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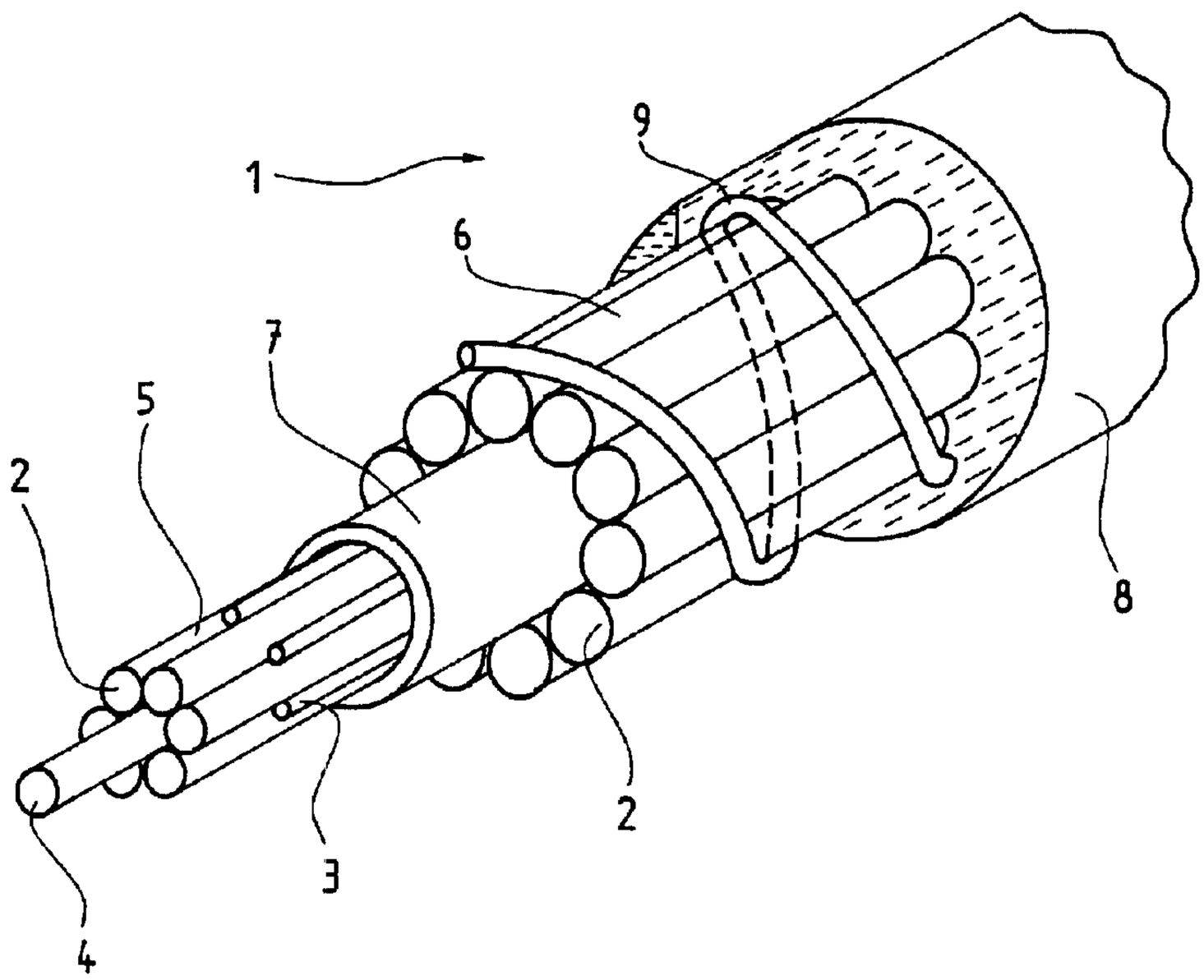
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(54) Title: SYNTHETIC FIBER CABLE



(57) Abrégé/Abstract:
A synthetic fibre cable (1), preferably of polyamide, according to the invention consists of a bundle of load-bearing synthetic material fibres (2) and at least one conductive temperature sensor element (9) participating in the cable (1). The temperature sensor element (9) forms, in dependence on the temperature, a conductive connection over the length of the cable (1), which connection is constantly monitored by measurement technology. The connection is interrupted at a checking control in the case of temperatures critical for the synthetic fibre cable (1). The temperature sensor element (9) in one embodiment is a fine wire melting at the critical temperature. The synthetic fibre cable (1) according to the invention is used in lift installations amongst other things as a safety device, especially as a fire alarm.

Summary

A synthetic fibre cable (1), preferably of polyamide, according to the invention consists of a bundle of load-bearing synthetic material fibres (2) and at least one conductive temperature sensor element (9) participating in the cable (1). The temperature sensor element (9) forms, in dependence on the temperature, a conductive connection over the length of the cable (1), which connection is constantly monitored by measurement technology. The connection is interrupted at a checking control in the case of temperatures critical for the synthetic fibre cable (1). The temperature sensor element (9) in one embodiment is a fine wire melting at the critical temperature. The synthetic fibre cable (1) according to the invention is used in lift installations amongst other things as a safety device, especially as a fire alarm.

(Figure 1)

Synthetic Fibre Cable

The invention relates to a synthetic fibre cable, particularly as a support element for lifts, consisting of a bundle of reinforced load-bearing synthetic material fibres.

Reinforced synthetic fibre cables replace conventional wire cables to an increasing extent in applications such as, for example, with lift installations where on the one hand large cable lengths are necessary and on the other hand for energy reasons the requirement exists for smallest possible moved masses.

Such synthetic fibre cables are a textile product of linear reinforced chemical fibre materials, preferably aramide or polyamide, which are spun into cable yarns and are produced by cable forming without rotation, by two-stage or multiple-stage twisting and/or sheathing. However, the cable breakage strength for chemical fibres significantly diminishes by comparison with steel cables even at substantially lower temperatures, before they finally melt. The melting point of aramides lies in the region of 450 to 500° celsius. At temperatures of above 180° celsius the load-bearing capability of synthetic fibre cables already begins to reduce.

In order to be able to use synthetic fibre cables of that kind, in particular as a running cable in conveying technology such as lift construction, it is necessary to recognise the cable state free of doubt.

For this purpose a device for recognition of readiness of synthetic fibre cables for discard is known from European patent specification 0 731 209 A1 of the applicant. The principle of function of this device consists in that indicator fibres are integrated in some of the strands of reinforced fibres with specific mechanical properties. The material properties of these indicator fibres depend on those of the load-bearing synthetic fibres, wherein the breaking elongation and the modulus of elasticity are so selected that the indicator fibres break, due to material fatigue and abrasive wear, etc., earlier than the load-bearing fibres. These indicator fibres conduct current and are constantly monitored in terms of measurement technology. If the constant monitoring recognises a predetermined number of failed indicator fibres the cable has to be replaced by a new one.

With the device described so far with respect to construction and function the breakdown of the cable caused by mechanical loading can be reliably recognised, but special fire protection requirements imposed on synthetic fibre cables cannot be satisfactorily fulfilled by that.

The invention indicated by the features of the claims meets the object of developing a synthetic fibre cable, of the kind stated in the introduction, in such a manner that operational safety in the case of thermal overheating and/or is the case of fire is ensured. The synthetic fibre cable fulfils in particular the fire protection requirements in lift construction where the safety of passengers must at no time be put at risk.

With the synthetic fibre cable according to the invention a monitoring of the temperature in the cable and thus indirectly also over the entire shaft length and engine room is possible for the first time. The conductive connection by the cable is formed only at temperatures below the temperature critical for the cable. In the case of temperatures lying above that the conductive connection is interrupted and accordingly no electrical or optical signal or the like can be transmitted, which can be simply established in terms of measurement technology. In co-operation with a checking device, cable damage caused by heat can be detected promptly in this manner, reproduced at, for example, a lift control, and appropriate measures for evacuation of passengers can be carried out by this without delay in time.

In a development of the invention, a temperature sensor element with temperature-dependent conductivity for the applied checking signal is provided. This offers the advantage that starting out from a constructionally determined value, the strength of the checking signal can also be correspondingly changed. The respective cable temperature can be ascertained on the basis of this quantitative signal. The temperature-dependence can in that case be selected so that, on exceeding of the critical temperature, conductivity is no longer present.

A preferred development of the invention proposes that the temperature sensor element has a temperature-critical material strength which is lower than that of the load-carrying synthetic material fibres. On attainment of a constructionally predetermined temperature the temperature sensor element fails in that, for example, it melts or breaks and thus

interrupts the conductive connection. A qualitative checking signal, for the evaluation of which a very simple measurement technology is sufficient, is thereby obtained.

In preferred embodiments the temperature sensor element can also be constructed as electrical conductors, optical conductors or the like, by which a checking signal can be transmitted. Essential in the selection of the conductor material used in that case is a fatigue bending strength which at least corresponds with that of the load-bearing fibres, so that a work-induced material failure is excluded. For example, the temperature sensor element can be worked in with the cable as an electrical conductor in the form of a metal wire or a synthetic yarn or a material combination consisting thereof.

The temperature sensor element is preferably wound around the cable and covered by cable sheathing preferably formed in a pressure injection-molding press. In an advantageous embodiment in that case, several temperature sensor elements are arranged parallel to the strands and/or embedded, in the cable longitudinal direction, in the cable sheathing around the cable. This offers the advantage that the temperature sensor element can be laid closely against the cable structure and the mechanical loading of the temperature sensor element when running over rollers is small.

In one aspect, the present invention resides in a synthetic fibre rope for use as an elevator cable supporting a load comprising: a bundle of load-bearing synthetic material fibres including an outer layer of strands formed around a core, said core and said strands extending between opposite ends of the rope; a sheathing covering said outer layer of strands and having an outer surface forming an outer surface of the rope; and at least one temperature sensor element positioned between said outer layer of strands and said outer surface of said sheathing and forming a conductive connection between the ends of the rope, said temperature sensor element changing a characteristic of said conductive connection at a predetermined temperature lower than a temperature at which the rope is damaged by heat to permanently interrupt conduction and to signal an operational safety concern related to the load-bearing capability of the rope.

In another aspect, the present invention resides in an elevator car support for use in an elevator installation to suspend an elevator car comprising: a synthetic fibre load-bearing rope having a length and an end for attachment to an elevator car, said rope including an outer layer of strands covered by a molded sheathing; and a sensor means extending said length of said rope for sensing a temperature and changing a characteristic at a

predetermined temperature lower than a temperature at which the said rope is damaged by heat, said sensor means being positioned adjacent said outer layer of strands and permanently changing from conductive to non-conductive at said predetermined temperature to signal an operational safety concern related to the load-bearing capability of said rope.

In yet another aspect, the present invention resides in a synthetic fibre rope for use as an elevator cable supporting a load comprising: a bundle of load-bearing synthetic material fibres including an outer layer of strands formed around a core, said core and said strands extending between opposite ends of the rope; a molded sheathing covering said outer layer of stands and having an outer surface forming an outer surface of the rope; and at least one temperature sensor means positioned on said outer layer of strands and embedded in said sheathing and forming a conductive connection between the ends of the rope, said temperature sensor means permanently interrupting conduction at a predetermined temperature lower than a temperature at which the rope is damaged by heat, said temperature sensor means having a temperature-critical material strength smaller than a material strength of said strands and a fatigue bending strength of said temperature sensor means at least corresponding with a fatigue bending strength of said strands.

The invention is more closely explained in the following on the basis of an example and with reference to the accompanying drawing. There:

Figure 1 shows a multi-layer aramide fibre cable with a temperature sensor element helically wound around the cable and laid in the cable sheathing,

Figure 2 shows, schematically, a monitoring circuit for the aramide fibre cable illustrated in the Figure 1, and

Figure 3 shows a circuit diagram of a checking circuit.

The perspective illustration in Figure 1 shows the build-up of a sheathed aramide fibre cable 1 of aramide fibre strands 2 which, together with filler strands 3, are arranged in the manner of layers around a core 4. A wear-reducing intermediate sheathing 7, which is preferably profiled, is formed between an inner strand layer 5 and an outermost strand

layer 6. The outermost strand layer 6 is covered by the cable sheathing 8, preferably of polyurethane or polyamide. A thinner wire 9 is here helically wound around the outermost strand layer 6 over the entire cable length. The cable sheathing 8 is extrusion moulded on over the wire 9, so that the wire 9 is embedded in the cable sheathing material and covered by this.

The wire 9 consists of a metal alloy and is electrically conductive. It has an electrical resistance which rises with increasing temperature. The resistance is constantly detected by a checking control device described further below. The composition of the alloy is selected in such a manner that the wire melts at a temperature range of 100 to 120° celsius.

Instead of winding the wire 9 around the cable 1, this can also be arranged to be laid in the cable sheathing 8 parallel to the aramide fibre strands 2 of the outermost strand layer 6 or, however, be worked up together with the load-bearing aramide fibre strands 2 to form the aramide fibre cable.

The monitoring, by measurement technology, of the aramide fibre cable 1 illustrated in Figure 1 is shown in Figure 2. For checking whether the electrically conductive connection produced by means of the temperature sensor element or elements, here the copper wire 9, is intact over the cable length 10 or a specific cable length portion, an electrical voltage can, for example, be applied in a checking circuit 11 to the two ends of the wire 9. A battery 12 or a voltage generator, for example, is suitable as voltage source for that purpose. It can then be recognised with the assistance of an ammeter 13 or telltale lamp whether or not a current flows through the copper wire 9.

In the case of embodiments with a plurality of wires 9 which are each individually monitored, a failure of the temperature sensor element on grounds other than a too high cable temperature can be recognised by comparison of the measurement results of the individual temperature sensor elements. An erroneous alarm can be excluded in this manner. Analogously, distinction is made between measurement results of temperature sensor elements of, for example, several cables associated with one lift drive in order to exclude a loss summation.

A circuit suitable for that purpose is known from, for example, European patent specification 0 731 209 A1. Figure 3 shows such a checking circuit 21, which is connected into the monitoring circuit 11 instead of an ammeter. A constant current 15 is fed by way of a voltage source 14 to each wire 9, a resistance RI to RN being illustrated for each wire 9. A low-pass filter 16 filters the arriving pulses and feeds these to a threshold value switch 17. The threshold value switch 17 compares the measured voltages. On exceeding of specific limit values, i.e. due to a thermal overheating of the temperature sensor element 9, the resistance is so large that the permissive voltage value is exceeded. This exceeding of the limit value is stored by a non-volatile store 18. This store 18 can be cancelled by means of a reset button 9 or it passes on its data to a logic device 20 which is connected with the lift control.

Each wire 9 is correspondingly linked to the network and constantly monitored. As soon as two or more of these temperature sensors are interrupted and thus a temperature-induced damage of the synthetic fibre cable is to be expected, the lift control automatically drives the lift cage to the evacuating position and arrests the cage. Moreover, it is possible to automatically inform a message centre or the fire service about the abnormal state by way of the checking control device.

A further possibility of protection against high temperatures consists in positioning thermoelements in fixed location at the end connection of the synthetic fibre cables, for example at a coupling to the cage, either on the upper yoke of the cage or on the counterweight or, however, in the engine room of 2:1 suspended lifts, and, on triggering of a bimetallic contact or the like at detected temperatures of about 100° celsius, issuing a report by way of the transmission apparatus to the control. The control then informs the emergency control centre or, directly, the fire service.

During travel down a shaft a smoke alarm mounted at the cage can in a given case detect smoke at specific storeys, localise it, control the lift to go past and notify the emergency call centre or fire service by way of the transmission apparatus. From the data, present at the control, with respect to the cage position in the shaft and the moment of triggering the alarm, the emergency call centre and/or fire service can obtain corresponding data for minimisation of damage.

What is claimed is:

1. A synthetic fibre rope for use as an elevator cable supporting a load comprising:

a bundle of load-bearing synthetic material fibres including an outer layer of strands formed around a core, said core and said strands extending between opposite ends of the rope;

a sheathing covering said outer layer of strands and having an outer surface forming an outer surface of the rope; and

at least one temperature sensor element positioned between said outer layer of strands and said outer surface of said sheathing and forming a conductive connection between the ends of the rope, said temperature sensor element changing a characteristic of said conductive connection at a predetermined temperature lower than a temperature at which the rope is damaged by heat to permanently interrupt conduction and to signal an operational safety concern related to the load-bearing capability of the rope.

2. The synthetic fibre rope according to claim 1, wherein the temperature sensor element has a temperature-dependent conductivity.

3. The synthetic fibre rope according to claim 1, wherein the temperature sensor element has a temperature-critical material strength, which is smaller than that of the load-bearing synthetic material fibres.

4. The synthetic fibre rope according to any one of claims 1 to 3, wherein the temperature sensor element comprises an electrical conductor or an optical conductor.

5. The synthetic fibre rope according to claim 1, wherein the temperature sensor element is formed as yarn or wire.

6. The synthetic fibre rope according to any one of claims 1 to 5, wherein the temperature sensor element is laid into the cable casing.

7. The synthetic fibre rope according to claim 1, wherein the temperature sensor element forms a conductive connection at temperatures below 100° celsius.

8. The synthetic fibre rope according to any one of claims 1 to 7, wherein the temperature sensor element comprises checking means for constant checking of its conductivity.

9. The synthetic fibre rope according to any one of claims 1 to 8 as a sensor for a fire alarm.

10. A lift installation with at least one support element connecting a lift cage with a counterweight, wherein the support element is a synthetic fibre rope according to any one of claims 1 to 8.

11. The rope according to claim 1 wherein a fatigue bending strength of said temperature sensor element at least corresponds with a fatigue bending strength of said strands.

12. An elevator car support for use in an elevator installation to suspend an elevator car comprising:

a synthetic fibre load-bearing rope having a length and an end for attachment to an elevator car, said rope including an outer layer of strands covered by a molded sheathing; and

a sensor means extending said length of said rope for sensing a temperature and changing a characteristic at a predetermined temperature lower than a temperature at which the said rope is damaged by heat, said sensor means being positioned adjacent said outer layer of strands and permanently changing from conductive to non-conductive at said predetermined temperature to signal an operational safety concern related to the load-bearing capability of said rope.

13. The support according to claim 12 wherein said predetermined temperature is in a range of approximately 100° through 120° Celsius.

14. The support according to claim 12 wherein said sensor means has a temperature-critical material strength smaller than a material strength of said strands and a fatigue bending strength of said sensor means at least corresponds with a fatigue bending strength of said strands.

15. A synthetic fibre rope for use as an elevator cable supporting a load comprising:

a bundle of load-bearing synthetic material fibres including an outer layer of strands formed around a core, said core and said strands extending between opposite ends of the rope;

a molded sheathing covering said outer layer of stands and having an outer surface forming an outer surface of the rope; and

at least one temperature sensor means positioned on said outer layer of strands and embedded in said sheathing and forming a conductive connection between the ends of the rope, said temperature sensor means permanently interrupting conduction at a predetermined temperature lower than a temperature at which the rope is damaged by heat, said temperature sensor means having a temperature-critical material strength smaller than a material strength of said strands and a fatigue bending strength of said temperature sensor means at least corresponding with a fatigue bending strength of said strands.

Fig. 1

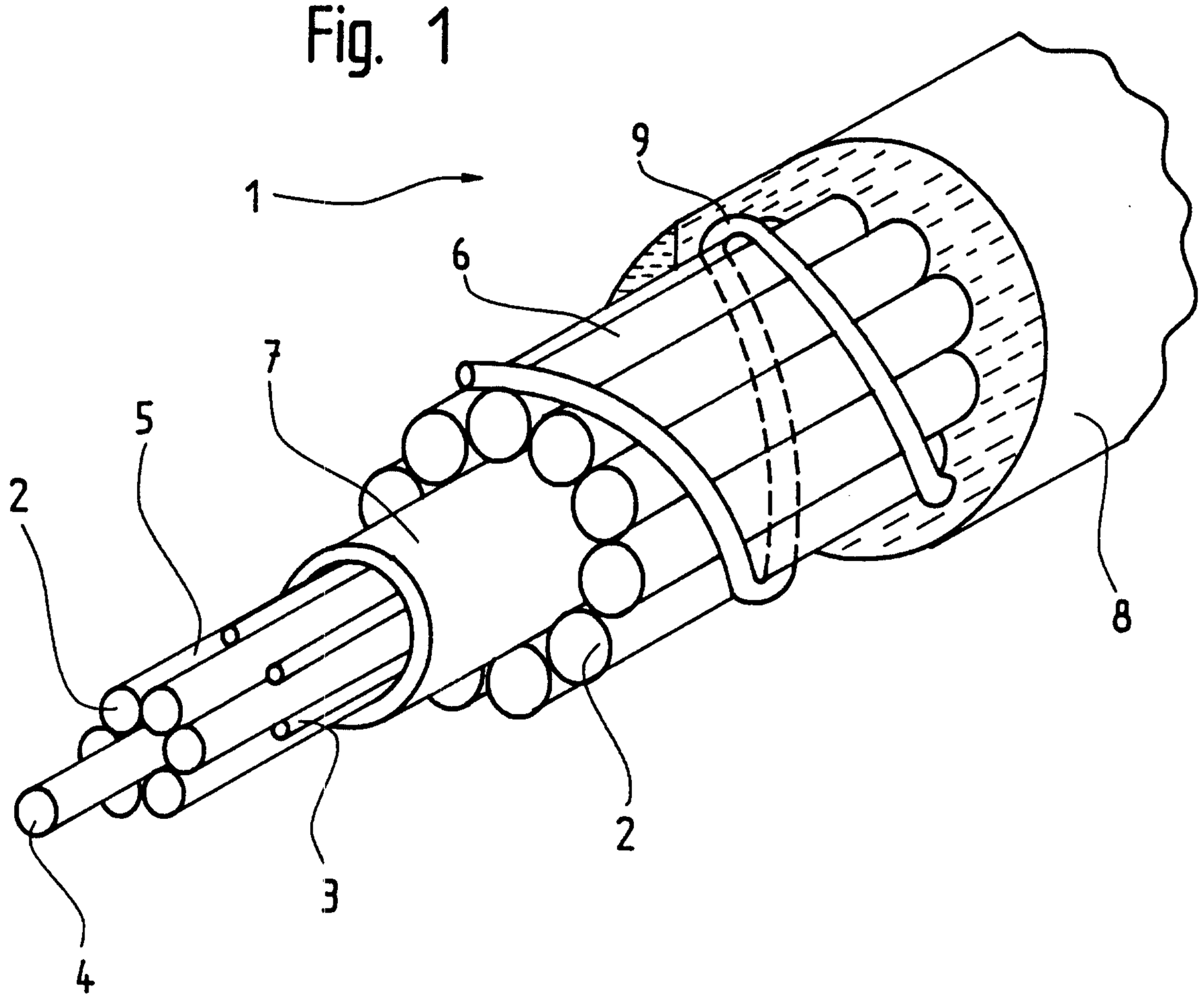


Fig. 2

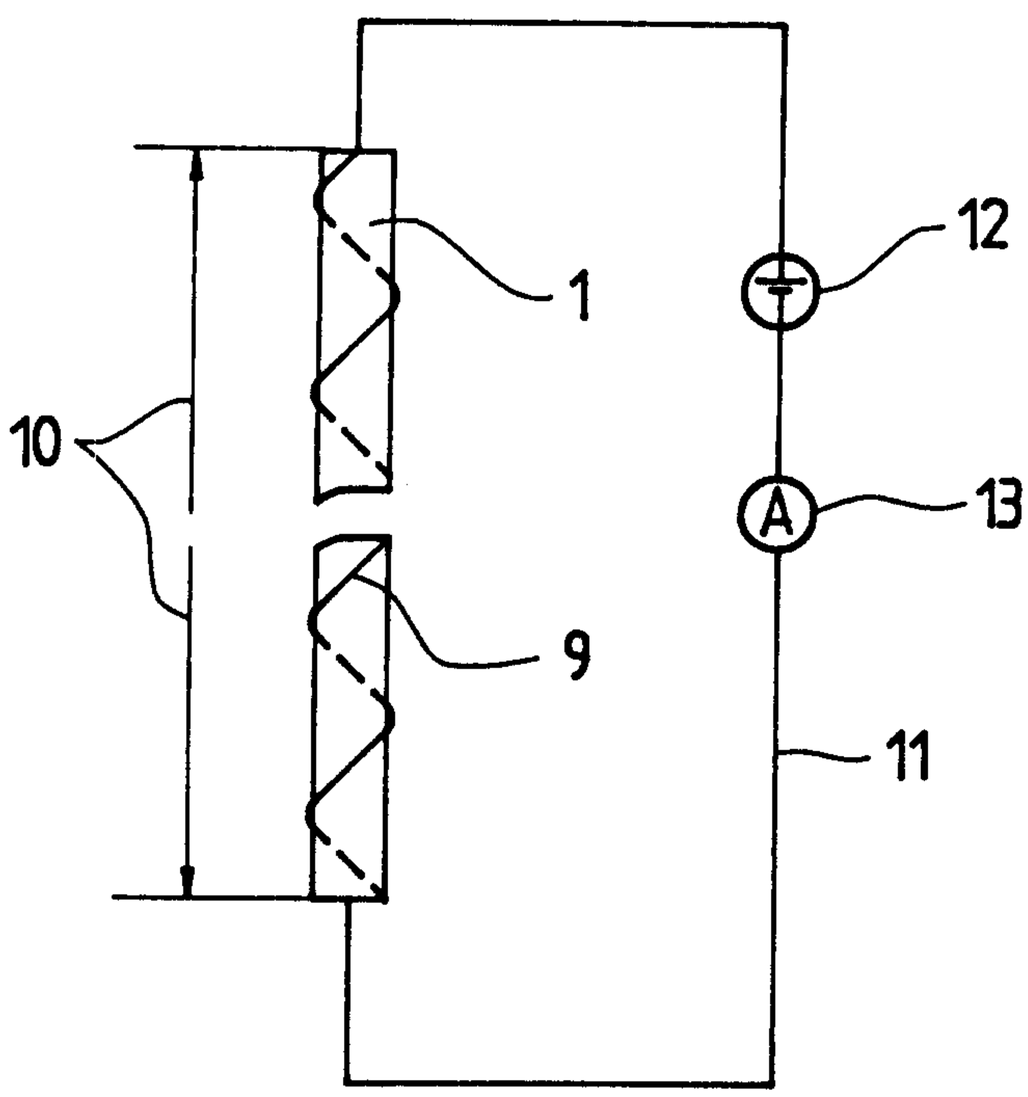
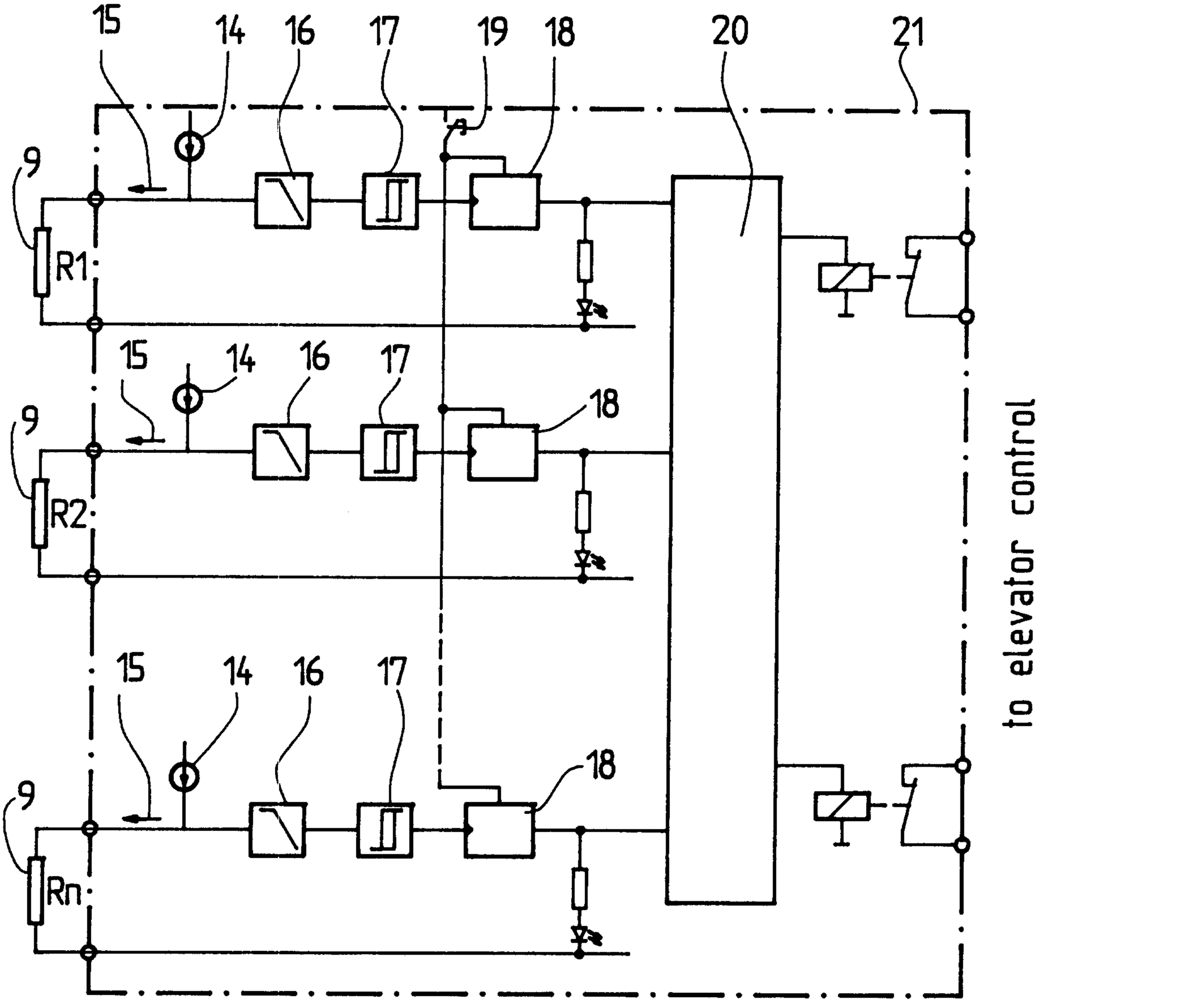
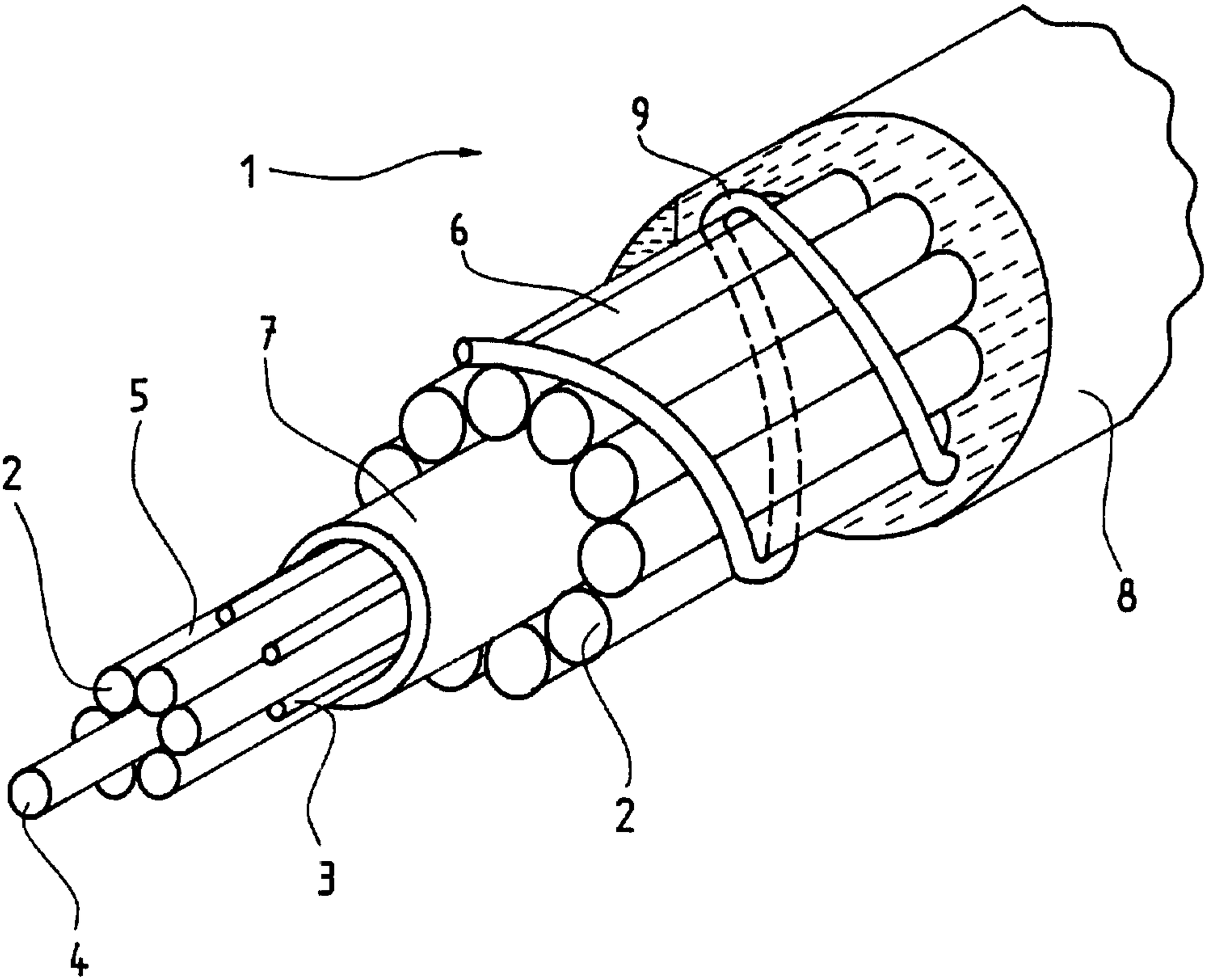


Fig. 3


15
14
16
17
19
18
20
21
9
R1
15
14
16
17
9
R2
18
15
14
16
17
18
9
Rn
to elevator control


1
9
6
7
5
2
8
3
2
4