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(54) Title: VALVE BANK COMMUNICATION MODULE WITH SAFETY I/O

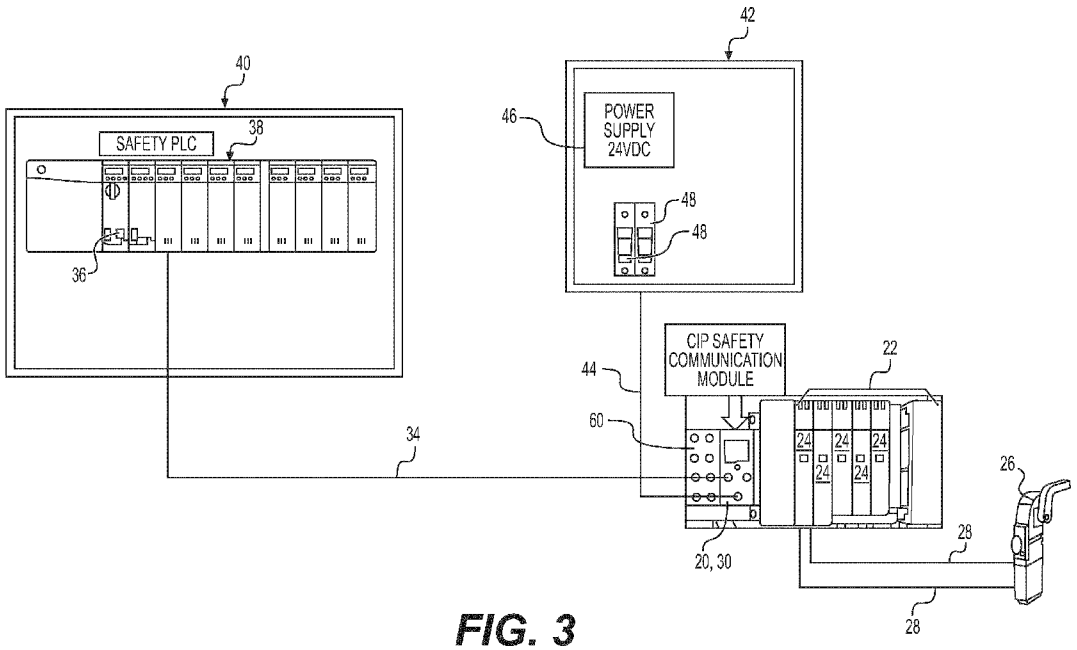

FIG. 3

(57) Abstract: A communication module and associated method of operation for controlling a valve bank including at least one fluid valve is provided. The communication module includes a module body mechanically and electrically coupled to the fluid valves and includes a safety processor which is responsive to a CIP safety control signal from a safety controller. The communication module also includes a safety power controller that is operable to remove safety output power from the fluid valves connected thereto in order to satisfy a given functional safety standard for machinery such as PLe or SIL4. The communication module may also include a safety relay with redundant and self-monitoring contacts to further its ability to reliably remove the safety output power from the fluid valves, particularly in the presence of a malfunction with the safety power controller.

[Continued on next page]

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VALVE BANK COMMUNICATION MODULE WITH SAFETY I/O

CROSS REFERENCE TO RELATED APPLICATION

[0001] This PCT International Patent Application claims the benefit of U.S. Provisional Patent Application Serial No. 62/528,110 filed July 2, 2017 entitled "Valve Bank Communication Module with Safety I/O," the entire disclosure of the application being considered part of the disclosure of this application and hereby incorporated by reference.

BACKGROUND

[0002] Different arrangements exist for controlling valve banks of one or more pneumatic valves such as those used for industrial automation equipment. One type of arrangement includes a communication module to switch an output power and to direct the pneumatic valves to go to a specified fluid flow configuration in response to a control signal that is communicated via a communications channel. A safety output power is a source of energy that can be reliably removed in order to cause devices such as pneumatic valves to go to a known or "safe" state.

[0003] An objective of the present disclosure is to provide a communication module and an associated method of operation for controlling a safety output power to at least one fluid valve as part of a control system that exceeds the functional safety standard for machinery as set forth in the Safety Integrity Level (SIL) as defined in the International Electrotechnical Commission's (IEC) 61508 standard and/or a Performance Level (PL) safety level as defined by the International Organization for Standardization in ISO 13849-1. In particular, it is an objective to provide a communication module that can provide a given functional safety standard for machinery up to Performance Level "e" (PLe) and/or Safety Integration Level 4

(SIL4), which each define the highest risk reduction factor (RRF) within the respective functional safety standard and to do so without the need for additional safety I/O devices or an additional safety relay.

SUMMARY

[0004] A communication module for controlling a valve bank including at least one fluid valve is provided. The communication module may include a module body configured to mechanically and electrically couple to the fluid valve or valves and a first communications channel for receiving a first control signal from a safety controller. The communications module may also include an electrical interface for controlling the fluid valves. The communication module provides a second control signal to the fluid valve to change a fluid flow characteristic of the fluid valve based upon the first control signal. A safety power controller within the module body provides a safety output power to the fluid valve. The communication module also includes a safety processor that receives and verifies the integrity of a safety input/output data within the first control signal and which removes the safety output power from the fluid valves in the case of an error in the safety input/output data or in response to a power-off command from the safety controller.

[0005] A method for controlling a safety output power to a fluid valve by a communication module is also provided and which includes the steps of receiving by the communication module electrical energy from a power supply; receiving by the communication module a first control signal from a safety controller via a first communications channel; receiving and verifying the integrity of a safety input/output data within the first control signal by the safety processor of the communication module; and removing by the safety power

controller the safety output power to the fluid valve or valves in response to an error in the safety input/output data or in response to a power-off command from the safety controller.

[0006] The device and method of the present disclosure may provide several advantages over the prior art including reductions in cost and complexity of a control system that includes fewer safety rated devices, and space savings within control panels and in the physical layout of an automation cell on a factory floor. It may also provide for reduction in the amount of networking cabling required which may reduce cost and increase system reliability. Furthermore, the device and method of the present disclosure may provide for a reduced number of I/O and/or memory requirements within the safety PLC and may simplify the programming of the safety PLC and may also reduce engineering and design time and associated costs.

DESCRIPTION OF THE DRAWINGS

[0007] The detailed description refers to the following drawings, in which like numerals refer to like items, and in which:

[0008] FIG. 1 is a schematic diagram of a system in accordance with the prior art;

[0009] FIG. 2 is a block diagram of a system in accordance with the prior art;

[0010] FIG. 3 is a schematic diagram of a system in accordance with the present disclosure;

[0011] FIG. 4 is a block diagram of a system in accordance with the present disclosure; and

[0012] FIG. 5 is a flow chart of a method in accordance with the present disclosure.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

[0013] The invention is described more fully hereinafter with references to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure is thorough, and will fully convey the scope of the invention to those skilled in the art. It will be understood that for the purposes of this disclosure, "at least one of each" will be interpreted to mean any combination the enumerated elements following the respective language, including combination of multiples of the enumerated elements. For example, "at least one of X, Y, and Z" will be construed to mean X only, Y only, Z only, or any combination of two or more items X, Y, and Z (e.g., XYZ, XZ, YZ, X). Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals are understood to refer to the same elements, features, and structures. The relative size and depiction of these elements may be exaggerated for clarity, illustration, and convenience. Unless otherwise stated, any reference to moving between two or more different positions should be construed as including moving in either direction from one position to another position or vice-versa.

[0014] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a communication module **20** for controlling a valve bank **22** including at least one fluid valve **24** is disclosed. The fluid valves **24**, which may also be called electrovalves, may each be fluidly connected to a mechanical actuator **26**, such as those used on industrial machinery, using one or more fluid conduits **28**.

[0015] As shown in FIGS. 1-2, a communication module **20** is provided for controlling at least one fluid valve **24** within a valve bank **22**. The communication module **20** includes a module body **30** with a standard, or non-safety processor **32** and is configured to mechanically and electrically couple to the fluid valves **24** in order to control the flow of a fluid through the fluid valves **24**. The standard processor **32** of the communication module **20** is configured to cause a corresponding one of the fluid valves **24** to change its fluid characteristics (i.e. to allow or to disallow fluid communication between two fluid ports) based upon a standard control signal, such as a standard (non-safety) CIP signal, that is communicated via a first communications channel **34** from a safety controller **36**, which may be, for example, a Safety Programmable Logic Controller (PLC) such as a GuardLogix processor by Allen Bradley and which may be installed in a PLC chassis **38**. The safety controller **36** may be located within a first electrical panel **40**, which may also be called a PLC panel. The communication module **20** may be, for example, an EX600-SEN1 Ethernet/IP module by SMC and may provide Common Industrial Protocol (CIP) connectivity over Ethernet. Industrial Protocol Ethernet (Ethernet/IP) and CIP are both technologies managed by ODVA, Inc. (formerly Open DeviceNet Vendors Association, Inc.) for communications between industrial automation devices.

[0016] As shown in Fig. 1, a second electrical panel **42** may be configured to provide the valve bank **22** with safety output power **43** in order to satisfy a given functional safety standard for machinery. The safety output power **43** may be supplied to the valve bank **22** by an electrical power cable **44** connected between the second electrical panel **42** and the communication module **20**. The second electrical panel **42** may include a power supply **46**, which may supply the communications module with a low voltage DC power, such as 5-50 VDC. In one example embodiment, the power supply **46** provides the valve bank **22** with 24

VDC. The second electrical panel **42** may also include one or more overcurrent protection devices **48** such as fuses or circuit breakers to prevent an electrical current produced from exceeding a predetermined value. The first and second electrical panels **40, 42** may be physically combined together into one combined electrical panel **40, 42**. The second electrical panel **42** may further include a safety processor **50**, which may include, for instance, a safety Point I/O module such as a 1734-OB8S safety output module from Allen Bradley and one or more safety relays **52** each having redundant and self-monitoring contacts for reliably controlling the supply of the safety output power **43** to the valve bank **22** in order to satisfy the requirements of the given functional safety standard. An example of such a safety relay **52** is catalog number 700-Z by Allen Bradley. The safety processor **50** may be responsive to a power-off control signal from the safety controller **36** as communicated by a second communications channel **54** therebetween, which may be designated as a safety communications channel. The safety processor **50** may also monitor the integrity of the second communications channel in order to ensure that vital signals such as the power-off control signal are received and may function to remove the safety output power **43** in case a malfunction in the second communications channel **54** or with the safety controller **36** is detected. Such action by a safety processor **50** may be required in order to satisfy a given functional safety standard for machinery. Other alternative configurations may be used for the second communications channel **54** which are designed and/or certified to verify the integrity of I/O data to satisfy a given functional safety standard for machinery, such as, for example, Safety variations of DeviceNET, Profibus or Profinet.

[0017] The communication module **20** includes an electrical interface **56** for controlling the fluid valves **24**. As shown in FIGS. 1-4, the valve bank **22** may be directly mechanically

coupled to the communication module **20**, which may directly replace an existing (non-safety) communication module **20** of the prior art. The communication module **20** provides a second control signal to the fluid valve **24**, which may be communicated, for instance, across a direct mechanical coupling or through a backplane and/or a chassis in order to change a fluid flow characteristic of the fluid valve **24** based upon the first control signal. The second control signal may use, for example, DeviceNet, a serial protocol such as RS-485 and/or a POINTBus protocol by Allen Bradley. In the example shown in FIGS. 1-4, a plurality of different fluid valves **24** are mechanically coupled to one-another in a stacked configuration, which is mechanically and electrically coupled to the communication module **20**. Alternatively, the fluid valves **22** may be provided as modules that individually couple to a backplane or chassis that provides the electrical and mechanical connection to the communication module **20**. One or more of the fluid valves **24** may also be provided with a source of pressurized fluid from the backplane or chassis or from one or more adjacent ones of the fluid valves **24** in the valve stack **22**. As shown in FIGS. 1 and 3, the fluid valves **24** may control, hydraulic or pneumatic (e.g. compressed air) flow to a mechanical actuator **26** such as in an industrial machine.

[0018] In accordance with the present invention and as shown in FIGS. 3-4, a communication module **20** for controlling a valve bank **22** including at least one fluid valve **24** includes a module body **30** configured to mechanically and electrically couple to the fluid valve or valves **24** and which also includes a safety processor **50** is provided. The communication module **20** may be configured to receive a first control signal, which may be for example, a CIP safety signal or an ASIsafe signal or a Profisafe signal via a first communications channel **34** from a safety controller **36**, which may be, for example, a safety PLC such as a GuardLogix processor by Allen Bradley. The first communications channel **34** may transmit the first

control signal using one or more physical networks, which may use, for example, EtherNet/IP and/or DeviceNet protocols. Other networking hardware and/or protocols may be used for the first communications channel **34** which are designed and/or certified to verify the integrity of I/O data to satisfy a given functional safety standard for machinery, such as, for example, Safety variations of ControlNet, EtherCat, Profibus, Profinet, or AS-Interface (AS-i).

[0019] As also shown in FIGS. 3-4, the power supply **46** directly provides electrical power, such as a low voltage power to the communication module **20**, without the electrical power being interrupted by a safety power controller **58** before the communication module **20**. Therefore, the communications module **20** can remain powered and able to provide diagnostics and other communications, even in cases where safety power is removed, for example, if an emergency stop (E-stop) is activated. The low voltage power provided by the power supply **46** may be 3-60 V AC or DC and is preferably 12 VDC or 24 VDC or 24 VAC. Alternatively, the communication module **20** may be directly powered with AC control power such as 120 VAC or 250 VAC.

[0020] In accordance with the present invention and as shown in FIGS. 3-4, a safety power controller **58** within the module body **30** provides a safety output power **43** to the fluid valve **24**. The communication module **20** also includes a safety processor **50** that receives and verifies the integrity of safety input/output data within the first control signal and which may also monitor the safety power controller **58** and which removes the safety output power **43** from the fluid valve **24** in the case of an error in the safety input/output data or in response to a power-off command from the safety controller **36**. The first, or safety control signal may enable the safety power controller **58** to reliably control the safety output power **43** supplied to the fluid valves **24** in order to satisfy the given functional safety standard for machinery. In

other words, the present disclosure provides a communication module **20** that accepts a CIP safety control signal to reliably control each of fluid valves **24** and which also triggers the safety output power **43** to the fluid valves **24** on and off without the need for additional safety hardware.

[0021] As also shown in FIG. 3, the communication module **20** is also configured to control and/or monitor one or more electrical input or output (I/O) channels connected to an electrical I/O interface **60** which is mechanically and electrically coupled to the module body **30**. The electrical I/O may include one or more digital, analog, and/or specialty inputs or outputs, which may be configured to control and/or monitor one or more electrical signals by the safety controller **36**. Specialty inputs may include, for example, thermocouple or RTD temperature inputs. The electrical I/O interface **60** also be configured to use the safety output power **43**. The first, or safety control signal may enable the safety power controller **58** to reliably control the safety output power **43** supplied to the electrical I/O interface **60** in order to satisfy the given functional safety standard for machinery.

[0022] According to an aspect, the communication module **20** may also include a safety relay **52** having redundant and self-monitoring contacts for removing the safety output power **43** from the fluid valve **24** in the presence of a malfunction with the safety power controller **58**. Such a safety relay **52** may include, for example, multiple positive-guided relays which can detect malfunctions such as a stuck or "welded" contact, and which include redundant contacts capable of switching the safety output power **43** even when a malfunction exists. Such a safety relay **52** may also signal the detection of a detected malfunction to prevent the safety output power **43** from being restored until the malfunctioning component is replaced.

[0023] As shown in FIG. 5, the subject disclosure also includes a method **100** for controlling a safety output power **43** to a fluid valve **24** by a communication module **20** and which includes the steps of: **102** receiving by the communication module **20** electrical energy from a power supply **46**; **104** receiving by the communication module **20** a first control signal from a safety controller **36** via a first communications channel **34**; **106** receiving and verifying the integrity of safety input/output data within the first control signal by the safety processor **50** of the communication module **20**; and **108** removing by the safety power controller **58** the safety output power **43** to the fluid valve **24** in response to an error in the safety input/output data or in response to a power-off command from the safety controller **36**. Such a power-off command may include, for example, an emergency stop (e-stop) command to remove the safety output power **43** from the fluid valve **24** and to thereby cause any machinery connected thereto to go to a known safe condition. The method **100** may also include the step of **110** removing by the safety power controller **58** the safety output power **43** from the fluid valve **24** in the presence of a malfunction with the safety power controller, such as may be detected by a safety relay **52** within the safety power controller and which has redundant and self-monitoring circuitry. Errors in the input/output data may include lost or malformed data packets, such as those that fail an error checking mechanism or those that are not received within a predetermined period of time.

[0024] Obviously, many modifications and variations of the present invention are possible in light of the above teachings and may be practiced otherwise than as specifically described while within the scope of the appended claims.

CLAIMS

What is claimed is:

Claim 1. A communication module for controlling a valve bank including a fluid valve and comprising:

a module body configured to mechanically and electrically couple to the fluid valve in the valve bank;

a first communications channel for receiving a first control signal from a safety controller;

an electrical interface for controlling the at least one fluid valve;

wherein said communication module provides a second control signal to the at least one fluid valve to change a fluid flow characteristic of the at least one fluid valve based upon said first control signal;

a safety power controller within said module body providing a safety output power to said at least one fluid valve; and

a safety processor configured to receive and verify the integrity of a safety input/output data within the first control signal to cause said safety power controller to remove said safety output power from said at least one fluid valve in the case of an error in said safety input/output data or in response to a power-off command from the safety controller.

Claim 2. The communication module according to Claim 1, wherein said safety power controller includes a safety relay having redundant and self-monitoring contacts for removing said safety output power from said at least one fluid valve in the presence of a malfunction with said safety power controller.

Claim 3. The communication module according to Claim 1, wherein said first communications channel uses Common Industrial Protocol (CIP) safety protocol.

Claim 4. The communication module according to Claim 1, wherein said first communications channel uses an EtherNet/IP protocol.

Claim 5. The communication module according to Claim 1, wherein said first communications channel uses a DeviceNet protocol.

Claim 6. The communication module according to Claim 1, wherein said first communications channel uses a PROFINET protocol.

Claim 7. The communication module according to Claim 1, further including said communication module receiving a low-voltage DC power from a power supply.

Claim 8. The communication module according to Claim 7, wherein said power supply provides said low-voltage DC power at 24 VDC.

Claim 9. The communication module according to Claim 7, wherein said safety output power is sourced from said low-voltage DC power.

Claim 10. The communication module according to Claim 1, wherein said module body is mechanically and electrically coupled to said fluid valve with one of a backplane or a chassis.

Claim 11. The communication module according to Claim 1, wherein said second control signal uses a POINTBus protocol.

Claim 12. The communication module according to Claim 1, wherein said valve bank includes a plurality of fluid valves in a stacked configuration electrically and mechanically coupled to said module body.

Claim 13. The communication module according to Claim 1, wherein said safety processor is configured to control or to monitor an electrical input or output channel connected to an electrical I/O interface electrically and mechanically coupled to said module body.

Claim 14. A method for controlling a safety output power to at least one fluid valve by a communication module comprising:

receiving by the communication module a first control signal from a safety controller via a first communications channel;

receiving and verifying the integrity of a safety input/output data within the first control signal by a safety processor of the communication module; and

removing by a safety power controller of the communication module the safety output power to the at least one fluid valve in response to an error in the safety input/output data or in response to a power-off command from the safety controller.

Claim 15. The method for controlling a safety output power to at least one fluid valve by a communication module according to Claim 14 and further including:

removing by the safety power controller the safety output power from the at least one fluid valve in the presence of a malfunction with the safety power controller.

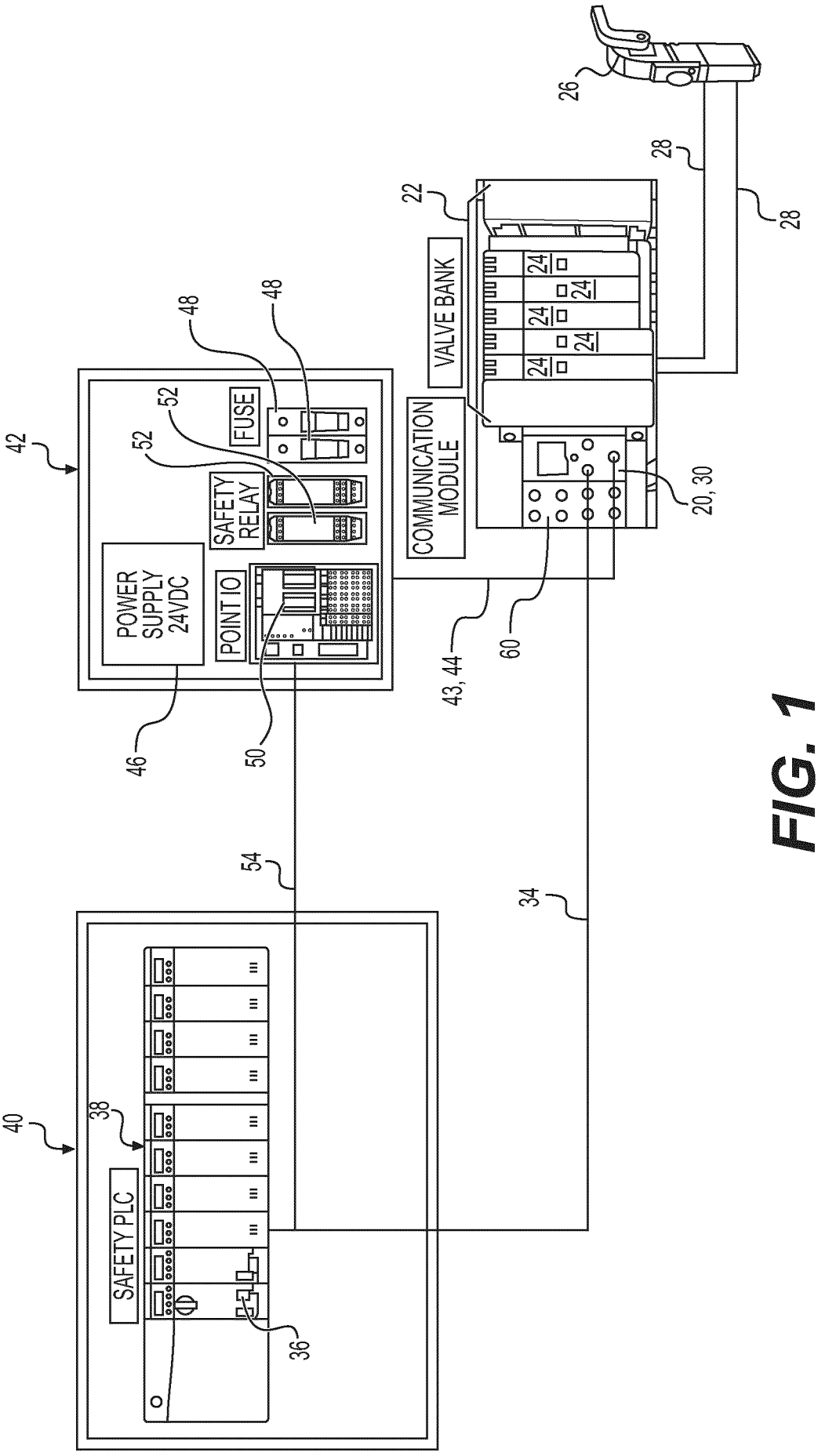
26
28
28
22
VALVE BANK
24
24
24
24
24
COMMUNICATION MODULE
20, 30
48
48
52
52
FUSE
SAFETY RELAY
42
POWER SUPPLY 24VDC
POINT IO
46
50
43, 44
60
54
34
40
38
SAFETY PLC
36

FIG. 1

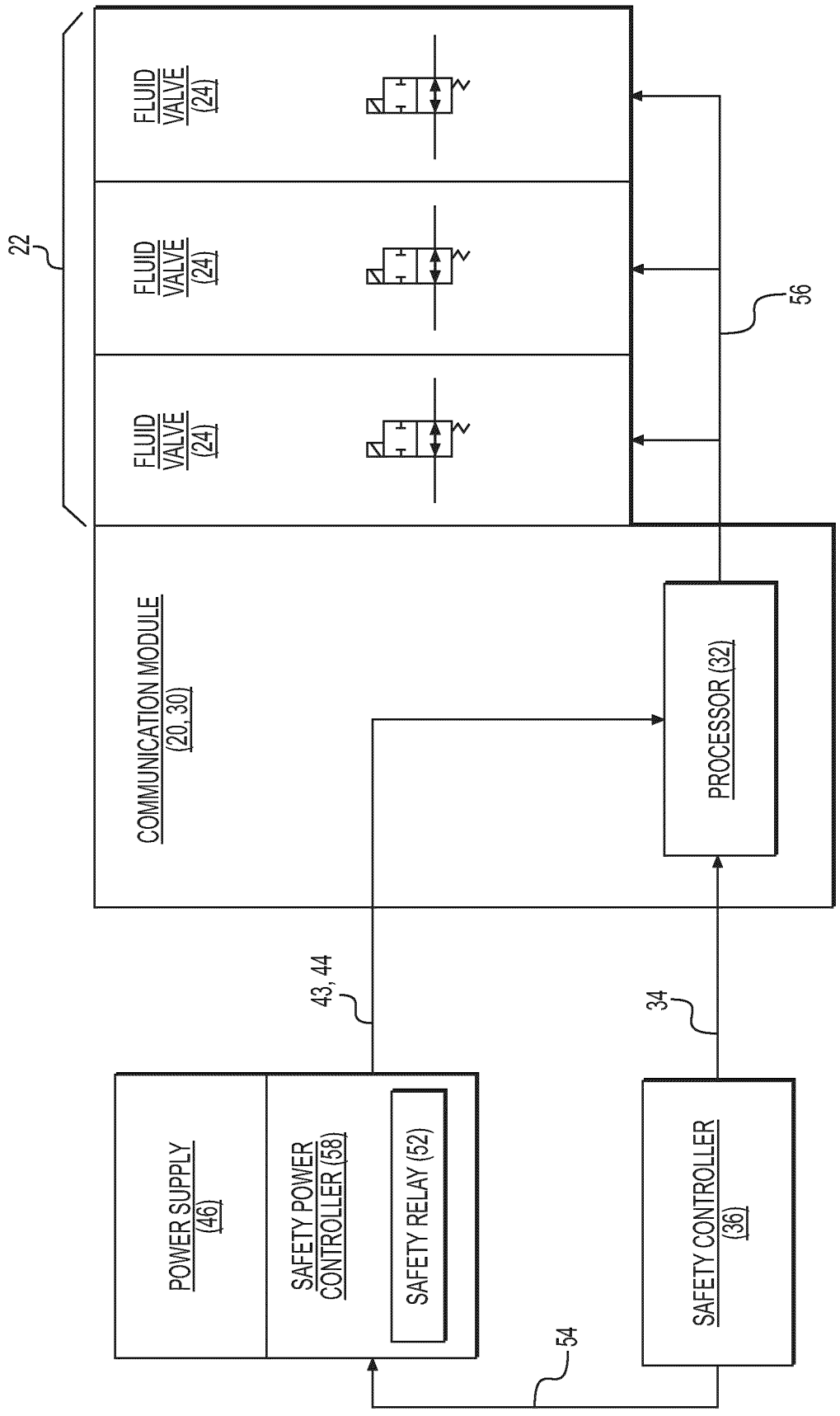
22
FLUID VALVE (24)
FLUID VALVE (24)
FLUID VALVE (24)
56
COMMUNICATION MODULE (20, 30)
PROCESSOR (32)
43, 44
34
POWER SUPPLY (46)
SAFETY POWER CONTROLLER (58)
SAFETY RELAY (52)
SAFETY CONTROLLER (36)
54

FIG. 2

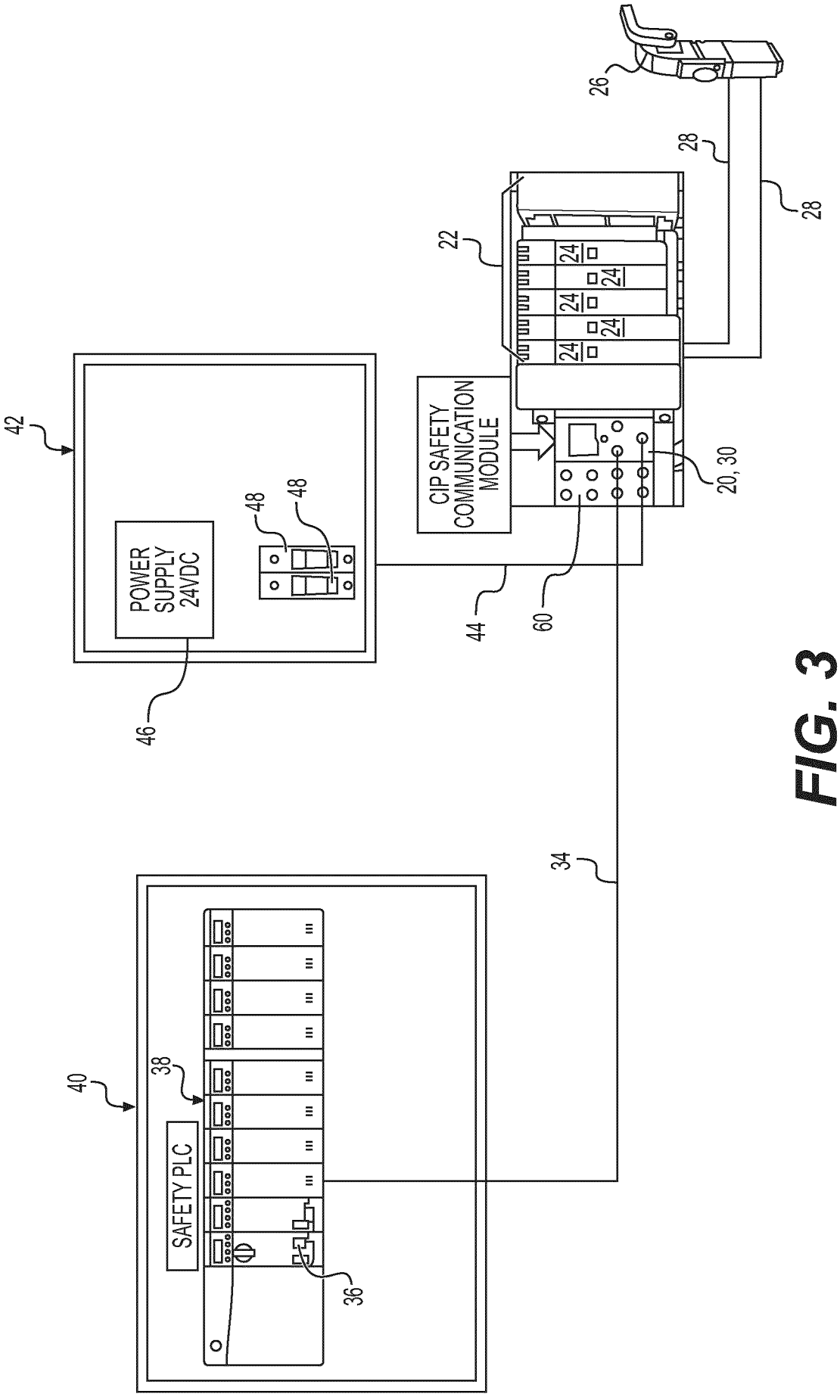
26
28
28
22
24
24
24
24
24
CIP SAFETY COMMUNICATION MODULE
20, 30
42
48
48
POWER SUPPLY 24VDC
46
44
60
34
40
38
SAFETY PLC
36

FIG. 3

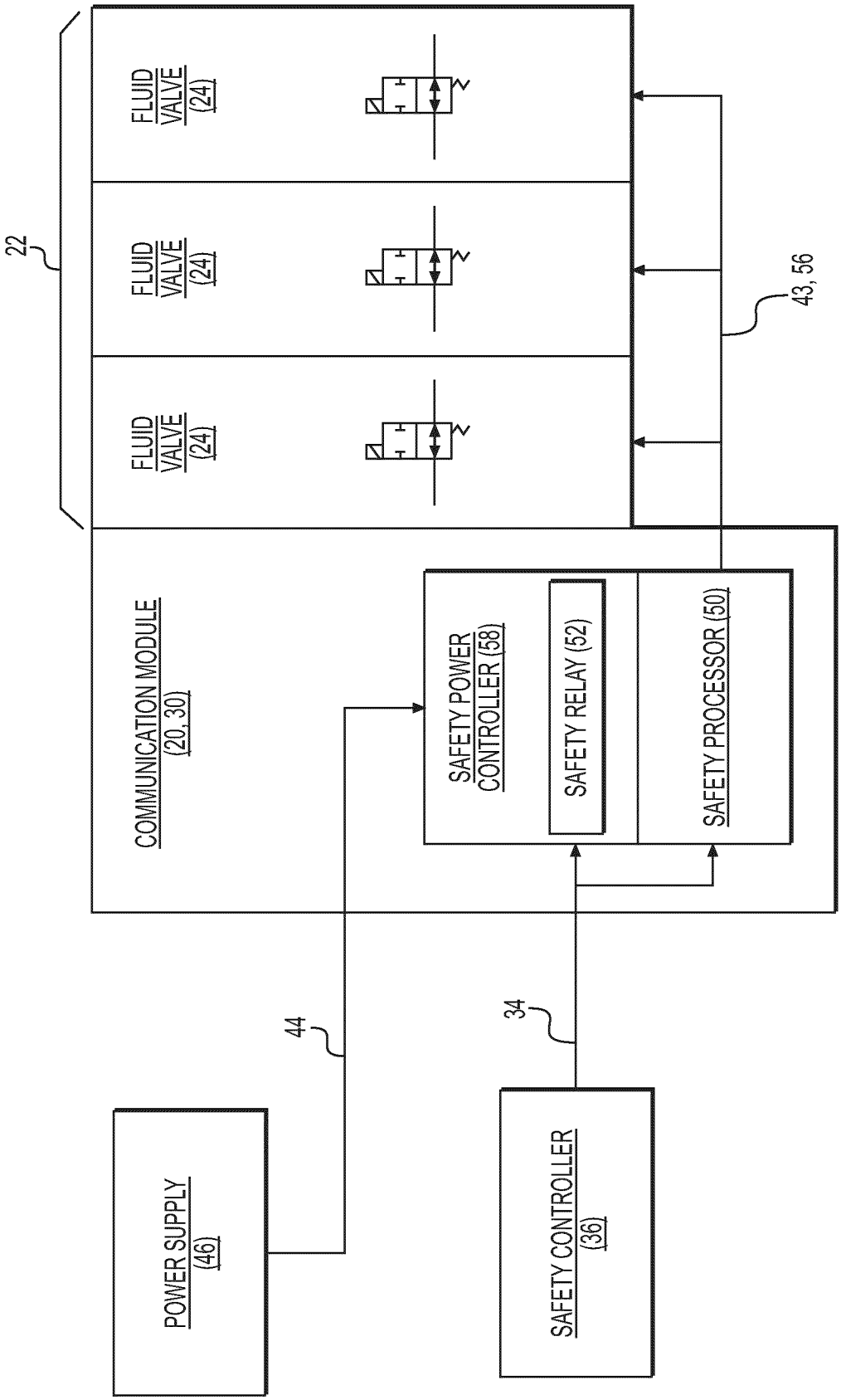
22
FLUID VALVE (24)
FLUID VALVE (24)
FLUID VALVE (24)
43, 56
COMMUNICATION MODULE (20, 30)
SAFETY POWER CONTROLLER (58)
SAFETY RELAY (52)
SAFETY PROCESSOR (50)
44
34
POWER SUPPLY (46)
SAFETY CONTROLLER (36)

FIG. 4

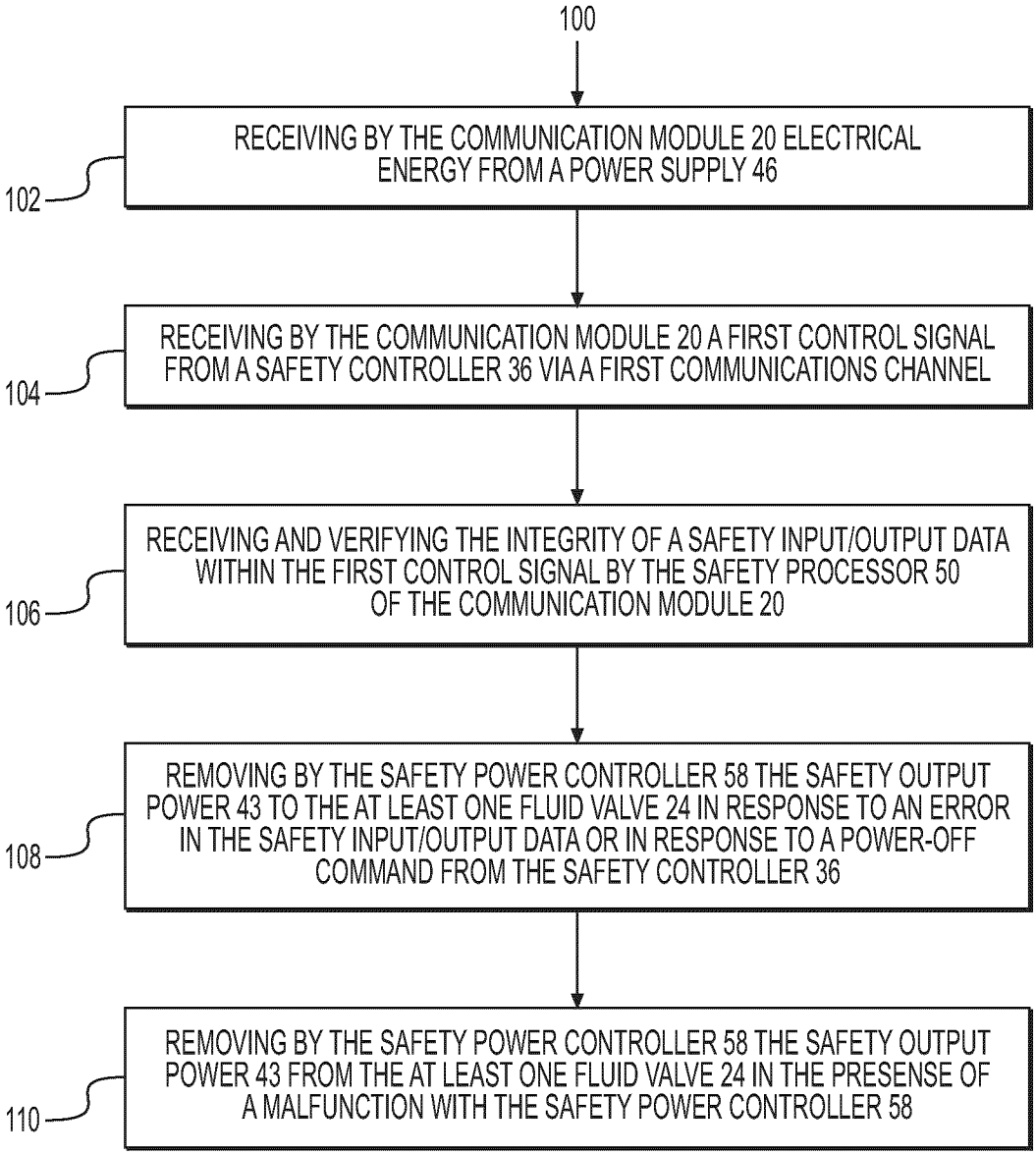
100
RECEIVING BY THE COMMUNICATION MODULE 20 ELECTRICAL ENERGY FROM A POWER SUPPLY 46
102
RECEIVING BY THE COMMUNICATION MODULE 20 A FIRST CONTROL SIGNAL FROM A SAFETY CONTROLLER 36 VIA A FIRST COMMUNICATIONS CHANNEL
104
RECEIVING AND VERIFYING THE INTEGRITY OF A SAFETY INPUT/OUTPUT DATA WITHIN THE FIRST CONTROL SIGNAL BY THE SAFETY PROCESSOR 50 OF THE COMMUNICATION MODULE 20
106
REMOVING BY THE SAFETY POWER CONTROLLER 58 THE SAFETY OUTPUT POWER 43 TO THE AT LEAST ONE FLUID VALVE 24 IN RESPONSE TO AN ERROR IN THE SAFETY INPUT/OUTPUT DATA OR IN RESPONSE TO A POWER-OFF COMMAND FROM THE SAFETY CONTROLLER 36
108
REMOVING BY THE SAFETY POWER CONTROLLER 58 THE SAFETY OUTPUT POWER 43 FROM THE AT LEAST ONE FLUID VALVE 24 IN THE PRESENSE OF A MALFUNCTION WITH THE SAFETY POWER CONTROLLER 58
110

FIG. 5

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference T8481131WO	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below
International application No. **PCT/CA2018/050811**	International filing date *(day/month/year)* 29 June 2018 (29-06-2018)	(Earliest)Priority date *(day/month/year)* 02 July 2017 (02-07-2017)
Applicant MAGNA INTERNATIONAL INC. ET AL		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☑ the international application in the language in which it was filed.

☐ a translation of the international application into which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☑ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 3

☐ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☑ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2018/050811

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F15B 20/00*** (2006.01) , ***G05B 9/02*** (2006.01) , ***H04L 29/06*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: ***F15B 20/00*** (2006.01) , ***G05B 9/02*** (2006.01) , ***H04L 29/06*** (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
N/A.

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel/Orbit & Canadian Patent Database (Intellect).
Keywords: control*, safe*, communicat*, valv*, fluid*, flow*, signal*, processor*, modul*, input*, output*, power*, etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016/0041539 A1 (KEMP, M.J. et al.) 11 February 2016 (11-02-2016) *Whole document*	1-15
A	US 2012/0296448 A1 (BALENTINE, J.R. et al.) 22 November 2012 (22-11-2012) *Whole document*	1-15
A	US 2003/0236579 A1 (HAUHIA, M. et al.) 25 December 2003 (25-12-2003) *Whole document*	1-15

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search 10 September 2018 (10-09-2018)	Date of mailing of the international search report 10 September 2018 (10-09-2018)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 819-953-2476	Authorized officer Stephane Ouellette (819) 639-7882

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2018/050811

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US2016041539A1	11 February 2016 (11-02-2016)	US2016041539A1	11 February 2016 (11-02-2016)
		US9869981B2	16 January 2018 (16-01-2018)
		AR101490A1	21 December 2016 (21-12-2016)
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		EP3180923A1	21 June 2017 (21-06-2017)
		WO2016025360A1	18 February 2016 (18-02-2016)
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		GB201208679D0	27 June 2012 (27-06-2012)
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		WO0205199A1	17 January 2002 (17-01-2002)