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(58) Field of Search:
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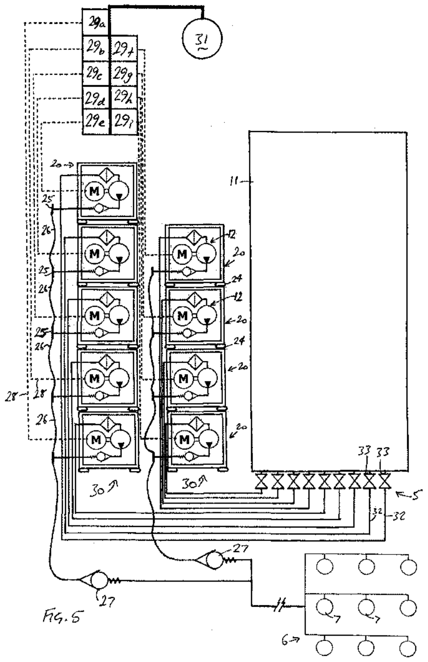
(54) Title of the Invention: **Water mist fire suppression system and method of installation**
Abstract Title: **Water mist system and method of installation**

(57) A system for pumping water is disclosed. The system is primarily for use in fire suppression systems within buildings and comprises a plurality of water pumps 12. The output from each pump is fed into a common outlet to give flow equivalent to a pump larger than each of the individual pumps. Each pump is mounted in a framework 21, multiples of which are stacked vertically in situ. Vibration reduction means 24, such as resilient rubber pads are included between neighbouring frameworks. The outlet from each pump includes a one-way valve 23 and a filter. The above allows work to be carried out on an individual pump without completely disrupting the water flow. Installation of individual frameworks enables a system to be installed more easily into a building and requires a smaller footprint compared with conventional systems.



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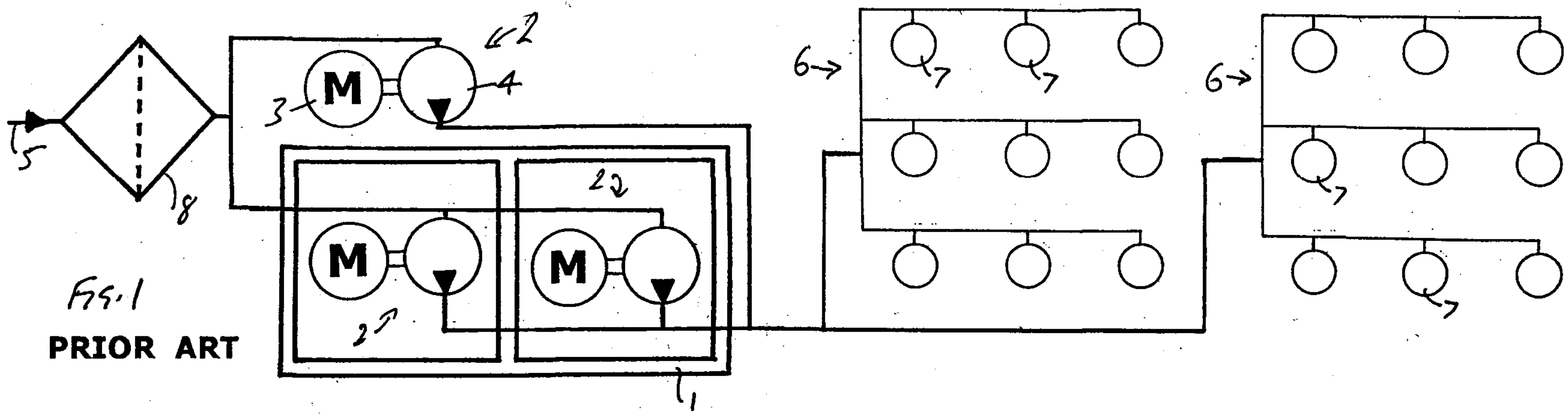

FIG. 1
PRIOR ART

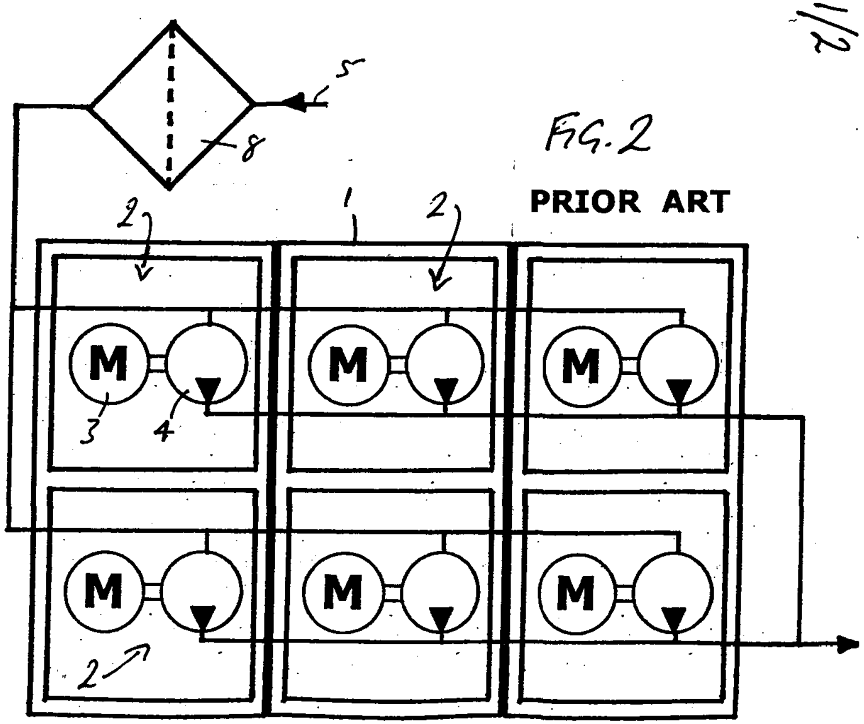

FIG. 2
PRIOR ART

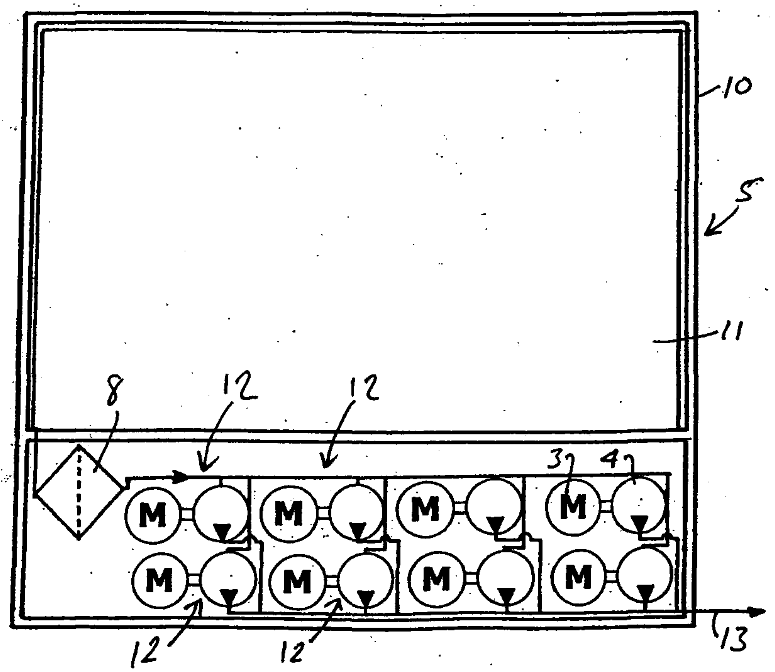

FIG. 3
PRIOR ART

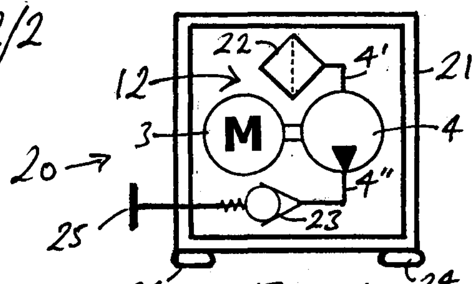
22
4'
21
12
M
3
4
20
4"
25
23
24
24

FIG. 4

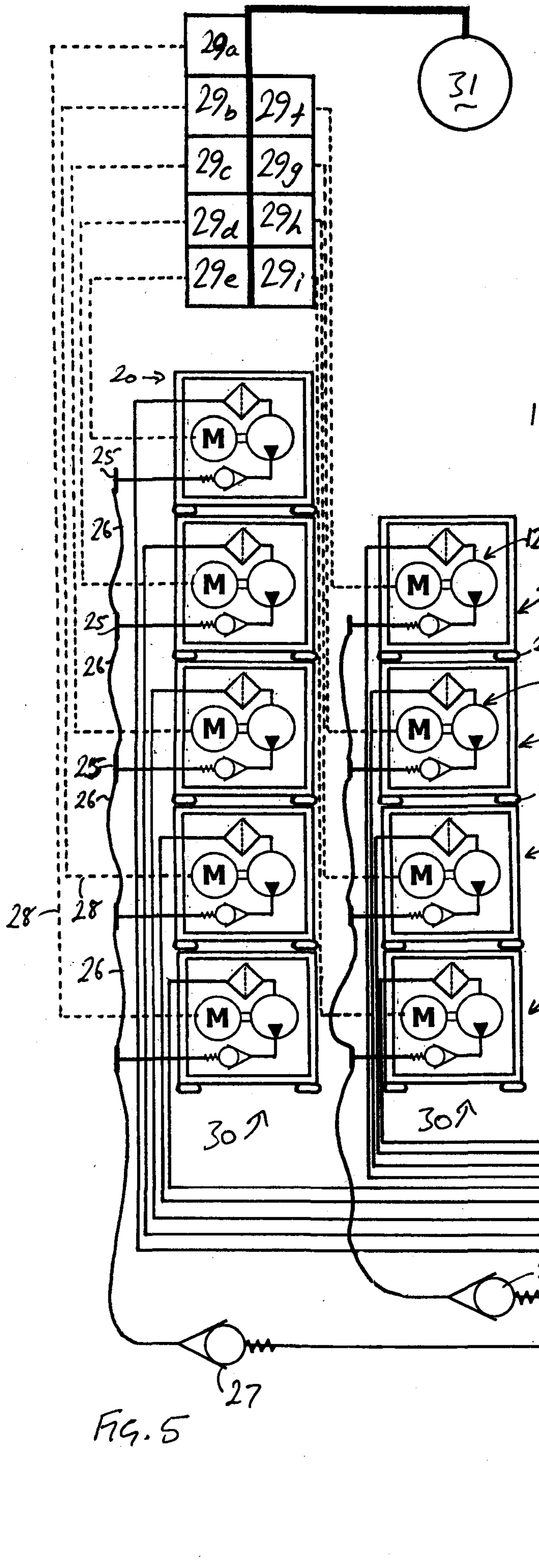
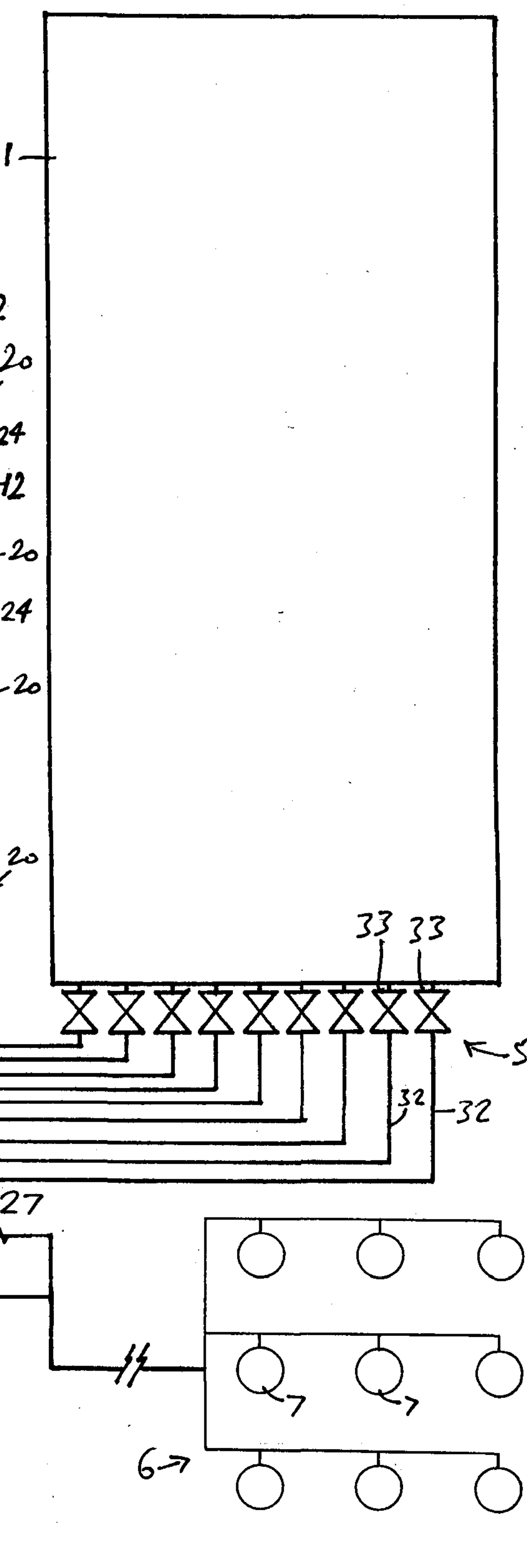
29a
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FIG. 5

Water mist fire suppression system and method of installation

This invention relates to the installation of water mist fire suppression systems, and particularly to pump assemblies for use in such systems.

Water mist fire suppression systems comprise an array of nozzles, which may include fixed nozzles and/or hand-held nozzles on hosereels, and one or more pumps which supply the nozzles with water via suitable pipework. In this specification, "water" means any suitable fire suppression fluid suitable for forming a mist, which is typically plain water but often includes additives. Hand-held nozzles are manually actuated while fixed nozzles are often actuated automatically, either individually by a glass bulb or other heat sensitive element arranged at each nozzle, or by valves responsive to sensors. Each nozzle is arranged to atomize water by passing it through one or a group of small orifices under high pressure, typically around 100 bar or more. This creates a mist or fog of fine water droplets, which are very much smaller than the droplets created by a conventional sprinkler system operating at much lower pressure. The very small droplets rapidly vaporise to cool the fire as well as displacing oxygen from the burning material so that even liquid fires are quickly suppressed using a much smaller volume of water than conventional low pressure systems.

High pressure water mist systems can be advantageously used for example in suppressing fires in data centres (computer rooms) due to the much reduced water damage that results from a water mist head activation as compared with a conventional sprinkler head. A typical installation protecting a data centre and compliant with current regulations specifying a minimum area of $76m^2$ to be covered by the nozzle array will comprise 9 water mist heads spaced equidistantly, each head supplying 12 l/m. Conventionally, such an installation would be supplied by a single pump of 120 l/m capacity, sufficient to supply the whole array, with a second 120 l/m pump providing redundancy in case of failure of the main pump. Conventionally, a framework is installed and then the pumps are arranged on the framework, either side by side or stacked up to two high.

Fig. 1 shows in simplified form a prior art arrangement of this type, comprising a framework 1 supporting three pumps 2, each comprising an electric motor 3 driving a positive displacement pump apparatus 4 which draws water from a supply 5 and delivers it at a pressure of up to about 150 bar to two nozzle arrays 6, each nozzle array comprising nine atomising nozzles 7 each consuming 12 l/m in use at a pressure of about 100 – 150 bar. A filter 8 is arranged to remove contaminants from the water supply to the three pumps. In this example each pump 2 has a maximum flow rate of 120 l/m so that each pump can supply one of the nozzle arrays, with the third pump providing redundancy.

Fig. 2 shows, again in simplified form, a similar prior art arrangement comprising a framework 1 supporting six pumps 2, each comprising an electric motor 3 and positive displacement pump apparatus 4; each pump supplies about 50 l/m at a working pressure of up to about 150 bar to a nozzle array (not shown) which has a maximum flow rate (defined by the flow which passes through the nozzles at the working pressure, typically about 100 bar – 150 bar) of about 150 l/m. The nozzle array is thus supplied by three of the pumps, with the remaining three pumps providing redundancy.

Arrangements of the general type shown in Figs. 1 and 2 are available from Fogtec Brandschutz GmbH & Co. KG of Cologne, Germany.

In each of the above examples the pumps are large, heavy and very expensive, and occupy a substantial footprint in the installed position.

Fig. 3 shows, again in simplified form, another prior art arrangement comprising a framework 10 including a water tank 11 and an assembly of eight smaller pumps

12, each comprising an electric motor 3 driving a positive displacement pump apparatus 4 which draws water through a filter 8 fitted in the supply line from the tank and supplies it to a stainless steel manifold 13 at a pressure of about 100 bar and a flow rate of 15 l/m. The manifold 13 supplies a nozzle array (not shown) which has a total flow rate of 108 l/m, so that the failure of any one of the pumps reduces the aggregate flow rate of the pump assembly to 105 l/m or 97% of the total flow rate of the nozzle array.

A complete assembly of the general type shown in Fig. 3 is available from Watermist Limited of Norfolk, United Kingdom.

In each of the above examples it often necessary to remove portions of the building, ship or other structure in which the system is to be fitted in order to bring in the pumps or pump assembly, which makes it difficult to carry out a phased installation or upgrade an existing system. If the nozzle array is extended to include an additional nozzle or nozzles, so that the flow rate of the nozzle array exceeds the capacity of the primary pumps, then in order to maintain the designed level of redundancy it is necessary to fit another pair of pumps or pump assembly of equivalent capacity.

Large positive displacement pumps, and assemblies of smaller positive displacement pumps, typically give rise to a strong vibration in use, which is undesirable for example where sensitive equipment may be damaged. Another problem is the substantial inrush current resulting from start-up of large electric motors, which in the worst case may activate circuit breakers, disabling the pump at the moment it is required, and which can also increase the cost of electricity supplied to the premises.

Another particular problem with high pressure water mist fire suppression systems is their susceptibility to fine particulate contaminants in the water supply. This is due to the small sliding clearances typical of the positive displacement or other high pressure pump elements which are required to generate the necessary system pressure, as well as the very small nozzle diameters used to create the required droplet size in the mist. In order to exclude contaminants capable of damaging the pumps and blocking the nozzles, it is necessary to pass the supply through very fine (e.g. 75 micron) filters, which however can rapidly clog.

It is the object of the present invention to provide a water mist fire suppression system and a method of installing such a system which addresses at least some of the above mentioned problems.

In accordance with the various aspects of the present invention there are provided a water mist fire suppression system and method of installation as defined in the claims.

Further features and advantages will be apparent from the following illustrative embodiment which is described, purely by way of example and without limitation to the scope of the claims, and with reference to the accompanying drawings, in which:

Fig. 1 – 3 are simplified representations of prior art systems as discussed in the preamble;

Fig. 4 is a simplified representation of a pump module in accordance with an embodiment of the present invention, and

Fig. 5 is a simplified representation of an installation comprising a plurality of the pump modules of Fig. 4.

Corresponding reference numerals indicate corresponding parts in each of the figures.

Referring to Figs. 4 and 5, a modular water mist fire suppression system including a nozzle array 6 and an assembly of identical, interchangeable pump modules 20, each module including a pump 12 and a welded rectilinear steel frame 21 surrounding and supporting the pump. The pump is preferably mounted on a rear portion of the frame so that it is accessible via the front of the frame in the configuration schematically represented in the drawings.

The pump comprises a three-phase electric motor 3 driving a positive displacement pump apparatus 4, which has an inlet 4' and an outlet 4". A filter 22 is arranged at the inlet between the water supply 5, comprising a tank 11, and the inlet 4'. A non-return valve 23 (which preferably includes a pressure regulator with a return path to the water supply, not shown, for bleeding off excess flow) is arranged at the respective outlet, and acts to prevent reverse flow to the pump and so prevents pressure loss from the remaining pumps in the assembly in the event that a single pump fails.

By using many smaller, interchangeable pumps to supply a nozzle array conventionally supplied by fewer, larger pumps, the level of redundancy can be safely reduced compared with conventional systems with fewer, larger pumps. At the same time, the smaller pumps are preferably assembled in situ in a vertical self-supporting stack or stacks 30 so as to be readily accessible, which allows much easier installation and maintenance and makes it possible to upgrade or extend the system after it is installed, as well as reducing the footprint of the installation. The smaller size and lighter weight of each pump (approximately 50 kg for a pump supplying 15 l/m at 120 bar) makes it possible easily to bring the pumps into a finished building or other structure and stack them at least 3 high, typically up to 5 high as shown.

The identical modules 20 are brought on site one by one and stacked interchangeably one upon another, with the frames 21 being fixed together in situ in the stacked configuration and separated by anti-vibration couplings 24 to form at least one stack of modules, and conveniently several stacks arranged side by side as shown, so that each of the pumps remains easily accessible for maintenance or replacement. Of course, the stacks could be arranged close together and fixed together with further anti-vibration couplings if desired.

The anti-vibration couplings comprise elastomeric pads or the like as known in the art, which may be mounted on flat rigid supports welded to each frame and are selected to absorb vibration at the characteristic frequency emitted by the pump in use. The couplings may comprise fixings for fixing the frames together or alternatively may be separate from the fixings. Surprisingly it is found that by selecting the couplings for the correct frequency response, the novel assembly is much quieter in use than prior art pump assemblies, and no sympathetic (resonant or harmonic) vibration is observed between adjacent modules in the stack.

The outlet 4" of each pump is preferably connected via the non-return valve 23 to a coupling 25, conveniently a simple tee connector, which permits two pressure hoses 26 to be connected to it. After assembly, the connectors 25 are coupled together by high pressure flexible hoses 26 which do not transmit vibration between modules. The hoses 26 and connectors 25 thus form a composite manifold which is assembled in situ. This provides much easier assembly and disassembly than the separate, rigid manifolds used in prior art assemblies, which also tend to transmit vibration, particularly where harmonic and resonant vibration is generated from assemblies of several pumps running simultaneously.

Each inlet filter 22 is connected via a separate supply hose 32 and manual valve 33 to the tank 11. By closing the valve 33 and disconnecting the outlet 4" from the non-return valve 23, each pump may be isolated from the stack and replaced by another while the remaining pump modules remain in operation. In an alternative embodiment (not shown), each inlet filter 22 may be connected, optionally via a manual isolating valve, to a common supply line from the tank 11 or other water supply. Of course, less preferably, each module may comprise only the pump 12 and not the other components, in which case a single filter can be provided in series with all of the pump modules.

Preferably the inlet and outlet of each pump and non-return valve are arranged to swivel so that the connections can be made in any convenient angular position. This can be achieved using conventional flanged pipe connectors in which the flanges define rotating abutment surfaces separated by a compressible washer with a threaded nut which can be tightened to draw the surfaces together after positioning them in the correct angular relation.

The pumps are preferably divided into at least two groups, each group conveniently (though not necessarily) comprising the modules of a single stack 30 as shown, and each group is connected to the nozzle array 6 via another respective non-return valve 27, which provides further protection in case of failure of any component of either stack by preventing reverse flow which would reduce the line pressure developed by the other stack. The valve 27 preferably also comprises a regulator with a return path (not shown) to the water supply for bleeding off excess flow.

The pump motors 3 are electrically powered from a power supply 31, each via a separate connection 28 to a timed sequential starter 29a...29i, which starts each pump sequentially so as to minimise the inrush current to that of a single pump motor.

Typically a minimum installation comprises nine nozzles 7 as shown, each consuming 12 l/m in use and so the array has a maximum flow rate F1 of 108 l/m at about 100 bar. The nozzles are actuated individually by heat sensitive elements. In this typical installation, if a minimum of six pumps are used with 0% redundancy (F1 = F2), then the failure of one pump leaves 83% output, which provides full flow to 8 out of the 9 nozzles. It is unlikely that all 9 nozzles would be activated so this represents an acceptable but economical approach to system redundancy. The modularity of the system, particularly in the stacked configuration, allows additional pumps to be easily added to upgrade the system by providing further redundancy.

Preferably n interchangeable pumps are provided, wherein n is preferably at least 6 and more preferably at least 8; and preferably each pump is relatively small, having a maximum flow rate for example of 15 l/m at 120 bar as in the illustrated embodiment, or alternatively of not more than 20 l/m. High pressure pumps of this size are much less expensive than the large pumps used in the conventional art. It will be appreciated that a greater number of pumps makes the system more convenient to install and less affected by a single failure, so that it is no longer necessary to provide a high level of redundancy. The installation can thus be more robust yet far more economical.

Each pump preferably has a maximum flow rate F2/n, wherein $n \geq 6$ and F2 is at least 100% F1 and not more than 140% F1. In the illustrated embodiment, the total flow rate F2 of the nine pumps is 135 l/m, so that F2 is 125% F1.

Preferably one additional pump is provided for redundancy, as in the example illustrated, where even if one pump fails, the remaining eight pumps can supply a total flow rate of 120 l/m which is still in excess of the demand of the nozzle array; which is to say, $F1 \leq (n-1).(F2/n)$.

Less preferably, two additional pumps may be provided, so that F1 $\leq$ (n-2).(F2/n). It would generally be unnecessary and hence undesirable to provide more than one or two redundant pumps.

Surprisingly it has been found in practice that when multiple filters are arranged in a parallel configuration in a system having relatively low flow rates (for example, 3-5 m/s), contaminants are typically concentrated in only one of the filters, often the last in line, and when this filter becomes blocked, the remaining filters are found to be relatively clean. This is contrary to what might be expected with the higher flow rates typical of most fire suppression systems operating at lower pressures, where multiple parallel filters might be expected to become blocked at the same time, for which reason such systems have conventionally been provided with a single main filter in series with the pump or pumps. Although the reasons for this phenomenon are not fully understood, the applicants have recognised that it may be exploited in high pressure, low flow systems by providing multiple redundant filters in parallel configuration, each in series with a single pump, to overcome the problem of system failure due to filter contamination. This advantage is particularly evident where the filters are supplied from a common supply line (not shown), but even where the filters are supplied via separate lines from a water tank as shown in the illustrated example, it is found that one filter tends to become blocked before the others. This advantage may be realised even where (less preferably) the modules are not arranged in a stacked configuration.

In addition to or instead of arranging anti-vibration couplings between the frames of the modules, anti-vibration couplings may be arranged between each pump and the frame or framework on which it is mounted; it will be understood that anti-vibration couplings between the frames of the modules effectively separate the pumps of those modules by preventing vibration from passing between them.

The power supply may be mains power or a generator, or alternatively may comprise a plurality of batteries, e.g. accumulators, which may be arranged in a single bank or may be arranged in each module adjacent the pump. In alternative embodiments, the pump may comprise a single phase motor (which is less preferred, particularly since it creates more vibration) or another type of prime mover, and the pump apparatus could be of another type than the positive displacement type, as long as it is capable of developing the high pressure necessary to supply the atomising nozzles.

In summary, in a preferred embodiment a water mist nozzle array in a fire suppression system is supplied at high pressure from a modular assembly of motor driven pumps, preferably mounted in individual frames which are assembled in situ in a stacked configuration and separated by anti-vibration couplings. Each module may include an inlet filter. Preferably the nozzle array is supplied by at least 6 or 8 stacked, interchangeable pumps with not more than 125% to 140% redundancy, so that each pump is relatively small in size and easy to install and maintain. The pumps are stacked one upon another and fixed together in situ to form at least one stack of pumps, the stack preferably comprising at least three pumps stacked one upon another and supported by the framework; in the illustrated embodiment the framework comprises the frames of the modules, although in alternative embodiments the pumps may be supplied separately from the framework, with the framework for example being supplied as a welded unit or assembled in situ from parts.

Many further adaptations will be evident to those skilled in the art, and it is to be understood that the invention is limited only by the scope of the claims.

CLAIMS

1. A method of installing a water mist fire suppression system including the steps of:
installing a nozzle array;
providing a plurality of interchangeable pump modules, each module including at least a pump and a frame supporting the pump, the pump having an inlet and an outlet;
stacking the modules one upon another and fixing the frames together in situ to form at least one stack of modules;
and connecting each inlet to a water supply and connecting each outlet to the nozzle array.

2. A method according to claim 1, wherein the pumps are electrically powered and started sequentially.

3. A method according to claim 1, wherein each pump includes a respective non-return valve arranged at the respective outlet.

4. A method according to claim 1 or claim 3, wherein the pumps are divided into at least two groups, and each group is connected to the nozzle array via a respective non-return valve.

5. A method according to claim 1, wherein the pumps in the stack are separated by anti-vibration couplings.

6. A method according to claim 1 or claim 5, wherein the outlets of the pumps in the stack are coupled together by flexible hoses.

7. A method according to claim 1, wherein each module includes a filter arranged between the water supply and the inlet.

8. A method according to claim 1, wherein each pump has a maximum flow rate of not more than 20 l/m.

9. A method according to claim 1, wherein each pump has a maximum flow rate of not more than 15 l/m.

10. A modular water mist fire suppression system including a nozzle array and an assembly of interchangeable pump modules, each module including a pump and a frame supporting the pump, the pump having an inlet and an outlet, each respective inlet being connected to a water supply, each respective outlet being connected to the nozzle array;
wherein the modules are arranged interchangeably one upon another in a stacked configuration.

11. A system according to claim 10, wherein the pumps are electrically powered and started sequentially.

12. A system according to claim 10, wherein each pump includes a respective non-return valve arranged at the respective outlet.

13. A system according to claim 10 or claim 12, wherein the pumps are divided into at least two groups, and each group is connected to the nozzle array via a respective non-return valve.

14. A system according to claim 10, wherein the pumps in the stack are separated by anti-vibration couplings.

15. A system according to claim 10 or claim 14, wherein the outlets of the pumps in the stack are coupled together by flexible hoses.

16. A system according to claim 10, wherein each module includes a filter arranged between the water supply and the inlet.

17. A system according to claim 10, wherein each pump has a maximum flow rate of not more than 20 l/m.

18. A system according to claim 10, wherein each pump has a maximum flow rate of not more than 15 l/m.

19. A method of installing a water mist fire suppression system including the steps of:
installing a nozzle array, the array having a maximum flow rate F1;
providing n interchangeable pumps, each pump having an inlet and an outlet;
stacking the pumps one upon another and fixing them together in situ to form at least one stack of pumps, the stack comprising at least three pumps stacked one upon another and supported by a framework;
and connecting each inlet to a water supply and connecting each outlet to the nozzle array;
each pump having a maximum flow rate F2/n,
wherein $n \geq 6$ and F2 is at least 100% F1 and not more than 140% F1.

20. A method according to claim 19, wherein $n \geq 8$.

21. A method according to claim 19, wherein F2 is not more than 125% F1.

22. A method according to claim 19, wherein the pumps are electrically powered and started sequentially.

23. A method according to claim 19, wherein each pump includes a respective non-return valve arranged at the respective outlet.

24. A method according to claim 19 or claim 23, wherein the pumps are divided into at least two groups, and each group is connected to the nozzle array via a respective non-return valve.

25. A method according to claim 19, wherein the pumps in the stack are separated by anti-vibration couplings.

26. A method according to claim 19 or claim 25, wherein the outlets of the pumps in the stack are coupled together by flexible hoses.

27. A method according to claim 19, wherein each module includes a filter arranged between the water supply and the inlet.

28. A method according to claim 19, wherein each pump has a maximum flow rate of not more than 20 l/m.

29. A method according to claim 19, wherein each pump has a maximum flow rate of not more than 15 l/m.

30. A modular water mist fire suppression system including a nozzle array, the array having a maximum flow rate F1,
and an assembly of n interchangeable pumps,
the pumps being arranged in at least one stack, the stack comprising at least three pumps stacked one upon another and supported by a framework;
each pump having an inlet connected to a water supply and an outlet connected to the nozzle array, each pump having a maximum flow rate F2/n,

wherein $n \geq 6$ and F2 is at least 100% F1 and not more than 140% F1.

31. A system according to claim 30, wherein $n \geq 8$.

32. A system according to claim 30, wherein F2 is not more than 125% F1.

33. A system according to claim 30, wherein the pumps are electrically powered and started sequentially.

34. A system according to claim 30, wherein each pump includes a respective non-return valve arranged at the respective outlet.

35. A system according to claim 30 or claim 34, wherein the pumps are divided into at least two groups, and each group is connected to the nozzle array via a respective non-return valve.

36. A system according to claim 30, wherein the pumps in the stack are separated by anti-vibration couplings.

37. A system according to claim 30 or claim 36, wherein the outlets of the pumps in the stack are coupled together by flexible hoses.

38. A system according to claim 30, wherein each module includes a filter arranged between the water supply and the inlet.

39. A system according to claim 30, wherein each pump has a maximum flow rate of not more than 20 l/m.

40. A system according to claim 30, wherein each pump has a maximum flow rate of not more than 15 l/m.

41. A modular water mist fire suppression system including a nozzle array, the array having a maximum flow rate F1,

and an assembly of n interchangeable pump modules, each module including a pump and a filter,

each pump having an inlet connected to a water supply and an outlet connected to the nozzle array,

the filter being arranged between the water supply and the inlet;

each pump having a maximum flow rate F2/n,

wherein $n \geq 6$ and F2 is at least 100% F1 and not more than 140% F1.

42. A system according to claim 41, wherein $n \geq 8$.

43. A system according to claim 41, wherein F2 is not more than 125% F1.

44. A system according to claim 41, wherein the pumps are electrically powered and started sequentially.

45. A system according to claim 41, wherein each pump includes a respective non-return valve arranged at the respective outlet.

46. A system according to claim 41 or claim 45, wherein the pumps are divided into at least two groups, and each group is connected to the nozzle array via a respective non-return valve.

47. A system according to claim 41, wherein each pump has a maximum flow rate of not more than 20 l/m.

48. A system according to claim 41, wherein each pump has a maximum flow rate of not more than 15 l/m.

49. A system according to claim 41, wherein the filters are supplied from a common supply line.

50. A modular water mist fire suppression system substantially as described with reference to the accompanying drawings.

Application No: GB1121631.4 **Examiner:** Mr David McWhirter

Claims searched: 1-40 **Date of search:** 25 April 2012

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	10-12 & 15-16	US 2002/117311 U (SUNDHOLM) see figure 1 and paragraphs 19-21

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

A62C; F04B; F04C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
A62C	0035/68	01/01/2006