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(54) **Title:** WEAPON LAUNCH SYSTEM FOR A SUBMERSIBLE VESSEL

(54) **Titre :** SYSTÈME LANCE-ARMES POUR UN NAVIRE SUBMERSIBLE

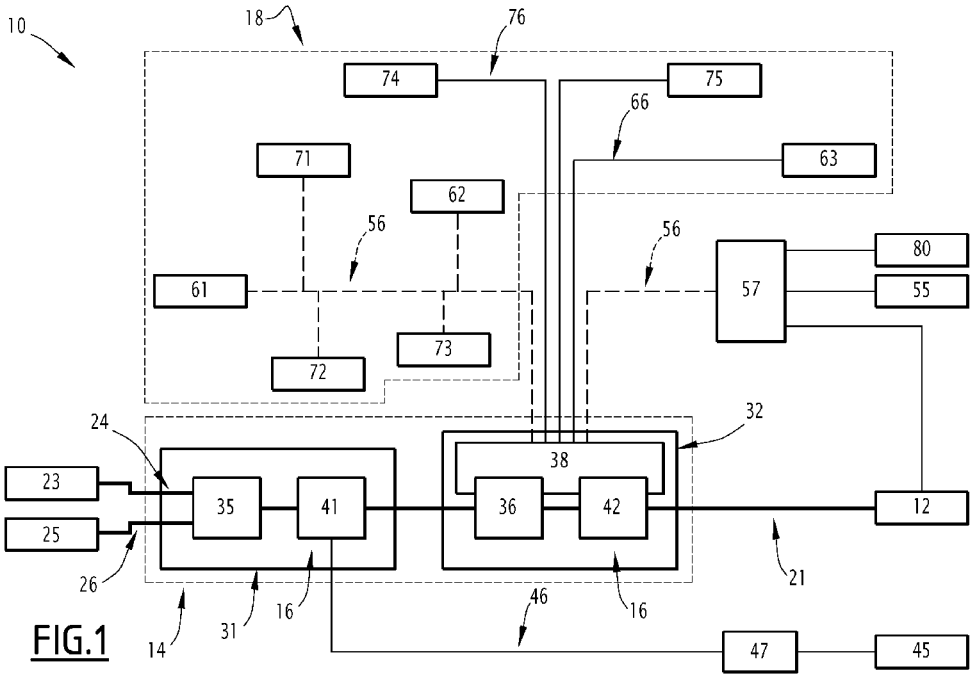

FIG.1

(57) **Abstract:** The present invention relates to a weapon launch system (10) for a submersible vessel, comprising at least one electric actuator (12) capable of performing a series of mechanical actions on a weapon launch tube, a first box (31) including a power module (35) capable of supplying electrical power, a second box (32) including a control module (36) capable of controlling the operation of the electric actuator (12), a first security module (41) electrically connecting the power module (35) to the control module (36), and a second security module (42) electrically connecting the control module (36) to the electric actuator (12). The boxes (31, 32) are separated from one another and from the electric actuator (12).

(57) **Abrégé :** La présente invention concerne un système lance-armes (10) pour un navire submersible, comprenant au moins un ac-

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[Suite sur la page suivante]

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tionneur électrique (12) apte à exercer un enchainement d'actions mécaniques sur un tube de lancement d'armes, un premier coffret (31) comportant un module de puissance (35) apte à fournir une puissance électrique, un deuxième coffret (32) comportant un module de commande (36) apte à commander le fonctionnement de l'actionneur électrique (12), un premier module de sécurité (41) raccordant électriquement le module de puissance (35) au module de commande (36), et un deuxième module de sécurité (42) raccordant électriquement le module de commande (36) à l'actionneur électrique (12). Les coffrets (31, 32) sont séparés l'un de l'autre et de l'actionneur électrique (12).

Weapon launch system for a submersible vessel

The present invention relates to a weapon launch system for a submersible vessel.

By submersible vessel, it is understood in particular, a submarine, for example a military submarine.

In a manner known per se, the systems integrated in military submarines are subject to many constraints specific to this environment. Among these constraints, we can cite in particular, shocks, vibrations, acoustic discretion, electromagnetic emission/sensitivity, congestion, passive and active diving security, weapons security, energy efficiency, etc.

In addition, because of their use, facilities related to submarine weapons, such as weapon-launching tubes, for example, must meet numerous requirements in terms of performance. These requirements relate, in particular, to weapon deployment time, energy consumption, cost of ownership, security, reliability and availability.

Thus, classically, these facilities are implemented on board submarines using hydraulic actuators. Indeed, hydraulic actuators make it possible to meet most of the aforementioned constraints and requirements.

However, facilities using hydraulic actuators present a bulky, heavy, energy-intensive and expensive architecture in operation and maintenance. This is mainly due to the extensive piping network required to ensure the operation of these facilities.

This network generally allows, on the one hand, to remotely control the operation of the hydraulic actuators and, on the other hand, to supply the necessary power to these actuators. It can thus extend throughout the vessel, which implies serious congestion.

The object of the present invention is to propose an architecture suitable for an onboard weapon launch system that makes it possible to avoid the use of hydraulic actuators while respecting the aforementioned constraints and requirements.

To this end, the invention has as its object a weapon launch system for a submersible vessel, comprising at least one electric actuator capable of performing a series of mechanical actions on a weapon launch tube; a first box comprising a power module capable of supplying electrical power; a second box comprising a control module capable of controlling the operation of the electric actuator; a first security module electrically connecting the power module to the control module; a second security module electrically connecting the control module to the electric actuator; the boxes being separated from one another and from the electric actuator.

Depending on other advantageous aspects of the invention, the system comprises one or more of the following features, taken alone or in any technically possible combination:

- the first security module is integrated in the first box and is suitable for monitoring the operation of the power module;

- the second security module is integrated in the second box and is capable of monitoring the function of the control module;

- the power module is connected to a main power source and to a backup power source for use when the main power source is lost;

- the power module is capable of selecting a power source from the main power source and the backup power source;

- in case of selection of the backup power source, the power module is further adapted to offload the electrical energy in the system;

- the first box and the second box are configured to be placed in different enclosures of the submersible vessel;

- a control means capable of controlling the operation of the control module;

- the control means are connected to the control module via a computer network and/or a direct control link.

These features and advantages of the invention will appear when reading the description that follows, given only as a non-limitative example, and made with reference to the appended drawings, on which :

- Figure 1 is a schematic view of a weapon launch system according to the invention, this system comprising in particular the actuating means and the control means;

- Figure 2 is a detailed schematic view of the actuating means of Figure 1; and

- Figure 3 is a schematic view illustrating the operation of the control means in Figure 1.

The weapon launch system 10 in Figure 1 is intended to be embedded on board a submarine and allows the launch of a weapon from this submarine to be activated. To do so, the weapon launch system 10 is intended to be related to at least one weapon launch tube and allows a sequence of mechanical actions to be performed on this tube to launch a submersible device contained in it. The submersible device corresponds in particular to a weapon but in the general case, can include any other object likely to be launched from the submarine.

In the rest of the description, the weapon launch system 10 will be explained with reference to a single weapon launch tube, for example the one on the port side. However, in the general case, it should be understood that this system may be related to several weapon launch systems, for example two tubes, one on the port side and one on the starboard side.

With reference to Figure 1, the weapon launch system 10 comprises at least one electric actuator 12, means of actuation 14 of the electric actuator 12, security means 16 monitoring the operation of the means of actuation 14 and control means 18 controlling the means of actuation 14.

The electric actuator 12 is related to the weapon launch tube and allows a mechanical action to be exerted on this tube in order to trigger a launch. This mechanical action may include, for example, pressurizing the tube with the pressure required for a launch.

The electric actuator 12 is connected to the means of actuation 14 by an electrical link 21 and is capable of exerting the corresponding mechanical action when the electrical link 21 provides the necessary electrical power.

Of course, when the weapon launch system 10 is related to several weapon launch tubes, it comprises at least one actuator for each of these tubes.

The means of actuation 14 are capable of creating in the electrical link 21 the electrical power necessary to actuate the electrical actuator 12.

For this purpose, the means of actuation 14 are connected to a main power source 23 via an electrical link 24 and to a back-up power source 25 via an electrical link 26.

The main and backup power supply 23, 25 correspond, for example, to the main and backup power supply systems on board the submarine, respectively.

The means of actuation 14 are illustrated in more detail in Figure 2.

Thus, in reference to this Figure 2, the means of actuation 14 are presented in the form of two boxes, the said first box 31 and second box 32.

Each of these boxes 31, 32 presents a case containing the mechanical/electronic/electrical components necessary to implement the corresponding functions as will be explained below.

Advantageously, each box 31, 32 is waterproof. Moreover, it can be resistant to shocks, different pressures, and other types of aggression (electromagnetic, thermal, or other) that may occur in the corresponding environment.

Even more advantageously, the boxes 31, 32 are configured to be placed in different compartments/enclosures of the submarine.

Between them, the boxes are connected by an electrical link 33.

The first box 31 contains a power module 35 connected directly to the power sources 23, 25.

The power module 35 thus enables the weapon launch system 10 to be powered by selecting one of the power sources 23, 25.

In particular, the primary power source 23 is selected when the weapon launch system 10 is in its nominal operating mode and the backup power source 25 is selected when the weapon launch system 10 is in its fault operating mode.

The power module 35 is thus composed of corresponding relays and/or electrical circuits to select either power source.

By selecting one of the two sources, the power module 35 also enables the corresponding upstream electrical components to be isolated from the other source and the electrical energy in the system 10 to be relieved.

As a complement, the power module 35 contains further electrical components, for example, to adapt the electrical power supplied by the power sources 23, 25 to supply the power to the actuator 12.

The second box 32 contains a control module 36 for controlling the electric actuator 12 by supplying power to the electrical connection 21 with the power supplied by the power module 35.

For this purpose, the control module 36 is connected via a controller 38, also integrated in the second box 32, to the control means 18 and is capable of receiving commands supplied by these means 18 and is also capable of processing these commands.

The control module 36 is thus at least partially in the form of a computer comprising the software required to process the corresponding commands and/or in the form of programmable logic circuits configured to ensure such processing.

The security means 16 form two security barriers that can monitor the operation of the control means 14 independently of each other.

For this purpose, the security means 16 presents in the form of a first security module 41 integrated in the first box 31 and a second security module 42 integrated in the second box 32.

In particular, the first security module 41 electrically connects the power module 35 to the control module 36 and enables the function of the power module 35 to be monitored.

In particular, the first security module 41 is connected to the first means of instrumentation 45 via a direct control link 46.

The first means of instrumentation 45 makes it possible to observe the operation of at least certain components of the weapon launch system 10 and its environment. Thus, for example, this instrumentation means 45 presents in the form of a first set of sensors. Each sensor of this set is related to at least one component of the weapon launch system 10 or its environment and allows the measurement of a physical quantity (such as pressure,

temperature, etc.) associated with this component. The connection of these sensors to the first security module 41 is made, for example, via a first junction box 47 visible in Figure 1.

To monitor the operation of the power module 35, the first security module 41 uses a first monitoring logic.

This first monitoring logic is implemented using hardware devices such as security relays, for example, and thus presents a so-called "hardwired" logic.

This logic makes it possible, for example, to monitor the electrical power supplied by the power module 35 and, in the event of non-compliance, to cut the electrical connection 33 between the power module 35 and the control module 36.

The second security module 42 electrically connects the control module 36 to the actuator 12 and can be used to monitor, notably, the function of the control module 36.

Furthermore, the second security module 42 is connected to the second instrumentation means 55 via a link 56 which is different and dissimilar from the connection 46 connecting the first security module 41 to the first instrumentation means 45.

In particular, the link 56 comprises a physical support, different from that of the link 46 with different characteristics, such as, for example, different electromagnetic sensitivity.

Thus, for example, the link 56 corresponds to a computer network of the submarine explained in more detail below.

As in the case of the first instrumentation means 45, the second instrumentation means 55 presents in the form of a second set of sensors. These sensors are analogous to the sensors of the first set but present different and independent devices from those. Advantageously, the sensors of the second set operate according to different technologies from those of the first set. The connection of the sensors of the second set to the link 56 is ensured by a second junction box 57 visible on figure 1.

In addition, the connection of the link 56 to the second control module 42 is provided by the controller 38.

To monitor the operation of the control module 36, the second security module 42 implements a second monitoring logic which is different and dissimilar to the first monitoring logic.

Thus, for example, this second monitoring logic is implemented using at least partially a software implementing a security PLC. In this case, the second security module 42 is at least partially in the form of a computer implementing such software.

The second monitoring logic consists in particular in analyzing the coherence of all the data accessible to the second security module 42 via the computer network 56 and the various control links.

If the second monitoring logic is not checked, the second security module cuts the electrical connection 21 between the control module 36 and the electrical actuator 12.

Advantageously, according to a design example, in addition the second security module 42 is connected to the first security module 41 via a data connection. In this case, this second security module 42 is able to receive security information produced by the first security module 41 and to analyze the coherence of this security information with the security information produced by itself. If this information is not coherent, the second security module 42 is also able to cut the electrical connection 21.

The control means 18 allows the operation of the control module 36 to be controlled and is connected to this module 36 via controller 38.

With reference to Figure 1, the control means 18 comprises a remote control station 61, a local control station 62 and a local control panel 63.

The remote control station 61 is located, for example, in a control room of the submarine and presents in the form of a known human machine interface.

The remote control station 61 is connected to the control module 36 via the computer network 56 of the submarine and is capable of sending commands in the form of digital data to this module 36.

The computer network 56 of the submarine presents a protected computer network known per se. This network complies with all the standards relating to its security and the security of the data transmitted via this network.

The local control station 62 is located close to the weapon launch tube to which the launch system 10 is related.

This local control station 62 presents in the form of a human-machine interface, which is also known as a touch screen, for example.

Like the remote control station 61, the local control station 62 is connected to the control module 36 via the computer network 56 and is able to control the operation of this module 36 by transmitting corresponding commands in the form of digital data via this network 56.

The local control panel 63 is also located close to the corresponding weapon launch tube and is connected to the control module 56 via a direct control link 66 separate from the computer network 56.

This local control panel 63 is capable of controlling the operation of the control module 56 by transmitting corresponding commands via this direct control link 66. The commands are transmitted, for example, in the form of analog signals.

The local control panel 63 presents, for example, in the form of mechanical buttons and/or lamps related to each control.

Advantageously, the local control panel 63 also includes the control means for activating the power supply of the electric actuator 12 via the backup power supply 25 in case of loss of the main power supply 23.

For this purpose, the local control panel 63 is connected, for example, to the power module 35 via a special control link (not visible in Figure 1) to control the selection of the backup power supply 25.

Of course, when the weapon launch system 10 is related to several weapon launch tubes, it advantageously includes a local control station and a local control panel for each of the tubes.

In the embodiment example in Figure 1, the control means 18 also comprises a weapon interface module 71, a combat management system 72, a weapon handling module 73, a firing authorization module 74 and a dive security panel 75.

The weapon interface module 71, the combat management system 72, and the weapon handling module 73 are connected to the computer network 56. The dive security panel 75 is connected to the controller 38 via a direct link. These components are known per se and will not be described in detail below.

The firing authorization module 74 is connected to the control module 36 via a direct control link 76 and via the controller 38. This module is also known per se and allows, especially, to authorize a firing, i.e. the actuation of the actuator 12, when a specific key (physical or digital) is inserted into this module.

Moreover, according to a particular example of an embodiment of the invention illustrated in Figure 1, the electric actuator 12 is connected to the actuating means 14 also via the computer network 56 through the second junction box 57 in order, for example, to communicate the state of its operation to these means.

According to the same example of embodiment, the weapon launch system 10 also includes a third instrumentation means 80 independent of the first and second instrumentation means 45, 55. These third instrumentation means 80 are connected to the actuating means 14 via the computer network 56 through the second junction box 57 and make it possible, for example, to transmit to these means the information relating to the operating state of the various components of the system 10.

The operation of the weapon launch system 10 will henceforth be explained with reference in particular to Figure 3 illustrating schematically the different levels of control implemented by the control means 18 of this system 10.

Initially, all the components of the weapon launch system 10 are in their nominal operating mode. The operation of the actuating means 14 is monitored by the security means 16 using the two security barriers described above. The actuating means 14 are powered by the main power supply 23.

To launch a submersible device, the operator enters a command via the remote control station 61 or the local control station 62 which together form a first control level N_1. This control level has priority over the other levels.

The command then issued by one of the stations 61, 62 is transmitted via the computer network 56 to the actuating means 14 to operate the actuator 12. After analysis of this command and any information from the other modules, the control module 36 supplies power to the electrical connection 21 from the electrical power transmitted by the power module 35.

If, for example, the computer network 56 is lost, the weapon launch system 10 switches to the fault operating mode and commands are given from a second control level N_2, which is formed by the control panel 63. In this case, the commands from this panel 63 are transmitted to the actuating means 14 via the control link 66.

For example, if the main power supply 23 is lost, the weapon launch system 10 switches to a degraded operating mode.

In this mode, commands are given, for example, from the second level N_2 to activate, notably, the power supply from the backup power supply 24.

When this is not possible, the electric actuator 12 can still be operated manually by an operator. This is therefore a third control level N_3.

The present invention has a number of advantages.

First of all, the proposed architecture of the weapon launch system 10 makes it possible to use an electric actuator instead of a hydraulic actuator conventionally used in submarines. Indeed, this architecture makes it possible to meet all the requirements and constraints related to the specific environment of submarines.

The replacement of a hydraulic actuator by an electric actuator therefore avoids the use of a complex piping network, thus making the system more compact and simpler to install and maintain.

In addition, the proposed architecture presents a block architecture which makes it possible to modify one of the components of this system without leading to modifications on the other components.

Thus, for example, it is possible that different submarines present different electric supply networks. In this case, only the power module of the weapon launch system needs to be modified to adapt it to the corresponding submarine.

In addition, some functions of the weapon launch system may present a lower level of security than others. In this case, one of the security barriers can be removed for these functions.

According to another example, the weapon launch system may include an existing actuator. In this case, to control it, only the control module needs to be adapted appropriately.

Furthermore, the proposed architecture of the weapon launch system according to the invention ensures a high level of security of this system.

Indeed, according to this architecture, the logic processing is separated between two distinct security modules which are integrated in two separate boxes. Thus, in case one of these modules loses its integrity, the security function is ensured by the other module. Such a loss can occur, for example, in the event of a loss of sealing on one of the boxes.

In addition, according to the proposed architecture, the security information and the commands are routed to the corresponding modules via different physical media that are implemented using different technologies. This increases the security level of the system.

Finally, the architecture of the weapon launch system according to the invention guarantees a high level of availability.

Indeed, in case of loss of the computer network, the weapon launch system can be controlled from the control panel which is connected to the actuating means via a direct link and independent of the computer network.

In the event of loss of the main power source, it is still possible to use the backup source, and in the event of total loss of the power sources, it is still possible to manually operate the actuator.

CLAIMS

1. A weapon launch system (10) for a submersible vessel, comprising:
- at least one electric actuator (12) capable of performing a series of mechanical actions on a weapon launch tube;
- a first box (31) comprising a power module (35) capable of supplying electrical power;
- a second box (32) comprising a control module (36) capable of controlling the operation of the electric actuator (12);
- a first security module (41) electrically connecting the power module (35) to the control module (36);
- a second security module (42) electrically connecting the control module (36) to the electric actuator (12);
the boxes (31, 32) being separated from one another and from the electric actuator (12).

2. The system (10) according to claim 1, wherein the first security module (41) is integrated in the first box (31) and is suitable for monitoring the operation of the power module (35).

3. The system (10) according to claim 1 or 2, wherein the second security module (42) is integrated in the second box (32) and is capable of monitoring the operation of the control module (36).

4. The system (10) according to any one of the preceding claims, wherein the power module (35) is connected to a main power source (23) and to a backup power source (25) for use when the main power source (23) is lost.

5. The system (10) according to claim 4, wherein the power module (35) is capable of selecting a power source from the main power source (23) and the backup power source (25).

6. The system (10) according to claim 5, wherein, in case of selection of the backup power source (25), the power module (35) is further adapted to offload the electrical energy in the system (10).

7. The system (10) according to any one of the preceding claims, wherein the first box (31) and the second box (32) are configured to be placed in different enclosures of the submersible vessel.

8. The system (10) according to any one of the preceding claims, further comprising control means (18) capable of controlling the operation of the control module (36).

9. The system (10) according to claim 8, wherein the control means (18) is connected to the control module (36) via a computer network (56) and/or a direct control link (66).

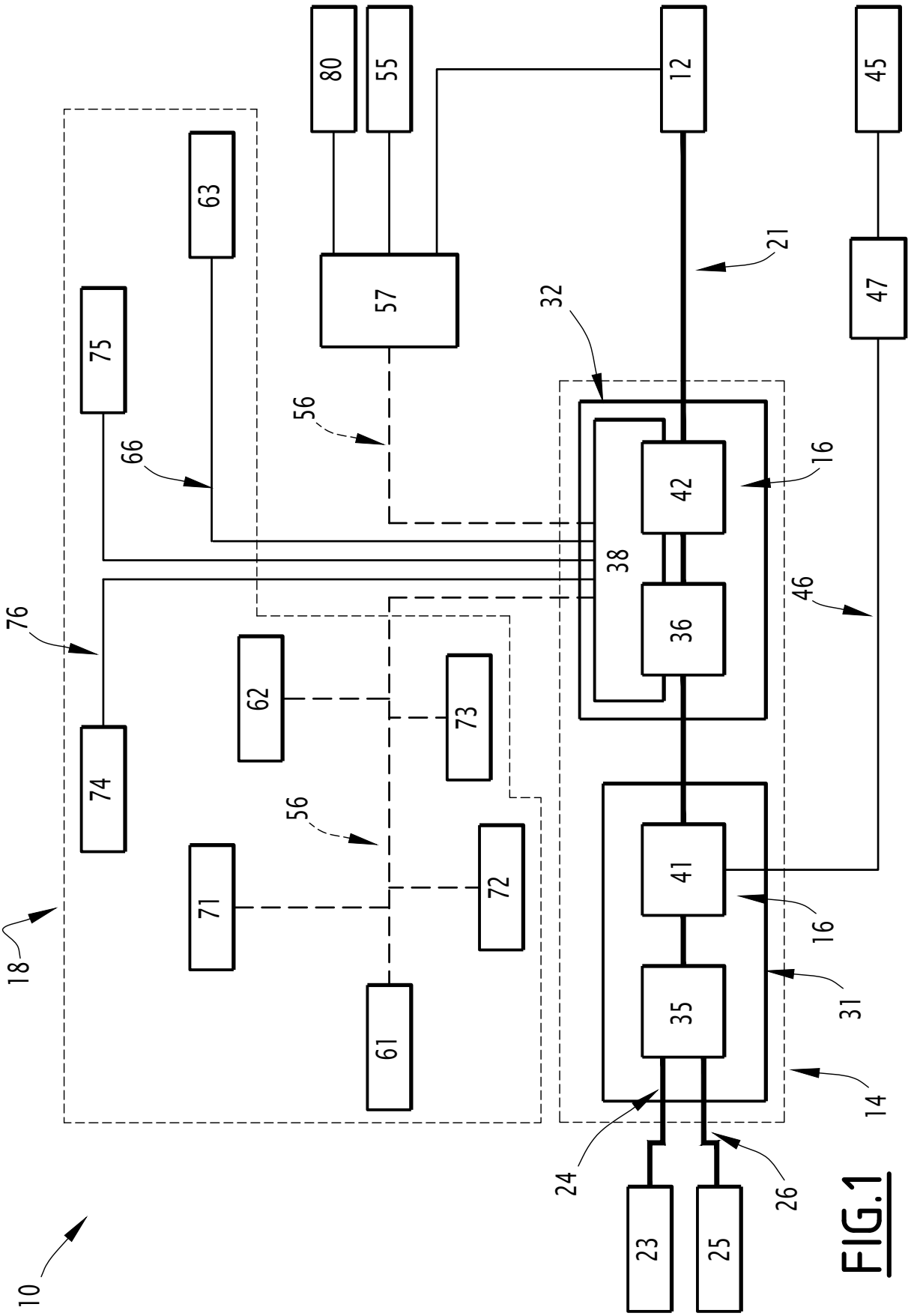
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FIG.1

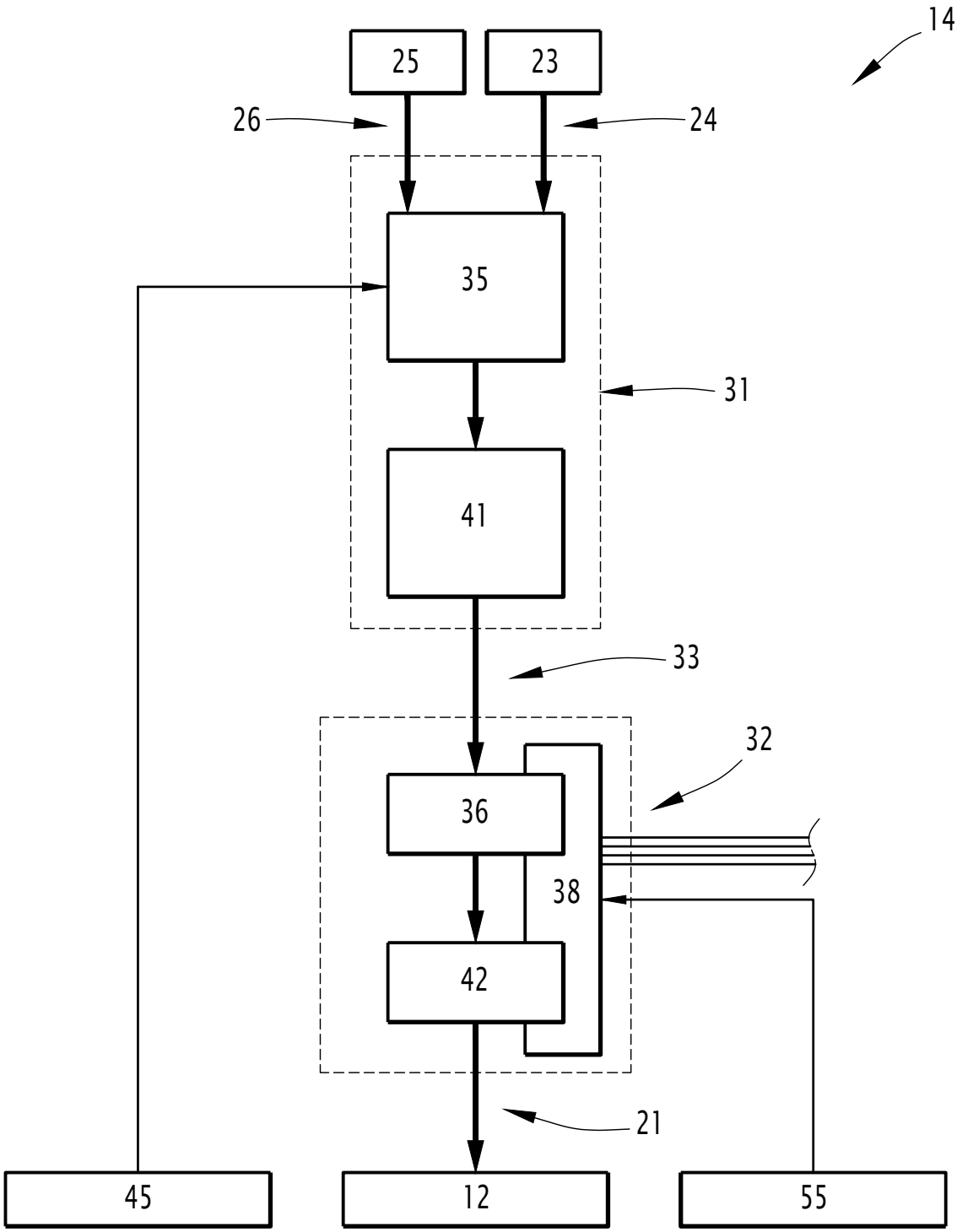

FIG.2

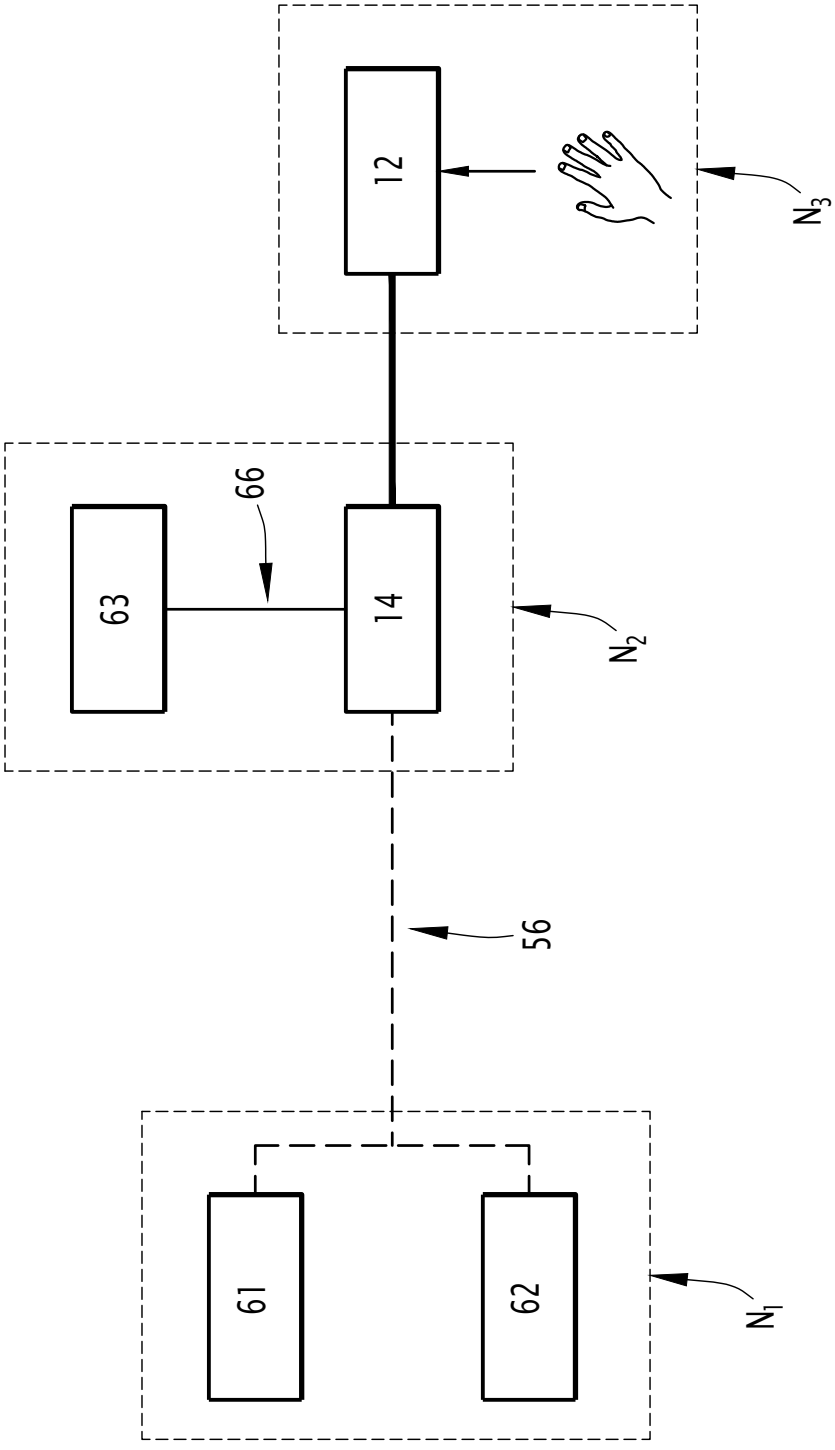

FIG.3