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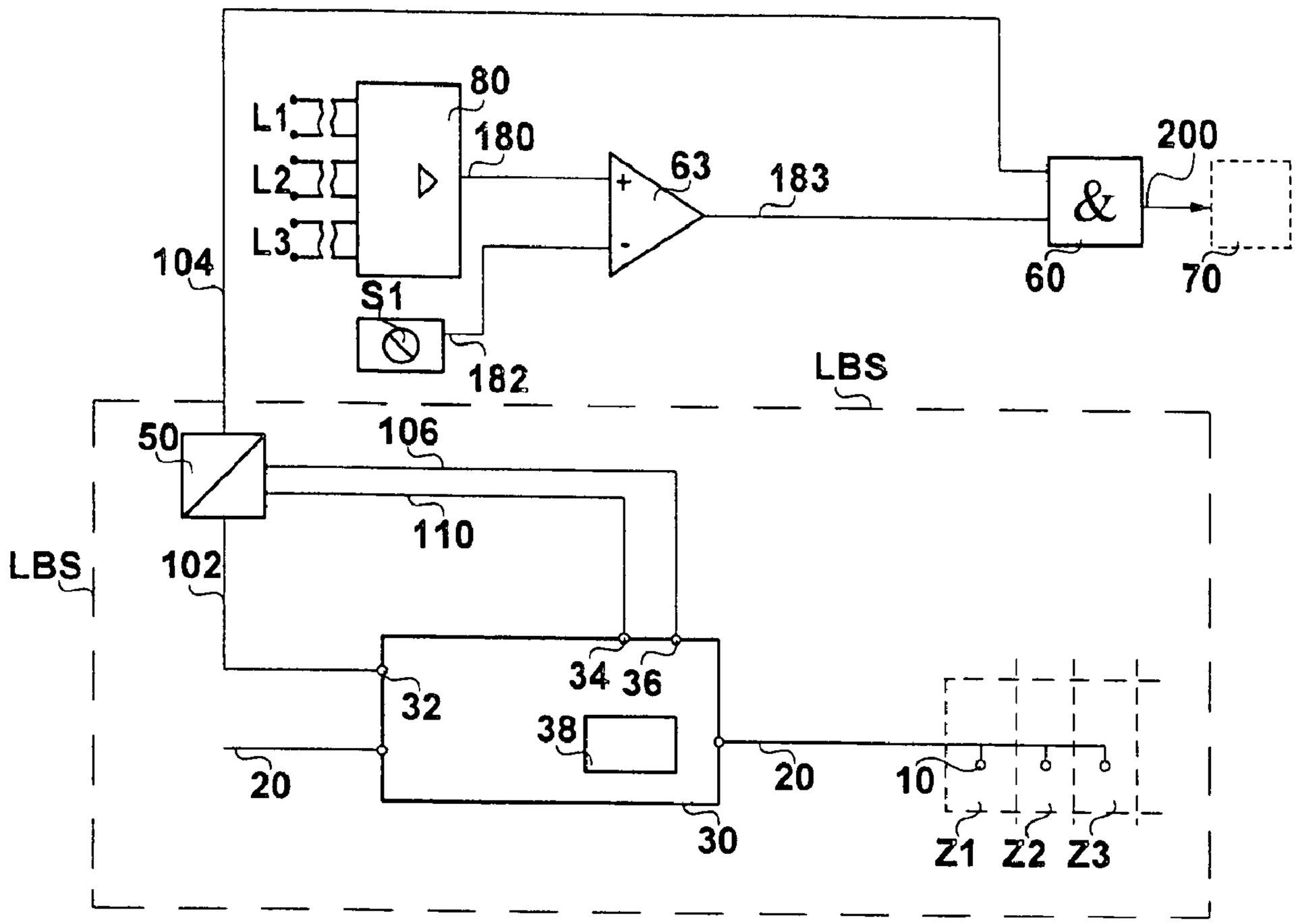

(57) Abrégé/Abstract:
The invention relates to a power switch configured for the purposes of preventing accidental arcs in a low-voltage switchgear. The invention provides the power switch with an overcurrent evaluation means responding to an accidental arc produced in the

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(57) Abrégé(suite)/Abstract(continued):
switchgear. An overcurrent signal 104 arriving from the arc monitoring system LBS (occurrence of the flash of an accidental arc) is linked to the signal 103 for triggering the control means via a first evaluation means S1, 182, 63 for evaluating the intensity of the overcurrent originating from the accidental arc. The means 70 for triggering the power switch is activated, on issuing of a turn-off pulse 200, merely if the signal 180 from the current detection means 80 is above a preadjustable threshold S1. The invention allows the power switch to cut off more rapidly an overcurrent based on an accidental arc.

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(54) **Title:** POWER SWITCH FOR PREVENTING ACCIDENTAL ARCS

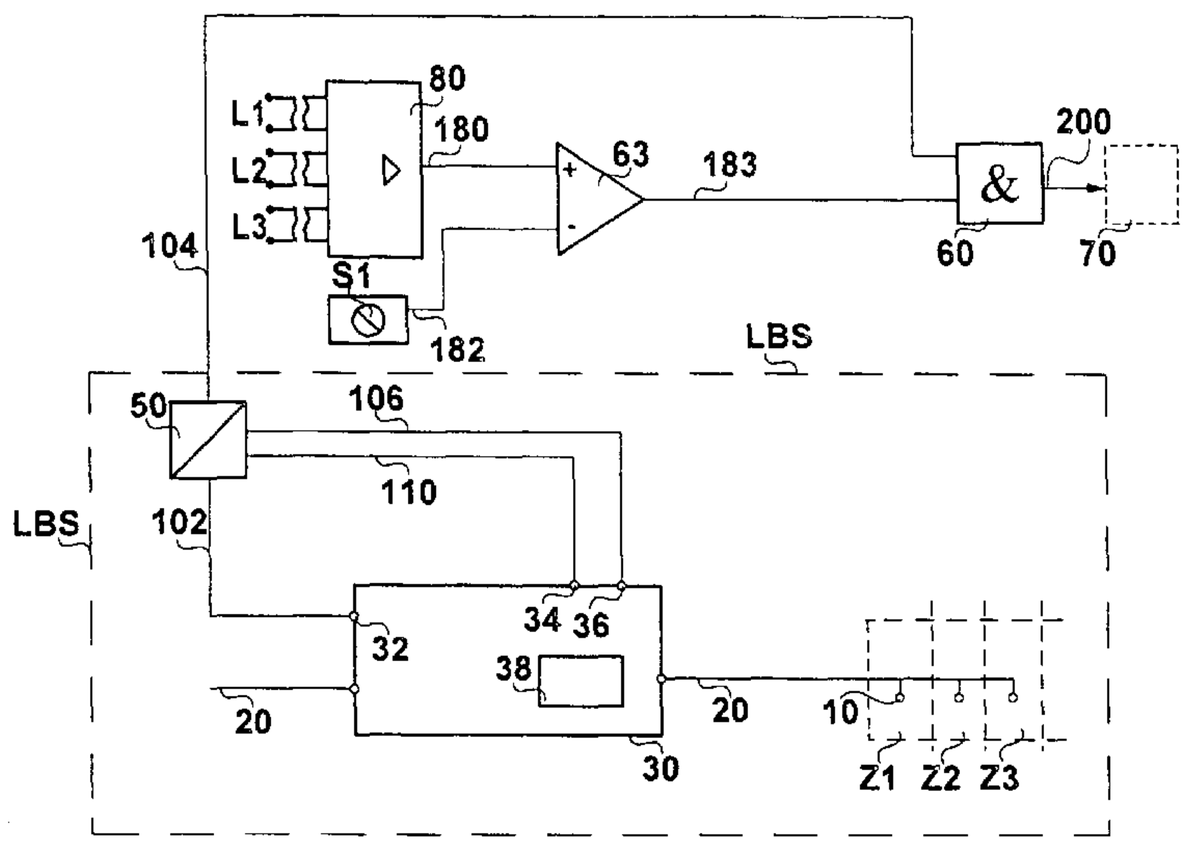

Fig. 1

(57) **Abstract:** The invention relates to a power switch configured for the purposes of preventing accidental arcs in a low-voltage switchgear. The invention provides the power switch with an overcurrent evaluation means responding to an accidental arc produced in the switchgear. An overcurrent signal 104 arriving from the arc monitoring system LBS (occurrence of the flash of an accidental arc) is linked to the signal 103 for triggering the control means via a first evaluation means S1, 182, 63 for evaluating the intensity of the overcurrent originating from the accidental arc. The means 70 for triggering the power switch is activated, on issuing of a turn-off pulse 200, merely if the signal 180 from the current detection means 80 is above a preadjustable threshold S1. The invention allows the power switch to cut off more rapidly an overcurrent based on an accidental arc.

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POWER SWITCH FOR PREVENTING ACCIDENTAL ARCS

The invention relates to a multipolar power switch in a housing comprising a contact breaker means for connecting to or disconnecting from a power source supplying a low-voltage switchgear, to a triggering means for disconnecting the low-voltage switchgear in the event of overloading, to a current detection means for detecting the conductor currents supplying the low-voltage switchgear, to a preferably electronic control means for processing the detected conductor currents and to the generation at least of triggering signals to the triggering means.

The cutout capability and switch-off time of a power switch in the event of an overcurrent, a short-circuit or an accidental arc are dependent on various parameters. The switching-off process is composed of the triggering time, the inherent time and the switch-off time. The triggering time is the time from the occurrence of the variable causing the triggering to the initiation of the triggering process, for example the disengagement of a switch latch. This is followed by the inherent time of the switch, which depends on the dynamic processes of the moving and opening contacts of the switch. In the case of a switch for a relatively high power range (nominal current of up to 100 kA), switch-off times can be up to 50 to 65 msec. There are known power switches which comprise electronic triggering means (for example, DE 19743997 A1) and allow the functional configuration of the protective conditions for a switchgear to be variably adjusted. However, the switch-off times are not altered by this electronic means.

The occurrence of an accidental arc in an electrical installation can cause serious damage to persons and/or to property; such injury and damage should be limited as much as possible if not ruled out. To avoid such damage there have been proposed various measures, of which the cut-off (the extinguishing) of the accidental arc in a time shorter than the switch-off time of the feed switch is the optimum solution. The detection of accidental arcs requires current transformers which have to be added to a switchgear installation. This takes up space and is expensive. Furthermore, additional means have to be installed to extinguish an accidental arc. The additional costs of accidental arc extinguishing means are not always financially justifiable.

It is known in the state of the art ("New Strategy to Counteract Arc Flash Hazards" in TANSMISSION & DISTRIBUTION CONF. and EXPOSITION: LATIN AMERICA, 2006, IEEE, pages 1-6; by Santos L.F. et al.) an arc monitoring system, which reacts to the occurrence of an accidental arc. The system is associated with one control means, for evaluating the accidental arc overcurrent. A turn-off pulse will be issued merely if the signal from the current detection means is above a preadjustable threshold.

The object of the invention is to add to a power switch an arrangement which leads to a reduction in the switch-off time thereof.

According to the invention, the object is achieved by the characterising features of the independent claim, whereas the dependent claims disclose advantageous developments of the invention.

The core of the invention is that the power switch can be activated by an overcurrent evaluation device (arc monitoring system) which reacts to an accidental arc occurring in the low-voltage switchgear, and an overcurrent signal arriving from the arc monitoring system can be linked to the signal for triggering the control means via a first evaluation means for evaluating the intensity of the overcurrent originating from the accidental arc, and the means for triggering the power switch is activated, on issuing of a turn-off pulse, merely if the

signal from the current detection means is above a preadjustable threshold. The occurrence of the flash of the accidental arc and the rapid rise in the fault current based on the arc produce a switching signal from the arc detection and evaluation unit directly to the means for triggering the power switch which is thus caused to open the contacts.

The advantage of the invention is substantially that, as a result of the direct activation of the means for controlling the power switch, the triggering mechanism is activated earlier (and therefore more rapidly) than in the event of activation via the device-internal current detection means of the power switch. The invention allows integration of the evaluation of data relevant to the accidental arc and utilisation of the current transformers which are present in the power switch anyway, associated with a reduction in the switch-off time for accidental arc prevention without making use of a potentially usable arc extinguishing device.

The switch-off command for the power switch is generated in the actual electronics of the power switch and acts directly on the magnet coil of the electronic triggering means. The direct influencing of the triggering process allows the switch-off time to be markedly reduced. In known power switches, the relay inherent time and the triggering chain using working current triggering means add up to a switch-off time of approx. 65 ms. The solution provided allows this time to be reduced by 20 to 30 ms, which means a reduction of about 50 %.

The invention has clear advantages in terms of cost. An accidental arc prevention means having a modular structure can be constructed. The use of power switches according to the invention should allow accidental arc prevention systems to become more widespread.

Accidental arc prevention systems generally detect not only optical phenomena but also a second physical variable. This is generally the current intensity. Detecting the current intensity requires current transformers which take up space and entail additional costs. The present invention utilises the current transformers which were already provided in the power switch and had previously been used merely for triggering the power switch.

Further advantageous embodiments of the invention have the following features which may be used individually or in combination with one another.

Preferably, the threshold of the first evaluation means should be set to double the nominal current. For specific switchgear fittings characterised, for example, by high conductor impedances, the threshold would be reduced.

The current detection means of the power switch consists of conventional means known to a person skilled in the art, use typically being made of Rogowski coils.

The arc monitoring system comprises at least one accidental arc sensor, the output signal of which can be transmitted to the control means via at least one monitoring line.

Accidental arc sensors detect physical effects which occur when accidental arcs appear. Preferably, the optical phenomena from the accidental arc are detected, so that optical detection means (namely photodiodes and/or optical fibres) are mainly proposed. An electronic gateway module may be inserted between the aforementioned monitoring line and the means for controlling the power switch. The gateway module combines access means of monitoring lines (which are preferably connectable to the gateway module via connectors) and at least one output line to the control means. Communication between the arc monitoring system and power switch is thus mediated in the gateway module.

The signals from the accidental arc sensor are optical signals if optical detection means are used. The gateway module accordingly comprises optical couplers in which the light signal is converted into an electrical signal for activating the means for controlling the power switch. The gateway module is thus electrically isolated from the control means. The monitoring line for transmitting an alarm signal may preferably be configured as an electronic bus.

The assembly according to the invention can be combined with a means (henceforth "short-circuiting means") which, in the event of an accidental arc, is activated in order to short-circuit phase-current-carrying flow paths. It is therefore possible, in addition to the detection of accidental arcs and the process, based on the detection, for switching off the power switch, to eliminate the almost incipient accidental arc. A short-circuiting means generates a metallic short-circuit which withdraws the power supplied to the accidental arc in less than 2 msec. There should therefore be configured in the control means a signal output for activating a short-circuiting means. This allows the assembly according to the invention to be retrofitted at any stage with a short-circuiting means.

If the aforementioned short-circuiting means is used, a second evaluation means for evaluating the accidental arc overcurrent should be associated with the control means. The preadjustable threshold of the second evaluation means should be above the threshold of the first evaluation means and the short-circuiting means should be activated, on issuing of a turn-off pulse, merely if the signal from the current detection means is above the threshold of the second evaluation means. Preferably, the threshold of the second evaluation means should be set at four times the nominal current. There are, as it were, two accidental arc prevention levels. These measures prevent the short-circuiting means from being activated at low accidental arc currents, as in the first place merely the power switch is connected as a result of the adjustable threshold values. Only at relatively high accidental arc currents is the short-circuiting means triggered almost immediately.

The detailed construction of elements of the arc detection means and the short-circuiting means may be configured by a person skilled in the art as desired. Use is advantageously made of an aforementioned electronic gateway module via which the short-circuiting means is activated using an actuating signal. As indicated hereinbefore, the gateway module is the communication member between the power switch and accidental arc detection and prevention system. It is also possible to stipulate in the gateway module that the short-circuiting means is activated merely if an accidental arc occurs in a preselectable compartment of the low-voltage switchgear. As a result of this, the cut-off of the accidental arc (by the short-circuiting means) can be associated only with specific protective zones of the switchgear (this will be described in greater detail hereinafter). The accidental arc prevention system may therefore be adapted to differing switchgears and is thus extendible without subsequent alterations.

In the manner of a simplified embodiment, a gateway module may be dispensed with if the arc detection signal is fed directly (via an opto-electronic gateway) to the electronics of the power switch. In a case of this type, the at least one light sensor may be connected directly to an input on the power switch.

The short-circuiting means for producing a short-circuit should be arranged on the load side (i.e. after the power switch) between the conductor rails of the load side. However, there may also be circuitry installations in which it is more beneficial to arrange the short-circuiting means on the mains side (i.e.

before the power switch). In this case, the purpose of the superordinate power switch is to connect the installation as a whole in a voltage-free manner in the event of a short-circuit generated by the short-circuiting means.

The power switch may have a lock to prevent the power switch from being switched back on, which lock becomes operative after triggering of the switching function in the short-circuiting means. The locking function may be mechanical or electromechanical in its configuration. This ensures that the switchgear can be reactivated only once an actuated short-circuiting means has been exchanged for a functionally new short-circuiting means and once the locking function has been cancelled.

Further details and advantages of the invention will emerge from the following embodiments illustrated in the drawings, in which:

Fig. 1 shows a schematic construction of the invention in the form of a circuit logic,

Fig. 2 shows the construction of the circuit logic incorporating a short-circuiting means,

Fig. 3 is a detailed illustration of Fig. 2, and

Fig. 4 shows a supplement to the circuit logic comprising a time-delay means.

The figures each show the schematic construction of the invention in the form of a circuit logic. The elements of the circuit arrangement may be discrete electronic components or integrated electronic components (microprocessors). Programmable, digital electronics may, in particular, be used instead of a rigid hardware construction (for example in forming a programmable controller). Alterations may then easily be made in terms of programming.

The elements in the figures are components of a power switch in a housing, excluding the arc detection unit LBS and the arc extinguishing means 12, LBQ, which are located outside the power switch.

Like all power switches, the construction according to the invention comprises a contact breaker means for connecting to or disconnecting from a power source supplying a low-voltage switchgear, a triggering means 70 for disconnecting the switchgear in the event of overloading, a current detection means 80 (for example, Rogowski coils) for detecting the conductor currents L1, L2, L3 supplying the low-voltage switchgear, and a control means for processing the detected conductor currents of the phases L1, L2, L3 and for the generation at least of triggering signals 183 to the triggering means 70. The triggering means 70 may preferably be an electronic triggering means, so the assembly according to the invention, configured as a logic circuit, may easily be integrated.

The elements of the control means are the threshold value adjustment means S1, adjustable by means of an adjustment button (accessible on the front of the power switch), the means for guiding an overcurrent signal 180 to a first comparator 63 at which the adjustment signal 182 undergoes the threshold value adjustment S1 and the means for forwarding the overcurrent signal 183 to the AND operation 60 where the electrical alarm or overcurrent signal 104 arrives from the accidental arc detection means LBS. If the overcurrent signal 180 is above the threshold set in the threshold value adjustment means S1, the mechanism 70 for triggering the power switch is addressed via the activation (turn-off pulse) 200, so the contacts open.

The adjustment range of the threshold value adjustment means Sl can include nominal current I_N values of from 0.5 to 6. For typical uses, Sl may be set to 2 I_N.

The arc detection unit LBS is schematically indicated in Fig. 2, in which an arc extinguishing means 12, LBQ is also schematically indicated.

Fig. 1 shows the details of the arc detection unit LBS. The arc monitoring system LBS includes at least one accidental arc sensor 10 which may be configured as a point sensor (photodiode) or a line sensor (optical fibre). The arc sensors may also be connected via a monitoring bus. Zl, Z2, Z3 denote compartments of the electrical switchgear each containing accidental arc sensors.

The division of a low- voltage switchgear into compartments Zl , Z2, Z3 defines differing functional units and protective zones. Differing subdivisions (busbar chambers, device chambers, connection chambers, each comprising partitions, covers or device sheaths) reduces the potential risks to staff performing maintenance and connection work. However, subdivisions produce shading for the arc sensors. The arrangement and selection of the arc sensors (point or line sensors) depend on the degree of subdivision of the switchgear. The electronic gateway module 30 may contain a means 38 for selecting and allocating the arc sensors to the compartments Zl , Z2, Z3. Depending on the construction of the switchgear set up by a user, the gateway module is able, when retrofitting the switchgear with arc sensors, to allow for the nature and sensitivity of the arc detection by setting zone selection switches 38. The zone selection switches may preferably be configured as DIP switches. Thus, the gateway module may also be configured in such a way that the short-circuiting means is activated merely if an accidental arc occurs in a preselectable compartment of the low-voltage switchgear. The assembly according to the invention is therefore flexible and adaptable for retrofitting without the assembly having to be specifically connected in advance.

The optical signal 102 from an accidental arc passes via the gateway module 30, via the line 102, to an optical coupler 50, which converts the optical signal 102 into the electrical signal 104. The gateway module 30 may be connectable to the optical coupler 50 and the short-circuiting means gateway 52 via a four-pole line, via an RJ45-type mini connector. The short-circuiting means gateway 52 is shown in Fig. 3. It has a binary output for activating the short-circuiting means 12 via an actuating signal 188. The contacts 32, 34, 36, 40 (see also Fig. 3 and 4) may be combined in the RJ45-type mini connector.

The position and arrangement of the current paths carrying the conductor currents Ll, L2, L3 are not shown. The short-circuiting means 12, LBQ is located spatially between the current paths as illustrated, for example, in WO 99/21255 Al .

Fig. 2 illustrates that the control means Sl, 180, 182, 183, 60 is a second evaluation means S2, 184, 64, 185 for evaluating the accidental arc overcurrent. The preadjustable threshold S2 of the second

evaluation means S2, 184, 64, 185 is in this case set so as to be higher than the threshold Sl of the first evaluation means Sl, 63, 60. The adjustment range of the threshold value adjustment means S2 can include values of from twice to ten times the nominal current I_N. Typically, S2 is set so as to be twice as high as the setting of S1. The short-circuiting means 12 is activated, on issuing of a switch pulse 200, only if the signal 180 from the current detection means 80 is above the threshold S2 of the second evaluation means.

The elements of the second evaluation means are the threshold value adjustment means S2 (with corresponding adjustment button), the means for branching and transmitting an overcurrent signal 180 to a second comparator 64, in which the adjustment signal 184 is subjected to the second threshold value adjustment S2, and the means for forwarding the signal 185 both to the triggering means (via the OR gate 62, AND operation 60 and signal 200) and to the short-circuiting means 12 (via the gateway 52 and gateway module 30).

The short-circuit mechanism 70 of the power switch is also activated if the overcurrent signal 180 is above the threshold set in the threshold adjusting means Sl but below the threshold S2. This is ensured by the OR gate 62. The overcurrent signal 180 is subjected to the AND operation 60 if the overcurrent condition (according to signal 180) is greater than threshold S2 (e.g. S2 = 4 I_N).

Fig. 3 breaks the schematic illustration of Fig. 2 down into details, although these have already been referred in Fig. 1 and the description thereof.

In Fig. 2, reference numeral 51 denotes an opto-electronic gateway which may also be a component of the means for controlling the power switch. The detection signals 102, 104 from the arc sensors can be transmitted directly to the control means via this gateway without an interface and an optical coupler (as shown in Fig. 1 in both cases) being provided.

Fig. 4 shows an addition to the circuit logic with a time-delay means (66, 67, 193). Switching devices, in particular protection switches for relatively high currents, generate a switching arc. In cases in which the power switch is arranged in the switch arrangement or in the vicinity thereof and the power switch is not spatially separated off, the arc sensors can also detect the switching arc of the power switch. In order to prevent the switching arc from actuating the short-circuiting means 12 during the process for switching OFF the power switch (especially under a high or very high current load), an electronic time-delay means 67 is used to delay the switch-off signal 188, 188' for a short time (approx. 2 to 5 msec). In Fig. 4, a switch-off actuator (manual actuation device) ST for switching off the power switch is shown. The actuation signal 192 is inputted via the current path 193, via the OR gate 66, to the short-circuiting means 70. In a case where the power switch carries a particularly high current, which is above the threshold S3 set by overcurrent adjusting means S3, the switch signal 185, 188' thus reaches the short-circuiting means only after a delay. The threshold S3 of the overload setting should be set higher than both of the first two threshold settings (Sl and S2).

REFERENCE NUMERALS, WHERE NOT ACCOUNTED FOR IN THE DESCRIPTION

10	arc sensor (point sensor, LWL)
12	short-circuiting means (arc extinguishing device LBQ)
20	detection line (monitoring bus)
30	gateway module
32	alarm signal socket 102
34	voltage supply terminal (for example, 24 VDC)
36	earth potential socket 106
38	zone selection switch, DIP switch, contact zone allocation (Z1, Z2, Z3)
50	coupling member (optical coupler)
51	opto-electronic gateway
52	short-circuiting means gateway (having a binary output)
60	AND operation
62, 62'	OR gate
63	first summer
64	second summer
65	third summer
66	OR gate
67	time-delay means
68	OR gate
70	triggering means (excitation coil, electromagnet)
80	measuring transducer; measured value preparation means; current detection means (for example, Rogowski coils)
102	alarm signal (optical)
104	alarm signal (electrical)
106	earth potential
110	supply voltage (for example 24 VDC)
180	overcurrent signal
182	threshold value S1
183, 183'	overcurrent signal above threshold value S1
184	threshold value S2
185	overcurrent signal above threshold value S2

188, 188'	short-circuiting means switching command
190	overload control value
191	signal overload control value S3
192	switch-off signal
193	switch-off signal 192 looped in
200	command to triggering means (switch-off signal)
LBS	arc monitoring system (overcurrent evaluation device)
LBQ	short-circuiting means 12
S1 S2	first, second threshold value setting means
S3	overload controller
ST	switch-off actuator
Z1 Z2	switchgear subdivision zones

CLAIMS

1. Power switch in a housing comprising:

- a contact breaker means for connecting to or disconnecting from a power source supplying a low-voltage switchgear,

- a triggering means (70) for disconnecting the low-voltage switchgear in the event of overloading,

- a current detection means (80) for detecting the conductor currents (L1, L2, L3) supplying the low-voltage switchgear,

- a control means (S1, 180, 182, 183, 60) for processing the detected conductor currents (L1, L2, L3) and for the generation at least of triggering signals (183) to the triggering means (70),

whereby the power switch can be activated by an arc monitoring system (LBS) which reacts to the occurrence of an accidental arc, an overcurrent signal (104) arriving from the arc monitoring system (LBS) being linked to the triggering signal (183) from the control means (S1, 180, 182, 183, 60) via a first evaluation means (S1, 63, 60) for evaluating an accidental arc overcurrent and the means (70) for triggering the power switch is activated, and

whereby there is configured in the control means a signal output (185) for activating a short-circuiting means (12, LBQ) for short-circuiting of current paths carrying the conductor currents (L1, L2, L3), and

whereby a second evaluation means (S2, 184, 64, 185) for evaluating the accidental arc overcurrent is associated with the control means (SI, 180, 182, 183, 60), and a preadjustable second threshold (S2) of the second evaluation means (S2, 184, 64, 185) being above a first threshold (S1) of the first evaluation means (S1, 63, 60),

and the short-circuiting means (12, LBQ) being merely activated, on issuing of an actuation signal (188), if the signal (180) from the current detection means (80) is above the second threshold (S2) of the second evaluation means (S2, 184, 64, 185).

2. Power switch according to claim 1, characterised in that the current detection means (80) consists of Rogowski coils.

3. Power switch according to either claim 1 or claim 2, characterised in that the arc monitoring system (LBS) comprises at least one accidental arc sensor (10), the output signal

from which can be transmitted to the control means (S1, 180, 182, 183, 60) via at least one monitoring line (20).

4. Power switch according to claim 3, characterised in that the control means (S1, 180, 182, 183, 60) of the power switch contains an opto-electronic gateway (51) which can be acted on directly by detection signal (102, 104) from the arc sensors.

5. Power switch according to any one of claims 1 to 4, characterised in that the second threshold (S2) of the second evaluation means (S2, 184, 64, 185) is set to double the first threshold (S1) of the first evaluation means (S1, 63, 60).

6. Power switch according to any one of claims 1 to 5, characterised in that the short-circuiting means (12) can be activated by an actuation signal (185, 188) via a gateway module (30).

7. Power switch according to any one of claims 1 to 6, characterised in that the short-circuiting means (12) is arranged between the conductor rails of the load side for producing a short-circuit.

8. Power switch according to any one of claims 1 to 7, characterised in that the power switch has a lock to prevent the power from being switched back on, which lock becomes operative after the triggering of the switching function in the short-circuiting means (12).

9. Power switch according to any one of claims 1 to 8, characterised in that an electronic time-delay means (67) is provided, which delays a short-circuit switch signal (192) to the short-circuiting means (12) for a time of 2 to 5 msec.

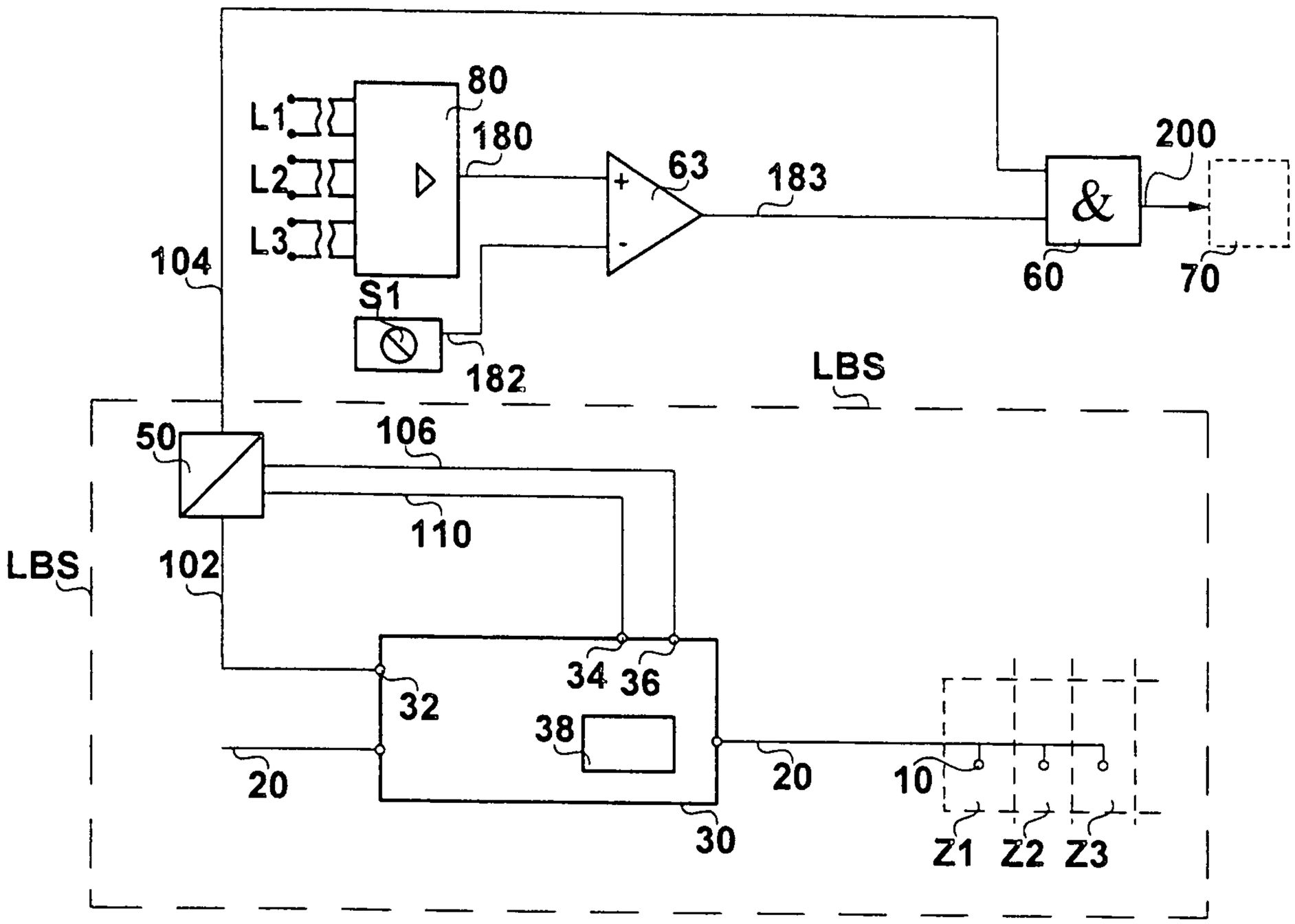
80
L1
180
L2
63
183
200
&
L3
104
S1
182
LBS
50
106
110
LBS
102
34
36
32
38
20
20
10
60
70
30
Z1
Z2
Z3

Fig. 1

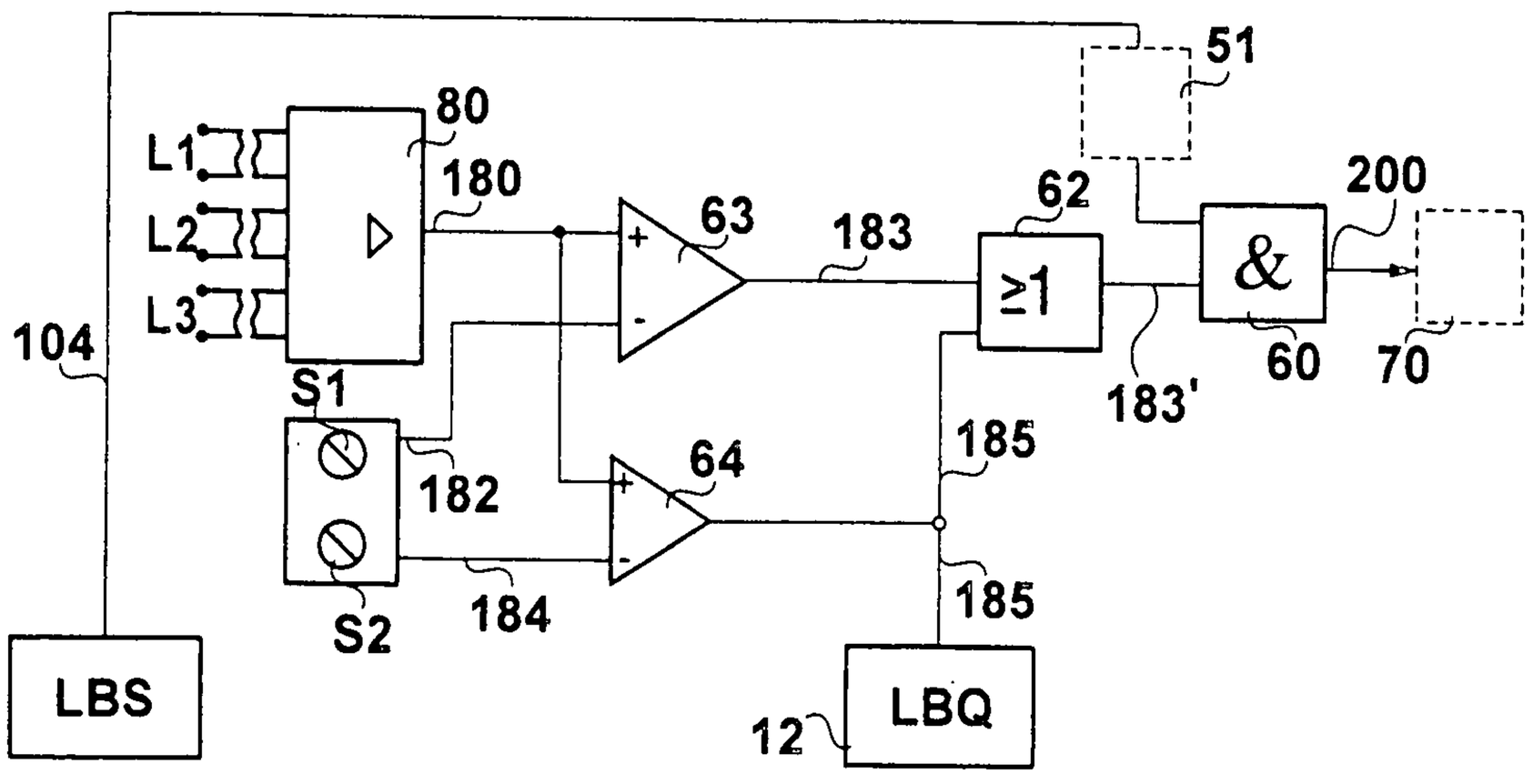
51
80
L1
180
62
200
L2
63
183
≥1
&
L3
104
S1
182
64
185
60
70
183'
185
S2
184
LBS
12
LBQ

Fig. 2

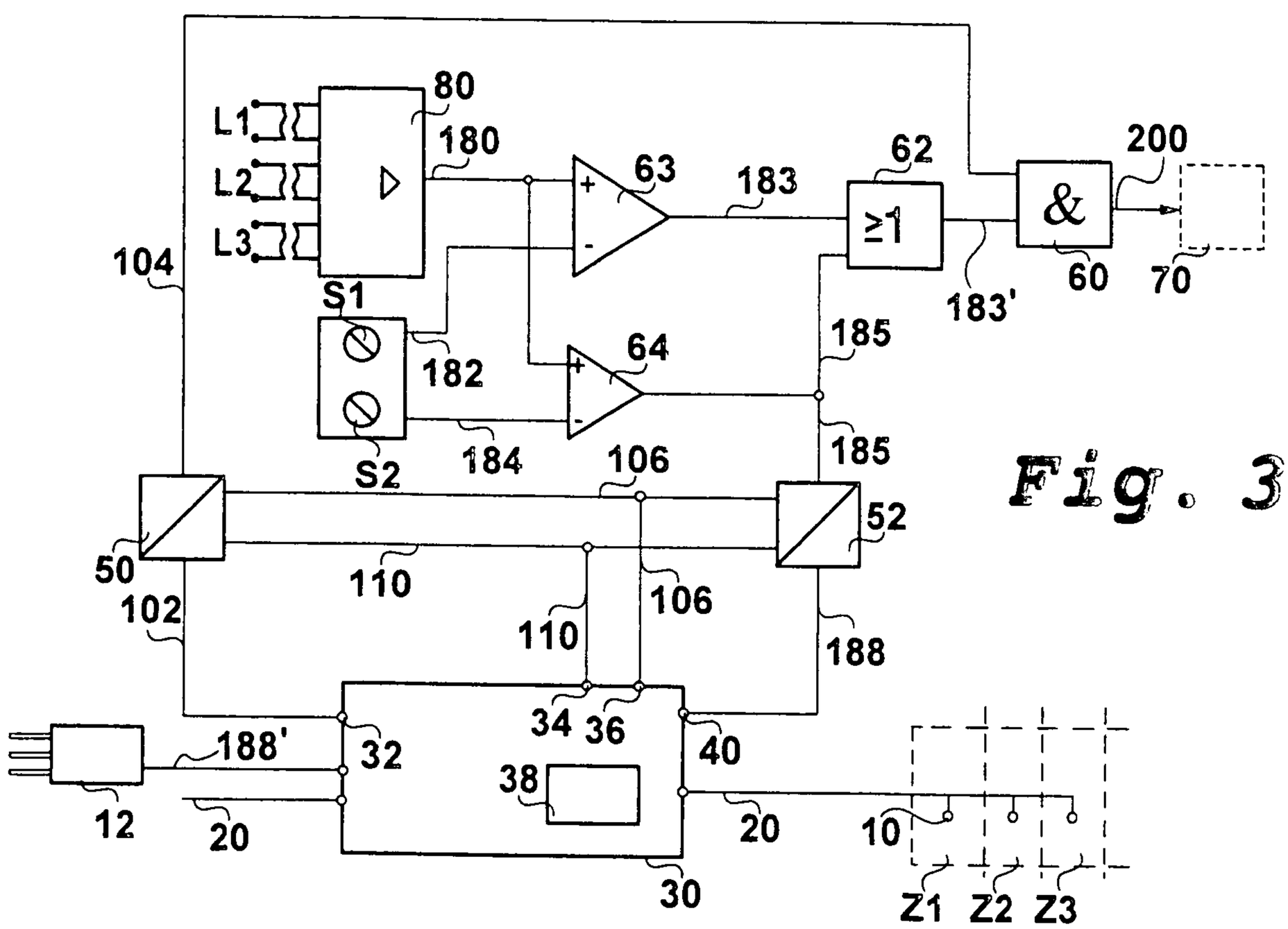
L1
L2
L3
80
180
63
183
62
200
&
≥1
104
S1
182
64
185
183'
60
70
S2
184
106
185
50
52
110
106
102
110
188
34
36
40
188'
32
38
12
20
20
10
30
Z1
Z2
Z3

Fig. 3

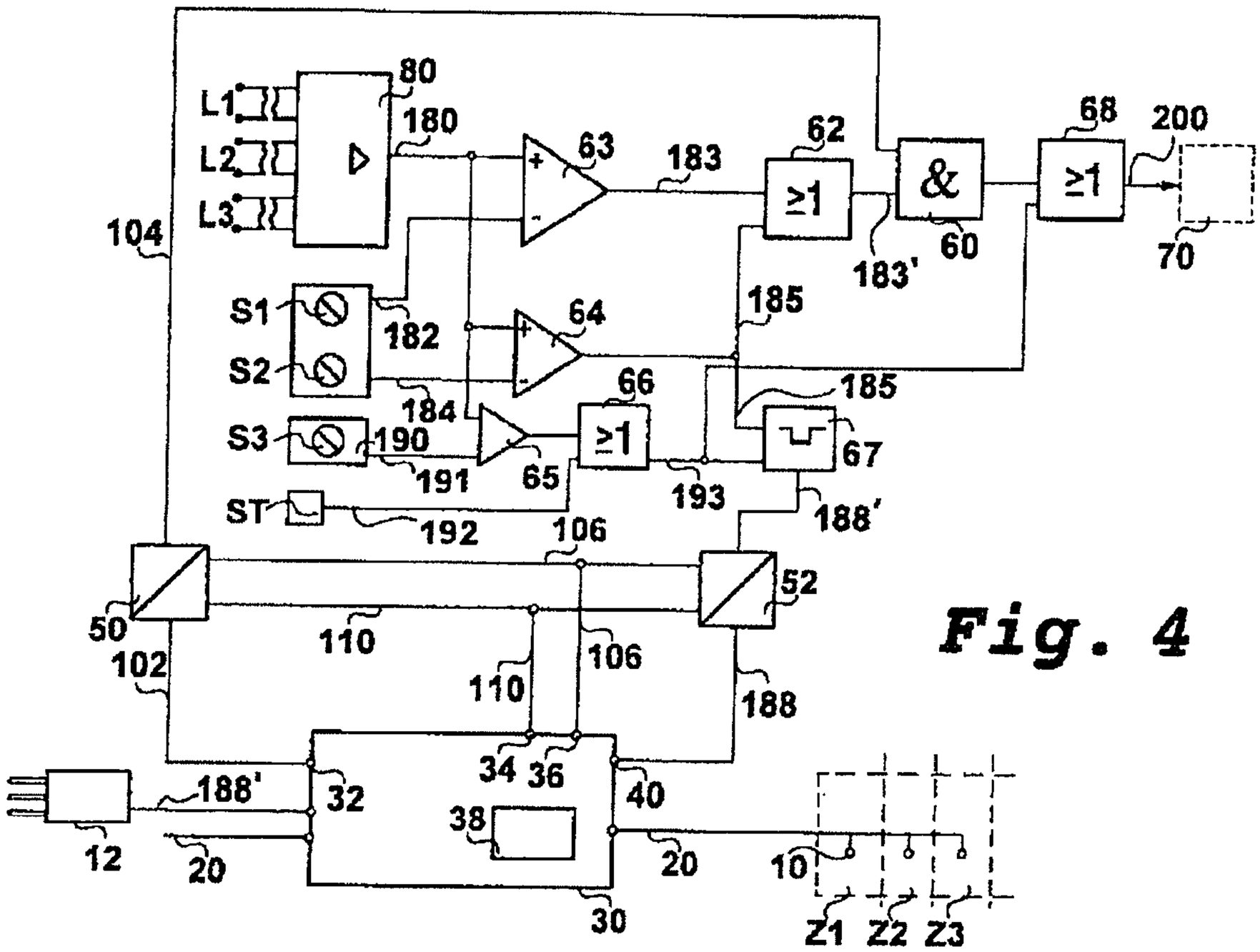
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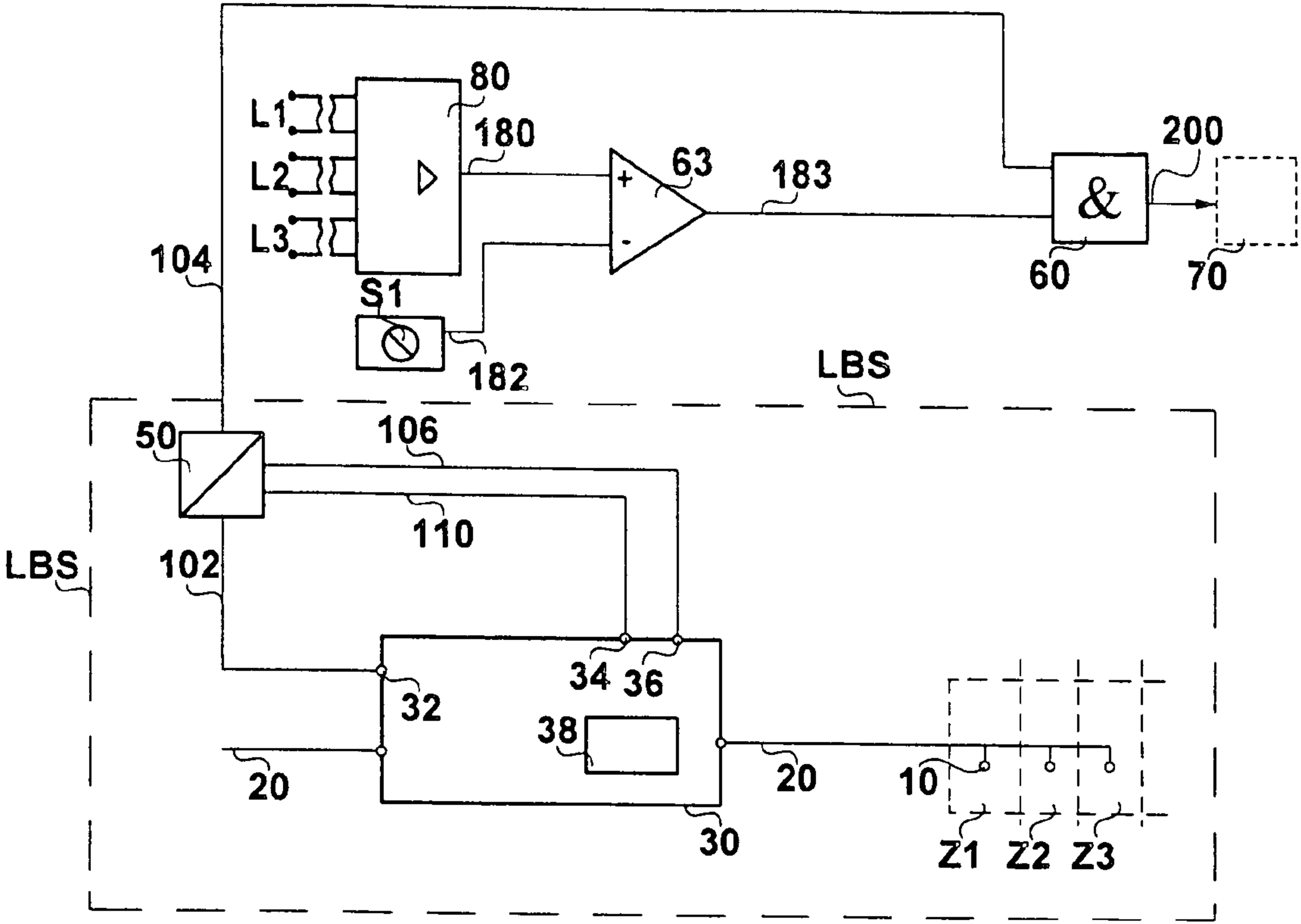
Fig. 4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Z1
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