductor **26**, through the single pole double throw manual silencing switch **40**, through the fault alarm **80** and conductors **82**, **104**, and **100**. In effect, then, the fault alarm **80** is connected directly across the energy source **94** and therefore sounds.

Should a dangerous condition arise during the power failure, one of the normally open condition responsive switches **90** will close to short out the current limiting resistor **54** and the end of line resistor **92**. The current flowing through the balanced relay coil **58** therefore increases over the amount which normally flows and causes a counterclockwise rotation of the armature member **64**. Current therefore flows from the auxiliary energy source **94** through the now closed contacts **96** and conductor **26** to the junction **36**. From junction **36** the current continues to flow through the alarm relay coil **50**, conductor **116**, the now closed contacts **68** and **74**, and conductors **72** and **42** back to junction **44** to which the energy source **94** is connected. With the alarm relay coil **50** energized, the relay contacts **50***a*, **50***b* and **50***c* associated therewith close. When contact arm **50***c* closes against its associated contact **114** the main alarm **84** is connected directly across the energy source **94** so that it is able to sound.

Thus it can be seen that this circuit of this invention is effective to give an alarm to indicate the presence of a dangerous condition to which the detectors **90** are responsive, and to provide an indication to supervisory personnel in the event that a fault occurs in the system.

From the above description it will be apparent that I have produced a system apparatus which possesses all of the features that are set forth as desirable; and while I have described and illustrated what appears to be the preferred form of the invention, I reserve the right to make all changes within the spirit of the invention and without the ambit of the prior art.

I claim:

1. In a supervised condition detection and alarm apparatus, first alarm means for indicating the presence of an undesired condition, second alarm means for indicating the presence of circuit trouble, switch actuating means having a balanceable member normally held in a center position and controlled by a first and a second winding to close a first switch when said member moves in a first direction and to close a second switch when said member

moves in an opposite direction, said first switch being closed when an output of said first winding produces to dominating force on said member, said second switch being closed when an output of said second winding produces the dominating force on said member, a source of power, a plurality of abnormal condition detector means, said detector means being normally open and connected in parallel, an end impedance connected adjacent a farthermost of said parallel detector means, a first resistance connected adjacent a closest of said detector means, circuit means including said first switch for connecting said second alarm to said source, circuit means including said second switch for connecting said first alarm to said source, circuit means including a parallel circuit of said first resistance, said end resistance and said parallel detectors for connecting said second winding to said source, a second resistance connected in parallel with said first alarm means, and circuit means comprising said second resistance for connecting said first winding to said source.

2. In a supervised condition detection and alarm apparatus, first alarm means for indicating the presence of an undesired condition, second alarm means for indicating the presence of an abnormal circuit, a source of power, switch actuating means having a balanceable member controlled by a first and a second winding to close a first switch when said member moves in a first direction and to close a second switch when said member moves in an opposite direction, said first switch being closed to energize said second alarm means when said first winding produces to dominating force on said member, said second switch being closed to energize said first alarm means when said second winding produces the dominating force on said member, a plurality of parallel connected abnormal condition detector means, said detectors closing upon the presence of an undesired condition, an end resistance connected adjacent a farthermost parallel detector means, a first resistance connected adjacent a closest detector means, circuit means including a parallel circuit of said first resistance, said end resistance and said parallel detectors for connecting said second winding to said source, a second resistance connected in parallel with said first alarm means, and circuit means comprising said second resistance for connecting said first winding to said source.

3. In a supervised condition detection and alarm apparatus, first alarm means for indicating the presence of an abnormal condition, second alarm means for indicating the presence of an abnormal circuit, switch actuating means having a pivoted member controlled by a first and a second winding to close a first switch when said member moves in a first direction and to close a second switch when said member moves in an opposite direction, said first switch being closed when said first winding produces to dominating force on said member, said second switch being closed when said second winding produces the dominating force on said member, circuit means for adjusting the resultant effect of the output of said windings on said member, a source of power, at least one normally open circuit abnormal condition detector means, a circuit termination means connected in parallel with detector means at one end of a circuit, a first resistance connected in parallel with detector means, circuit means including said first switch for connecting said second alarm to said source, circuit means including said second switch for connecting said first alarm to said source, circuit means comprising two parallel conductors connecting said first resistance, said termination means and said detector in parallel for connecting said second winding to said source, a second resistance connected in parallel with said first alarm means, and circuit means comprising said second resistance for connecting said first winding to said source.

4. In a supervised condition detection and alarm apparatus, first alarm means for indicating the presence of an undesired condition, second alarm means for indicating the presence of circuit trouble, switch actuating means having a balanceable member controlled by an output of a first and a second actuator winding to close a first switch when said member moves in a first direction and to close a second switch when said member moves in an opposite direction, said first switch being closed when said output of said first winding produces to dominating force on said member, said second switch being closed when said output of said second winding produces the dominating force on said member, a source of power, a plurality abnormal condition detector means, said detector means being normally open and connected in parallel, an end resistance connected adjacent a farthermost of said parallel detector means, a first resistance connected adjacent a closest of said detector means, circuit means including said first switch for connecting said second alarm to said source, circuit means including said second switch for connecting said first alarm to said source, voltage balancing circuit means, circuit means including a parallel circuit of said first resistance, said end resistance, said parallel detectors and said voltage balancing circuit means for connecting said second winding to said source, a second resistance connected in parallel with said first alarm means, and circuit means comprising said second resistance for connecting said first winding to said source.

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