

PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF
 MULTI-CONDUCTOR CABLES

- (71) We, BRITISH INSULATED CABLES LIMITED, a British Company, of, 21 Bloomsbury Street, London W.C.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 This invention relates to telecommunication cables of the kind comprising a multiplicity of plastics insulated conductors enclosed within a waterproof sheath. If such cables, whether buried in the ground or drawn into ducts, become locally damaged to an extent to allow water to enter through the damaged sheath, the water will travel along the cable through the interstices between the insulated conductors and between the conductors and the sheath and so will have an adverse effect upon the electrical characteristics of the whole cable length, for instance by shorting of circuits via pinholes in the wire insulation.
- 25 With the object of preventing water that has entered through a defective sheath or joint casing from travelling even a short distance along the cable from the point of entry it has been proposed to fill the interstices between the insulated cable conductors and between them and the cable sheath throughout the entire length of the cable with water impermeable filling material.
- 30 For forming a continuous barrier throughout the length of a cable it is desirable to use a waterproof, impermeable material which will not drain under the influence of gravity or such hydrostatic pressure as may arise in the event of damage to the cable sheath or joint casing but which will permit relative sliding movement of the plastics insulated conductors or group of conductors over one another during such bending of the cable as occurs during manufacture and installation of the cable.
- 45 Examples of such materials are:
- (a) Microcrystalline petroleum waxes;
 - (b) Mixtures of microcrystalline petroleum waxes and oils, for instance petroleum jelly;
 - (c) Low molecular weight, high Melt Flow Index polyethylene or polypropylene of a semi-solid or grease-like nature;
 - (d) Mixtures of petroleum jelly, microcrystalline petroleum waxes, polyethylene, polyisobutylene and aluminium stearate.
 - (e) a blend of two or more of filling materials (a) to (d).
- The choice of filling material is to some extent limited by the method of introducing the filling material into the cable core and by the nature of the dielectric of the conductors forming the core.
- In the manufacture of plastics insulated multi-conductor cables that are filled throughout with water impermeable filling material, it has been considered necessary to transfer such material from a storage vessel to the cable and to apply it to the cable under super-atmospheric pressure by some form of pump. It is difficult however to pump such material in its solid condition because almost inevitable cavitation will occur within the storage vessel and cause a break in the feed to the pump. If pumping in such condition can be achieved, at the required rates of flow, for example 100 ft/min (30.7 m/min) at 4 gallons/min (18.2 litres/min) in a pipe having a cross-sectional area of 1 sq. in. (6.5 sq. cms.), some breakdown of the crystal bonds in the material will result thus degrading the material by lowering its viscosity, so rendering it less capable of forming a barrier permanently resistant to water under pressure.
- In the complete specification of our patent 1,120,011 it is stated that degradation of the material occasioned by pumping is reduced if pumping takes place whilst the material is at a temperature just above the temperature at which crystallisation begins and the

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invention described and claimed in that specification is the method of providing a cable core with a barrier of sealing material which comprises pumping the sealing material from a thermo-statically controlled storage vessel to a cable feeding station whilst at a temperature just above that at which crystallisation begins and cooling the material to effect crystallisation whilst transferring it from said cable feeding station to the cable core. We have now found that it is not necessary to cool the sealing material whilst it is transferred from the cable feeding station to the cable core and that a core can be provided with a satisfactory barrier of sealing material if the sealing material is transferred to the cable core whilst the material is still at a temperature just above that at which crystallisation begins and is cooled to effect crystallisation by abstraction of heat by the insulated conductors constituting the core.

Accordingly the present invention is an improvement in or modification of the method described and claimed in the aforesaid complete specification and consists of a method of providing a multi-conductor cable core with a barrier of sealing material which comprises pumping the sealing material from a thermostatically controlled storage vessel to a cable feeding station whilst at a temperature just above that at which crystallisation begins, transferring the sealing material from the cable feeding station to the cable core whilst still at such a temperature, and cooling the material to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

The rate of delivery of sealing material to the core may be adjusted in relation to the linear speed of travel of the core but preferably the rate of delivery of sealing material is such that, for any linear speed of travel at which the core is required to travel, sufficient material will be applied to the core to form an effective barrier when it becomes solidified.

By a temperature just above that at which crystallisation begins is meant a temperature at which the sealing material is in a sufficiently liquid state to permit pumping of the material to be effected with substantially no degradation of the material occurring. Where, as is preferred, the sealing material is a mixture of micro-crystalline petroleum waxes and oils, such as petroleum jelly, the temperature at which crystallisation begins is approximately 70°C and the temperature just above the crystallisation temperature at which the material can be pumped without causing substantial degradation is approximately 76°C.

The invention also includes apparatus for carrying out the aforesaid method comprising a thermostatically controlled storage vessel for storing the sealing material whilst at a temperature just above that at which crystallisation begins, the vessel being connected to one or more than one cable feeding station having means for applying sealing material to the cable core whilst still at such a temperature and, connected between the storage vessel and the applicator means of the or each cable feeding station, means for withdrawing sealing material from the storage vessel and for controlling the rate of delivery of the material to the applicator means.

It is preferred to have a feeding station at each stranding point and to transfer sealing material in a liquid state to the core at, or shortly in advance of, the closing die of the stranding head, in which case the number of feeding stations in operation will be the same as the number of layers of conductors, pairs or quads laid up around the centre conductor, pair or quad, but where the first layer is laid up around a group of two or more conductors, pairs or quads it may be advantageous to have a feeding station at the point where these two or more conductors, pairs or quads are brought together to form a core centre. A further feeding station may be located at the outlet end of the final closing die but we have found that this is not generally necessary.

Preferably the sealing material is applied to the core through an applicator die constituting or forming a separable part of the closing die associated with a stranding head and in this case the sealing material is applied to the surface of the last-formed layer of conductors, pairs or quads, to the surface of each conductor of the layer of conductors, pairs or quads being brought down by the closing die onto said last-formed layer, and to the surface of the layer of conductors, pairs or quads formed at said closing die, thereby ensuring that the cable interstices are completely filled with sealing material. Each feeding station may have its own individual source of supply and surplus material (i.e. material that is not carried forward through the stranding head) in a liquid or semi-solid state may either be returned to the storage vessel to be brought back to the requisite temperature in or on its way to such vessel or it may be collected for re-processing by the supplier.

Alternatively there may be a common source of supply for some or all of the feeding stations at a machine or for some or all of the feeding stations at a number of machines. In such case sealing material is maintained in a thermostatically controlled storage vessel at a temperature just above that at which crystallisation begins and is con-

tinuously circulated through a ring main which is thermally insulated and may be trace heated to maintain the circulating material at the appropriate temperature. From this ring main sealing material whilst still at such a temperature is bled off at intervals and fed to the feeding stations. Transfer of the sealing material to the cable core is preferably controlled by a valve at each feeding station but may be controlled by a metering pump. Surplus material from the feeding stations cannot in this case be fed back into the ring main unless it is first brought back to the temperature of the circulating material. It will generally be preferable either to pump it back into the common storage vessel or to collect it for re-processing. Preferably the sealing material is circulated in the ring main at a much higher rate than the aggregate rate at which it is withdrawn for transfer to the cable core, for example at a rate five to ten times as great. Such circulation is preferably effected by a pump having an intake in a part of the storage vessel remote from the part to which the circulating material is returned.

The invention will now be described in more detail, and by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic illustration of apparatus suitable for use in providing a multi-conductor cable core with a barrier of sealing material which extends throughout the length of the cable core, whilst the cable core is being manufactured by a conventional stranding machine.

Figure 2 is an end view of an applicator die of the apparatus diagrammatically illustrated in Figure 1.

Figure 3 is a section on the line III-III in Figure 2, and

Figure 4 is a diagrammatic illustration of an alternative form of apparatus for providing a continuous barrier of sealing material in a multi-conductor cable core.

Referring to Figure 1, the apparatus comprises a storage vessel 1 for the sealing material thermostatically controlled in any convenient manner and, connected to the lower part of the vessel, a ring main 2 comprising an outward pipe 3, in which is connected a pump 5, and a return pipe 4. At each of a plurality of locations spaced at intervals along the length of the return pipe 4, of which three only are shown, is a cable feeding station 11 at which sealing material at a temperature just above that at which crystallisation begins and hence in a liquid state is continuously bled off from the ring main 2 and transferred to the cable core. Each cable feeding station 11 has a valve 12 for controlling the rate of flow of sealing material being bled off from the system 2 and a die 15 for applying the material to the

cable core. The die 15 is detachably secured to the entry end of the closing die of a stranding head.

The storage vessel 1 and all piping of the ring main 2 are lagged and the piping is provided with steam trace heating. In the lower part of the storage vessel 1 there are provided stainless steel steam heating coils 7 for use when the sealing material in the vessel has been allowed to go solid, as for instance when commencing circulation of the sealing material in preparation for applying sealing material to a cable core. During circulation of the sealing material and application of the material to a cable core the sealing material in the thermostatically controlled storage vessel 1 is maintained in a liquid state by any suitable method.

At each feeding station 11 sealing material, which is being pumped around the ring main 2 in a liquid state, is continuously bled off and transferred in a liquid state into the applicator die 15. The rate of delivery of the sealing material in a liquid state to the cable core via each applicator die 15 is controlled by its associated valve 12. The sealing material is cooled to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core. Circulation of the sealing material through the ring main 2 will generally be maintained at a rate five to ten times as great as the aggregate rate at which it is withdrawn from the ring main at the cable feeding stations 11.

Surplus material spewing from each applicator die 15 is returned to a collecting tank 16 where any loss of temperature may be compensated by trace heating the tank. From the collecting tank 16 the surplus material is pumped by a scavenge pump 18 back through a filter 17 into the upper part of the storage tank 1 from where, after it has been brought back to the temperature of the circulating material, it can be re-circulated through the ring main 2. At each feeding station 11, a pipe 19 is provided for feeding sealing material directly from the ring main 2 into the collecting tank 16 when required, as for instance preparatory to starting up the sealing operation.

As will be seen on referring to Figures 2 and 3, each of the dies 15 by which the sealing material in a liquid state is applied to the cable core during its manufacture comprises a body 21 having a smoothly tapering bore 22 which is bell-mouthed at its entry end and which, at its exit end, corresponds to or is somewhat greater than the circumscribing circle of the cable core passing through the die. The outer surface of the wall of the body 21 is stepped at three locations along its length to form three cyl-

indrical portions, 23, 24 and 25. Portion 23 at the exit end of the die is externally screw threaded. In the portion 24 of the die wall are three ports 26 for entry of sealing material which are distributed uniformly around the axis of the die and are inclined to it so as to impart to the liquefied material a component of movement in the same axial direction as the direction of travel of the cable core passing through the die. A sleeve 27, which has at one end an internal diameter corresponding to the external diameter of the cylindrical portion 25 and which has at the other end an inwardly directed internally screw threaded flange 28, is screwed on to the end portion 23 of the body 21 until the sleeve fits tightly over the cylindrical portion 25 and abuts the step thereof. A hole 29 in the wall of the sleeve 27 is bounded by an upstanding continuous wall 31 and provides access for flow of sealing material in a liquid state to an annular chamber 30 lying between the internal surface of the sleeve 27 and the cylindrical portion 24. The wall 31 bounding the hole 29 is internally screw threaded for connection to a pipe carrying sealing material from the feeding station 11. Sealing material in a liquid state is fed from the annular chamber 30 to the cable core passing through the die via the ports 26. As previously stated the die 15 is detachably secured to the entry end of the closing die of a stranding head.

The rate of flow of sealing material into each die 15 is at least sufficient to maintain a "pool" of material in a liquid state in the annular chamber 30 and in the bell-mouth of the die. Surplus material from each die 15, if any, is allowed to fall into its associated collecting tank 16 to be reheated and pumped back into the storage tank as previously described.

By way of example it is mentioned that in providing a multi-conductor cable core comprising 100 pairs laid in six stranded layers with a continuous barrier of petroleum jelly having a drop melting point within the approximate range 73°C to 78°C using the method and apparatus described with reference to Figures 1 to 3, the petroleum jelly in a liquid state and at a temperature of approximately 76°C is delivered to the core at each of six applicator dies at a rate of approximately 2 gal/min (9.1 litres/min), the linear speed of travel of the core being approximately 225 ft/min (69 m/min).

Although in the foregoing description reference is made to the continuous filling of a single multi-conductor cable core during its manufacture, it will be appreciated that the ring main may serve two or more adjacently sited cable-making machines.

In the alternative form of apparatus shown in Figure 4, each stranding head of a conventional stranding machine has at its inlet

end an applicator die 45 which is of a form similar to that shown in Figures 2 and 3 and at which sealing material in a liquid state is fed to a cable core from an individual thermostatically controlled tank 41 in which the sealing material is maintained in a liquid state in any suitable manner, for instance by heating coils 47. The sealing material in a liquid state is fed to the applicator die 45 through a pipe 42 constituting the cable feeding station, and filter 43 by a metering pump 44. Surplus material spewing from the applicator die 45 falls back into the tank 41 where it is reheated and pumped back to the applicator die. In advance of the applicator die 45 a pipe 46 is provided for feeding sealing material being pumped through the pipe 42 directly back into the tank 41 when required, as for instance preparatory to starting up the sealing operation.

As in the method using the first form of apparatus sufficient sealing material is caused to become solidified by abstraction of heat by the insulated conductors constituting the core to form an effective barrier to the passage of moisture along the core.

The process of fully filling a multi-conductor cable in accordance with the present invention has the advantage that it eliminates substantially all mechanical working of the sealing medium — generally petroleum jelly—and so eliminates the separating out of oil from the wax which occurs under the action of shear brought about by pumping such material when in its solid state,

WHAT WE CLAIM IS:—

1. A method of providing a multi-conductor cable core with a barrier of sealing material which comprises pumping the sealing material from a thermostatically controlled storage vessel to a cable feeding station whilst at a temperature just above that at which crystallisation begins, transferring the sealing material from the cable feeding station to the cable core whilst still at such a temperature and cooling the material to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

2. A method of providing a multi-conductor cable core with a barrier of sealing material which comprises maintaining the sealing material in a thermostatically controlled storage vessel at a temperature just above that at which crystallisation begins, continuously pumping the material from the storage vessel and circulating it whilst at such a temperature around a ring main to one or more cable feeding stations located in the ring main transferring the sealing material from the or each cable feeding station to the cable core whilst still at such a temperature and cooling the material to



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indricial portions, 23, 24 and 25. Portion 23 at the exit end of the die is externally screw threaded. In the portion 24 of the die wall are three ports 26 for entry of sealing material which are distributed uniformly around the axis of the die and are inclined to it so as to impart to the liquefied material a component of movement in the same axial direction as the direction of travel of the cable core passing through the die. A sleeve 27, which has at one end an internal diameter corresponding to the external diameter of the cylindrical portion 25 and which has at the other end an inwardly directed internally screw threaded flange 28, is screwed on to the end portion 23 of the body 21 until the sleeve fits tightly over the cylindrical portion 25 and abuts the step thereof. A hole 29 in the wall of the sleeve 27 is bounded by an upstanding continuous wall 31 and provides access for flow of sealing material in a liquid state to an annular chamber 30 lying between the internal surface of the sleeve 27 and the cylindrical portion 24. The wall 31 bounding the hole 29 is internally screw threaded for connection to a pipe carrying sealing material from the feeding station 11. Sealing material in a liquid state is fed from the annular chamber 30 to the cable core passing through the die via the ports 26. As previously stated the die 15 is detachably secured to the entry end of the closing die of a stranding head.

The rate of flow of sealing material into each die 15 is at least sufficient to maintain a "pool" of material in a liquid state in the annular chamber 30 and in the bell-mouth of the die. Surplus material from each die 15, if any, is allowed to fall into its associated collecting tank 16 to be reheated and pumped back into the storage tank as previously described.

By way of example it is mentioned that in providing a multi-conductor cable core comprising 100 pairs laid in six stranded layers with a continuous barrier of petroleum jelly having a drop melting point within the approximate range 73°C to 78°C using the method and apparatus described with reference to Figures 1 to 3, the petroleum jelly in a liquid state and at a temperature of approximately 76°C is delivered to the core at each of six applicator dies at a rate of approximately 2 gal/min (9.1 litres/min), the linear speed of travel of the core being approximately 225 ft/min (69 m/min).

Although in the foregoing description reference is made to the continuous filling of a single multi-conductor cable core during its manufacture, it will be appreciated that the ring main may serve two or more adjacently sited cable-making machines.

In the alternative form of apparatus shown in Figure 4, each stranding head of a conventional stranding machine has at its inlet

end an applicator die 45 which is of a form similar to that shown in Figures 2 and 3 and at which sealing material in a liquid state is fed to a cable core from an individual thermostatically controlled tank 41 in which the sealing material is maintained in a liquid state in any suitable manner, for instance by heating coils 47. The sealing material in a liquid state is fed to the applicator die 45 through a pipe 42 constituting the cable feeding station, and filter 43 by a metering pump 44. Surplus material spewing from the applicator die 45 falls back into the tank 41 where it is reheated and pumped back to the applicator die. In advance of the applicator die 45 a pipe 46 is provided for feeding sealing material being pumped through the pipe 42 directly back into the tank 41 when required, as for instance preparatory to starting up the sealing operation.

As in the method using the first form of apparatus sufficient sealing material is caused to become solidified by abstraction of heat by the insulated conductors constituting the core to form an effective barrier to the passage of moisture along the core.

The process of fully filling a multi-conductor cable in accordance with the present invention has the advantage that it eliminates substantially all mechanical working of the sealing medium — generally petroleum jelly—and so eliminates the separating out of oil from the wax which occurs under the action of shear brought about by pumping such material when in its solid state,

WHAT WE CLAIM IS:—

1. A method of providing a multi-conductor cable core with a barrier of sealing material which comprises pumping the sealing material from a thermostatically controlled storage vessel to a cable feeding station whilst at a temperature just above that at which crystallisation begins, transferring the sealing material from the cable feeding station to the cable core whilst still at such a temperature and cooling the material to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

2. A method of providing a multi-conductor cable core with a barrier of sealing material which comprises maintaining the sealing material in a thermostatically controlled storage vessel at a temperature just above that at which crystallisation begins, continuously pumping the material from the storage vessel and circulating it whilst at such a temperature around a ring main to one or more cable feeding stations located in the ring main transferring the sealing material from the or each cable feeding station to the cable core whilst still at such a temperature and cooling the material to

effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

3. In the manufacture of a multi-conductor cable core by the conventional stranding process employing a stranding machine having at least one stranding head, a method of providing the cable core being manufactured with a barrier of sealing material which comprises pumping the sealing material from a thermostatically controlled storage vessel to an applicator die at a cable feeding station whilst at a temperature just above that at which crystallisation begins, transferring the sealing material through the applicator die to the cable core whilst still at such a temperature and cooling the material to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

4. A method as claimed in Claim 3, wherein each of a plurality of cable feeding stations is fed with sealing material from a separate source of supply.

5. A method as claimed in Claim 4, wherein surplus sealing material spewing in a liquid or semi-solid state from each applicator die is returned to the storage vessel associated with the die and is brought back to the requisite temperature in the vessel.

6. In the manufacture of a multi-conductor cable core by the conventional stranding process employing a stranding machine having at least one stranding head, a method of providing the cable core being manufactured with a barrier of sealing material which comprises maintaining the sealing material in a thermostatically controlled storage vessel at a temperature just above that at which crystallisation begins, continuously pumping the material from the storage vessel and circulating it whilst at such a temperature around a ring main to a plurality of cable feeding stations located at intervals in the ring main, transferring the sealing material from each cable feeding station through an applicator die to the cable core whilst still at such a temperature and cooling the material to effect crystallisation by abstraction of heat by the insulated conductors constituting the core to cause sufficient sealing material to become solidified to form an effective barrier to the passage of moisture along the core.

7. A method as claimed in Claim 6, wherein surplus material spewing in a liquid or semi-solid state from the applicator dies is returned to the storage vessel and is

brought back to the requisite temperature in or on its way to the vessel.

8. A method as claimed in Claim 6 or 7, wherein the sealing material is pumped around the ring main at a rate substantially exceeding the aggregate rate of flow of material from the cable feeding stations to the cable core.

9. A method as claimed in Claim 8, wherein the sealing material is pumped around the ring main at a rate five to ten times as great as the aggregate rate of flow of material from the cable feeding stations to the cable core.

10. A method as claimed in any one of Claims 3 to 9, wherein the sealing material is applied to the core at, or a short distance in advance of, the closing die of each stranding head of the stranding machine.

11. A method as claimed in Claim 10 in which the first layer of conductors, pairs or quads of the cable core is laid up around a group of two or more conductors, pairs or quads forming a core centre, wherein sealing material at a temperature just above that at which crystallisation begins is delivered through an applicator die at the point where the two conductors, pairs or quads are brought together to form the core centre.

12. A method claimed in any one of Claims 3 to 11, wherein the ring main is thermally insulated and is trace heated to control the temperature of the sealing material circulating therethrough.

13. Apparatus for use in providing a multi-conductor cable core with a barrier of sealing material comprising a thermostatically controlled storage vessel for storing the sealing material whilst at a temperature just above that at which crystallisation begins, the vessel being connected to one or more than one cable feeding station having means for applying sealing material to the cable core whilst still at such a temperature and, connected between the storage vessel and the applicator means of the or each cable feeding station, means for withdrawing sealing material from the storage vessel and for controlling the rate of delivery of the material to the applicator means.

14. Apparatus for use in providing a multi-conductor cable core with a barrier of sealing material comprising a thermostatically controlled storage vessel for storing the sealing material whilst at a temperature just above that at which crystallisation begins a ring main for the sealing material in which is connected means for continuously withdrawing sealing material from the storage vessel, driving it around the ring main and back into the vessel, and, at one or at each of more than one location in the ring main, a cable feeding station having means for applying sealing material being bled-off from the ring main to the cable core whilst still





at such a temperature and means for controlling the rate of delivery of the material to the applicator means.

15. Apparatus as claimed in Claim 13 or 14, wherein the or each means for controlling the rate of delivery of the material to the applicator means is a valve.

16. Apparatus as claimed in Claim 14 or 15, wherein a heated tank is associated with each applicator means for collecting surplus material spewing from the applicator means, a pipe extends from the collecting tank to the storage vessel, and a scavenge pump is provided for pumping the surplus material from the collecting tank back into the storage vessel.

17. Apparatus for use in providing a multi-conductor cable core with a barrier of sealing material comprising a plurality of thermostatically controlled storage vessels for storing the sealing material whilst at a temperature just above that at which crystallisation begins, each of which vessels being connected to a separate cable feeding station having means for applying sealing material to the cable core, whilst still at such a temperature, and, connected between each storage vessel and the applicator means of its associated cable feeding station, means for withdrawing sealing material from the storage vessel and controlling the rate of delivery of the material to the applicator means.

18. Apparatus as claimed in Claim 17, wherein each means for withdrawing sealing material from the storage vessel and controlling its rate of delivery to the applicator means is a metering pump.

19. Apparatus as claimed in Claim 17 or 18, wherein each storage vessel is so located with respect to the applicator means of its associated cable feeding station as to collect surplus material spewing from the applicator means.

20. Apparatus as claimed in any one of Claims 13 to 19, wherein the or each applicator means comprises a die which constitutes, or forms a separable part of, the closing die of a stranding head.

21. Apparatus as claimed in Claim 20 wherein the applicator die has a smoothly tapering bore which at its exit end corres-

ponds to or is somewhat greater than the circumscribing circle of the cable core to pass there-through, the wall of the bore having a number of ports for entry of sealing material.

22. Apparatus as claimed in Claim 21, wherein the ports of the applicator die extend between the bore and an annular chamber bounded by a part of the outer surface of the die wall and an outer sleeve which is in screwthreaded engagement with the die and which has in its wall a hole for entry of sealing material into the annular chamber.

23. Apparatus as claimed in Claim 21 or 22, wherein the ports of the applicator die are distributed uniformly around the axis of the die and are inclined to it so as to impart to sealing material entering the die a component of movement in the same axial direction as the direction of travel of the cable core.

24. Apparatus as claimed in any one of Claims 13 to 23, wherein the or each storage vessel is lagged and contains heating coils.

25. A method of providing a multi-conductor cable core with a barrier of sealing material substantially as hereinbefore described with reference to and as shown in Figures 1 to 3 of the accompanying drawings.

26. A method of providing a multi-conductor cable core with a barrier of sealing material substantially as hereinbefore described with reference to and as shown in Figure 4 of the accompanying drawings.

27. Apparatus for use in providing a multi-conductor cable core with a barrier of sealing material substantially as hereinbefore described with reference to and as shown in Figures 1 to 3 of the accompanying drawings.

28. Apparatus for use in providing a multi-conductor cable core with a barrier of sealing material substantially as hereinbefore described with reference to and as shown in Figure 4 of the accompanying drawings.

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ERRATUM

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