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(54) A SAFETY APPARATUS FOR A SWIMMING POOL

(57) A safety apparatus (1) for a swimming pool (10) comprises at least two pressure switches (31,41) in use hydraulically connected in a same point (22) upstream of a pump (25) of a swimming pool water purification circuit, each pressure switch comprising a first (33,43) and a second (34,44) contact arranged to open or close when an emergency stop pressure (P_a) and a maximum operation pressure (P_e) is reached, respectively, and also comprises a logic unit (50) electrically connected to each pressure switch (31,41) and, in use, with a contactor (24) of the circulation pump (25), the logic unit (50) configured to compare the statuses of the second contacts (34,44) with each other, and for transferring a pump-stop/block electric signal (55) to the contactor (24) when a status of at least one pressure switch (31,41) it is detected which corresponds to a pressure lower than the emergency stop pressure (P_a), or when a condition is detected in which the status of the second contact (34) of one of the pressure switches (31) indicates a suction pressure lower than the maximum operation pressure (P_e), while the status (44) of the other pressure switch (41) indicates a suction pressure higher than the maximum operation pressure (P_e); in this condition, an instrument out-of-service alarm signal is also generated. In an exemplary embodiment, a key device is provided, associated with a key confidentially entrusted to a subject, which serves allow switching on the pump even in the presence of such a condition.

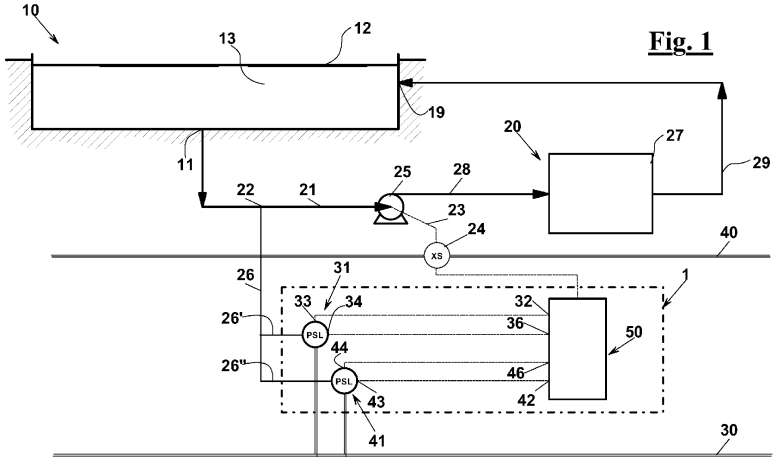

Fig. 1

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Description

Field of the invention

[0001] The present invention relates to a safety apparatus to preserve the users' safety in pools, including swimming pools, therapeutic pools, as well as spa baths and the like.

Background of the invention

[0002] It is well known that the pools intended for receiving people for sport, recreational and rehabilitative activities require a continuous water change in order to avoid a quick quality degradation, i.e. to prevent turbidity, algae formation and in any case accumulation of dirt and potentially pathogen matter. The water change is normally carried out as a continuous process, therefore it takes place also while users are present in the pool. It is carried out by withdrawing water at a predetermined flowrate through withdrawal mouths and ducts, by causing the water to flow through conventional purification devices, and by returning the purified water into the pool through return mouths. The withdrawal is operated by pumps. Therefore, a certain suction is created in the withdrawal ducts and at the withdrawal mouths, which are arranged in the bottom or laterally in the pool, the vacuum degree depending on the features of the pump or the pumps and of the circuit.

[0003] This suction can cause serious harm to the users, in particular to children and disabled subjects. In fact, the vacuum degree can be strong enough to suck a user's arm or leg into the duct and to hurt it by excessive stretching. In particular, if the dimensions allow it, small size users, in particular children, can be entirely sucked. It should be noted that large size ducts are often so that the pool can be emptied quickly, when necessary. The swimming pools including countercurrent swimming devices, in which large amounts of water are moved by an external circuit, are particularly dangerous.

[0004] Moreover, if such an accident is not timely detected and therefore no rescue action is promptly undertaken, the user can drown for holding his/her breath too long. A user, in particular a child, can also drown if he/she is retained at a mouth by suction-cap effect, even if none of his/her limbs has been sucked.

[0005] Protection devices are known against such accidents. However, in most countries the legal framework is still lacking, and often no protective measures are taken, in particular, in small and/or private installations. More in detail, passive protection devices exist such as grids to be placed upon the withdrawal mouths, in particular shaped grids, which are intended to contain their own possibly blocked surface, and to maintain a passageway for the water, which limits the local vacuum degree, even if a body rests thereon. However, such devices usually deteriorate with time, also due to corrosive substances, such as chloride, that are present in the pool water, and require a care level people does not always take, in other words, even if such grids are provided, they are not always replaced timely, therefore they can be deformed or break.

[0006] Techniques are also known in which the water suction pump is switched off upon detecting such an accident condition. For instance, US 6,059,536 describes a device for automatically switching off the water circulation pump of a treatment plant of a swimming pool when a vacuum condition is detected in the suction side of the pump higher than in the normal operation. In this device:

a) a vacuum switch is arranged in communication with the pump suction line for locally detecting a vacuum condition and for generating a high vacuum signal to be used to switch off the pump;
b) an acoustic alarm and a visual alarm are triggered in the presence of the high vacuum signal;
c) the device includes a check switch with four positions that selectively allow:

- normally operating the device, as described in a) and b), in which case maintaining the above block and alarm conditions are maintained until the signal is present and the device is not reactivated ("ON" position);
- neglecting the high vacuum signal and enabling the pump to run also in these conditions, for examples, when the pool must be quickly emptied, operating however the alarms ("VACUUM BYPASS" position);
- neglecting the high vacuum signal, in order to allow the pump to start also even in a strong suction conditions that occurs just after the pump has been switched off ("SPRING-LOADED START position"): this position is maintained during a short time range; as an alternative to this position, an automatic start relay is provided ("self-start relay") for the case of particularly frequent stop-start events;
- maintaining the pump and the device off ("OFF" position).

d) a key device is provided for deactivating the acoustic alarm only, under responsibility of the operator that performs this manoeuvre.

[0007] A drawback of the device of US 6,059,536 is that it cannot ensure that the pump will be promptly switched off if the vacuum switch does not operate properly. Moreover, this device cannot notify the vacuum switch fault condition.

[0008] EP 1 081 312 A2 describes a safety apparatus for a swimming pool including a circulation pump for the water, in which a sensor comprising a load cell is arranged behind a water-permeable cover in a swimming pool discharge port that is connected to the suction of the water circulation pump. This way, if a part of the body

of a child is sucked in the discharge port and comes into contact with the cover, the load cell is pressed by the cover, so as to send a signal to a control circuit that establishes whether the change of the pressure applied to the sensor is anomalous, in which case an alarm is triggered and the pump is stopped in order to release the child from the discharge port.

[0009] US 5 690 476 A and US 5 865 601 A describe safety devices intended for preventing entrapment in a discharge mouth of a water reservoir by means of a vacuum switch that breaks the power supply to a pump of the reservoir when the discharge mouth is blocked. A switch is also provided for manually reactivating the pump of the reservoir once the block condition has been removed. US 5 865 601 also describes a pressurization pump to generate a positive pressure, in order to remove the obstruction from the discharge mouth.

Summary of the invention

[0010] It is therefore a feature of the present invention to provide a safety apparatus for swimming pools that overcomes the above-mentioned prior art drawbacks.

[0011] These and other objects are reached by a safety apparatus for a swimming pool as defined by independent claims 1 and 4, and by a method for safely operating a swimming pool as defined by independent claims 14 and 15, wherein the swimming pool has at least one withdrawal mouth and at least one return mouth, and is associated with a water purification circuit hydraulically connected between the withdrawal mouth and the return mouth and comprising a circulation pump. Exemplary specific embodiments of the invention are defined by the dependent claims.

[0012] According to one aspect of the invention, a safety apparatus for such a swimming pool comprises:

- a power supply line;
- at least two pressure switches configured to:
    - be hydraulically connected to a same branch of the purification circuit, upstream of the circulation pump, substantially in a same pressure-detection point of the branch, for example through a same duct;
    - detect a negative suction relative pressure in the branch;
- a logic unit
    - electrically connected to each of the pressure switches;
    - configured to be electrically connected to a power supply contactor of the circulation pump,

each pressure switch comprising a respective first contact configured to switch between an open status and a closed status, and located between the power supply line and a respective input port of the logic unit;
wherein each pressure switch is configured to:

- open or close the respective first contact when the detected suction pressure becomes lower than a predetermined emergency stop pressure;
- close or open, respectively, the respective first contact when the detected suction pressure becomes higher than the emergency stop pressure;

wherein the logic unit is configured to:

- detect the open or closed status of the first contact of each pressure switch;
- generate and transfer a pump-stop/block electric signal to the contactor when an emergency condition is detected in which the open or closed status of the respective first contact of at least one of the pressure switches is detected, according to whether said at least one of the pressure switches is configured to open or close the respective first contact when the detected suction pressure becomes lower than the predetermined emergency stop pressure,

wherein the contactor is configured to receive the pump-stop/block electric signal discontinuing/disabling the power supply to the circulation pump upon receiving the pump-stop/block electric signal,
wherein:

- each pressure switch comprises a respective second contact configured to switch between an open status and a closed status, and located between the power supply line and a further respective input port of the logic unit;
- each pressure switch is configured to:
    - open or close the respective second contact when the detected suction pressure becomes lower than a predetermined maximum operation pressure, the maximum operation pressure higher than the emergency stop pressure;
    - close or open, respectively, the respective second contact when the detected suction pressure becomes higher than the maximum operation pressure;
- the logic unit is configured to sequentially carry out the steps of:
    - receiving a pump-start command for the circulation pump;
    - detecting the open or closed status of the second contact of each pressure switch;
    - comparing the status of the second contact of one of the pressure switches with the status of the second contact of another of the pressure switches,

and, when an instrument-inconsistency condition is detected, in which the detected status of the second contact of one of the pressure switches indicates that the suction pressure is lower than the maximum operation pressure, while the detected status of the second contact of another of the pressure switches indicates that the suction pressure is higher than the maximum operation pressure, the logic unit is configured to carry out the further steps of:

- generating and transferring the pump-stop/block electric signal to the contactor thus discontinuing/disabling the power supply to the circulation pump upon receiving the pump-stop/block electric signal;
- generating an instrument out-of-service alarm signal.

[0013] The two pressure switches are installed in such a way to detect the vacuum degree that the circulation pump creates in a same branch of the suction piping connected thereto, more in particular, the pressure detection points are very close to each other, i.e. they are substantially coincident with each other. This can be advantageously put into practice, as described, using a same connection duct of the pressure switches themselves with the suction branch, for example, a duct made of Rilsan® or a similar material.

[0014] In any case, the expression "substantially in a same pressure-detection point of the branch" means that the sensors of the two pressure switches are connected at points of the branch that are so close to each other that the pressure drop or in any case the pressure difference between the two points, at the circulation flowrate of the pump, is lower than a predetermined maximum value, in particular it is lower than the instrument pressure detection resolution of the pressure switch.

[0015] In these conditions, it is expected that the two pressure switches always detect the same vacuum value. If this is not the case, then one of the two pressure switches is out of order, i.e. it does not switch its own status when the vacuum degree reaches a predetermined lower threshold value, on the contrary it switches its own status at a different vacuum value.

[0016] In a pressure switch, this condition may occur due to a mechanical fault, or a wrong calibration, or because the calibration was lost, which can happen if the pressure-sensitive portion includes a deteriorated membrane, the resilient material forming the latter having lost its original elastic properties. In these cases, if a pressure switch were used as disclosed in US 6,059,536, in order to switch off the circulation pump in case a user is caught in a swimming pool withdrawal mouth, that pressure switch would switch at a pressure value different from the predetermined pressure value, or would not switch at all, when such an accident occurs, and the safety system would become unreliable and ineffective.

[0017] In the invention, on the contrary, the logic unit systematically checks the at least two pressure switches for mutual consistency, in particular, each time the pump is switched on. To this purpose, the status of each of the two pressure switches is compared with the maximum operation pressure value, i.e. with minimum operation vacuum value, which is higher than the emergency stop pressure, and preventing the pump from starting / stopping the pump, if the two pressure switches do not have the same status, in other words, if they do not signal reaching the predetermined suction vacuum at the same time. Therefore, a swimming pool manager becomes aware of such an anomaly because the pump could not start or, which is better, by an instrument fault alarm, as explained more in detail in this description. This way of notifying the instrument fault condition is missing in the above-mentioned prior art.

[0018] In an exemplary embodiment, the logic unit, when the open or closed status of the respective first contacts of at least two of the pressure switches is detected, according to whether these at least two pressure switches are configured to open or close their respective first contacts when the detected suction pressure becomes lower than the predetermined emergency stop pressure, is configured to:

- generate an emergency alarm signal for operating an emergency warning device;
- receiving an alarm silence command to silence the emergency warning device;
- receiving a safety apparatus reactivation command, so that the circulation pump can be switched on.

[0019] In other words, if at least two pressure switches or, in an exemplary embodiment, both the pressure switch of the apparatus indicate that the pressure has drop below the emergency stop pressure, the logic unit triggers a block to the free starting the pump and an optical and/or acoustic emergency alarm, as described more in detail hereinafter, that can be perceived by people who are in the neighbourhood of the swimming pool, so as to rescue a user possibly caught by the pump suction.

[0020] Advantageously, when one of the pressure switches detects that the suction pressure becomes lower than the emergency stop pressure, the logic unit is also configured to carry out a step of generating an instrument out-of-service alarm signal, when the detected status of the second contact of another of the pressure switches indicates that the suction pressure is higher than the emergency stop pressure and lower than the maximum operation pressure. This way, a further instrument-inconsistency condition is taken into account in order to establish whether the pressure switches are properly working.

[0021] According to another aspect of the invention, a safety apparatus for a swimming pool including a purification circuit as indicated above comprises:

- a power supply line;
- at least two pressure switches configured to:
    - be hydraulically connected to a same branch of the purification circuit, upstream of the circulation pump, substantially in a same pressure-detection point of the branch;
    - detect a negative suction relative pressure in the branch;
- a logic unit
    - electrically connected to each of the pressure switches;
    - configured to be electrically connected to a power supply contactor of the circulation pump,

each pressure switch comprising a respective first contact configured to switch between an open status and a closed status, and located between the power supply line and a respective input port of the logic unit;
wherein each pressure switch is configured to:

- open or close the respective first contact when the detected suction pressure becomes lower than a predetermined emergency stop pressure;
- close or open, respectively, the respective first contact when the detected suction pressure becomes higher than the emergency stop pressure;

wherein:

- said logic unit is configured to carry out the steps of:
    - receiving a pump-start command for the circulation pump;
    - detecting the open or closed status of the first contact of each pressure switch;
    - generating and transferring a pump-stop/block electric signal to the contactor when the open or closed status of the respective first contact of at least one of the pressure switches is detected, according to whether the at least one of the pressure switches is configured to open or close the respective first contact when the detected suction pressure becomes lower than the predetermined emergency stop pressure, wherein the contactor is configured to receive the pump-stop/block electric signal discontinuing/disabling the power supply to the circulation pump upon receiving the pump-stop/block electric signal,

wherein the logic unit, when the open or closed status of the respective first contact of at least two of the pressure switches is detected, according to whether the at least two pressure switches are configured to open or close the respective first contact when the detected suction pressure becomes lower than the predetermined emergency stop pressure, is configured to:

- generate an emergency alarm signal for operating an emergency warning device;
- receive an alarm silence command to silence the emergency warning device;
- receive a safety apparatus reactivation command so that the circulation pump can be switched on.

[0022] This way, if the pressure switches are installed as described above, the apparatus provides a solution to ensure safe operation of a swimming pool, said solution being based on the use of at least two pressure switches connected to a same suction duct, so that the safety apparatus operates based on an active redundancy.

[0023] In an advantageous exemplary embodiment,

- each pressure switch comprises a respective second contact configured to switch between an open status and a closed status, and located between the power supply line and a further respective input port of the logic unit;
- each pressure switch is configured to:
    - open or close the respective second contact when the detected suction pressure becomes lower than a predetermined maximum operation pressure of the apparatus, the maximum operation pressure higher than the emergency stop pressure;
    - close or open, respectively, the respective second contact when the detected suction pressure becomes higher than the maximum operation pressure of the apparatus;

  and the logic unit is also configured to carry out the step of:
    - detecting an instrument-inconsistency condition and generating an instrument out-of-service alarm signal, when the detected status of the second contact of another of the pressure switches different from the at least one of the pressure switches indicates that the suction pressure is higher than the emergency stop pressure and lower than the maximum operation pressure.

This way, the surveillance is ensured over a possible instrument-inconsistency condition, in which one of the pressure switches indicates that the suction pressure is lower than the emergency stop pressure, while another pressure switch indicates that the suction pressure is set between the emergency stop pressure and the maximum operation pressure.

[0024] Advantageously, the logic unit is configured to

perform, before the step of detecting the open or closed status, a step of waiting a predetermined flow-stabilization time. In fact, just after being switched on, if no hydraulic dampers are provided, the pump can immediately create a transitory vacuum degree higher than the previously-established maximum value enabling a regular start of the pump (i.e. a pressure can be reached that is lower than the maximum operation pressure), which practically does not allow the pump to start.

[0025] Advantageously, the logic unit is configured to carry out the step of generating and transferring the pump-stop/block electric signal to the contactor and the step of generating an instrument out-of-service alarm signal only if the instrument-inconsistency condition is detected during a time longer than a predetermined instrument-inconsistency minimum time. In particular, this instrument-inconsistency minimum time is set between 10 and 100 ms, more in particular, between 30 and 70 ms. In other words, in the logic unit a function is provided of filtering off very short instrument-inconsistency events, which are not caused by any true instrument fault condition.

[0026] Advantageously, the apparatus also comprises a key device for enabling a pump operation in the presence of the instrument out-of-service alarm signal or in the presence of the emergency alarm, said key device configured to generate an instrument-out-of-service pump-operation enablement signal, and the logic unit is configured to:

- receive the instrument-out-of-service pump-operation enablement signal;
- generating an instrument-out-of-service pump-operation enablement condition, in which the generation of the pump-stop/block electric signal is inhibited.

This makes it possible to switch on the system and to operate the swimming pool even in a condition that is anomalous because an instrument fault alarm condition or an emergency alarm condition has occurred, which is only possible if a direct, aware and responsible decision is made by the swimming pool manager or by anyone who is in charge of the safety apparatus.

[0027] In particular, the device is a double-key device. This way, it is possible to designate at least two different subjects of the swimming pool and safety apparatus management who are entrusted with the operation of the system even in an instrument fault condition. Preferably, in the presence of the emergency alarm, an emergency warning device can be silenced by using a single key, while the circulation pump can be switched on only if both the keys are used.

[0028] In particular the key device is selected among a mechanical key device, an alphanumerical key device and a combination thereof.

[0029] Advantageously, the apparatus comprises a warning device configured to emit a signalling when the pump-stop/block electric signal is generated, the warning device comprising a device selected from the group consisting of:

- an acoustic warning device;
- a visual warning device;
- a combination thereof.

This makes it possible to notify the instrument-out-of-service condition in a sensorially perceptible and preferably permanent way, which avoids a diagnostic procedure for unsuccessful pump start and instrument fault, permanently reminds that a correct operation of the apparatus, in particular of the pressure switches, must be restored.

[0030] Advantageously, the first contact of the pressure switch is a normally-closed contact. This way, if a power cable is accidentally cut or anyway damaged, such an event is treated in the same way as the emergency condition occurring when a maximum vacuum degree is exceeded, which stops the pump and possibly generates alarms.

[0031] Advantageously, the second contact of the pressure switch is a normally-open contact that, at the start-up of the pump, is blocks once achieved the maximum operation pressure.

[0032] Advantageously, the logic unit is configured to:

- receive a command of temporary inhibition of the pump-stop/block electric signal;
- generate an emergency-stop temporary inhibition condition in which, during a predetermined inhibition time starting from when said command of temporary inhibition is received, the generation of the pump-stop/block electric signal is inhibited,
- remove the emergency-stop temporary inhibition condition upon elapsing of the inhibition time,

so that the contactor maintains the power supply to the circulation pump even if the open or closed status of the respective first contact of at least one of the pressure switches is detected, according to whether each pressure switch is configured to open or close the respective first contact when the detected suction pressure becomes lower than the emergency stop pressure. This makes it possible to carry out maintenance operations of the swimming pool while the pump is running in a high- or maximum-suction condition, for example operations are enabled that require partially or totally emptying the pool. Actually, the pool is preferably emptied by running the circulation pump at an emptying flowrate higher than the normal continuous water recycle and purification flowrate, in order to emptying the swimming pool in an acceptably short time, in which condition the pressure can drop below the emergency stop pressure.

[0033] Advantageously, the logic unit is configured to generate an emergency-stop temporary inhibition alarm signal upon receiving the command of temporary inhibition, and the apparatus comprises a warning device con-

figured to receive the emergency-stop temporary inhibition alarm signal and to emit a emergency-stop temporary inhibition alarm signalling when the emergency-stop temporary inhibition alarm signal is received and up to the end of the inhibition time, the warning device comprising a device selected from the group consisting of: an acoustic warning device; a visual warning device; a combination thereof. This way, the above-mentioned maintenance operations can be performed more safely, since a signalling is present indicating that the safety system is temporarily off.

[0034] In particular, the logic unit is configured to emit a signal of forthcoming end of the emergency stop temporary inhibition stop a predetermined forthcoming safety reactivation time before the inhibition time elapses. This way, the maintenance operators are made aware that the time allowed to complete their work is about over.

[0035] Advantageously, the logic unit is configured to receive a command of discontinuing the emergency-stop temporary inhibition condition and/or of extending it for a predetermined extension time. This way, the emergency-stop temporary inhibition condition can be maintained during a time actually required to complete the maintenance operation, which can be shorter or longer than the predetermined inhibition time.

[0036] The above mentioned objects are reached also by a method to ensure safe operation of a swimming pool, the swimming pool having at least one withdrawal mouth and at least one return mouth, the swimming pool associated with a water purification circuit hydraulically connected between the withdrawal mouth and the return mouth, the purification circuit comprising a circulation pump equipped with a power supply contactor, the method comprising the steps of:

- connecting at least two pressure sensors with a same branch of the purification circuit, upstream of the circulation pump, substantially in a same pressure-detection point of the branch,
- prearranging a logic unit functionally connected to the at least two pressure sensors and to the power supply contactor;
- detecting a negative suction relative pressure in the branch by the at least two pressure sensors,
- generating respective detected pressure values by the at least two pressure sensors;
- comparing, by the logic unit, the detected pressure values with a predetermined emergency stop pressure,
- generating and transferring a pump-stop/block electric signal to the contactor, by the logic unit, when an emergency condition is detected, in which at least one of the detected pressure values becomes lower than a predetermined emergency stop pressure;
- discontinuing/disabling a power supply to the pump by the contactor when the pump-stop/block electric signal is received;

the main feature of said method being that it also comprises the steps, sequentially carried out, of:

- comparing, by the logic unit, the detected pressure values with a predetermined maximum operation pressure,

and, when it is detected an instrument-inconsistency condition in which one of the detected pressure values is higher than the maximum operation pressure while the other pressure value detected is lower than the maximum operation pressure, steps of:

- generating and transferring a pump-stop/block electric signal to the contactor, by the logic unit;
- discontinuing/disabling a power supply to the pump by the contactor when the pump-stop/block electric signal is received;
- generating an instrument out-of-service alarm signal, by the logic unit.

[0037] Advantageously, the method comprises a step of waiting a predetermined flow-stabilization time after said step of receiving a pump-start command and before said step of comparing said detected pressure values, in order to avoid that a transitory vacuum degree higher than the previously established maximum value enabling a regular start of the pump (i.e. a pressure lower than the maximum operation pressure), which can occur when the pump is switched on, practically does not allow the pump to start.

[0038] Advantageously, the logic unit is configured to:

- receive a command of temporary inhibition of the pump-stop/block electric signal;
- generate an emergency-stop temporary inhibition condition, in which, during a predetermined inhibition time starting from when the command of temporary inhibition is received, the generation of the pump-stop/block electric signal is inhibited,
- remove the emergency-stop temporary inhibition condition upon elapsing of the inhibition time,

so that the contactor maintains the power supply to the circulation pump even if it the emergency condition is detected, in order to allow maintenance operations of the swimming pool while the pump is running in a high- or maximum-suction condition, as already explained.

Brief description of the drawings

[0039] The invention will be now shown with the description of its exemplary embodiments, exemplifying but not limitative, with reference to the attached drawings, in which:

- Fig. 1 diagrammatically shows an apparatus according to the invention for a a swimming pool equipped

with a water continuous purification circuit;

- Fig. 2 shows a wiring diagram of the apparatus according to the invention, in an exemplary embodiment;
- Fig. 3 is a block diagram including the main functions of the apparatus, in order to prevent the pump from switching on / to switch off the pump if an instrument-inconsistency condition occurs, and in order to notify this condition;
- Fig. 4 is a block diagram that also shows the normal safety functions of the apparatus if an excessive vacuum degree is reached;
- Fig. 5 is a block diagram of the steps of controlling the temporary inhibition of the pump-stop/block electric signal;
- Figs. 6-20 are detailed wiring diagrams of a safety apparatus according to a preferred exemplary embodiment of the invention.

Description of a preferred exemplary embodiment

[0040] With reference to Fig. 1, a safety apparatus 1 is described to preserve the users' safety in a swimming pool 10 equipped with at least one withdrawal mouth 11 and at least one return mouth 19. The withdrawal mouths can be located at the bottom of pool 10, like depicted mouth 19, or substantially at the normal level 12 of water 13, in the latter case in order to remove material floating on water 13 (skimmer). For the sake of simplicity, and without prejudice to the generality, only one withdrawal mouth 19 located on the bottom is shown, which can also serve as a drainage, i.e. it can be used to empty the pool.

[0041] A purification circuit 20 is associated to swimming pool 10, including a conventional purification plant 27, through which water 13 of swimming pool 10 is caused to flow continuously at a predetermined flowrate. Purification circuit 20 comprises a circulation pump 25, a suction piping schematically represented as a suction duct or branch 21, a delivery duct 28 and a delivery piping 29 to supply purified water to the possible multiple return mouths 19 of swimming pool 10. Circulation pump 25 is powered through a power supply line 40, including a fuse 39, and a contactor 24 enabling a remote control of the pump. Typically, as shown in Fig. 1, circulation pump 25 is a centrifugal pump, but in some exemplary embodiments it can be a positive displacement pump.

[0042] In an exemplary embodiment, safety apparatus 1, shown in a box of Fig. 1, comprises at least two pressure switches 31,41 that are electrically connected to a power supply line 30 advantageously including a fuse 39', which is preferably a DC power supply line at a suitable voltage, e.g. 24V or 12V, said pressure switches in use hydraulically connected to suction duct 21 of purification circuit 20. DC power supply line 30 can be connected to main power supply line 40 via a transformer 37.

[0043] Pressure switches 31,41 can be conventional pressure switches, for example provided by SMC company, and the parts of them that are in contact with water are advantageously selected so as to chemically resist to the oxidant agents normally used to treat the swimming pool water, such as chloride, oxygen, ozone, or various salts.

[0044] Apparatus 1 also comprises a logic unit 50 electrically connected to pressure switches 31,41 and to warning devices that can be parts of apparatus 1 or external devices, as described more in detail hereinafter. Logic unit 50 preferably includes a microcontroller, for example it can include a Siemens "LOGO!" PLC, or can be a microprocessor logic unit, but it can also be a fully electromechanical logic unit.

[0045] In the exemplary embodiment as depicted, two pressure switches 31 and 41 are connected to a same pressure-detection point 22, preferably through a same tube 26, which can be made of Rilsan or a similar material, comprising tubes 26' and 26" for two pressure switches 31 and 41. In other exemplary embodiments, not shown, two pressure switches 31 and 41 can be connected to suction duct 21 trough distinct tubes, substantially in the same pressure-detection point 22 i.e. in points that are so close to each other that the pressure difference between these detection points is lower than an given amount, preferably lower than the resolution of pressure switches 31 and 41, so as to read substantially the same suction pressure P.

[0046] Pressure switches 31,41 are configured to detect negative relative pressures, within a range including vacuum degree values that can be obtained as the suction pressure by pump 25 having a given characteristic curve, and that can be determined from the prefixed circulation flowrate in circuit 20, the features of duct 21 and the distance between the pressure-detection point 22 and the suction side of pump 25.

[0047] Each pressure switch 31,41 at least comprises a respective first contact 33,43 and a respective second contact 34,44.

[0048] Each pressure switch 31,41 is configured to be calibrated in such a way that first contacts 33,43 change their own state, by preferably opening, but possibly by closing, when pressure P at the pressure-detection point drops below an emergency stop pressure P_a, predetermined responsive to an abnormal vacuum value that is expected if withdrawal mouth 11 is even partially blocked. This can occur when a user who is close to withdrawal mouth 11 is sucked by pump 25 and retained on withdrawal mouth 11, or trapped within it. When pressure P exceeds emergency stop pressure P_a again, first contacts 33,43 change their own status in the opposite way with respect to before. Preferably, as described, first contacts 33,43 of pressure switches 31,41 are normally-closed contacts.

[0049] In practice, a suitable value of relative emergency stop pressure P_a for the calibration can be set between -0.3 and -0.6 bar, in particular between -0.4 and -0.5 bar, typically this value can be set at about -0,45 bar. Emergency stop pressure P_a can be selected taking into account that other withdrawal mouths are present that,

like withdrawal mouth 11, are hydraulically connected to the suction branch or duct 21, and by performing suction tests when installing safety apparatus 1 in a specific circuit 20 of a specific pool 10.

[0050] Similarly, each pressure switch 31,41 is configured to be calibrated in such a way that seconds contacts 34,44 change their own state, opening or closing, when pressure P at the pressure-detection point drops below a maximum operation pressure P_e, i.e. when the vacuum degree at the pressure-detection point 22 reaches an expected operation value. Even in this case, if pressure P becomes higher than maximum operation pressure P_e again, seconds contacts 34,44 change their own status in in the opposite direction. Preferably, seconds contacts 34,44 of pressure switches 31,41 are normally-open contacts.

[0051] Preferably, apparatus 1 also includes a warning device 65, which can comprise a device selected among an acoustic warning device 66-67, a visual warning device 68, or a combination of visual and acoustic devices. As described hereinafter, the acoustic warning device can include one or more units 66,67 like conventional hooters that are connected to respective outputs 51,52 of logic unit 50. For example, visual warning device 68 can comprise a conventional blinker, and is connected to an output 53 of logic unit 50. A power supply line 30', which is preferably a DC supply line and advantageously incudes a fuse 39", can be derived from main power supply line 40 through a transformer 38 to power, inter alia, the components of warning device 65.

[0052] Preferably, warning device 65 includes both visual 68 and acoustic 66,67 warning devices.

[0053] Logic unit 50 is preferably configured to operate warning device 65, preferably both acoustic devices 66,67 and visual devices 68, when at least one of first contacts 33,43 changes its own status into the status corresponding to the alarm emergency condition, in which $P<P_a$.

[0054] Similarly, logic unit 50 is preferably configured to operate warning device 65, preferably both acoustic devices 66,67 and visual device 68, when the statuses of second contacts 34,44 indicate pressure P values different from each other and at opposite sides of maximum operation pressure P_e, i.e. when one of these status indicates that suction pressure $P<P_e$, while the other status indicates that suction pressure $P>P_e$.

[0055] Logic unit 50 is preferably configured to cause acoustic warning device 66-67 to emit different tones for the alarm emergency condition, in which $P<P_a$, and for the instrument-inconsistency condition, in which [$P<P_e$ and $P>P_e$]. For instance, in the former case the tone can be high and continuous, while in the latter case the tone can be lower and preferably intermittent. As an alternative, the tone can be high and continuous if the alarm emergency condition $P<P_a$ is generated by both pressure switches 31 and 41, and lower and preferably intermittent if the alarm emergency condition $P<P_a$ is generated by only one of pressure switches 31 and 41, and also if an instrument-inconsistency condition occurs.

[0056] Moreover, logic unit 50 is preferably configured to operate visual device 68 in a different ways according to whether an alarm emergency condition occurs, in which $P<P_a$, or an instrument-inconsistency condition occurs, in which the statuses of first contacts 33,43 indicate pressure P values different from each other, and at opposite sides with respect to maximum operation pressure P_e, i.e. when one of them indicates that suction pressure $P<P_e$, while the other indicates that suction pressure $P>P_e$, for instance blinkers or lights of different colours can be actuated, provided obviously that pump 25 is prevented from running in that condition.

[0057] A further different tone can even be emitted if the expected operating conditions are nor reached within a predetermined time since when a pump-start command for pump 25 has been received, i.e., if the condition $P>P_e$ is still present after this predetermined time. A signalling corresponding to a pressure value P higher than maximum operation pressure P_e during the operation of pump 25 provides an additional indication, unrelated with the users' safety function, of a possible hydraulic fault of circuit 20, typically of a possible fault of pump 25.

[0058] In practice, in the calibration, a value of maximum operation pressure P_e can be set between -0.1 and -0.3 bar, in particular between -0.15 and -0.25 bar, typically this value can be close to -0.19 bar. The selected value can be based on a hydraulic calculation and/or established when testing the plant at the design water flowrate of the purification plant 27.

[0059] The flowrate of purification circuit 20 can be set by conventional control devices, not shown, such as a control valve or an orifice having a predetermined diameter arranged along purification circuit 20, or by an inverter device arranged to controlling the RPM of pump 25. Moreover, the characteristic curve of pump 25 can be selected such that the pump, in a specific operation mode, can quickly empty the pool. The pull 10 empty mode can be selected by acting on the above-mentioned control means or by bypassing them.

[0060] Logic unit 50 has two inputs 32 and 42 electrically connected to the first contacts of pressure switch 31 and of pressure switch 41, respectively, so as to detect the open status, if contact 33,43 are normally closed, or the closed status, if they are normally open. The statuses of contacts 33,43 indicate with redundancy whether suction pressure P in suction branch 21 has exceeded or has dropped below emergency stop pressure P_a. Moreover, logic unit 50 has two other inputs 36 and 46 electrically connected to the seconds contacts of pressure switch 31 and of pressure switch 41, respectively, so as to detect the open or closed status, if contact 34,44 are normally closed or normally-open contacts, respectively. In other words, the statuses of contacts 34,44 indicate with redundancy whether the pressure in suction branch 21 has dropped below or has exceeded the maximum working pressure P_e, corresponding to the minimum vacuum degree, i.e. they indicate whether the stationary con-

ditions of purification circuit 20 have been reached.

[0061] In use, logic unit 50 is also electrically connected to contactor 24, arranged to power pump 25, so as to open or close the contactor according to a program provided in a microprocessor, of by a plurality of contacts of the logic unit.

[0062] In particular, logic unit 50 is configured to generate and transfer a pump stop/block electric signal 55 to contactor 24 when it detects the open or closed status of at least one of first contacts 33,43, according to whether this is a normally-closed contact -which is preferable-, or a normally-open contact. Contactor 24 is configured to block the power supply to circulation pump 25 upon receiving pump stop/block electric signal 55.

[0063] The normal operation conditions of safety apparatus 1, in which the status of the pump depends on the status of first contacts 33,43 of pressure switches 31,41, have been described above.

[0064] Moreover, as shown in the block diagram of Fig. 3, in a first aspect of the invention, logic unit 50 is typically configured to carry out a step 110 of receiving a pump-start command for circulation pump 25 and, according to the invention, it is also configured to carry out sequentially the subsequent steps indicated below, in order to control the apparatus, as described hereinafter.

[0065] Cyclically, after performing a step 120 of detecting the open or closed status of each second contact 34,44, logic unit 50 carries out a step 130 of comparing the statuses of second contacts 34,44 of two pressure switches 31,41 with each other. If in one of detection and comparison cycles 120-130 an instrument-inconsistency condition is encountered, i.e. if the detected status of second contact 34 of pressure switch 31 indicates a suction pressure lower than maximum operation pressure P_e, while the detected status of the second contact 44 of the other pressure switch 41 indicates a suction pressure higher than pressure P_e, or vice-versa, logic unit 50 performs steps of generating 141 and transferring 142 pump stop/block electric signal 55 to contactor 24 of pump 25, so that contactor 24 breaks or prevents any power supply to pump 25. Still in the instrument-inconsistency condition, logic unit 50 is also configured to carry out a step 150 of generating an instrument out-of-service alarm signal.

[0066] With reference to Fig. 4, in a second aspect of the invention, logic unit 50 is typically configured to carry out a step 110 of receiving of a pump-start command for circulation pump 25 and, according to the invention, it is also configured to sequentially carry out the apparatus control steps described hereinafter.

[0067] Cyclically, after performing a step 120 of detecting the open or closed statuses of first contacts 33,43 and of second contacts 34,44, logic unit 50 carries out a step 131 of verifying the statuses of first contacts 33,43 of two pressure switches 31,41. If in one of detection and verification cycles 120-131 a condition is detected in which first contacts 33,43 are in a logic status according to which the pressure is higher than emergency stop pressure, in particular if first contacts 33,43 are normally closed -which is preferred -, when this logic status is 0 V, logic unit 50 performs steps of generating 141 and transferring 142 pump stop/block electric signal 55 to contactor 24 of pump 25, in such a way that contactor 24 breaks or prevents any power supply to pump 25. Still in the emergency alarm condition, logic unit 50 is also configured to carry out a step 145 of generating an emergency alarm signal, so as to actuate emergency warning devices 66,68, as described hereinafter. Such a block condition can be withdrawn with a reset command, the logic unit being configured for a step 148 of receiving it. If no such a command is received, pump-block status and the emergency alarm continue, while, in the opposite case, the running of circulation pump 25 is enabled again, upon receiving 110 a command therefor.

[0068] Still cyclically, after performing step 120 of detecting the statuses of contacts 33, 34, 43, 44 of pressure switches 31,41, logic unit 50 carries out a step 135 of checking the presence of an instrument-inconsistency condition, wherein - in the preferred cases in which first contacts 33,43 are normally closed and seconds contacts 34,44 are normally open - only one of said contacts has the logic status 0 V, logic unit 50 is configured to carry out steps 141, 142 of generating and transferring pump stop/block electric signal 55, and step 150 of generating an instrument out-of-service alarm signal, as already described with reference to Fig. 3. In fact, in a condition of regular operation of pressure switches 31,41, if the normal statuses of the contacts are those indicated above, 24 V must be present at second contacts 34,44, because the pump provides a suction pressure lower than maximum operation pressure P_e, and 24 V must be present also at first contacts 33,43, because the suction pressure is lower than emergency value P_a.

[0069] It will be obvious to a skilled person which logic status or logic status combination will have to be taken into account as representative of the instrument-inconsistency condition if the normal logic statuses of the contacts are different from those indicated above.

[0070] In some advantageous exemplary embodiments, after receiving the pump-start command for circulation pump 25 in the reception step 110, logic unit 50 is configured to carry out a step 115 of waiting a flow-stabilization time t_s previously set inside it, before detecting and cyclically processing the statuses of contacts 33,43 and 34,44 of pressure switches 31,41 in the steps 120-130 and 120-135-136, in order to avoid a permanent block condition of pump 25. Actually, immediately after switching on pump 25, the vacuum degree in suction duct 21 can reach and exceed for a short time the vacuum degree corresponding to emergency stop pressure P_a. The object of the step of waiting is to neglect this transitory condition. In Figs. 3 and 4, the step 115 of waiting is shown by a dashed line because it is an optional step.

[0071] In an advantageous exemplary embodiment, apparatus 1 can comprise an unblock key device 60, i.e. a device for manually removing the block condition gen-

erated by the instrument-inconsistency condition, in other words a key device can be provided to enable manually switching the pump on even if an instrument inconsistency or fault conditions is present. Such unlock device 60 comprises a switch or switch unit whose status can be modified preferably by introducing a confidential code into the logic unit, i.e. a code that is not shown on the device. This code can be confidentially entrusted to the swimming pool manager or to a delegated person. In this exemplary embodiment, key device 60 is configured to generate a signal for enabling the pump to be operated if an instrument fault condition is present, and logic unit 50 is configured to receive this signal and to generate a condition for enabling a pump operation even in the presence of an instrument fault condition, in which the step of generating pump stop/block electric signal 55 is inhibited.

[0072] Preferably, key device 60 is a multiple key device, in which multiple switches 61,62 are provided, the status of which can be modified with respective keys that are different from one another.

[0073] Preferably, key device 60 is a mechanical key unit, in other words the apparatus comprises at least one switch 61,62 accessible and/or configured to be switched by means of a conventional mechanical key that is entrusted to the manager or to a person delegated by him/her. In addition, or as an alternative, key device 60 can in any case comprise an alphanumerical key unit, in other words, apparatus 20 can comprise a keyboard or an equivalent means for introducing a confidential alphanumerical code.

[0074] As the block diagram of Fig. 5 shows, in an advantageous exemplary embodiment, logic unit 50 is configured to carry out a step 160 of receiving a command of temporary inhibition of pump stop/block electric signal 55 and, upon receiving this command, to carry out also a step 170 of generating an emergency-stop temporary inhibition condition and a step 165 of starting a timer t that measures the duration of that condition until a predetermined inhibition time t_i has elapsed. In other words, during time t_i, even if the pressure drops below emergency stop pressure P_a, i.e. even if the status of respective contact 33,43 of at least one of pressure switches 31,41 is detected corresponding to a pressure $P<P_a$, pump stop/block electric signal 55 is not transferred to contactor 24 of pump 25, so that pump 25 can run.

[0075] Upon receiving the command of temporary inhibition, inhibition time t_i can be set by a conventional timer 49, which operates a contact 59 that is maintained closed during the predetermined inhibition time t_i, and that is opened again upon elapsing of inhibition time t_i. For instance, inhibition time t_i can be set to 15 minutes, or in any case it can be as long as the time required for completely or partially emptying pool 10 and/or performing a maintenance operation that requires that pump 25 delivers its maximum flowrate, in order to empty the pool at an acceptable speed, even if a vacuum degree is created in duct 21 higher than the emergency alarm value, corresponding to emergency stop pressure P_a. Elapsing of inhibition time t_i triggers a step 190 of removing the emergency-stop temporary inhibition condition, and then apparatus 1 is enabled again to stop circulation pump 25 by pump stop/block electric signal 55, if the pressure in the suction duct drops below P_a.

[0076] Still with reference to Fig. 5, in an exemplary embodiment, logic unit 50 can be configured to perform a step 180 of generating an emergency-stop temporary inhibition alarm signal, which can be used for operating warning device 65, in order to notify the condition of high suction vacuum safety inhibition during inhibition time t_i, which can be prolonged by an extension time t_p, as described hereinafter. To this purpose, for example, the same contact 47 can be used that is connected to an input 57 of logic unit 50.

[0077] Still with reference to Fig. 5, advantageously, in some exemplary specific embodiments, logic unit 50 can be configured to perform:

- a step 181 of receiving a command of discontinuing the emergency-stop temporary inhibition condition, and/or
- a step 186 of receiving a command of continuation of the emergency-stop temporary inhibition condition for a predetermined extension time t_p,

wherein such commands are available, for instance, if the maintenance operations are completed in a time shorter than time t_i, or, on the contrary, if it the inhibition time must be extended by the extension time t_p, which can be as long as t_i, in particular, it can be extended by further 15 minutes. In the former case, a step 182 follows of stopping the timer and then directly the step 190 follows of removing the emergency-stop temporary inhibition condition. In the latter case, a step 187 takes place of resetting the timer timeout from t_i into t_i+t_p. To this purpose, a normally-open contact 48 is provided that is connected to an input 58 of logic unit 50, to be closed in order to input the command of discontinuing or extending the emergency-stop temporary inhibition condition.

[0078] Moreover, in an exemplary embodiment, logic unit 50 can be configured to carry out a step 189 of emitting a signal of forthcoming end of the emergency-stop temporary inhibition condition a forthcoming safety reactivation time t_{ir} before the inhibition time t_i elapses. This signal can operate a second acoustic alarm or hooter through output 52 of logic unit 50, for example by emitting an intermittent tone.

[0079] In Fig. 5, steps 180, 189 and the sequences of steps 181-182, 186-187, are shown with dashed lines, since they are distinct modifications, which can also be combined to one another, of an exemplary embodiment providing the sequence of steps 160-165-170-190, i.e. the condition of inhibition on demand of the emergency stop of the pump during a predetermined inhibition time. These exemplary embodiments and modifications correspond to embodiments of a method for safely operating

a swimming pool, according to the invention.

[0080] In an exemplary embodiment, instead of the least two pressure switches 31,41, pressure sensors/transmitters can be used that have switch thresholds corresponding to emergency alarm pressures P_a and to maximum operation pressure P_e, and that are arranged to detect pressure values in a continuous pressure range including the values P_a and P_e and, preferably, other values that are important to understand various operating conditions of pump 25 and of purification circuit 20.

[0081] In another exemplary embodiment of apparatus 1, input peripheral devices (pressure switches, pressure sensors/transmitters, push-buttons, timers etc.) and/or output peripheral devices (visual and acoustic warning devices, etc.) are used configured to be wirelessly connected to logic unit 50.

[0082] Figs. 6-20 show detailed wiring diagrams of a safety apparatus according to a preferred exemplary embodiment of the invention.

[0083] Fig. 6 shows the logic unit or drive control unit 50 providing 24V direct voltage inputs, indicated as +, -, 11, 12, 13, 14, 15, 16, 17, I8 and outputs, Q1, Q2, Q3, Q4.

[0084] Fig. 7 shows a terminal board 70 that is preferably arranged in the same main electrical cabinet where logic unit 50 is housed, the terminal board providing a plurality of terminals 71-100 for connecting logic unit 50 with the inlet and output peripherals and, in some instances, for connecting the peripherals with each other. Fig. 7 also indicates the function of each terminal 71-100.

[0085] In Fig. 6 two voltage transformers, or power supply units 37, 38, are also shown arranged to be supplied at a 230V AC voltage by power supply line 40 and connected to terminals 71, 72 corresponding to the phase L and to the neutral N, and configured to change said voltage into a 24 V DC voltage. A first transformer 37 is arranged to supply logic unit 50 and the input peripherals (pressure switches, command push-buttons, the timer), while a second transformer 38 is arranged to supply the output peripherals (acoustic/visual warning devices, the relay of the circulation pump) of the apparatus, as described hereinafter. A terminal 73 allows the ground connection of control unit 50.

[0086] In particular, as Figs. 6 and 8 show, pressure switches 31 and 41 and logic unit or control unit 50 are electrically supplied through terminals 74, 75. First contacts 33,43, in this case normally-closed contacts, of pressure switches 31 and 41 are connected between 24V terminal 74 and inputs 76 and 77, respectively. A lack of 24V voltage at terminals 76 and 77 indicates to control unit 50 that pressure switches 31 and 41 have detected a pressure that is the same value as or lower than emergency stop pressure P_a, respectively.

[0087] As shown in Fig. 10, in these conditions, logic unit 50 acts on a relay R of circulation pump 25 through an own output Q1 (Fig. 6), by a pump-stop/block signal, preventing the pump from running.

[0088] Moreover, in the same conditions, logic unit 50, through output Q3 connected to a terminal 85, allows supplying the 24V voltage to acoustic and visual emergency warning devices 66 and 68, which are connected in parallel between terminals 85 and 86 (0 V), and are arranged to notify people who are in the neighbourhood of the swimming pool of a condition of excessive vacuum degree and probable entrapment of someone upstream of the circulation pump. To this purpose, acoustic warning device 66 can be a hooter, and emergency visual warning device 68 can be a red high-intensity blinker.

[0089] As an alternative, logic unit 50 operates general acoustic and visual emergency warning devices 66 and 68 through output Q3 only if both pressure switches 31 and 41 indicate the condition $P \leq P_a$, i.e. if the 24 V voltage is not present at any of contacts 76, 77, without prejudice of the block of the circulation pump even if one only of the pressure switch indicates the condition $P \leq P_a$, i.e. if one only of contacts 76, 77 does not receive the 24 V voltage.

[0090] Still with reference to Fig. 8, second contacts 34,44, in this case normally-open contacts, of pressure switches 31 and 41, are connected between 24V terminal 74 and inputs 78 and 79, respectively. The presence of the 24V voltage at one only of terminals 78 and 79, i.e. at one only of inputs I3 and 14, notifies to control unit 50 that pressure switches 31 and 41 are in a condition of inconsistency, i.e. they indicate pressures that are the one higher than emergency stop pressure P_e and the other lower than or equal to the latter.

[0091] As shown still in Fig. 10, in these conditions, logic unit 50, through output Q2 connected to terminal 87, allows feeding the 24V voltage only to a visual fault warning device 69, connected between terminals 87 and 86 (0 V), and arranged at the electrical cabinet, in order to notify an instrument fault condition to an operator, which requires to be checked and possibly fixed. Visual fault warning device 69 can be a light of a different colour and lower intensity than above-mentioned blinker 68, for example, it can be a yellow light.

[0092] Moreover, in the same conditions, logic unit 50, still through output Q1 (Fig. 6), also acts even in this case on relay R of circulation pump 25, preventing the latter from running.

[0093] In an improved configuration, logic unit 50 similarly acts on visual fault warning device 69 and on relay R of the pump, responsive not only to the voltage values at inputs I3 and 14, but also to the voltage values at inputs I1 and 12, which are connected to terminals 76 and 77, i.e. to the first contacts of two pressure switches 31 and 41, respectively. In particular, in the configuration of Fig. 8, in which first contacts 33,43 are normally closed and seconds contacts 34,44 are normally open, in a condition of normal operation, the 24 V voltage is expected to be present at all four inputs I1, 12, 13, 14.

[0094] If such a condition does not occur, i.e. if at least one of the inputs I1, 12, 13, I4 is to 0 V, logic unit 50, through output Q1 (Fig. 6), also in this case acts on relay R of circulation pump 25, preventing the latter from run-

ning and, through output Q2, allows supplying the 24V voltage only to visual fault warning device 69, in order to notify the instrument fault condition to an operator, which requires to be checked and possibly fixed. This condition can be an instrument fault, such as a fault of the power supply coil of a pressure switch, or a cut wire, which prevents the 24 V signal from reaching logic unit 50.

[0095] Fig. 9 shows a portion of the electrical cabinet that controls the condition of temporary inhibition of the pump-stop/block electric signal, in particular, during a maintenance operation. Between a terminal 80 carrying a 24V voltage generated by transformer 37, and terminals 82, 83 connected to inputs I5 and 16, respectively, of the control unit, two normally closed push-buttons 47 are arranged to reactivate the apparatus after a temporary inhibition condition, as well as a push-button 48 for temporary inhibiting pump stop/block electric signal 55 i.e. for setting a maintenance time. Therefore, only in the presence of 24V voltage at terminal 81 and, therefore, at input 15, logic unit 50 enables the operation of the apparatus. Instead, by pushing key P_2, input I6 receives the 24V voltage, and in this case logic unit 50 activates the temporary inhibition condition of the pump-stop/block electric signal, during a predetermined inhibition time, even if a pressure $P<P_a$ is detected.

[0096] In these conditions, when the end of the inhibition time approaches, logic unit 50, through output Q4 connected to terminal 83, can allow the 24V voltage to be supplied to maintenance acoustic warning device 67, connected between terminals 87 and 86 (0 V), and arranged to notify a maintenance operator of the condition of forthcoming end of the maintenance time. Preferably, maintenance acoustic warning device 67 is caused to emit an intermittent signal with a frequency that gradually increases as the end of the inhibition time approaches. Preferably, in such conditions, logic unit 50 can be configured also to activate visual fault warning device 69, as indicated above when describing Fig. 8.

[0097] Concerning the operation of circulation pump 25, Figs. 17 and 18 show 24V contactor 24 for a circulation pump having a single-phase electric motor 25' (the phase and neutral are indicated by L and N) and for a circulation pump having a three-phase electric motor 25" (the three phases are indicated by L1, L2, L3), respectively, each motor connected between a terminal 92 (0 V) and a terminal 93 in turn connected to common contact C of relay R, which can be selectively supplied at 24V, as it can be seen in Figs. 12-14.

[0098] With reference to Fig. 14, upstream of the common contact, 2 terminals 99 and 100 are arranged that can be connected to respective terminals of an emergency button 54 that has a normally-closed contact and is shown in Fig. 16, which button can be operated in any condition to prevent a 24V voltage from reaching terminal 93 and, therefore, to prevent the circulation pump from running.

[0099] Still with reference to Fig. 14, a terminal 96 carrying a 24V voltage generated by transformer 38 is connected through a terminal 95 to normally-open contact NO of relay R. The pump stop/block signal emitted by control unit 50, if a high vacuum degree is attained, P<Pa, or if one of two pressure switches 31 and 41 indicates that $P>P_e$ while the other indicates that $P<P_e$, switches the relay bringing the common contact C from contact NO to contact NC thus preventing the 24V voltage from reaching terminal 93 and the contactor of pump 25, and preventing therefore the pump from running.

[0100] However, between terminals 88 and 89 of Fig. 14, which are connected to the contacts NC and NO, respectively, of relay R, a double-key device 60, as shown in Fig. 11, can be arranged comprising two normally-open contacts in series which can be closed, for example, acting at the same time on first key 61 and on second key 62, thus bypassing the relay and bringing the 24V voltage to common contact, i.e. to terminal 93, in any condition, so as to enable pump 25 to run regardless of the status of relay R, i.e. regardless of whether pump stop/block signal 55 has been emitted by control unit 50 in the case $P<P_a$.

[0101] Operating first key 61 only, the 24 V voltage available at a terminal 91 is brought to terminal 90 and from here to input I7 of logic unit 50 that, in this case, is configured to block the supply of the 24V voltage to acoustic 66 and visual 68 emergency warning devices, which occurs through output Q3 and terminal 85, but is not configured to enable circulation pump 25 to start. Double-key device 60 increases the surveillance on whether the apparatus is reactivated and on whether pump 25 is switched on again after a general alarm general, for instance, by confidentially consigning the first and the second key to two different subjects that shares this responsibility, while making it easier to silence acoustic/visive warning devices 66,68, so as to reduce the inconvenience they cause to the operators.

[0102] A similar reasoning on the operation of the pump can be made If the connector the pump 24' is supplied at 230V AC, with reference to Figs. 13, 19, 20.

[0103] In Figs. 6 and 7 terminals 97, 98 are also shown connected to input I8 of the control unit, and to 24V supply unit 37, respectively, in order to connect timer 49, for example a timer 49 previously in use, for measuring the time during which circulation pump 25 is running.

[0104] The foregoing description of exemplary specific embodiments of the invention will so fully reveal the invention according to the conceptual point of view, so that others, by applying current knowledge, will be able to modify and/or to adapt for various applications such exemplary specific embodiments without further research and without parting from the invention, ant it is therefore to be understood that such adaptations and modifications will have to be considered as equivalent to the exemplary specific embodiments. The means and the materials to realise the different functions described herein can have a different nature without, for this reason, departing from the invention. It is to be understood that the phraseology or terminology employed herein is for the purpose of de-

scription and not of limitation.

Claims

1. A safety apparatus (1) for a swimming pool (10), said swimming pool (10) having at least one withdrawal mouth (11) and at least one return mouth (19), said swimming pool (10) associated with a water purification circuit (20) hydraulically connected between said withdrawal mouth (11) and said return mouth (19), said purification circuit (20) comprising a circulation pump (25), said safety apparatus (1) comprising:

    - a power supply line (30);
    - at least two pressure switches (31,41) configured to:

        - be hydraulically connected to a same branch (21) of said purification circuit (20), upstream of said circulation pump (25), substantially in a same pressure-detection point (22) of said branch (21);
        - detect a negative suction relative pressure (P) in said branch (21);

    - a logic unit (50)

        - electrically connected to each of said pressure switches (31,41);
        - configured to be electrically connected to a power supply (23) contactor (24) of said circulation pump (25),

    each of said pressure switches (31,41) comprising a respective first contact (33,43) configured to switch between an open status and a closed status, and located between said power supply line (30) and a respective input port (32,42) of said logic unit (50);
    wherein each of said pressure switches (31,41) is configured to:

        - open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than a predetermined emergency stop pressure (P_a);
        - close or open, respectively, said respective first contact (33,43) when said detected suction pressure (P) becomes higher than said emergency stop pressure (P_a);

    wherein said logic unit (50) is configured to carry out the steps of:

        - detecting said open or closed status of said first contact (33,43) of each of said pressure switches (31,41);
        - generating and transferring a pump-stop/block electric signal (55) to said contactor (24) when said open or closed status of said respective first contact (33,43) of at least one of said pressure switches (31,41) is detected, according to whether said at least one of said pressure switches (31,41) is configured to open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than said predetermined emergency stop pressure (P_a),

    wherein said contactor (24) is configured to receive said pump-stop/block electric signal (55) discontinuing/disabling said power supply to said circulation pump (25) upon receiving said pump-stop/block electric signal (55),
    wherein:

        - each of said pressure switches (31,41) comprises a respective second contact (34,44) configured to switch between an open status and a closed status, and located between said power supply line (30) and a further respective input port (36,46) of said logic unit (50);
        - each of said pressure switches (31,41) is configured to:

            - open or close said respective second contact (34,44) when said detected suction pressure (P) becomes lower than a predetermined maximum operation pressure (P_e) of said apparatus, said maximum operation pressure (P_e) higher than said emergency stop pressure (P_a);
            - close or open, respectively, said respective second contact (34,44) when said detected suction pressure (P) becomes higher than said maximum operation pressure (P_e) of said apparatus;

        - said logic unit (50) is configured to sequentially carry out the steps of:

            - receiving (110) a pump-start command for said circulation pump (25);
            - detecting (120) said open or closed status of said second contact (34,44) of each of said pressure switches (31,41);
            - comparing (130) said status of said second contact (34) of one of said pressure switches (31) with said status of said second contact (44) of another of said pressure switches (41),

        and, when an instrument-inconsistency condition is detected, in which said detected status of said second contact (34) of one of said pressure

switches (31) indicates that said suction pressure is lower than said maximum operation pressure (P_e), while said detected status of said second contact (44) of another of said pressure switches (41) indicates that said suction pressure is higher than said maximum operation pressure (P_e), said logic unit (50) is configured to carry out the further steps of:

- generating (141) and transferring (142) said pump stop/block electric signal (55) to said contactor (24);
- generating (150) an instrument out-of-service alarm signal.

2. The apparatus (1) according to claim 1, wherein said logic unit (50), when said open or closed status of said respective first contact (33,43) of at least two of said pressure switch (31,41) is detected, according to whether said at least two pressure switches (31,41) are configured to open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than said predetermined emergency stop pressure (P_a), is configured to carry out the steps of:

- generating (145) an emergency alarm signal for operating an emergency warning device (66,68);
- receiving an alarm silence command to silence said warning device (66,68);
- receiving (148) a reactivation command of said apparatus (1) so that said circulation pump (25) can be switched on.

3. The apparatus (1) according to claim 1, wherein

- when one of said pressure switches (31,41) detects that said suction pressure (P) becomes lower than said emergency stop pressure (P_a), said logic unit (50) is also configured to carry out the step of:

  - generating (150) an instrument out-of-service alarm signal, when said detected status of said second contact (44,34) of another of said pressure switches (41,31) indicates that said suction pressure is higher than said emergency stop pressure (Pa) and lower than said maximum operation pressure (P_e).

4. A safety apparatus (1) for a swimming pool (10), said swimming pool (10) having at least one withdrawal mouth (11) and at least one return mouth (19), said swimming pool (10) associated with a water purification circuit (20) hydraulically connected between said withdrawal mouth (11) and said return mouth (19), said purification circuit (20) comprising a circulation pump (25), said safety apparatus (1) comprising:

- a power supply line (30);
- at least two pressure switches (31,41) configured to:

  - be hydraulically connected to a same branch (21) of said purification circuit (20), upstream of said circulation pump (25), substantially in a same pressure-detection point (22) of said branch (21);
  - detect a negative suction relative pressure (P) in said branch (21);

- a logic unit (50)

  - electrically connected to each of said pressure switches (31,41);
  - configured to be electrically connected to a power supply (23) contactor (24) of said circulation pump (25),

each of said pressure switches (31,41) comprising a respective first contact (33,43) configured to switch between an open status and a closed status, and located between said power supply line (30) and a respective input port (32,42) of said logic unit (50);
wherein each of said pressure switches (31,41) is configured to:

- open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than a predetermined emergency stop pressure (P_a);
- close or open, respectively, said respective first contact (33,43) when said detected suction pressure (P) becomes higher than said emergency stop pressure (P_a);

wherein:

- said logic unit (50) is configured to carry out the steps of:

  - receiving (110) a pump-start command for said circulation pump (25);
  - detecting (120) said open or closed status of said first contact (33,43) of each of said pressure switches (31,41);
  - generating (141) and transferring (142) a pump-stop/block electric signal (55) to said contactor (24) when said open or closed status of said respective first contact (33,43) of at least one of said pressure switches (31,41) is detected, according to whether said at least one of said pressure switches

(31,41) is configured to open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than said predetermined emergency stop pressure (P_a), wherein said contactor (24) is configured to receive said pump-stop/block electric signal (55) discontinuing/disabling said power supply to said circulation pump (25) upon receiving said pump-stop/block electric signal (55),

wherein said logic unit (50), when said open or closed status of said respective first contact (33,43) of at least two of said pressure switches (31,41) is detected, according to whether said at least two pressure switches (31,41) are configured to open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than said predetermined emergency stop pressure (P_a), is configured to carry out the steps of:

- generating (145) an emergency alarm signal for operating an emergency warning device (66,68);
- receiving an alarm silence command to silence said emergency warning device (66,68);
- receiving (148) a reactivation command of said apparatus (1) so that said circulation pump (25) can be switched on.

5. The apparatus (1) according to claim 4, wherein

- each of said pressure switches (31,41) comprises a respective second contact (34,44) configured to switch between an open status and a closed status, and located between said power supply line (30) and a further respective input port (36,46) of said logic unit (50);
- each of said pressure switches (31,41) is configured to:

  - open or close said respective second contact (34,44) when said detected suction pressure (P) becomes lower than a predetermined maximum operation pressure (Pe) of said apparatus, said maximum operation pressure (Pe) higher than said emergency stop pressure (Pa);
  - close or open, respectively, said respective second contact (34,44) when said detected suction pressure (P) becomes higher than said maximum operation pressure (Pe) of said apparatus;

and wherein said logic unit (50) is also configured to carry out the step of:

- detecting an instrument-inconsistency condition and generating (150) an instrument out-of-service alarm signal, when said detected status of said second contact (44,34) of another of said pressure switches (41,31) different from said at least one of said pressure switches (31,41) indicates that said suction pressure is higher than said emergency stop pressure (P_a) and lower than said maximum operation pressure (P_e).

6. The apparatus (1) according to any of the previous claims, wherein said logic unit (50) is configured to perform, before said step of detecting (120) said open or closed status, a step of waiting (115) a predetermined flow-stabilization time (ts).

7. The apparatus (1) according to any of claims 1-3, 5-6, wherein said logic unit (50) is configured to carry out said steps of:

- generating (141) and transferring (142) said pump stop/block electric signal (55) to said contactor (24);
- generating (150) an instrument out-of-service alarm signal,

only if said instrument-inconsistency condition is detected during a time longer than a predetermined instrument-inconsistency minimum time.

8. The apparatus (1) according to any of the previous claims, also comprising a key device (60) for enabling a pump operation in the presence of said instrument out-of-service alarm signal or in the presence of said emergency alarm, in particular a double-key device (60), wherein said key device (60) is configured to generate an instrument-out-of-service pump-operation enablement signal, and said logic unit (50) is configured to:

- receive said instrument-out-of-service pump-operation enablement signal;
- generating an instrument-out-of-service pump-operation enablement condition, in which said step of generating said pump stop/block electric signal (55) is inhibited,

in particular, said key device (60) is selected from the group consisting of:

- a mechanical key device;
- an alphanumerical key device;
- a combination thereof.

9. The apparatus (1) according to any of the previous claims, wherein said first contact (33,43) of said pressure switch (31,41) is a normally-closed contact.

10. The apparatus (1) according to any of claims 1-3, 5-10, wherein said second contact (34,44) of said pressure switch (31,41) is a normally-open contact.

11. The apparatus (1) according to any of the previous claims, wherein said logic unit (50) is configured to carry out the steps of:

- receiving (160) a command of temporary inhibition of said pump stop/block electric signal (55);
- generating (170) an emergency-stop temporary inhibition condition in which, during a predetermined inhibition time (t_i) starting from when said command of temporary inhibition is received, said step of generating said pump stop/block electric signal (55) is inhibited,
- removing (190) said emergency-stop temporary inhibition condition upon elapsing of said inhibition time (t_i),

so that said contactor (24) maintains said power supply to said circulation pump (25) even if said open or closed status of said respective first contact (33,43) of at least one of said pressure switches (31,41) is detected, according to whether each of said pressure switches (31,41) is configured to open or close said respective first contact (33,43) when said detected suction pressure (P) becomes lower than said predetermined emergency stop pressure (P_a).

12. The apparatus (1) according to claim 11, wherein said logic unit (50) is configured to carry out a step of:

- generating (180) an emergency-stop temporary inhibition alarm signal upon receiving (160) said command of temporary inhibition,

and said apparatus comprises a warning device (65) configured to receive said emergency-stop temporary inhibition alarm signal and to emit a signalling temporary inhibition of said emergency stop when said emergency-stop temporary inhibition alarm signal is received and up to the end of said inhibition time, said warning device (65) comprising a device selected from the group consisting of:

- an acoustic warning device (67);
- a visual warning device (69);
- a combination thereof,

in particular, said logic unit (50) is configured to carry out a step of emitting (189) a signal of forthcoming end of said emergency stop temporary inhibition a predetermined forthcoming safety reactivation time (t_{ir}) before said inhibition time (t_i) elapses.

13. The apparatus (1) according to claim 11, wherein said logic unit (50) is configured to carry out a step of receiving (181) a command of discontinuing said emergency-stop temporary inhibition condition and/or of extending it for a predetermined extension time (t_p).

14. A method to ensure safe operation of a swimming pool (10), said swimming pool (10) having at least one withdrawal mouth (11) and at least one return mouth (19), said swimming pool (10) associated with a water purification circuit (20) hydraulically connected between said withdrawal mouth (11) and said return mouth (19), said purification circuit (20) comprising a circulation pump (25) equipped with a power supply contactor (24), said method comprising the steps of:

- connecting at least two pressure sensors (31,41) with a same branch (21) of said purification circuit (20), upstream of said circulation pump (25), substantially in a same pressure-detection point (22) of said branch (21),
- prearranging a logic unit (50) functionally connected to said at least two pressure sensors (31,41) and to said power supply contactor (24);
- detecting a negative suction relative pressure (P) in said branch (21) by said at least two pressure sensors (31,41),
- generating respective detected pressure values (P_3,P_4) by said at least two pressure sensors (31,41);
- comparing, by said logic unit (50), said detected pressure values (P_3,P_4) with a predetermined emergency stop pressure (P_a),
- generating and transferring a pump stop/block electric signal (55) to said contactor (24), by said logic unit (50), when an emergency condition is detected, in which at least one of said detected pressure values (P_3,P_4) becomes lower than a predetermined emergency stop pressure (P_a);
- discontinuing/disabling a power supply to said pump (25) by said contactor (24) when said pump-stop/block electric signal (55) is received;

characterized in that steps are also provided of:

- receiving, by said logic unit (50), a pump-start command for said circulation pump (25);
- comparing, by said logic unit (50), said detected pressure values (P_3,P_4) with a predetermined maximum operation pressure (P_e),

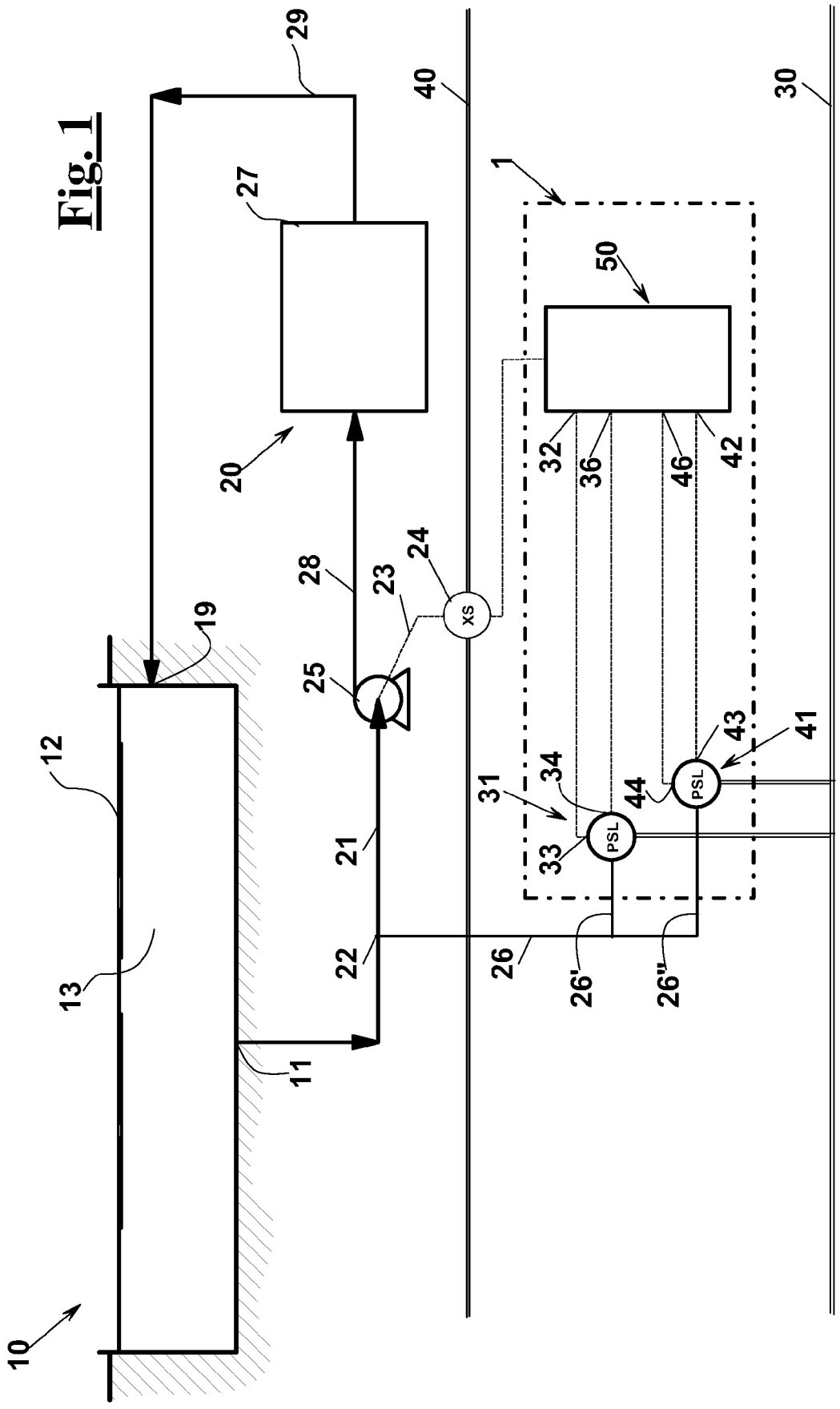
and, when a value (P_3,P_4) of said detected pressure values (P_3,P_4) is higher than said maximum operation pressure (P_e) while another value (P_4,P_3) of said detected pressure values (P_3,P_4) is lower than said maximum operation pressure (P_e), steps of:

- generating (141) and transferring (142) a pump stop/block electric signal (55) to said contactor (24), by said logic unit (50);
- discontinuing/disabling a power supply to said pump (25), by said contactor (24), when said pump-stop/block electric signal (55) is received;
- generating an instrument out-of-service alarm signal, by said logic unit (50).

15. A method to ensure safe operation of a swimming pool (10), said swimming pool (10) having at least one withdrawal mouth (11) and at least one return mouth (19), said swimming pool (10) associated with a water purification circuit (20) hydraulically connected between said withdrawal mouth (11) and said return mouth (19), said purification circuit (20) comprising a circulation pump (25) equipped with a power supply contactor (24), said method comprising the steps of:

- connecting at least two pressure sensors (31,41) with a same branch (21) of said purification circuit (20), upstream of said circulation pump (25), substantially in a same pressure-detection point (22) of said branch (21),
- prearranging a logic unit (50) functionally connected to said at least two pressure sensors (31,41) and to said power supply contactor (24);
- detecting a negative suction relative pressure (P) in said branch (21) by said at least two pressure sensors (31,41),
- generating respective detected pressure values (P_3,P_4) by said at least two pressure sensors (31,41);
- comparing, by said logic unit (50), said detected pressure values (P_3,P_4) with a predetermined emergency stop pressure (P_a),
- generating and transferring a pump stop/block electric signal (55) to said contactor (24), by said logic unit (50), when a condition is detected, in which at least one of said detected pressure values (P_3,P_4) becomes lower than a predetermined emergency stop pressure (P_a);
- discontinuing/disabling a power supply to said pump (25) by said contactor (24) when said pump-stop/block electric signal (55) is received.
- generating, by said logic unit (50), an emergency alarm signal for operating an emergency warning device (66,68) when both said pressure values (P_3,P_4) are lower than said emergency stop pressure (P_a).

Fig. 1


29
40
30
1
27
50
20
32
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46
42
28
23
24
XS
19
25
43
41
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34
31
44
PSL
PSL
21
33
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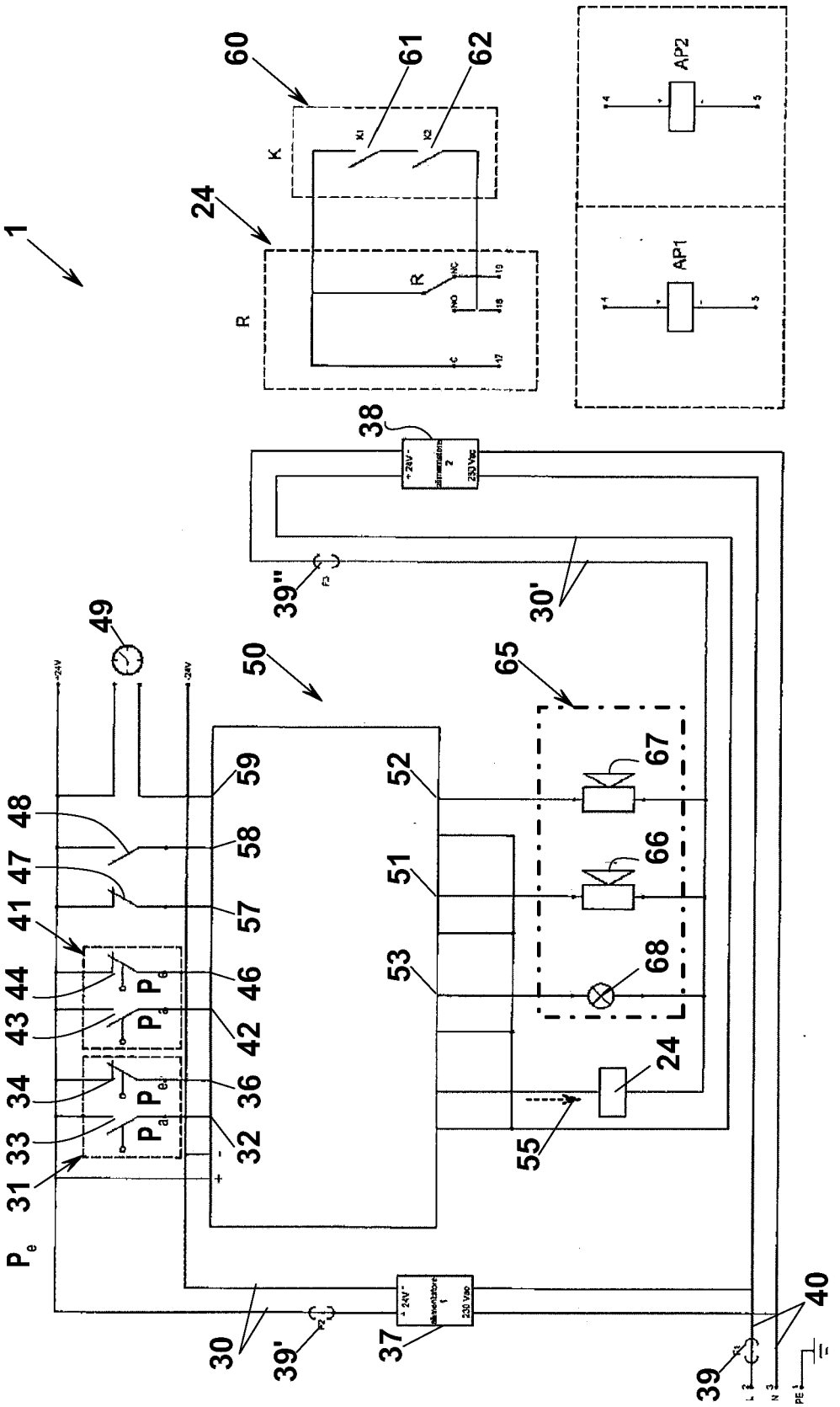
26'
26"
11
10

Fig. 2


1
60
61
62
K
K1
K2
24
R
NC
NO
C
19
18
17
AP2
AP1
38
39"
30'
49
50
65
67
66
68
24
55
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39'
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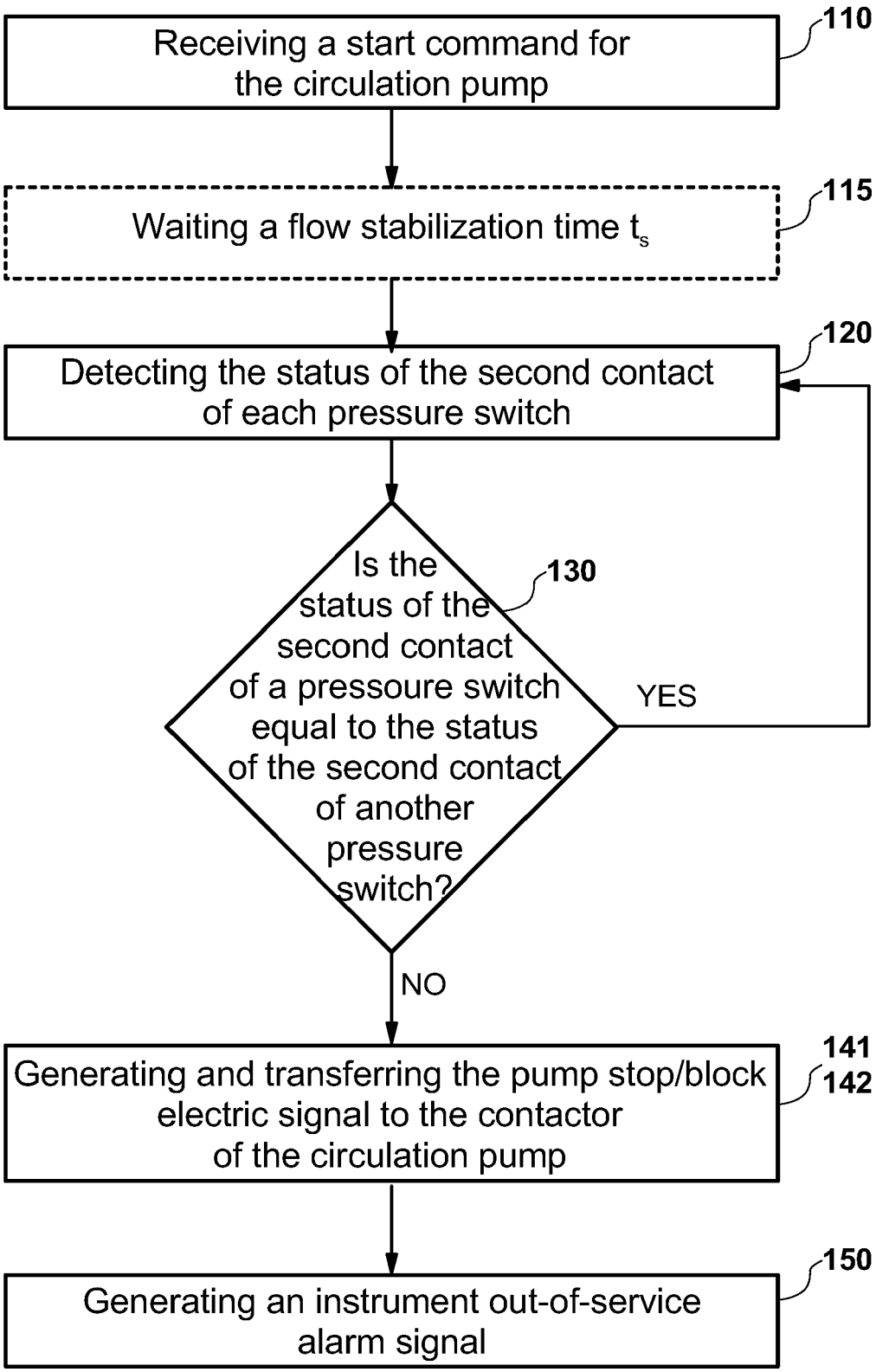
39
40
L1
N
PE

Fig. 3


Receiving a start command for the circulation pump
110
Waiting a flow stabilization time t_s
115
Detecting the status of the second contact of each pressure switch
120
Is the status of the second contact of a pressoure switch equal to the status of the second contact of another pressure switch?
130
YES
NO
Generating and transferring the pump stop/block electric signal to the contactor of the circulation pump
141
142
Generating an instrument out-of-service alarm signal
150

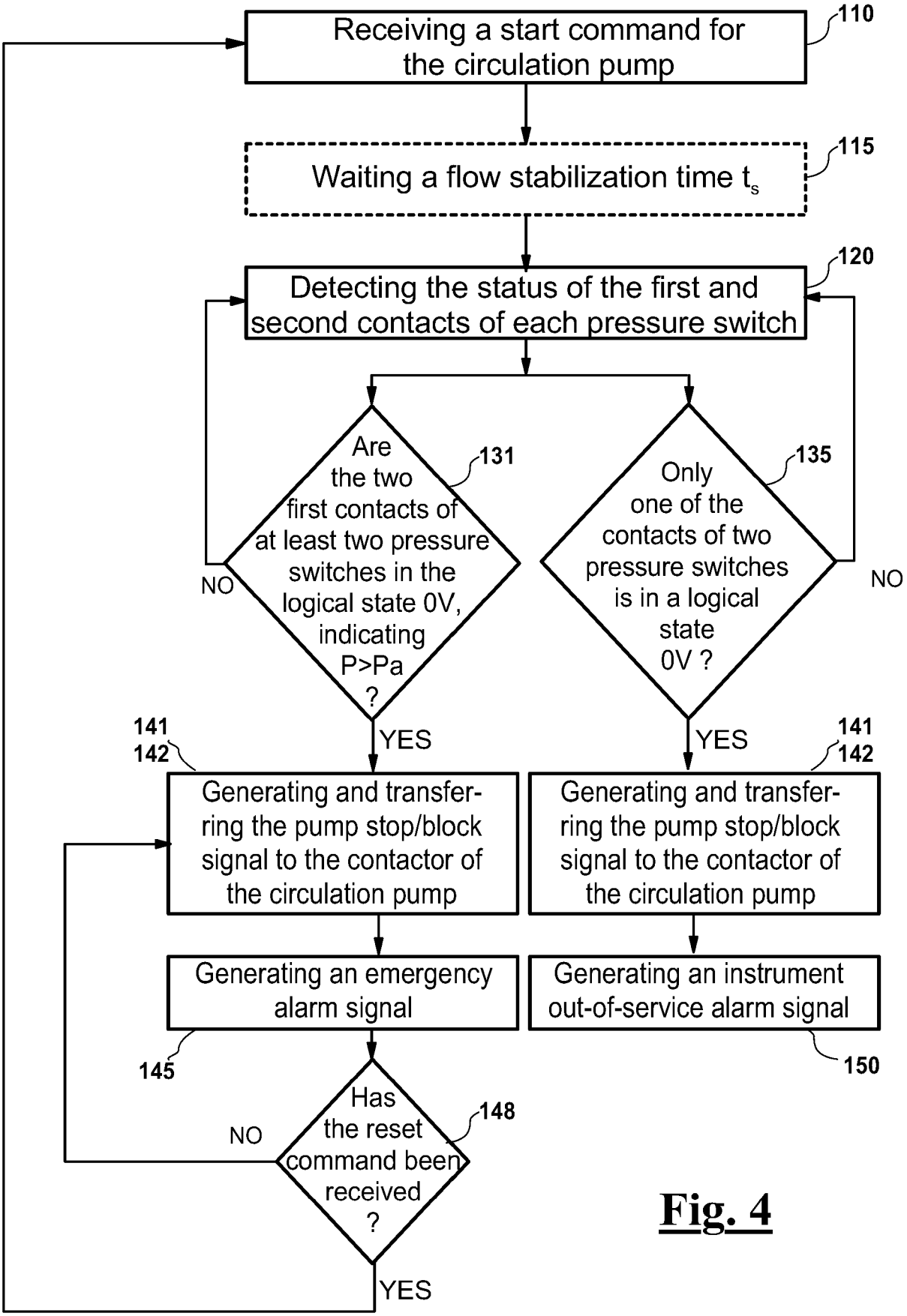

Receiving a start command for the circulation pump
110
Waiting a flow stabilization time t_s
115
Detecting the status of the first and second contacts of each pressure switch
120
Are the two first contacts of at least two pressure switches in the logical state 0V, indicating P>Pa ?
131
NO
YES
Only one of the contacts of two pressure switches is in a logical state 0V ?
135
NO
YES
141
142
Generating and transferring the pump stop/block signal to the contactor of the circulation pump
141
142
Generating and transferring the pump stop/block signal to the contactor of the circulation pump
Generating an emergency alarm signal
145
Generating an instrument out-of-service alarm signal
150
Has the reset command been received ?
148
NO
YES

Fig. 4

Fig. 5

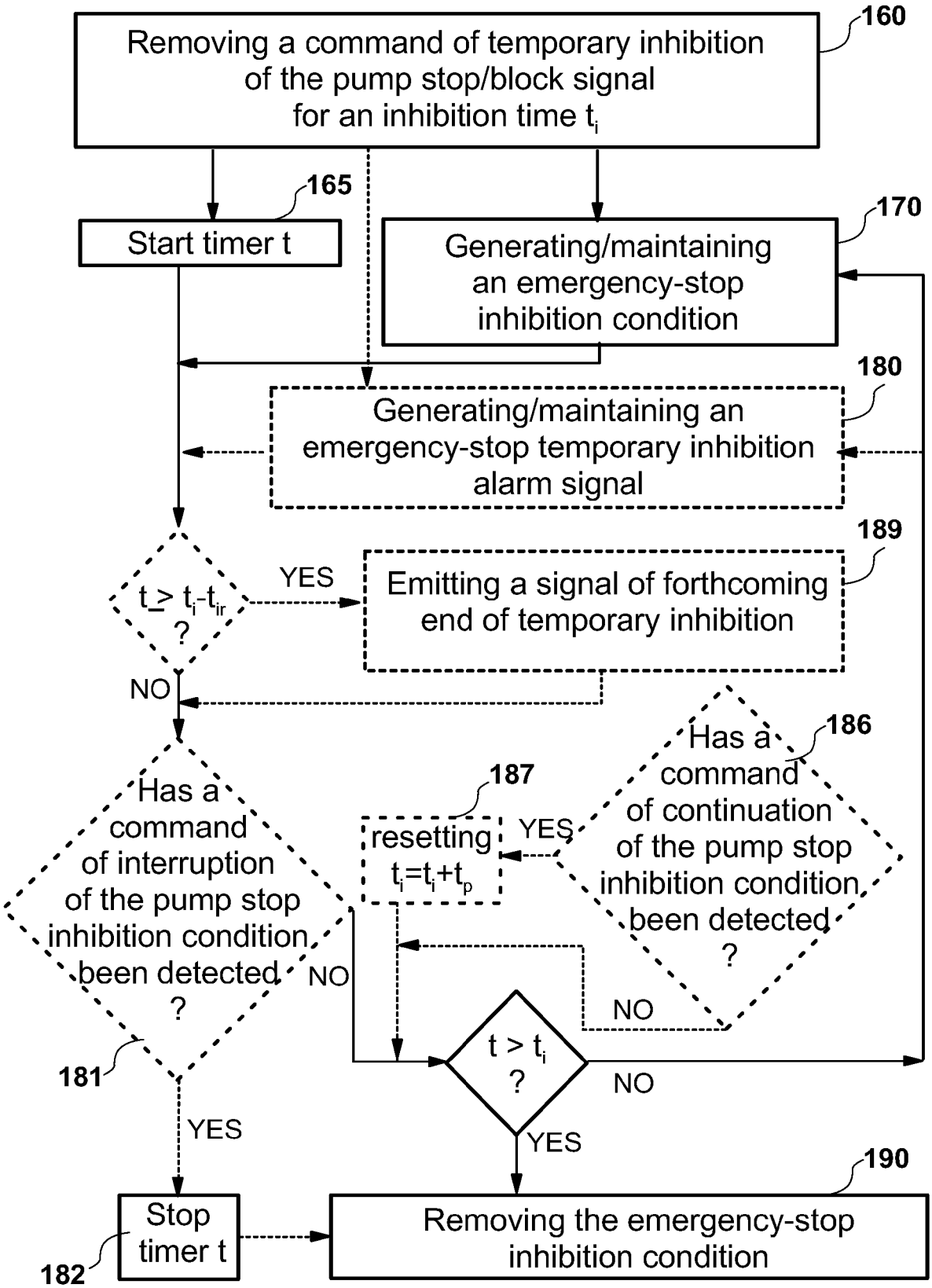
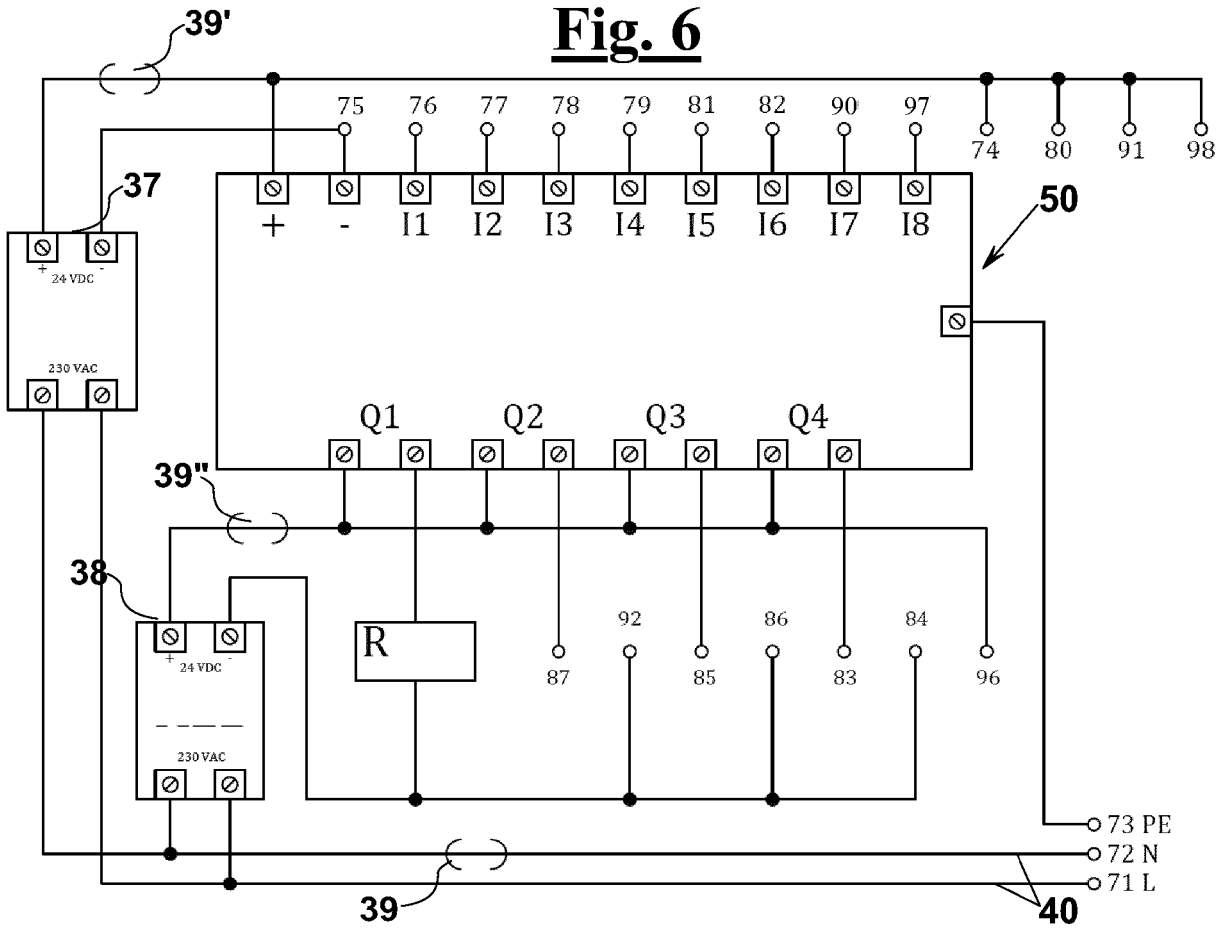

Removing a command of temporary inhibition of the pump stop/block signal for an inhibition time t_i
160
Start timer t
165
Generating/maintaining an emergency-stop inhibition condition
170
Generating/maintaining an emergency-stop temporary inhibition alarm signal
180
$t \geq t_i - t_{ir}$?
YES
Emitting a signal of forthcoming end of temporary inhibition
189
NO
Has a command of interruption of the pump stop inhibition condition been detected ?
181
YES
NO
resetting $t_i = t_i + t_p$
187
Has a command of continuation of the pump stop inhibition condition been detected ?
186
YES
NO
$t > t_i$?
NO
YES
Stop timer t
182
Removing the emergency-stop inhibition condition
190

Fig. 6


39'
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82
90
97
74
80
91
98
+
-
I1
I2
I3
I4
I5
I6
I7
I8
Q1
Q2
Q3
Q4
24 VDC
230 VAC
R
92
86
84
87
85
83
96
73 PE
72 N
71 L

Fig. 7

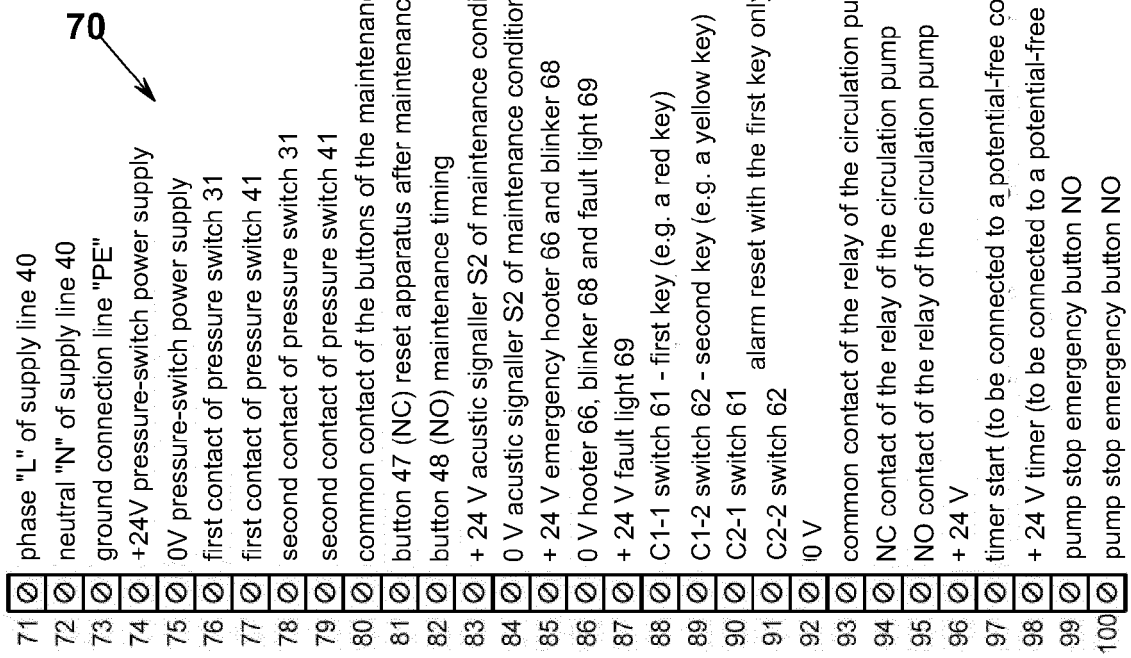

70
71 phase "L" of supply line 40
72 neutral "N" of supply line 40
73 ground connection line "PE"
74 +24V pressure-switch power supply
75 0V pressure-switch power supply
76 first contact of pressure switch 31
77 first contact of pressure switch 41
78 second contact of pressure switch 31
79 second contact of pressure switch 41
80 common contact of the buttons of the maintenance box
81 button 47 (NC) reset apparatus after maintenance
82 button 48 (NO) maintenance timing
83 + 24 V acustic signaller S2 of maintenance condition
84 0 V acustic signaller S2 of maintenance condition
85 + 24 V emergency hooter 66 and blinker 68
86 0 V hooter 66, blinker 68 and fault light 69
87 + 24 V fault light 69
88 C1-1 switch 61 - first key (e.g. a red key)
89 C1-2 switch 62 - second key (e.g. a yellow key)
90 C2-1 switch 61 alarm reset with the first key only
91 C2-2 switch 62
92 0 V
93 common contact of the relay of the circulation pump
94 NC contact of the relay of the circulation pump
95 NO contact of the relay of the circulation pump
96 + 24 V
97 timer start (to be connected to a potential-free contact)
98 + 24 V timer (to be connected to a potential-free contact)
99 pump stop emergency button NO
100 pump stop emergency button NO

Fig. 8

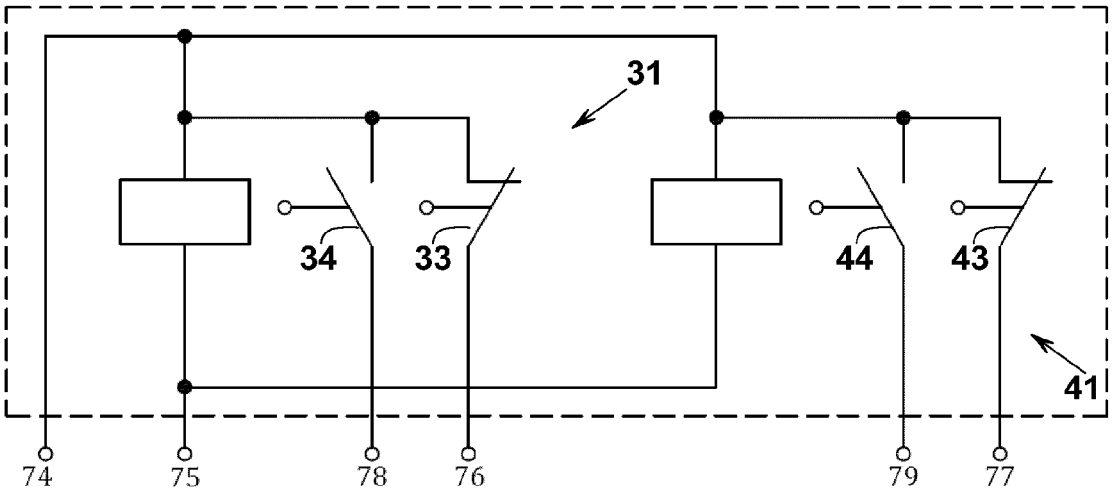


Fig. 9

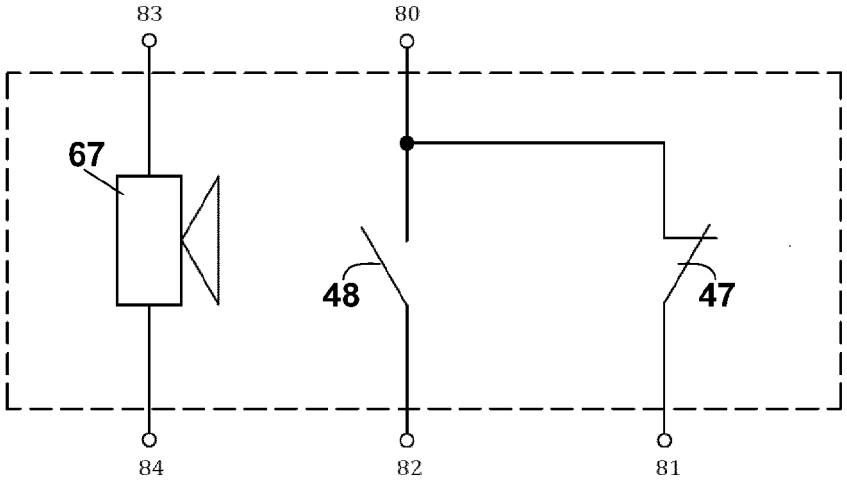


Fig. 10

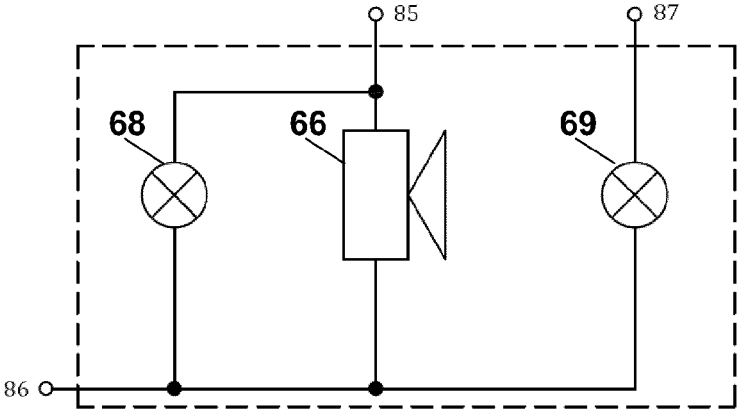


Fig. 11

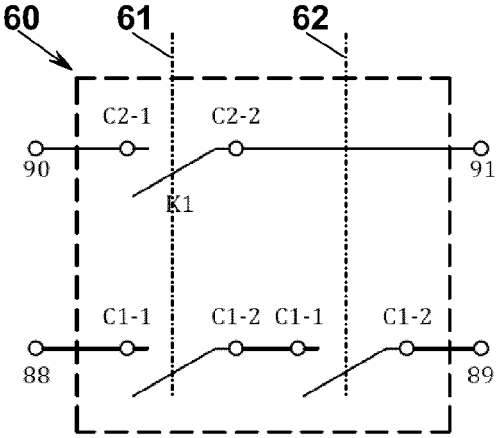


Fig. 12

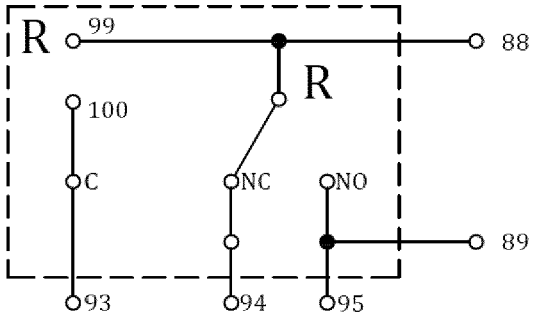


Fig. 13

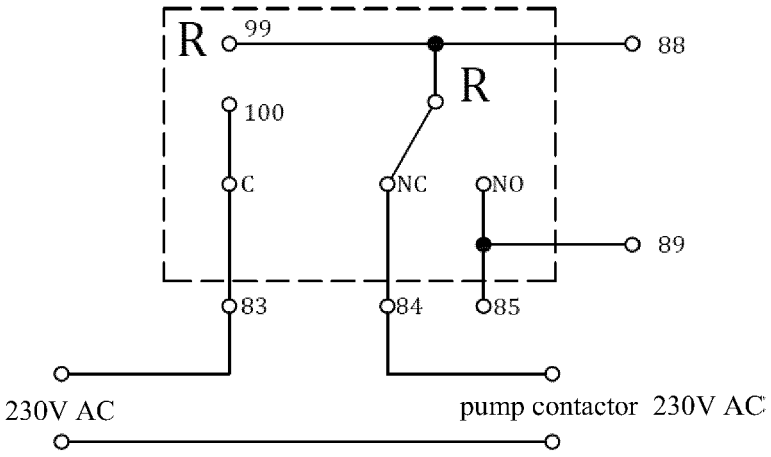


Fig. 14

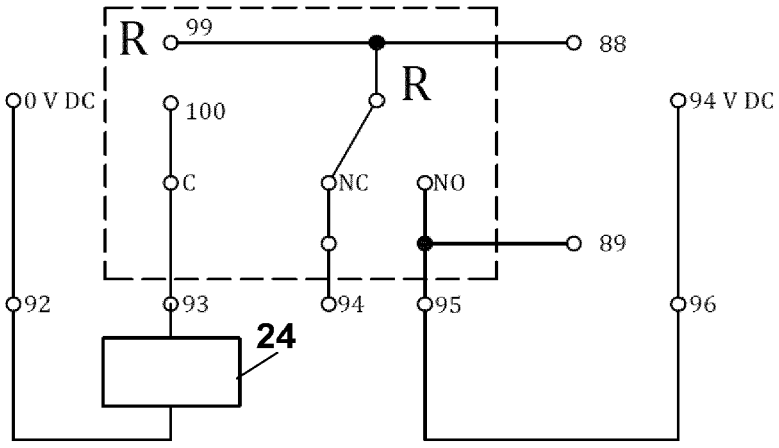


Fig. 15

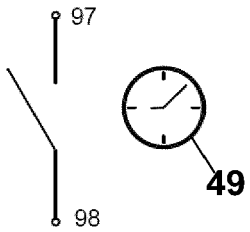


Fig. 16

Fig. 17

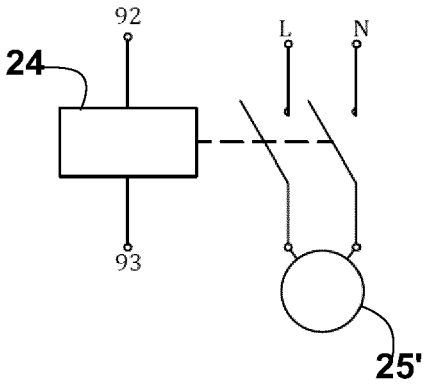


Fig. 18

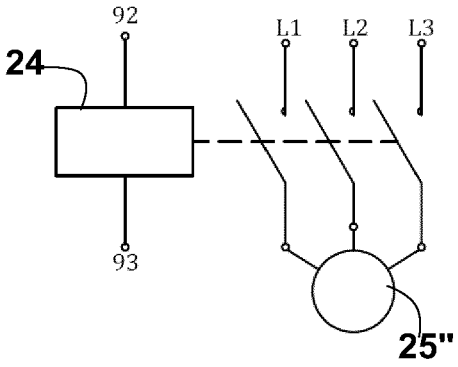


Fig. 19

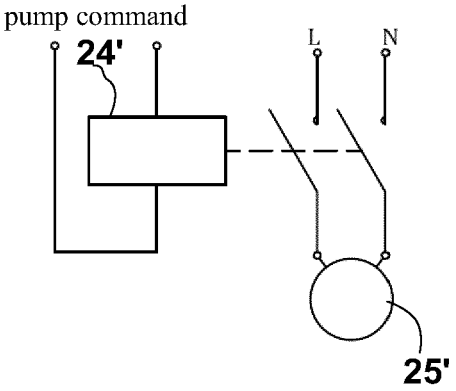
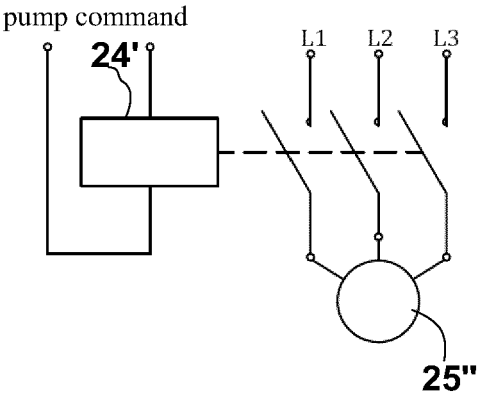


Fig. 20



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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 9945

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 6 059 536 A (STINGL DAVID A [US]) 9 May 2000 (2000-05-09) * column 1, line 53 - column 8, line 38; claim 1; figures 1-5 *	1-15	INV. E04H4/06 A61H33/00 F04B49/00
A,D	EP 1 081 312 A2 (NICHIGI ENGINEERING CO LTD [JP]) 7 March 2001 (2001-03-07) * claim 1; figure 1 *	1-15	
A,D	US 5 690 476 A (MILLER BERNARD J [US]) 25 November 1997 (1997-11-25) * claim 1; figures 1-7 *	1-15	
A,D	US 5 865 601 A (MILLER BERNARD J [US]) 2 February 1999 (1999-02-02) * claim 1; figures 1,2 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E04H
F04B
A61H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 May 2020	Decker, Robert

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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13-05-2020

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