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[54] **CABLE SEPARATING JOINT**

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[52] **U.S. Cl.** ..... **174/11 R,** 174/22 R, 174/91

[51] **Int. Cl.** **H02g 15/24**

[58] **Field of Search** ..... 174/11 R, 15 C, 20, 21 R, 174/21 JS, 22 R, 23 R, 88 R, 88 S, 91

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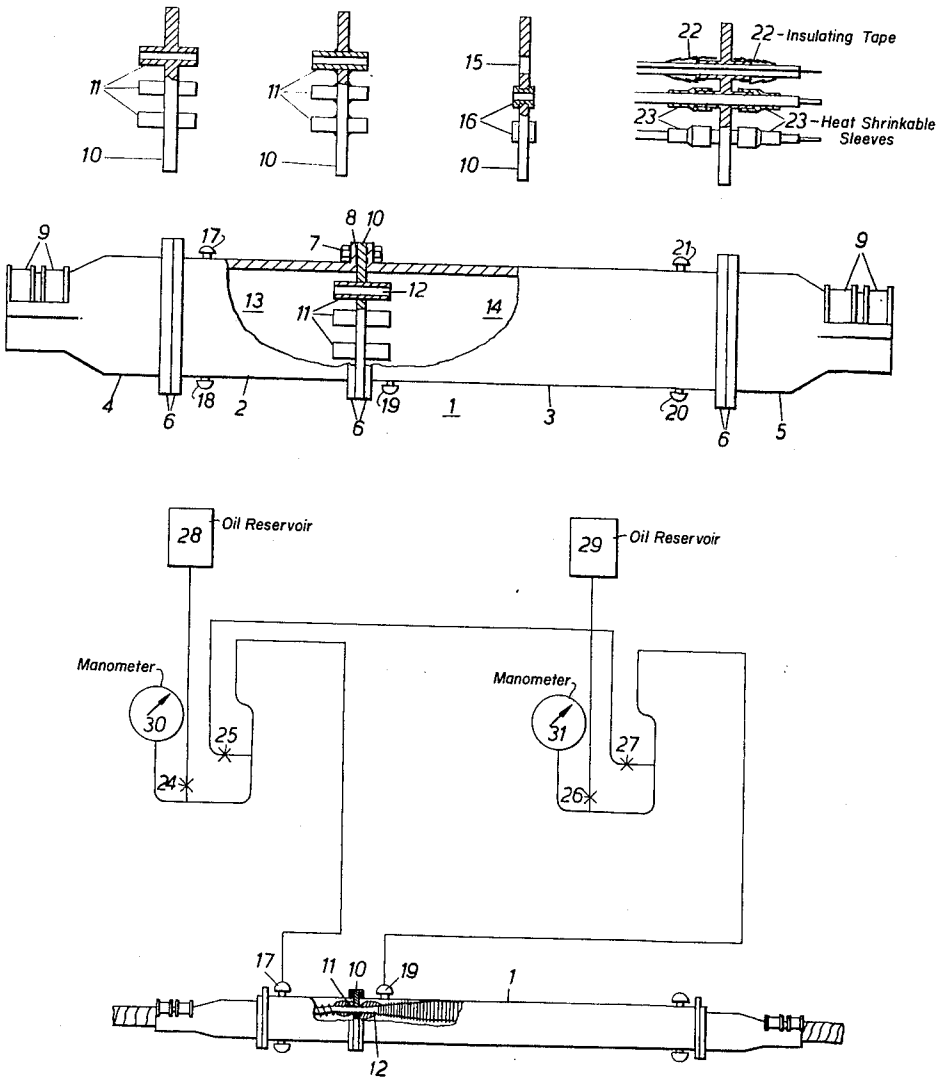
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[57] **ABSTRACT**

An oil filled cable is divided into separate hydraulic chambers by a stop joint to prevent excess leakage from cable portions adjacent a fault. A separating flange between sections has tight fitting passageways for the insulated wire conductors to permit slight flow between chambers and prevent large leaks. Normally the joint is bypassed by external valves which apply equalized oil pressure to each section. Occurrence of low pressure from a leak causes the valves to close and separates the sections while limiting leakage from the adjacent section until the faulty section is repaired. The construction permits a reduction in the usual number of completely separate stop joints which require additional electrical joint connections.

12 Claims, 6 Drawing Figures



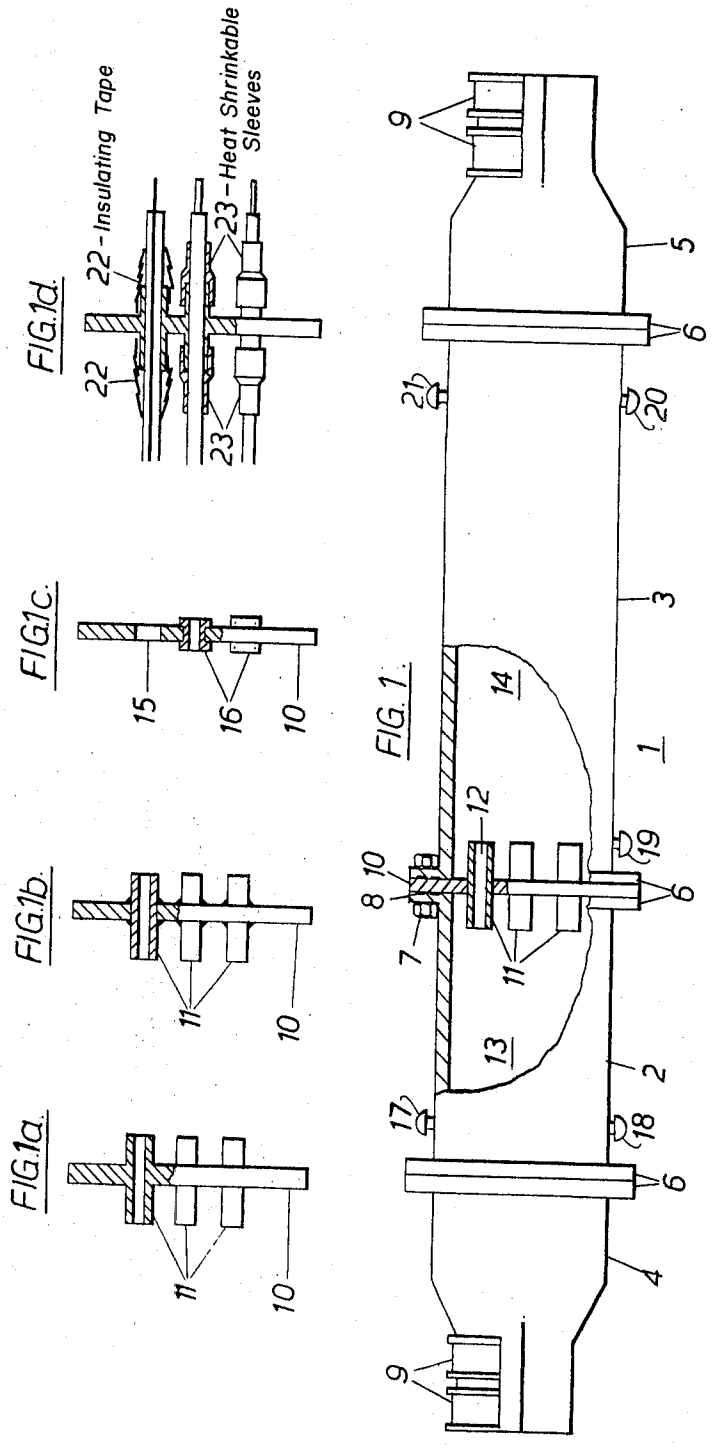
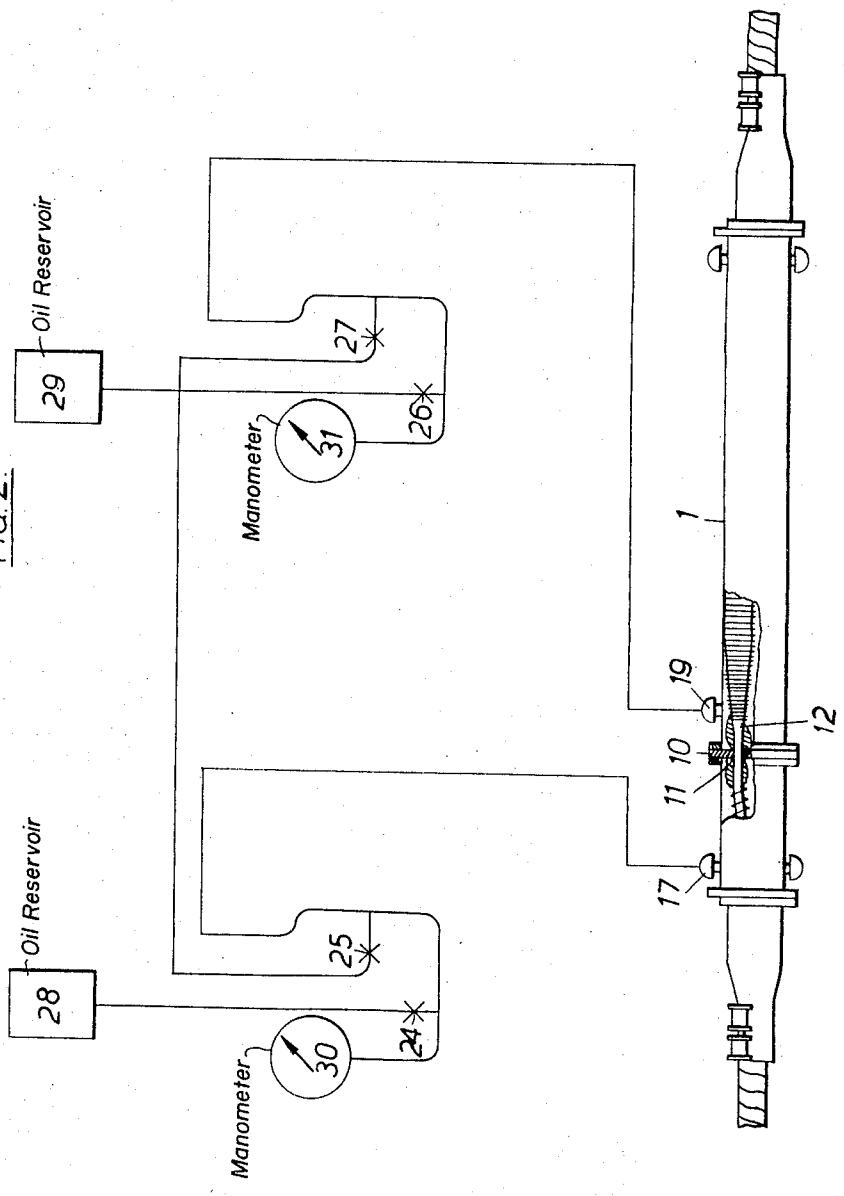

FIG. 1.
FIG.1a.
FIG.1b.
FIG.1c.
FIG.1d.
22 - Insulating Tape
23 - Heat Shrinkable Sleeves

FIG. 2


Oil Reservoir
29
27
26
Manometer
31
1
19
12
10
11
17
Oil Reservoir
28
25
24
Manometer
30

CABLE SEPARATING JOINT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a separating joint for oil filled cables and particularly to a cable having two hydraulic chambers which prevent excess leakage from portions adjacent a fault.

2. Description of the Prior Art

In oil filled cable installations where three core types are usually used, it is possible to feed very long lengths (10 – 20,000 m) without intermediate feeding points. This is possible because the dynamic oil pressure is greatly reduced by the use of corrugated aluminum sheathed cable. The latter offers a much larger effective cross sectional area of the oil passage than is normally the case in lead sheathed cables. Although few feeding points and long hydraulic lengths are economically advantageous, service engineers are in favor of cable installations with short hydraulic sections in order to limit the cable length influenced by an oil leakage. Therefore stop joints are introduced in such oil cable installations.

In known stop joints, the oil systems on the two sides of the joint are completely separated while the electrical system in the two sections are directly connected to each other. This may be obtained by means of rigid electrical connectors, one for each electrical cable conductor, passing through a cast separating flange of china or ceramic material. The separating flange with the metallic connectors protruding on both sides, has to be mounted into a housing in such a manner that the flange forms a tight seal between the two hydraulic sections. When such a conventional stop joint design is used, the conductors of the cable have to be connected to the connectors on both sides of the separating flange. In other words, a connection has to be established at two different places in the joint.

This conventional arrangement represents a good technical solution. However, it also has some drawbacks which up to now have been considered as being associated with all stop joint designs. These drawbacks are: the construction of three-core type stop joints for high voltages such as 66 or 132 kV is expensive due to the high cost of the separating flange with its through connections. The separating flange is also exposed to damage since it is made of breakable material which may have inherent stresses after the casting process, and it requires relatively tight clamping between packing means to give a completely tight seal. Finally, it requires a great deal of time to mount the joint into a cable since a connection has to be established on both sides of the separating flange.

There also exist straight through joints which are much less expensive and easier to produce. In such straight through joints the oil is allowed to flow freely from one side of the joint to the other.

During the design of an oil cable installation it is therefore necessary to choose between expensive apparatus with many stop joints and simple servicing or a less expensive arrangement with few stops joints and many straight through joints and therefore more difficult servicing.

SUMMARY OF THE INVENTION

A favorable compromise can be obtained by means of a separating joint according to this invention. The present joint is one which works as a straight through joint under normal conditions but can be turned into a stop joint under fault conditions to give practically the same effect as obtained by ordinary stop joints but at a considerably lower cost.

This invention concerns a separating joint for an oil filled electrical cable in which the oil on each side of the joint is divided into two hydraulic chambers by a separating flange. The main feature of the invention is that the sealing between the two hydraulic chambers is not absolutely tight but allows a small flow of oil from one side of the separating flange to the other when a pressure difference between the two sides arises. It is not necessary to establish a complete separation between the two sides of the joint. In most cases it is sufficient to obtain a separation which allows a small flow of oil between the two hydraulic sections when a pressure difference between the two sides arises. Such a small leakage flow however, is not permitting in a conventional cast separating flange of the type described above. A small leak of this type would probably be caused by a small defect or crack in the cast insulating body. Such a defect can cause large shear forces which may result in a sudden breakdown of the insulation material.

In order to allow a small flow between the hydraulic chambers in the joint, it is necessary to maintain the flow at a safe low level even if high pressure differences exist and the flow should not be caused by any defects in the material which can result in a breakdown. The invention will now be explained in more detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates one embodiment of a joint according to the invention,

FIGS. **1***a* – **1***d* illustrate details of the construction, and

FIG. **2** illustrates how the joint may be used in pressurized oil installations.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. **1**, the reference number **1** represents the main tube of the joint. This tube is divided into two or more tube sections **2, 3** which may be connected securely in an oil tight manner to each other and to the end sections **4, 5** via flanges **6.** This tight coupling may be obtained in any conventional manner, such as by means of a screw and nut connection **7** and packings **8.** The end sections **4, 5** are equipped with clamping devices **9** which are adapted to fit securely and tightly around the outer cable sheath (not shown).

A separating flange **10** is placed between two of the flanges **6** of the main tube sections **2** and **3** and an oil tight connection is obtained by proper sealing components. This separating flange is provided with a number of protruding pipe sockets **11** in the form of short tubular sections through which passageways **12** are provided between the otherwise separated hydraulic chambers **13, 14.** The protruding pipe sockets **11** have inner diameters which correspond to the outer diameters of the fully insulated cable conductors with a very small clearance. The number of pipe sockets usually corresponds with the number of conductors in the cable in question.

The pipe sockets **11** may be an integral part of the separating flange and may then be cast as one unit with any suitable insulating or conducting material, such as shown in FIG. 1*a*. The pipe sockets and the separating flange may also be produced of metallic material and are then welded or soldered together as in FIG. 1*b*. Instead of having the holes **15** in the separating flange penetrated by pipe sockets, it is also possible to omit the pipe sockets or replace them with shorter reinforcements such as bushings **16** shown in FIG. 1*c*.

Some or all of the main tubes portions **2, 3** may also be equipped with oil nipples **17, 18, 19, 20** and **21.** These nipples may be provided with valves or may be closed by means of adaptable plugs or the like.

During mounting of such a separating joint, the cable ends are led into the end portions of the joint tube. Then the cable ends are dismantled and the conductors from one of the cable ends in fully insulated condition are pulled through the pipe sockets or the openings in the separating flange. The conductors are then stripped, jointed and insulated and the joint is sealed and secured in a known manner. During this operation only one jointing operation between the two cable ends is undertaken and this joint is situated in the longer part **3** of the main joint tube.

Since the pipes or the reinforced holes of the separating flange are adapted to accommodate the insulated conductors of the cable, the oil which is allowed to flow from one side of the separating flange to the other has to pass longitudinally through the conductor insulation or longitudinally alongside the surface of the conductor insulation. It is apparent that this flow will be relatively small and it will not have the tendency to increase with time as it would in a faulty conventional stop joint.

In the indicated figures a separating joint of a three core type oil filled cable is illustrated. A separating joint according to the invention may, however, be used in connection with any type of oil filled cable in which the oil channels are not situated within the cable cores but may also be on the inner surface of the cable sheath or in the interstices between the cable cores.

To reduce the flow path alongside the surface of the conductor insulation in a simple manner, it is preferred to use the embodiment with pipes protruding from the separating flange **10.** A good seal may then be obtained by rolling a tape **22** tightly around both the pipe socket and the conductor at the point where the conductor enters into the pipe socket, or to seal the same point by means of a shrinkable plastic sleeve **23.** These methods are illustrated in FIG. 1d. Sealing by means of a plastic hardening or setting material is also possible.

When such a separating joint is mounted in a cable, it may be operated in different ways. In FIG. **2** a complete installation is shown. As far as possible the same reference numbers are used as in FIG. **1.** The "X" symbols at **24, 25, 26, 27** represent valves in the oil pipes. Reference numbers **28, 29** are oil reservoirs and **30, 31** manometers.

In operation, if the valves **25** and **27** are closed while **24** and **26** are open, the two cable sections are separated and are fed from the reservoirs **28** and **29** respectively. By use of regulation means (not shown) it is possible to adjust the oil pressure in the two sections to be substantially at the same value. The joint will then operate as a known stop joint and it provides complete separation between the sections as long as the pressure is maintained.

During normal operation the valves **25** and **27** may be left open. The oil then passes freely through the valves between the two sections and the joint operates as a normal straight through joint. If a fault occurs in the cable section connected with valve **27,** the oil pressure decreases and this is registered on the manometers. The valves **25** and **27** are then closed and the joint operates as a stop joint. The faulty cable section may then be repaired or replaced. When no fault exists, the cable section may be fed from both sides. A separating joint according to this invention will therefore act as a straight through joint under normal conditions, but will provide sufficient separation of the sections only in case of faults when the valves **25** and **27** are closed. The invention is not limited to the embodiments described above and illustrated in the drawings, and a substantial number of modifications may be made within the scope of the invention as described in the following claims.

What is claimed is:

1. A separating joint for an oil filled electrical cable comprising a plurality of insulated conductors, first and second adjacent cable enclosures around said conductors, said enclosures having adjacent facing end flanges, and a common separating flange secured to and between said facing end flanges of said enclosures, said common separating flange providing two hydraulic chambers for oil on respective opposite sides thereof separated only by said common separating flange, said separating flange having a plurality of openings passing said insulated conductors between said two hydraulic chambers, said insulated conductors fitting sufficiently closely in said openings to allow only a small flow of oil from one side of the separating flange to the other upon occurrence of a pressure difference between the two sides.

2. The device of claim **1,** including reinforcing means fitting within said openings receiving said insulated conductors in a close fit.

3. The device of claim **2,** wherein said reinforcing means includes sections of pipe having an inner diameter substantially equal to the outer diameter of said insulated conductors.

4. The device of claim **3,** wherein said separating flange and pipe sections are of metal and including heat fusible metal sealing means securing said pipe sections to said separating flange around said openings.

5. The device of claim **3,** wherein said pipe sections are an integral unit with said separating flange.

6. The device of claim **3,** wherein said pipe sections and separating flange are of an insulating material.

7. The device of claim **3,** wherein said pipe sections and flange are of a conducting material.

8. The device of claim **3,** including tape windings covering said insulated conductors at the entrance points of said pipe sections and providing sufficiently tight connections between said pipe sections and said insulated conductors to allow only said small flow of oil through said openings.

9. The device of claim **3,** including shrinkable plastic sleeves covering said insulated conductors at the entrance points of said pipe sections and providing sufficiently tight connections between said pipe sections and said insulated conductors to allow only said small flow of oil through said openings.

10. The device of claim **3,** including plastic setting material sealing said insulated conductors to said entrance points of said pipe sections and providing suffi-

ciently tight connections to allow only said small flow of oil through said openings.

11. The device of claim **3,** wherein said enclosures on opposite sides of said flange include oil nipples.

12. The device of claim **2,** including means supplying oil to said two hydraulic chambers, means sensing said pressure difference between said two sides, and valve means for controlling the oil supplied between said two chambers.

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