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(54) Abstract Title
Cable device for inspecting conduits

(57) Apparatus for facilitating internal access to a conduit 4, especially for inspection, comprises a cable 13 having an irregular surface and being of a size allowing it to pass freely along the conduit. The apparatus further includes a pressurised fluid supply means 13 in the form of a fully pressurised system connectable to the conduit to supply a stream of pressurised fluid to the cable to urge the cable along the conduit. The irregular surface on the cable 13 may comprise grooves, ripples or fins. The cable 13 preferably carries sensors for inspection of the conduit 4.

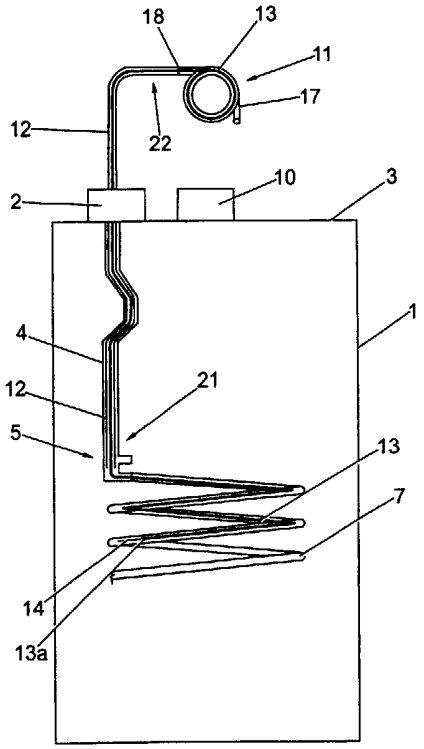

Fig. 4

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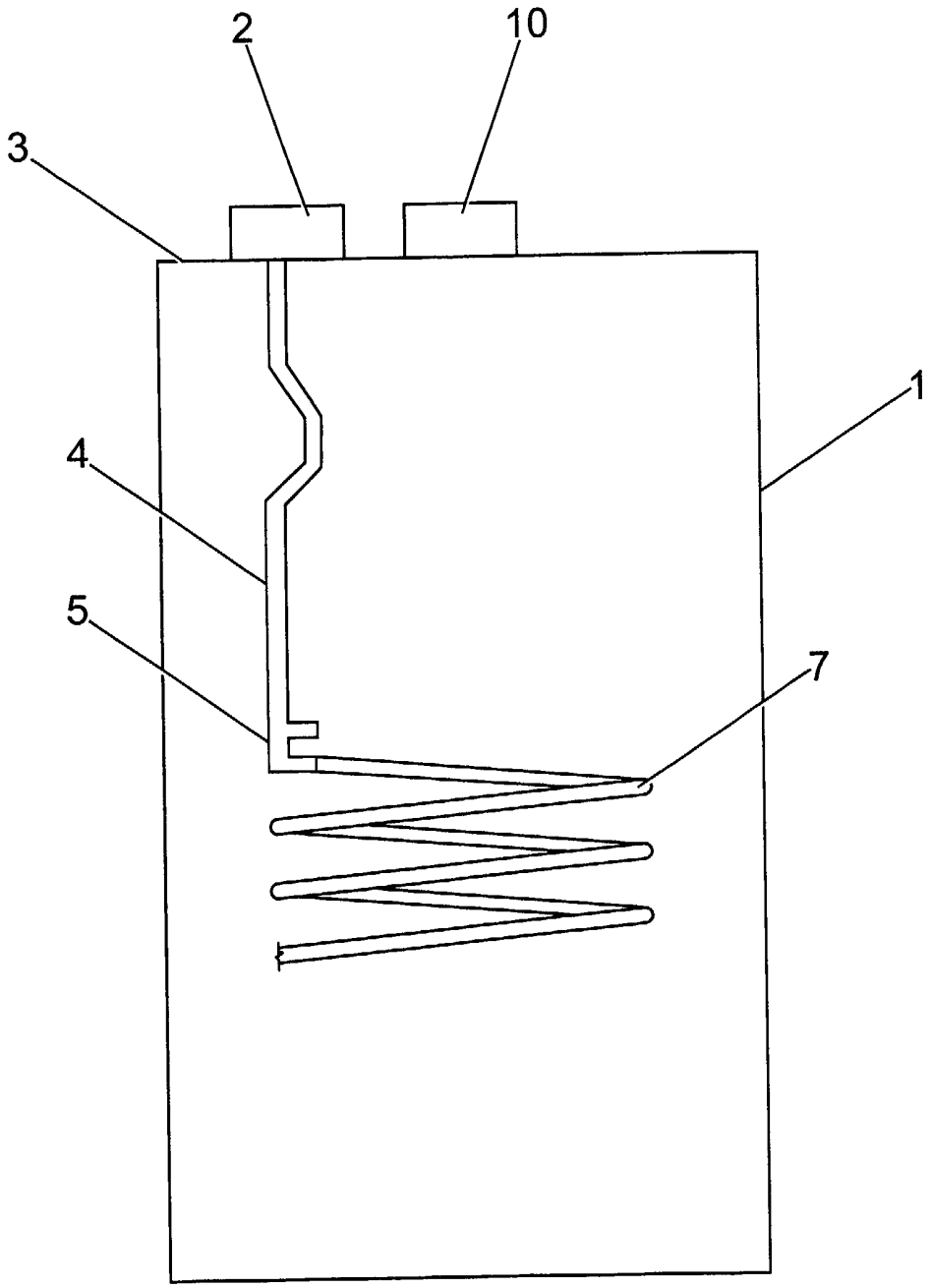

Fig. 1

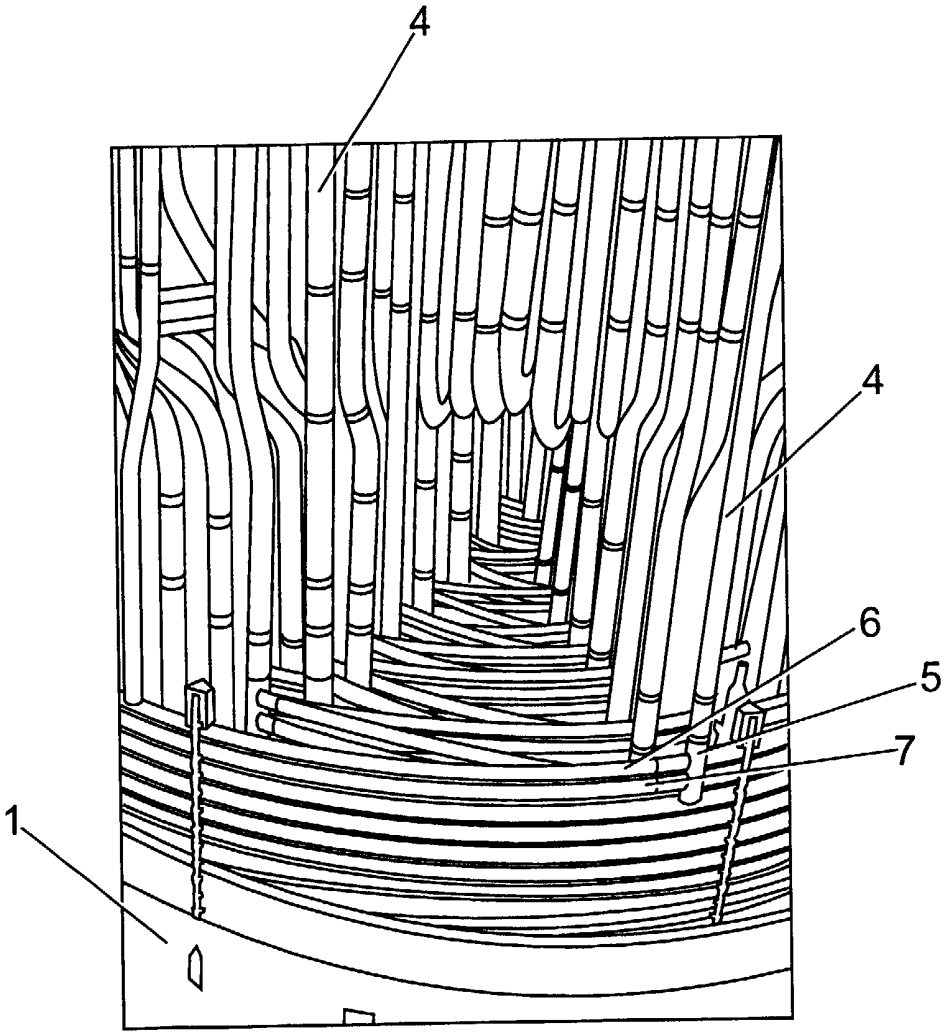

Fig. 2

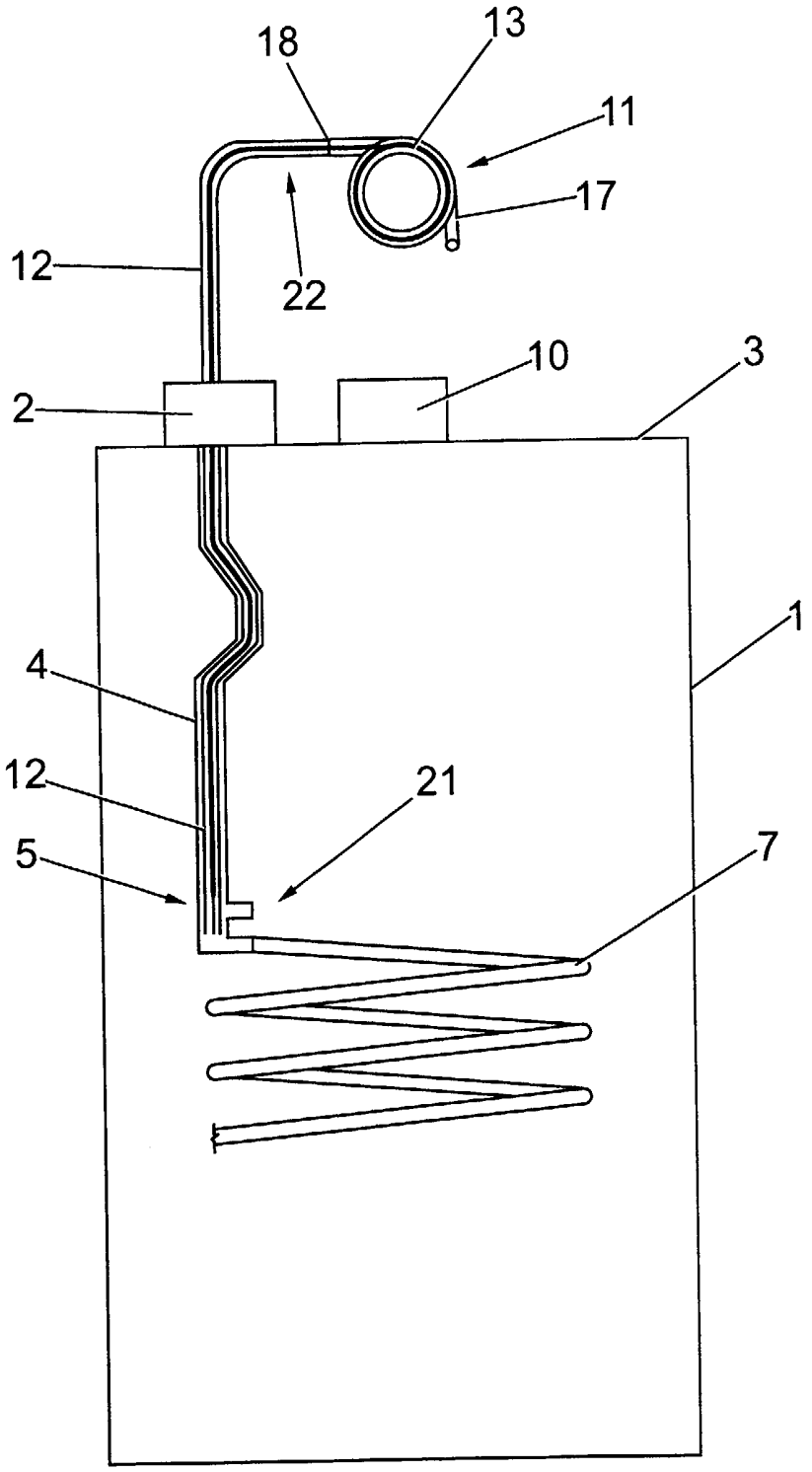

Fig. 3

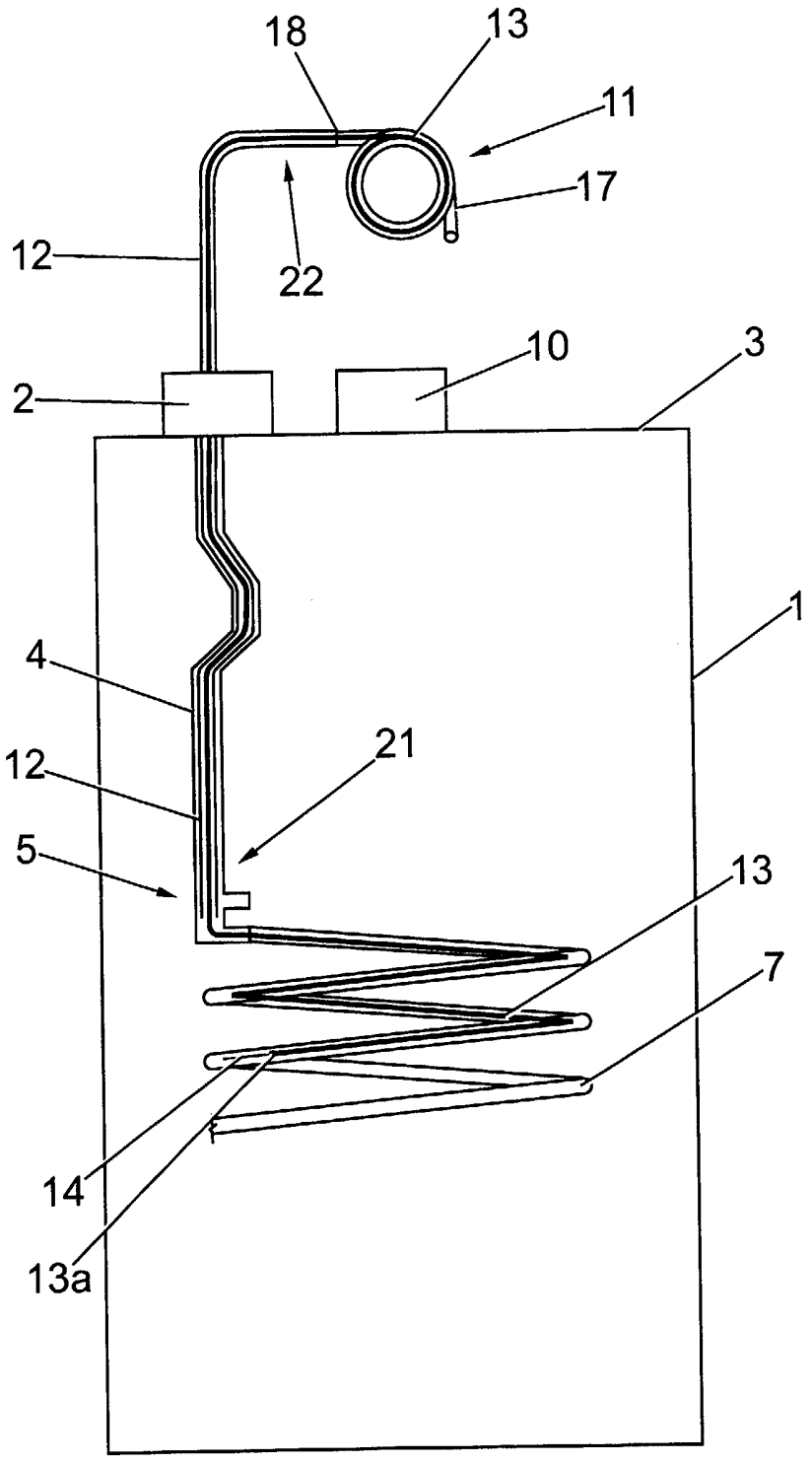

Fig. 4

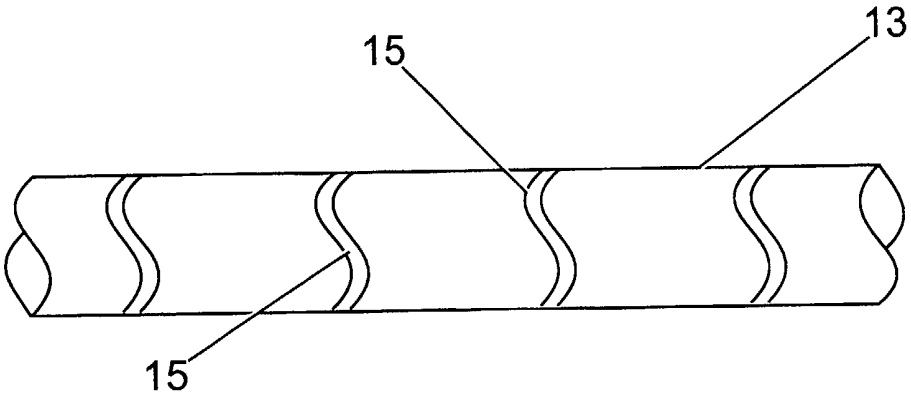

Fig. 5

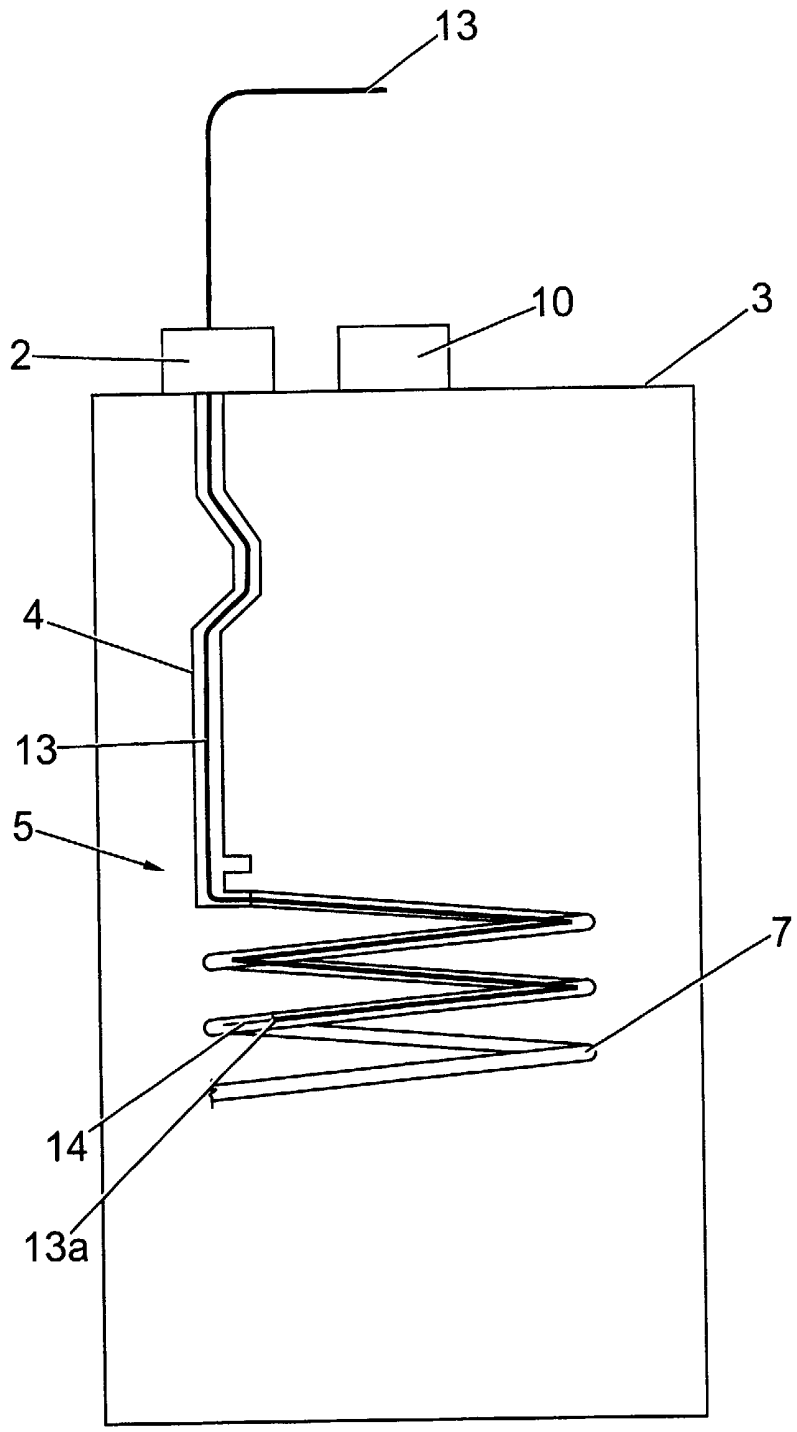

Fig. 6

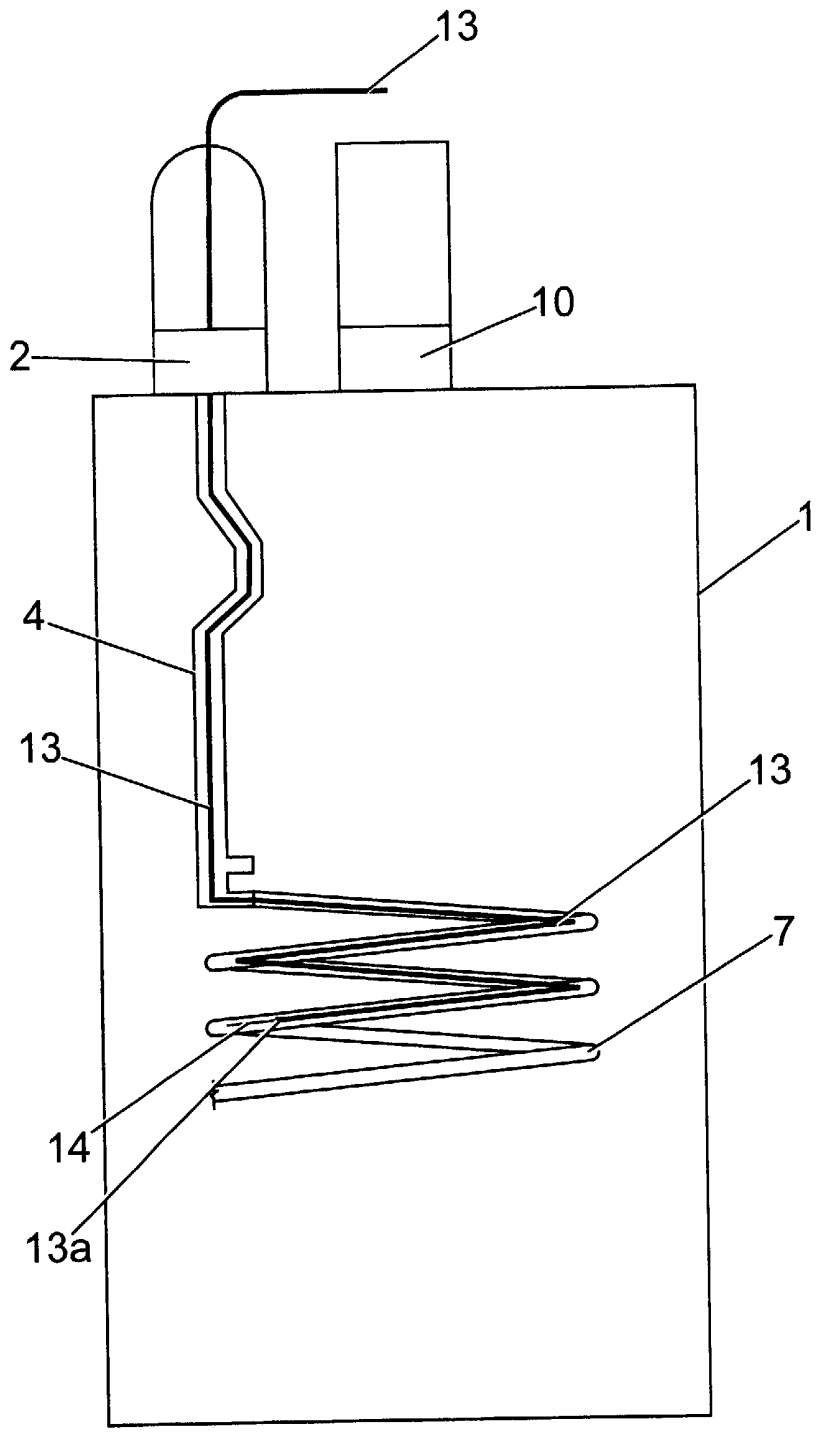

Fig. 7

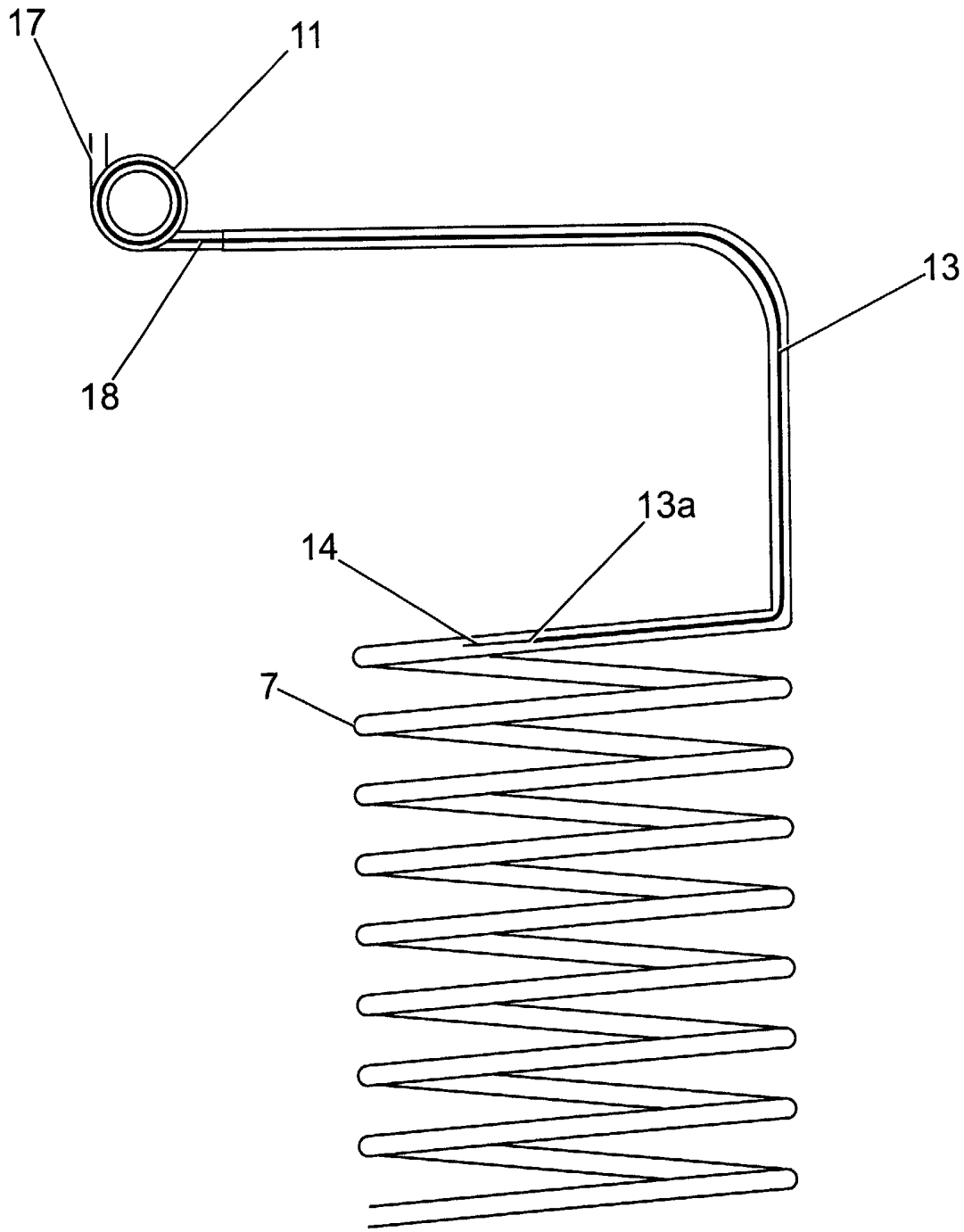

Fig. 8

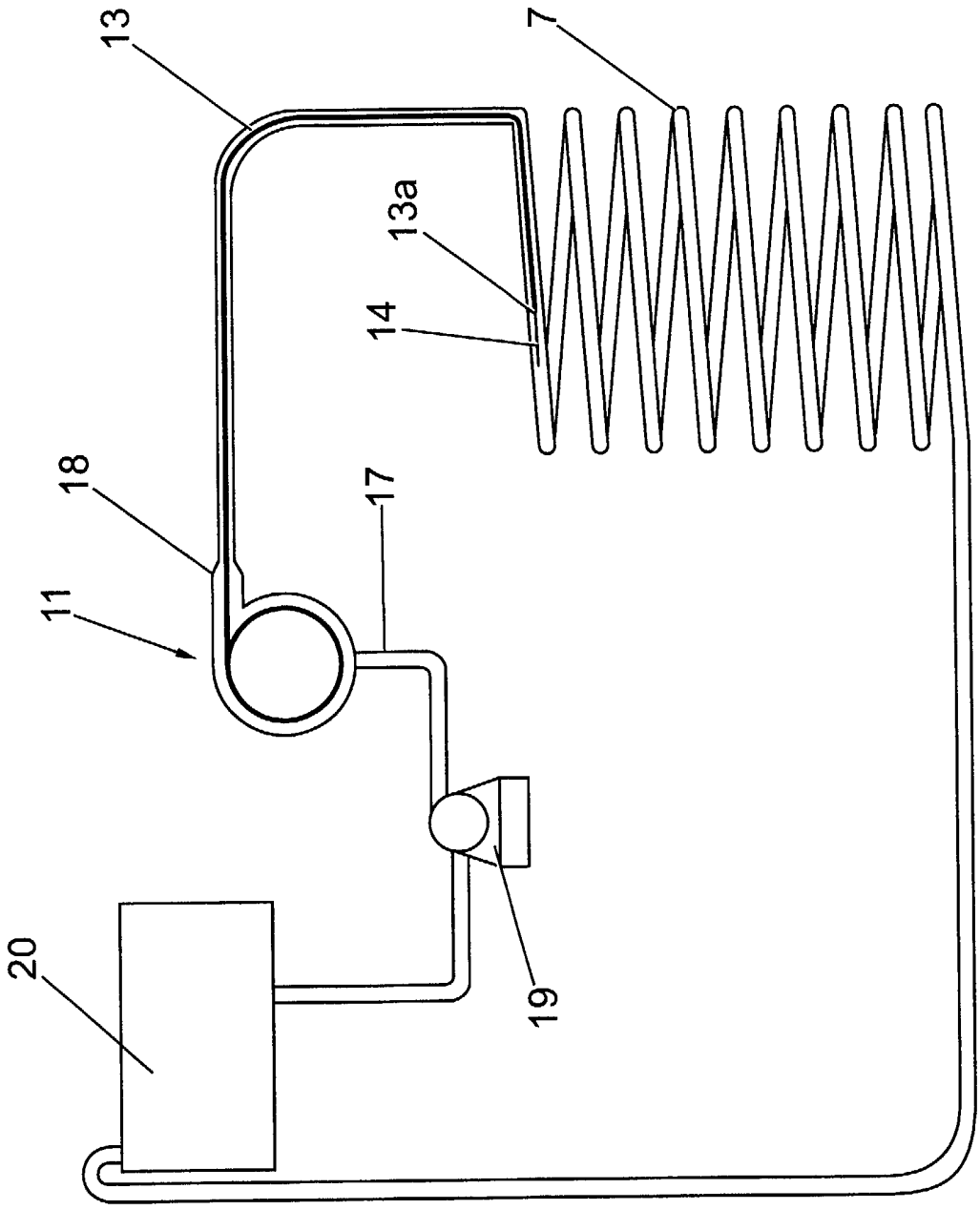

Fig. 9

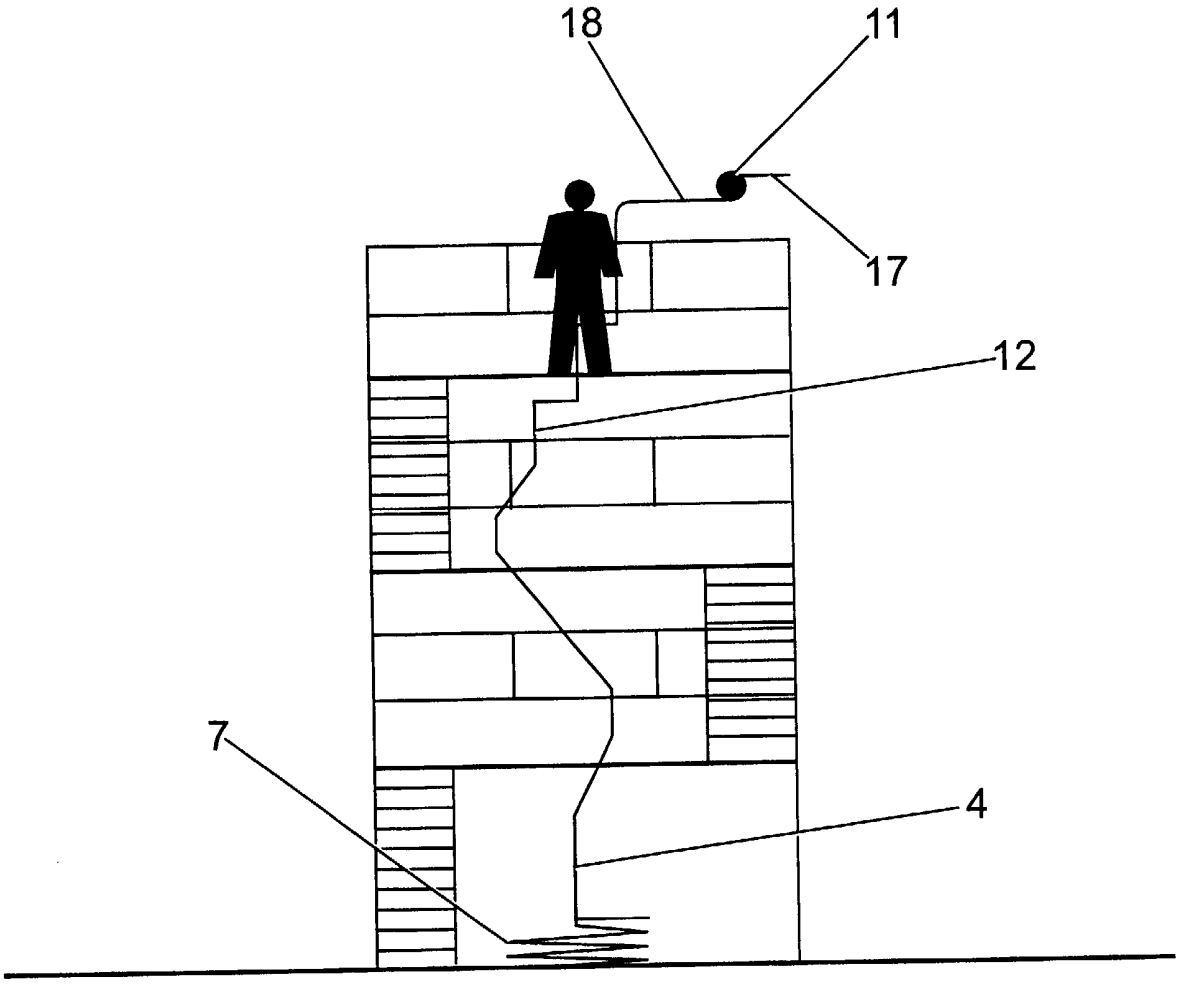

Fig. 10

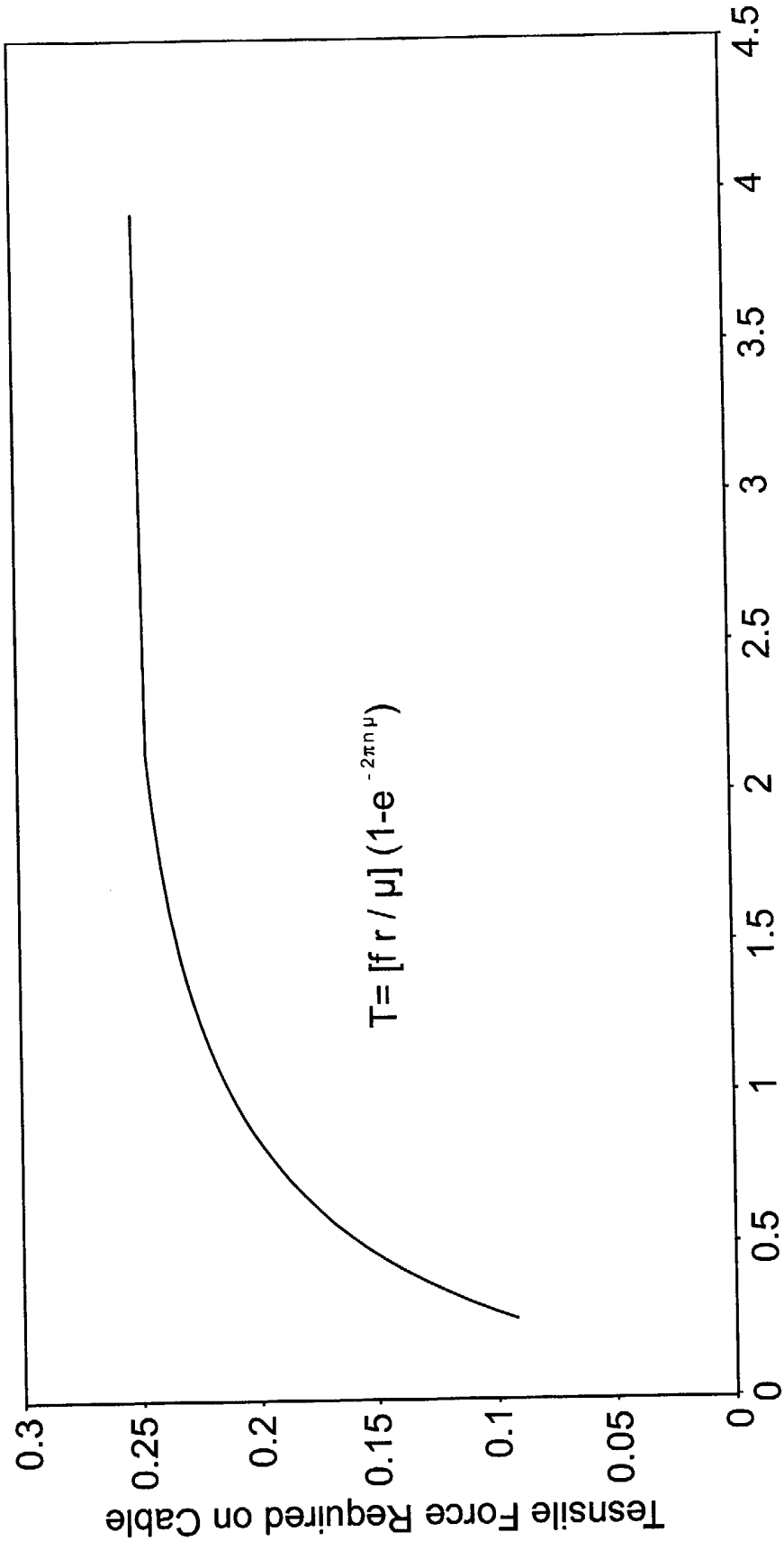
Tensile Force Required on Cable
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Number of Turns
T= [f r / μ] (1-e -2πnμ)

Fig. 11

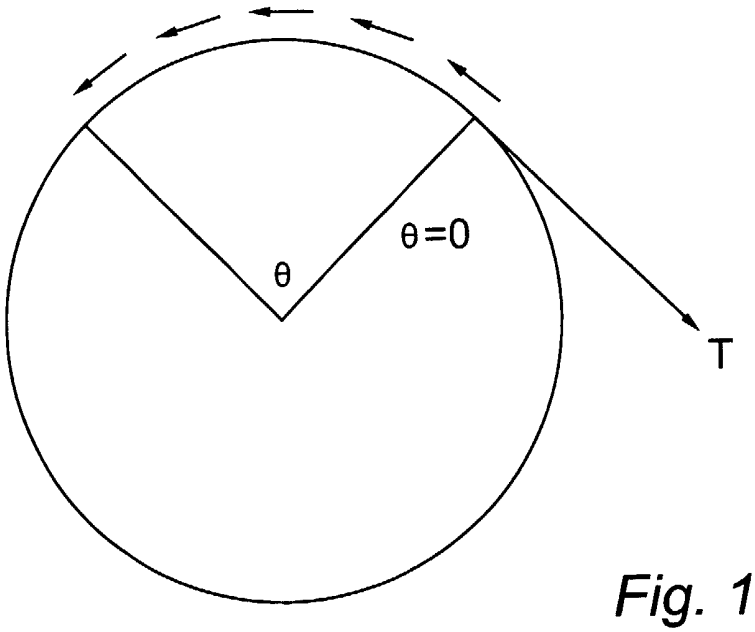

Fig. 12

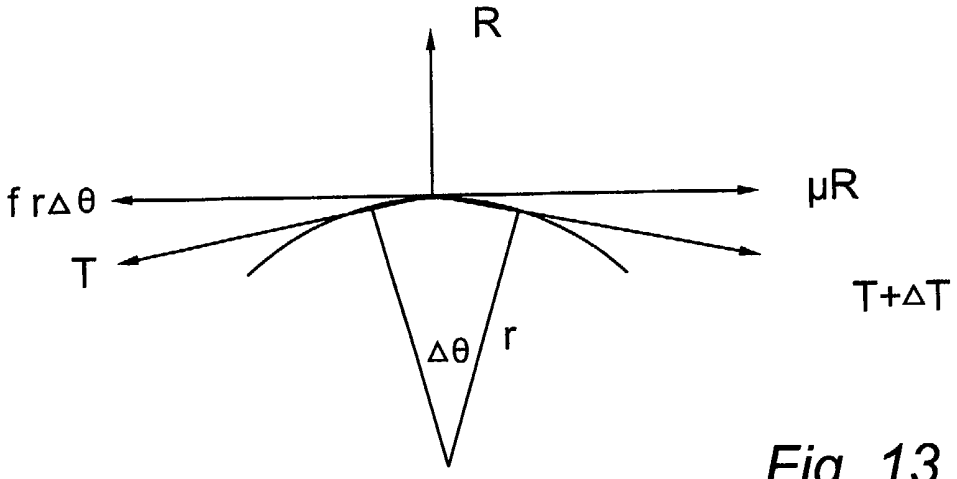

Fig. 13

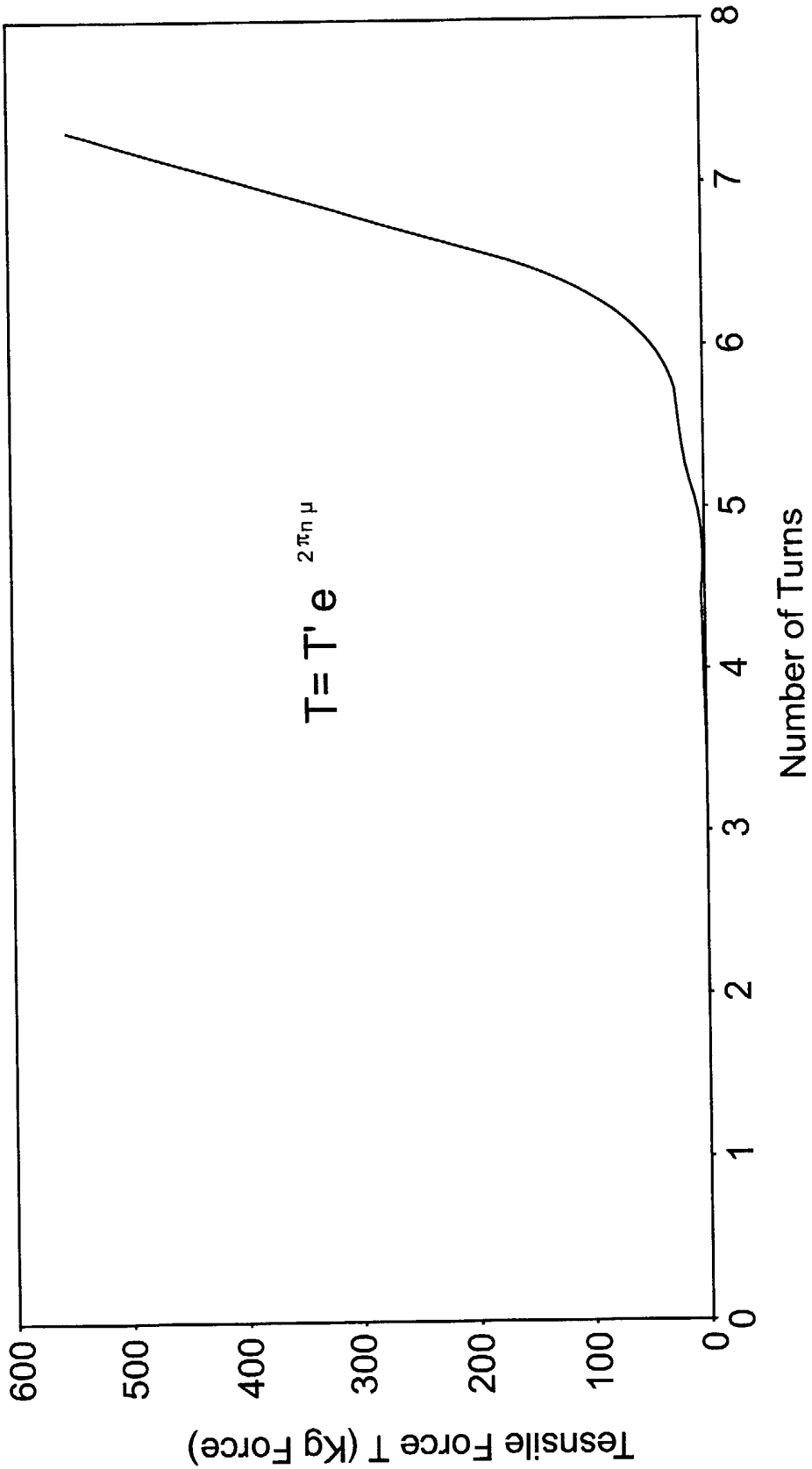
Tensile Force T (Kg Force)
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
Number of Turns
T= T' e 2πnμ

Fig. 14

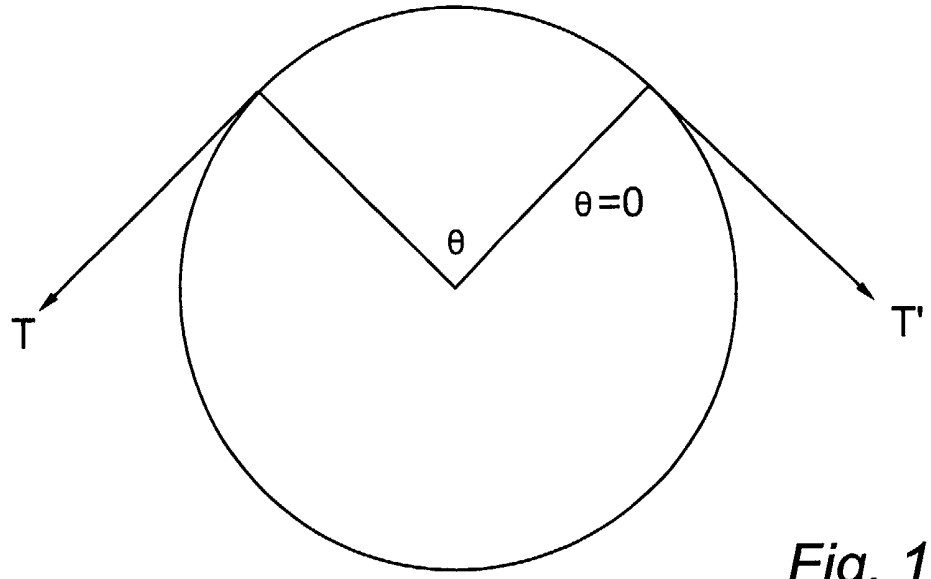

Fig. 15

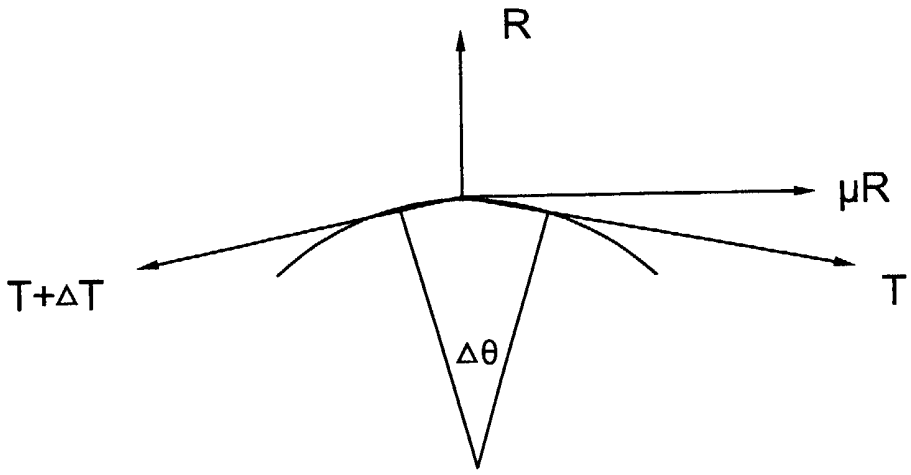

Fig. 16

Cable Transport System

The present invention relates to a cable transport system and in particular to a method for the inspection of a conduit and to apparatus for use in said method.

It is desirable and often necessary to undertake an internal inspection of a conduit to help locate such things as cracks or other flaws which may exist. It may also be desirable to determine certain parameters, for example temperature, along the length of the conduit to establish, for example in the case of a heat exchanger, its efficiency. In all cases, a sensor or a number of sensors are usually attached to a length of cable which is pushed down the conduit. However, in the case of a coiled conduit or a conduit having a number of bends the force required to be applied to the end of the cable must rise dramatically to carry the cable around each successive bend. This is known by those skilled in

the art as the "windlass effect" which will be described later. Hence, inspecting a conduit with a large number of bends using this method is not very feasible due to the substantial forces required. In some cases it may not be viable to use this inspection technique because the conduit or the cable itself may not be able to withstand the forces necessary to transport the cable around all the bends.

Expired UK Patent No. 1453189 discloses a device for the inspection of tubular conduits which attempts to overcome these problems. However, the invention proves to have limitations as "severe kinks and bends in the tubes can prevent the efficient functioning of the device". It is also mentioned in this Patent Document that where tubes are joined, the welds should be of a size not to obdurate the tube at that point which would otherwise block the progress of the device through the conduit.

The present invention is directed to overcoming at least some of the above mentioned problems and as such has special relevance to the internal inspection of such conduits in the form of coiled tubes, for example, heat exchangers, boilers and steam generator equipment.

According to the invention there is provided apparatus for facilitating internal access to a conduit comprising a cable member having an irregular surface passable freely along a conduit, and a

pressurised fluid supply means comprising a fully pressurised system adapted to be connectable to a conduit to supply a stream of pressurised fluid to the cable member to urge the cable member along a conduit.

Preferably, the irregular surface of the cable member comprises grooves or ripples on the surface thereof.

Preferably, the grooves or ripples extend along the surface of the cable member in a direction generally perpendicular to a centre line of the cable member.

Optionally, the irregular surface comprises circumferential fins extending perpendicularly from and radially about the cable member.

Preferably, the grooves, ripples or fins extend partially or completely about the cable member.

Preferably, the inspection apparatus further includes a leading member attachable to a leading end of the cable member.

Preferably, the leading member comprises a flexible length of cable which is lighter in weight and shorter in length than the cable member.

Preferably, the pressurised fluid is air or an inert gas. Optionally, the pressurised fluid may be a liquid, for example, water.

Advantageously, and where the pressurised fluid is in a gaseous form, pressure is supplied by a compressor. Where the pressurised fluid is a liquid, pressure is supplied by a pump. Preferably, the pump is a centrifugal pump.

Preferably, the pressurised fluid supply means includes a pressure vessel having a fluid inlet, a fluid outlet and a cable outlet.

Preferably, the fluid outlet comprises the cable outlet.

Preferably, the cable member and leading member are housed within the pressure vessel.

Preferably, the pressure vessel includes support means for effecting the movement of the cable member from the pressure vessel to the conduit.

Preferably, the support means is a rotatable drum.

Preferably, the drum comprises a continuous helical groove for locating the cable member on the drum.

Preferably, a trailing end of the cable member is anchored on the drum.

Preferably, the inspection apparatus further includes an access sleeve insertable into an auxiliary conduit for easing insertion of the rippled cable into a conduit where access to a conduit is via an auxiliary

conduit. Typically, the sleeve is used in the case where access to a conduit is via an auxiliary conduit of larger diameter.

Preferably, the access sleeve is in the form of a hollow tubular member, for example a hose.

Preferably, the access sleeve has a bore generally equal to that of the conduit.

Preferably, the access sleeve is of a durable material capable of withstanding the pressurised fluid, for example a braided pressure hose and which is also flexible to negotiate bends in the auxiliary conduit.

In another aspect of the present invention there is provided a method for facilitating internal access to a conduit comprising inserting a cable member having an irregular surface into the conduit, the cable member being of a size allowing it to pass freely along the conduit, and feeding a pressurised fluid to the conduit to urge the cable member along the conduit.

Preferably, the cable member is urged along the conduit by providing drag along the whole length of the cable member.

Preferably, the method includes the steps of increasing the drag force exerted on the cable member, inducing tension in the cable member, and

rotating the drum unwinding the cable member therefrom and urging it through the conduit.

Preferably, the cable member is capable of transporting a sensor. The sensor transported along the conduit is monitored and readings on an external monitoring instrument are taken to provide a continuous trace of the condition of the conduit.

Optionally, a number of sensors can be provided along the length of the rippled cable.

The readings taken may be, for example, readings relating to the temperature within the conduit or relating to the structural integrity of the conduit wall.

After readings have been taken, the cable member is removed from the conduit by reversing the direction of flow of the pressurised fluid or by removing the pressurised fluid supply and winding the cable member onto the drum.

The invention will be more clearly understood from the following description of an embodiment thereof, given by way of example only with reference to the accompanying diagrammatic drawings in which:-

Fig. 1 is a cross sectional front view showing only partial detail of a boiler vessel and its internal tubing for inspection in accordance with the method of the present invention;

Fig. 2 is a view from above and the side of a portion of the boiler vessel of Fig. 1 having a section of its side wall removed showing more detail of the internal tubing;

Fig. 3 shows a pressure vessel and access sleeve of the apparatus of the invention attached to the boiler vessel of Fig. 1;

Fig. 4 shows progress of rippled cable in accordance with the invention from the pressure vessel, through the access sleeve of Fig. 3 and along the helical tubing of the boiler vessel;

Fig. 5 is a length of the rippled cable of the apparatus of the invention clearly showing the rippled surface;

Fig. 6 is a view similar to Fig. 4 with the pressure vessel and access sleeve removed;

Fig. 7 is a view similar to Fig. 6 showing the complete superheater header and feed waterheader of the boiler vessel;

Fig. 8 is a cross sectional side view of the rippled cable passing from the pressure vessel and along a portion of helical tubing;

Fig. 9 is a cross sectional view of the apparatus of the present invention wherein the pressurised fluid is water;

Fig. 10 shows an operator inserting the rippled cable into the coiled tubing of a boiler vessel mock-up;

Fig. 11 is a plot showing the relationship between the number of bends in a coiled tubing and the force necessary to urge the cable therethrough according to the invention; and

Fig. 12 shows the forces exerted on the whole length of the cable when transporting the cable through the coiled tubing according to the invention;

Fig. 13 shows the forces exerted on a portion of the cable of Fig. 12 when the tension in the cable is increased;

Fig. 14 is a plot similar to Fig. 11 showing the relationship observed in a cable transport system of the prior art, using handforce alone;

Fig. 15 shows the forces exerted on a cable required to prevent the cable from slipping when wrapped on a windlass drum in the cable transport system of Fig. 14; and

Fig. 16 shows the forces exerted on a portion of the cable when the tension in the cable is increased in the cable transport system of Fig. 15.

Referring to the drawings and initially to Figs 1 to 5, there is illustrated a conduit inspection apparatus according to the present invention for inspecting a boiler vessel 1.

The boiler vessel 1 is a conventional boiler vessel of a generally cylindrical shape having a superheater header 2 at a top external end 3 of the boiler 1 and a steam tail pipe 4 extending downwardly from the header 2 and inwardly of the vessel 1. The tail pipe 4 bi-furcates at one end 5 remote from the header 2 leading to two helical tubes 6 and 7.

With the exception of Fig. 2 and to promote clarity of drawings, only the helical tube 7 is shown. Both helical tubes 6 and 7 have return pipes (not shown) attached to the ends thereof remote from the steam tail pipe 4 and terminate at a feedwater header 10.

The conduit inspection apparatus, the assemblage of which is described below and can be seen most clearly in Figs. 3 and 4 includes a pressure vessel 11, an access sleeve 12 in the form of a pipe or hose being open at both ends a rippled cable 13 and a leader cable 14 attached to a leading end 13a of the rippled cable 13.

The leader cable 14 is shorter in length lighter and more flexible than the rippled cable 13 and is of a flexible metallic or plastics type material. These properties help the leader cable 14 and hence the rippled cable 13 to negotiate very tight bends in the tube 7, for example, the bifurcation 5.

Ripples 16 in the form of circumferential grooves extend laterally across the surface of the rippled

cable 13. The rippled cable 13 also has a number of sensors (not shown) placed along its length.

The pressure vessel 11 houses the cable 13 on a winding drum (not shown) which is mounted on a horizontal rotating spindle (not shown). A trailing end of the rippled cable 13 is anchored on the drum, the drum being provided, at the curved surface thereof with a continuous helical groove for locating the rippled cable 13 when it is wound on the drum.

The vessel 11 has a pressurised driving fluid inlet 17 and pressurised driving fluid outlet 18. Fig. 9 illustrates a pressurised system wherein the pressurised driving fluid is water, clearly showing the fluid inlet 17 and fluid outlet 18. In this case, the pressure is supplied by a centrifugal pump 19 and the fluid pressurised system is completed by the water return tank 20. In the case where the pressurised driving fluid is a gas, for example air, the pressure can be supplied by a compressor (not shown) and the pressurised fluid after travelling through the tube 7 may simply be vented to atmosphere; the tank 20 not being required.

The pressurised driving fluid employed in the present embodiment of the invention is air and will further be described with reference thereto.

Before inspection, any water or fluid within the steam tail pipe 4 or helical tube 7 is first removed through the feedwater header 10 by blowing air

through the steam tail pipe 4 from the compressor. Failure to remove the water in this way could suggest a blockage within the piping of the boiler vessel 1.

In use, and after the fluid has been removed from the tailpipe 4 and helical tube 7, the access sleeve 12 is placed within the steam tail pipe 4. The sleeve 12 should be of a flexible type material, for example flexible braided hose, allowing the sleeve 12 to negotiate the bends along the tail pipe 4. A leading end 21 of the sleeve 12 when fully inserted in to the tail pipe 4 should fall short of the opening of the helical tube to be investigated. The fluid outlet 18 of the pressure vessel 11 is connected by means of a screwed pressure tight adapter (not shown) to an opening of the sleeve 12 at a trailing end 22 thereof.

The compressor delivers pressurised air to the pressure vessel 11 through the fluid inlet 17. The driving fluid on passing over the cable 13 exerts a drag force thereon which is amplified by the ripples 16. The drag force causes tension in the cable which rotates the drum unwinding the cable 13 therefrom and urging it through the fluid outlet 18 along the sleeve 12 and the tube 7.

The drag force exerted on the cable can be controlled by regulating the air pressure delivered by the compressor; the higher the air pressure the greater the drag.

As can be clearly seen from Figs. 3 and 4, the leading end of 21 of the sleeve 12 falls short of the opening of the helical tube 7 but extends beyond that of the helical tube 6, as it is intended in this embodiment to investigate helical tube 7. This prevents the cable 13 being carried into the wrong helical tube. Alternatively, or in addition the tube not being investigated, which in this embodiment is the helical tube 6 can simply be blocked off. This can be done by blocking the exit of the return pipe (not shown) located near the feedwater header 10.

Generally, the smaller the diameter of pipe through which the rippled cable 13 travels the greater will be the drag force exerted thereon by the driving fluid. As such, the diameter of the sleeve 12 is generally equal to that of the helical tube 7 so that the drag force exerted on the cable 13 in the helical tube 7 will be equal to that in the sleeve 12. This ensures a smooth transition of the cable 13 from the tail pipe 4 to the helical tube 7.

The leader cable 14 is of a flexible material, for example flexible metallic or plastics material, and further helps smooth transition of the cable 13 from the tail pipe 4 to the helical tube 7 via the bifurcation 5.

Although the applicants do not wish to be bound by any theorem, in order to understand more clearly the present invention and the problems it seeks to overcome, a brief description of the problem known as

the "windlass effect" experienced in the prior art is explained below.

THE WINDLASS EFFECT

Consider a cable wrapped around a Windlass drum as shown in Fig. 15. Suppose that at one end of the cable a tension T is applied in an attempt to pull the cable around the drum and suppose that a tension T' is applied at the other end of the cable so as just to prevent the cable from slipping. The cable is then in equilibrium under the action of the applied tensions and the reaction and friction at the surface of the drum. Let the angular position at which T is applied be θ.

Consider an element of the cable as shown in Fig. 16. Since this element is in equilibrium the net force on it must be zero. Resolving forces tangential to the circumference:

$$(T+\Delta T)\ \mathrm{Cos}\ (\Delta\theta/2) = \mu R + T\ \mathrm{Cos}\ (\Delta\theta/2) \qquad (1)$$

where $\Delta\theta$ = is the angle subtended by the element

ΔT = is the change in tension over the element

μR = is the frictional force on the element

R = is the normal reaction on the element

μ = is the coefficient of friction

as $\Delta\theta \rightarrow 0$, equation (1) becomes:

$$dT = \mu R \qquad (2)$$

Resolving forces normal to the circumference:

$$T \sin(\Delta\theta/2) + (T + \Delta T) \sin(\Delta\theta/2) = R \quad (3)$$

as $\Delta\theta \rightarrow 0$, equation (3) becomes:

$$T\, d\theta = R \quad (4)$$

Combining equation(2) and (4) gives:

$$dT = \mu T\, d\theta \quad (5)$$

Equation (5) is a separable differential equation which can be written as

$$1/T\, dT = \mu\, d\theta \quad (6)$$

Integrating both sides of the above equation (6) we get:

$$\text{Ln } T = \mu\theta + C \quad (7)$$

Where C is the constant of integration.

Equation (7) can be rewritten:

$$T = K\, e^{\mu\theta} \quad (8)$$

If we now apply the boundary condition that $T = T'$ when $\theta = 0$ we get $K = T'$, hence:

$$T = T' e^{\mu\theta} \quad (9)$$

Equation (9) can be rewritten as:

$$\mathbf{T = T' e^{2\pi n\mu}} \quad (10)$$

Where $\theta = 2\pi n$

n = number of turns

As the number of turns increase the tensile force required to move the cable rises dramatically as illustrated in Fig. 14.

OVERCOMING THE WINDLASS EFFECT

Alternatively, consider the analysis of a cable transport system whereby the cable is transported by

drag forces distributed along the whole length of the cable by means of fluid flow, according to the invention.

Consider an element of the cable as shown in Fig. 13. Since this element is in equilibrium the net force on it must be zero. Resolving forces tangential to the circumference:

$$(T+\Delta T)\ \mathrm{Cos}\ (\Delta\theta/2) + \mu.R = f\ r\ \Delta\theta + T\ \mathrm{Cos}\ (\Delta\theta/2) \quad (1)$$

where $\Delta\theta$ = the angle subtended by the element

ΔT = is the change in tension over the element

μR = is the frictional force on the element

R = is the normal reaction on the element

μ = is the coefficient of friction

r = is the helix radius

f = is the drag force per unit length of cable

as $\Delta\theta \rightarrow 0$, equation (1) becomes:

$$dT + \mu R = f\ r\ d\theta \quad (2)$$

Resolving forces normal to the circumference:

$$T\ \mathrm{Sin}\ (\Delta\theta/2) + (T+\Delta T)\ \mathrm{Sin}\ (\Delta\theta/2) = R \quad (3)$$

as $\Delta\theta \rightarrow 0$, equation (3) becomes:

$$T\ d\theta = R \quad (4)$$

Resolving equations (2) and (4) gives:

$$dT + \mu T\ d\theta = f\ r\ d\theta \quad (5)$$

Equation (5) is a separable differential equation and can be written as:

$$1/\ [f\ r/\mu - T]\ dT = \mu\ d\theta \quad (6)$$

If we integrate both sides of equation (6) we get:

$$- \text{Ln} [f\ r/\mu - T] = \mu\ \theta + C \qquad (7)$$

Where C is the constant of integration.

Equation (7) can be re-written as:

$$[f\ r/\mu - T] = K\ e^{-\mu\theta}$$

If we now apply the boundary condition that T = 0 when $\theta = 0$ we get $K = f\ r/\mu$, hence:

$$T = f\ r/\mu\ [1 - e^{-\mu\theta}] \qquad (8)$$

Equation (8) can be rewritten as:

$$\mathbf{T = (f\ r/\mu)\ [1 - e^{-2\pi n\mu}]}$$

Where $\theta = 2\pi n$

and n = number of turns

As the number of turns increases the tensile force required to move the cable tends to a constant value of $f\ r/\mu$ as illustrated in Fig. 11. There is no exponential rise in required tensile force as the number of turns increase, hence the "Windlass Effect" is overcome.

Therefore, the force required on the end of the cable 13 to transport the rippled cable 13 through the helical tube 7 of the present invention can be described by the equation:-

$$F = \frac{f * r}{\mu}\left(1 - e^{-2\pi n\mu}\right)$$

Where;

F = Force on end of cable

r = Helix radius

f = Drag force per unit length of cable

μ = Coefficient of friction

n = number of coils

The graph of Fig. 11 clearly shows that the critical force required to urge the cable 13 through the tube 5 is very small and that this force will generally urge the cable through a tube with a large number of bends.

Comparatively, the force required to transport a cable through the helical tube 7 by a force on the end of the cable alone is given by the following equation:-

$$F = T' \exp(2\pi n \mu)$$

Where:-

F = Force exerted on end of cable

T′ = Small restraining force experienced by cable (normally estimated)

n = number of coils

μ = co-efficient of friction

The graph of Fig. 14 for a typical cable clearly shows that the force required to transport such a cable beyond the first few coils in the helical tube 7 increases greatly and continues to do so as the number of bends in the helical tube 7 increases. If necessary once the cable 13 has been fully inserted into the helical tube 7, the pressure vessel 11 is disconnected by unscrewing the adaptor (not shown) between the pressure vessel 11 and the sleeve

12. The cable 13 is then connected to monitoring equipment (not shown) where readings from the sensors (not shown) of the cable 13 can be logged. This allows parameters such as temperature to be taken for each section of the helical tube 7.

The cable 13 may be left in the tube 7 as a permanent fixture if required or it can be removed by re-attachment of the sleeve 12 to the pressure vessel 11 and a reverse flow of the fluid activated.

When inspection of the tube 7 has been completed the rippled cable 13 is simply removed by rewinding the cable 13 onto the drum within the pressure vessel 11. Alternatively the cable 13 can be simply forced out by fluid drag force by reversing the initial flow of the fluid. In such case the fluid would be forced into the tube (not shown) of the feedwater header 10 and would exit at the superheater header 2 via the steam tail pipe 4.

It will be appreciated that while the pressurised fluid in this embodiment is air, other suitable fluids may be used, for example inert gases or water. Where a liquid is used as the pressurised fluid a vessel may be employed to receive the liquid exiting the helical tube 7. The liquid in the vessel may be recycled through the helical tube 7 as the pressurised fluid.

It will be appreciated that the grooves can be of any form which make the surface of the cable irregular, for example ripples and fins.

It will also be appreciated that the jet of air used to initially clear the coiled tubes of fluid before transporting the cable 13 therethrough may be provided by the pressurised fluid used to transport the cable.

It will further be appreciated that the cable 13 may be connected to the monitoring equipment as it passes through the conduit allowing a single sensor attached to the cable 13 to take readings at various sections of the conduit.

The invention is not limited to the embodiments hereinbefore described which may be varied in construction and detail.

CLAIMS

1. Apparatus for facilitating internal access to a conduit comprising a cable member having an irregular surface passable freely along a conduit, and a pressurised fluid supply means comprising a fully pressurised system adapted to be connectable to a conduit to supply a stream of pressurised fluid to the cable member to urge the cable member along a conduit.

2. Apparatus as claimed in Claim 1, wherein the irregular surface of the cable member comprises grooves or ripples on the surface thereof.

3. Apparatus as claimed in Claim 2, wherein the grooves or ripples extend along the surface of the cable member in a direction generally perpendicular to a centre line of the cable member.

4. Apparatus as claimed in any of Claims 1 to 3, wherein the irregular surface comprises circumferential fins extending perpendicularly from and radially about the cable member.

5. Apparatus as claimed in claim 4, wherein the grooves, ripples or fins extend partially or completely about the cable member.

6. Apparatus as claimed in any preceding claim, wherein the inspection apparatus further includes a

leading member attachable to a leading end of the cable member.

7. Apparatus as claimed in Claim 6, wherein the leading member comprises a flexible length of cable which is lighter in weight and shorter in length than the cable member.

8. Apparatus as claimed in any preceding claim, wherein the pressurised fluid is air, an inert gas, or a liquid.

9. Apparatus as claimed in any of claims 5 to 8, wherein the pressurised fluid supply means includes a pressure vessel having a fluid inlet, a fluid outlet and a cable outlet.

10. Apparatus as claimed in claim 9, wherein the fluid outlet comprises the cable outlet.

11. Apparatus as claimed in claim 9 or claim 10, wherein the cable member and leading member are housed within the pressure vessel.

12. Apparatus as claimed in claims 9 to 11, wherein the pressure vessel includes support means for effecting the movement of the cable member from the pressure vessel to the conduit.

13. Apparatus as claimed in Claim 12, wherein the support means is a rotatable drum.

14. Apparatus as claimed in Claim 13, wherein the drum comprises a continuous helical groove for locating the cable member on the drum.

15. Apparatus as claimed in claims 13 or Claim 14, wherein and a trailing end of the cable member is anchored on the drum.

16. Apparatus as claimed in any preceding claim, wherein the inspection apparatus further includes an access sleeve insertable into an auxiliary conduit for easing insertion of the rippled cable into a conduit where access to a conduit is via an auxiliary conduit.

17. Apparatus as claimed in claim 16, wherein the access sleeve is in the form of a hollow tubular member.

18. Apparatus as claimed in claim 17, wherein the access sleeve has a bore generally equal to that of the conduit.

19. Apparatus as claimed in any of claims 16 to 18, wherein the access sleeve is of a durable material.

20. Apparatus as claimed in any of claims 16 to 19, wherein the access sleeve is of a flexible material.

21. A method for facilitating internal access to a conduit comprising inserting a cable member having an irregular surface into the conduit, the cable

member being of a size allowing it to pass freely along the conduit, and feeding a pressurised fluid to the conduit to urge the cable member along the conduit.

22. A method as claimed in claim 21, comprising providing drag force along the whole length of the cable member.

23. A method as claimed in claim 21 or claim 22, including the steps of increasing the drag force exerted on the cable member, inducing tension in the cable member, and rotating the drum unwinding the cable member therefrom and urging it through the conduit.

24. A method as claimed in any of claims 21 to 23, wherein the cabled member transports a sensor or sensors.

25. A method as claimed in Claims 24, comprising transporting the sensor/sensors along the conduit and taking readings on an external monitoring instrument.

26. A method as claimed in any of Claims 21 to 25, comprising reversing the direction of flow of the pressurised fluid and removing the cable member from the conduit.

27. Apparatus for facilitating internal access to a conduit substantially as hereinbefore described with

reference to and as shown in the accompanying drawings.

28. A method for facilitating internal access to a conduit substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

25.

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Application No: GB 0128678.0 **Examiner:** Dr Steve Chadwell
Claims searched: 1-28 **Date of search:** 9 May 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F2P (PG1)

Int Cl (Ed.7): F16L 55/26, 55/38, 55/40; G02B 6/44, 6/52; G21C 17/017; H02G 1/08

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2156539 A	(BICC) see whole document, especially the abstract and figures	X: 1-3, 8-10,21-23 Y: 11-15, 24,25
X,P	WO 01/42842 A1	(THINK TANK) see whole document, especially figures 1 and 2	1,8,21-23
X,Y	WO 00/28366 A1	(ERICSSON) see whole document, especially page 6 lines 6-31 and figures 3 and 4	X: 1-3,5, 6,8,21,22 Y: 24,25
X,Y	US 5156376	(STANDARD TELEPHONES) see whole document, especially column 2 line 64 to column 3 line 6 and figures 4 and 5	X: 1,4,5, 8,16,17, 19,21,23 Y: 24,25
X,Y	US 5011332	(SIEMENS) see whole document, especially column 2 line 50 to column 3 line 51 and figures 1 and 3-13	X: 1-5,8, 21,22,26 Y: 24,25
X,Y	DE 4126559 A1	(PHILIPS) see figures 1-3 and WPI Abstract Accession No. 1993-053880 [07] in particular	X: 1-3,5, 8,21,22 Y: 24,25

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.

26.

INVESTOR IN PEOPLE

Application No: GB 0128678.0 **Examiner:** Dr Steve Chadwell
Claims searched: 1-28 **Date of search:** 9 May 2002

Category	Identity of document and relevant passage		Relevant to claims
X,Y	JP 040336505 A	(FURUKAWA) see PAJ abstract and figures 1 and 2	X: 1-3,5, 8,21,22 Y: 24,25
X,Y	JP 030220511 A	(HITACHI) see figures 1,3 and 4, PAJ abstract and also WPI Abstract Accession No. 1991-329397 [45]	X: 1,8-10, 21-23 Y: 11-15, 24,25
Y	GB 1453189	(BABCOCK & WILCOX) see whole document, especially page 2 lines 39-56, page 3 lines 21-40 and figures 2, 5 and 6	11-15,24, 25

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.
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