Jan. 21, 1958 R. COLOMBO 2,820,249

APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

Filed Oct. 6, 1953 5 Sheets-Sheet 1

Fig. 1

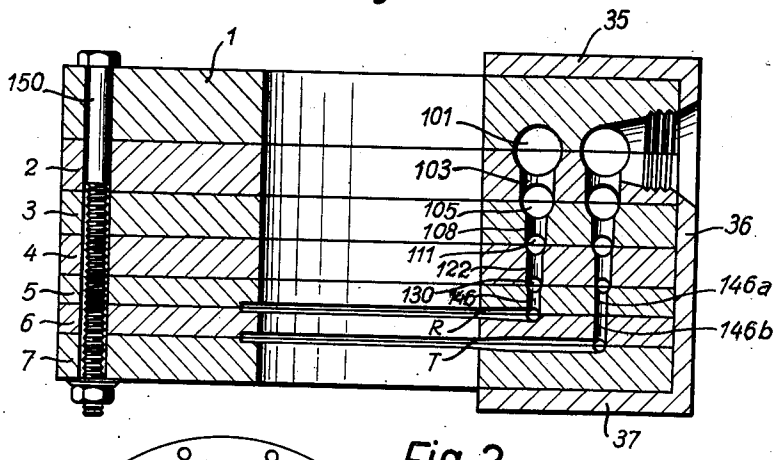


Fig. 2

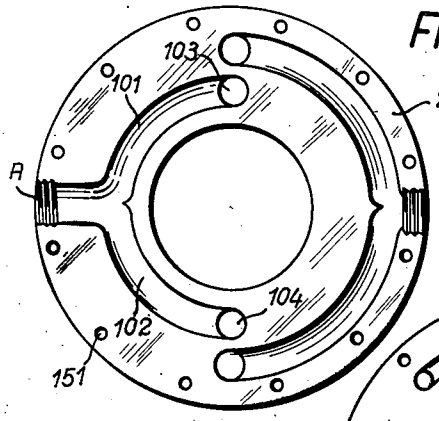
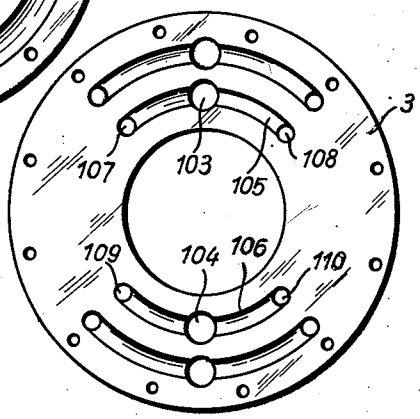


Fig. 3



APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

Filed Oct. 6, 1953 5 Sheets-Sheet 2

Fig. 4

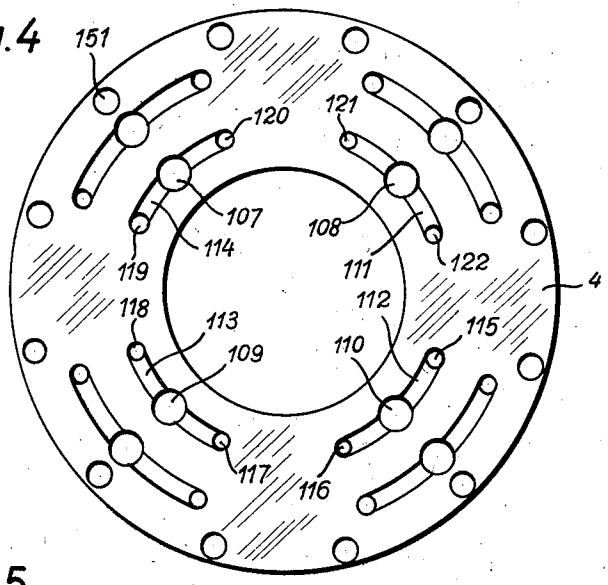
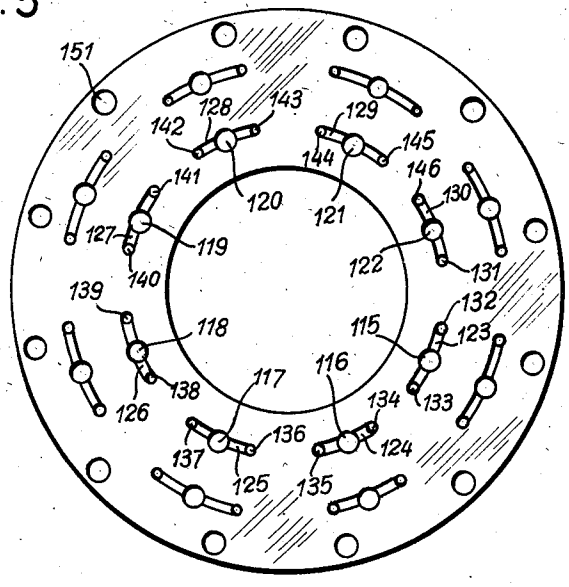


Fig. 5



Jan. 21, 1958 R. COLOMBO 2,820,249

APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

Filed Oct. 6, 1953 5 Sheets-Sheet 3

Fig. 7

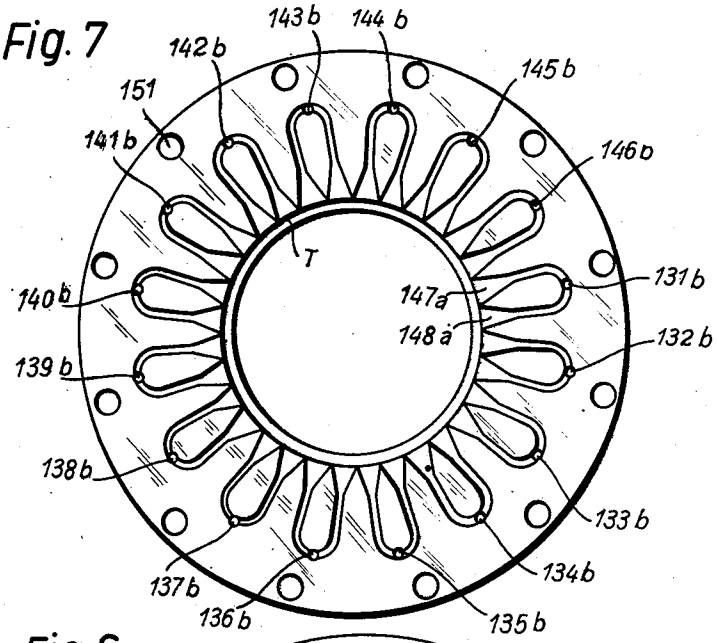
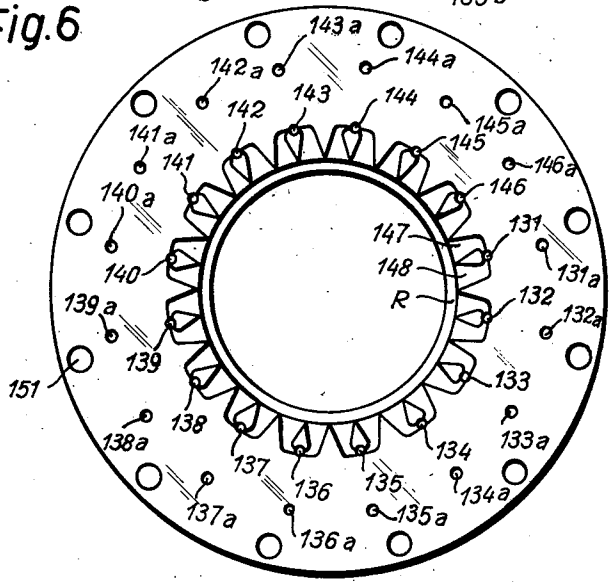


Fig. 6



APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

Filed Oct. 6, 1953 5 Sheets-Sheet 4

Fig. 8

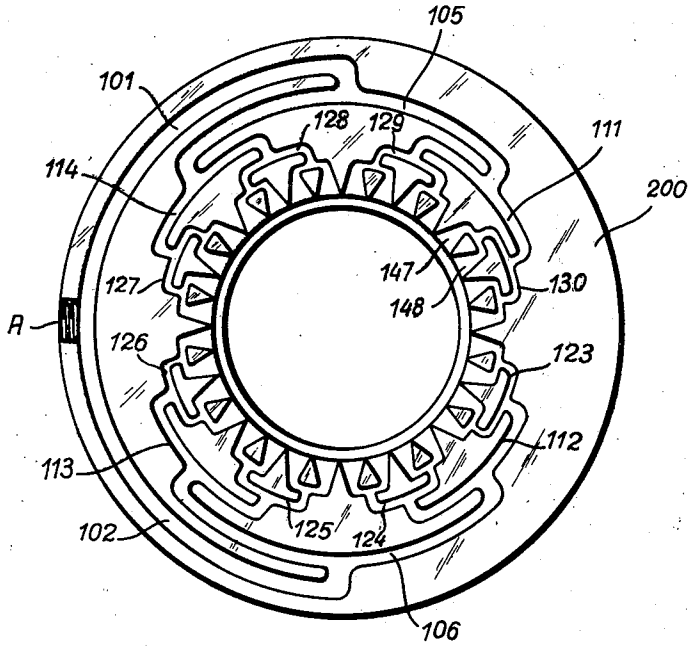
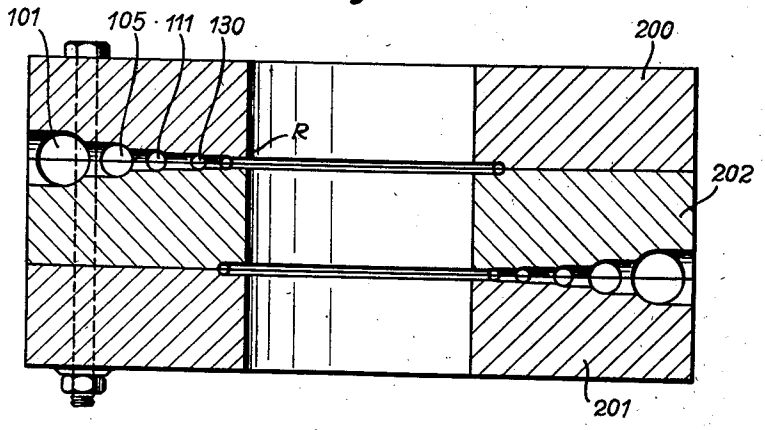


Fig. 9



Jan. 21, 1958 R. COLOMBO 2,820,249

APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

Filed Oct. 6, 1953

5 Sheets-Sheet 5

Fig. 10

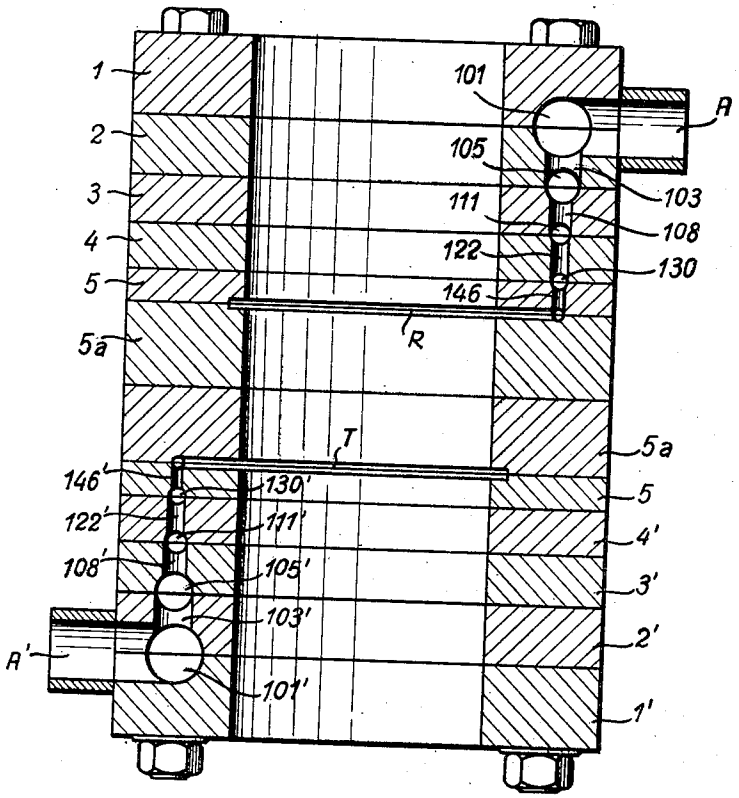
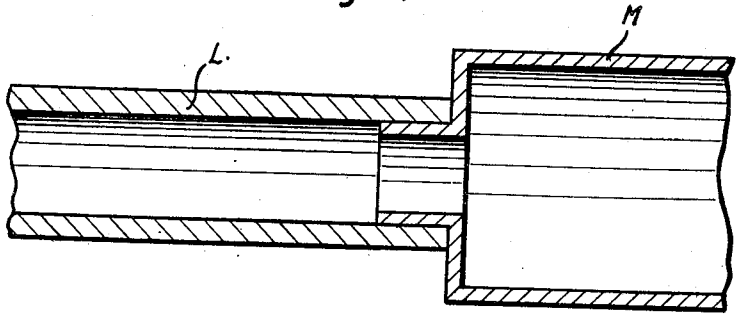


Fig. 11



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2,820,249

APPARATUS FOR COATING ARTICLES WITH MULTI-LAYER LININGS

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Claims priority, application Italy October 8, 1952

7 Claims. (Cl. 18—13)

It is known that iron and steel articles, and more particularly tubes and pipes for conveying liquids or gas which are buried in the ground at various depths, are subject to corrosion for various reasons such as the effect of stray currents in the ground and electrolysis processes due to these currents. This corrosion leads to the perforating of the pipings through which liquids or gases conveyed thereby are dispersed.

The problem of protecting pipes embedded in the ground is at present of especially great interest in connection with ducts or pipe lines conveying natural gas, such as methane, inasmuch as, while pressure rates of coke gas in gas mains are very low, the gas pressure for methane and the like reaches considerable values.

Protection of pipes against stray currents was taken care of heretofore by coating the pipes with linings made from tar layers or layers of tar admixed with jute and glass wool. Special paints have also been employed. The chief drawback of these types of protection resides in the fact that they can be injured during transport and laying on account of the low strength against wear and shock of the lining.

A further known protection against stray currents consists of laying the metal pipes in cement ducts further protected on the outside or inside by layers of materials opposing the access of stray currents. This method, which has heretofore afforded the best results, is very expensive.

The requirements which should be met by the protecting lining are chiefly as follows:

(1) High electric resistance;

(2) High strength against shock and wear in order to avoid injuries during transport and laying.

It has been rather difficult in practice to find materials meeting both requirements.

It has further been attempted to solve the problem of coating pipes by employing synthetic resin linings. A decided improvement was reached by the winding around metallic pipes plates of vinyl resins and welding the plates along a pipe generatrix. The polyvinyl resin plates are unattacked by acids and reduce the action of stray currents on the pipe. Moreover, they insulate the pipe from the ground preventing rusting thereof. Polyvinyl chloride suffers, however, from the drawback of an insufficient electric resistance, which is variable with moisture content.

The polyvinyl resin layer has been produced by direct winding about the pipe and welding of the abutting edges, or by extruding the thermoplastic material on the pipe so as to uniformly deposit the material on the outer pipe surface.

The process according to this invention solves the problem of coating pipes by adopting a multilayer lining, each layer having special properties, so that the lining as a whole actually meets all requirements. The invention further provides an apparatus for coating the pipe by one step in a simple and inexpensive manner.

With the process according to this invention, each layer may be made of a material properly meeting a given requirement. For instance, a layer of a material of high electric resistance may be combined with a layer of high mechanical strength, so as to obtain a unit which fully meets operating conditions. For instance, by coating an iron pipe with a layer of polyethylene resin, a lining results which is excellent from the standpoint of insulation, though it hardly resists abrasion, because the superficial hardness of polyethylene resin is limited. By superposing on this first layer a coating of polyvinyl resin worked without the addition of plasticizers, an outer layer is obtained which for a very great strength against abrasion. The pipe protected by the two coating layers is fully satisfactory.

The two-layer lining makes up for any discontinuity in the layer in direct contact with the pipe. This safely avoids any access of moisture and stray currents to the pipe.

With the apparatus according to this invention a multilayer lining can be obtained on a metal article by one step. The lining on the article is of uniform thickness, even if the surface of the article is not smooth or even. The apparatus serves for coating pipes of uneven outer surface or pipes previously coated by a previous process and slightly corroded.

The process and apparatus according to this invention can be employed for the continuous coating of pipes of any diameter.

The basic principle of the process consists of extruding the thermoplastic material through a continuous slot fed from openings uniformly distributed over the periphery of the slot. The slot opens on a surface approximately coaxial with the surface of the article to be coated, which is fed along the axis of the surface, extrusion of the thermoplastic material being effected in a direction normal to the surface of the article to be coated. The distribution of the opening feeding the continuous annular slot is such as to produce a uniform lining. With this object in view, besides arranging the supply openings at the corners of a regular polygon, care is taken that the load loss occurring in flow of the material from the extrusion press to the individual supply openings is the same at all the openings, whereby the delivery of the openings is uniform throughout the same.

Figure 1 is a diagrammatical axial section of a first embodiment of the apparatus;

Figures 2 to 7 show the elements of the apparatus shown in Figure 1;

Figure 8 shows an element of a further embodiment of the apparatus;

Figure 9 is a diagrammatic axial section thereof;

Figure 10 is a diagrammatic axial section of a still further embodiment;

Figure 11 shows a pipe provided with an extension for obtaining a thermoplastic two-layer section exceeding in diameter the diameter of the pipe lining.

Figure 1 shows on the right in a conventional manner the successive conduits for delivering the two thermoplastic materials adapted to form the two layers of the lining, and on the left the mechanical connections for holding the head elements together.

The material forming the inner layer of the lining enters the head of the apparatus through the supply opening A (Figure 2) from an extrusion press, under a pressure such that the material reaches the annular slot R. From the connection A the material flows along the two circular conduits 101 and 102 (Figure 2), reaching conduits 103 and 104 bored in the element 2 feeding the two circular conduits 105, 106 bored in the element 3 (Figure 3). At the ends of the last mentioned conduits four

vertical conduits **107, 108, 109, 110** feed four circular conduits **111, 112, 113, 114** (Figure 4). These four conduits end by the eight vertical conduits **115, 116, 117, 118, 119, 120, 121, 122** bored in the element **4** and feeding in turn eight circular conduits **123, 124, 125, 126, 127, 128, 129, 130**. Each of these conduits feeds at both ends two vertical conduits, sixteen vertical conduits **131, 146** (Figure 5) in all each of which feeds in turn two distinct conduits **147, 148** (Figure 6) merging into each other at the annular slot cut in the inner surface of the apparatus. The supply conduits **147, 148** (thirty-two in number in all) leading to the annular slot R are arranged so as to afford a uniform delivery of the material throughout the length of the slot, the resistance opposing the flow of the material from the extrusion press to the conduits **147, 148** being the same throughout the conduits.

In this manner, the material issuing from the annular slot R in a direction normal to the inner surface forms a layer practically of uniform thickness on the pipe which is fed along the axis of the apparatus.

Delivery of the second material forming the inner layer of the lining from the extrusion press to the annular slot T is effected as shown on the drawings in a manner similar to the delivery of the first material. The material flows through the element **5** along the vertical bores **131*a*, 146*a*** (Figures 1 and 6) bored in the element **5**, and through conduits **131*b*, 146*b*** to the opening **147*a*, 148*a*** feeding the annular slot T.

A basic feature of the invention consists in the fact that the bore of the conduit into which the annular slots open is considerably larger than the outer diameter of the pipe to be coated, whereby articles having an uneven outer surface, more particularly articles having an end socket can be successfully coated.

The apparatus just described is maintained at the desired temperatures from the outside by heating means denoted in Figure 1 by **35, 36, 37**. The heating means may consist of electric resistances or jackets for the circulation of liquid or steam at suitable temperature.

It will be understood that the apparatus has been described merely by way of example and apparatus can be designed in which the individual annular conduits are fed through a larger number of supply openings. In this manner, the thickness of the pipe lining may be kept uniform even as the pipe diameter increases. It is possible to increase the number of supply conduits to the annular slots by increasing the number of elements composing the apparatus.

The apparatus may be adapted by obvious modifications for making linings comprising more than two layers.

The pipe to be coated is fed along the axis of the apparatus by means not shown on the drawing. It is possible to vary the thickness of the lining simply by varying the rate of feed of the pipe along the axis. It is further possible to vary the ratio between the thickness of the two layers of the lining simply by varying the ratio between the delivery of the two presses extruding the different coating materials. When coating pipes with end sockets, the possibility of varying the rate of feed of the pipe along the axis is of considerable importance, inasmuch as it is then possible to deposit on the pipe portion of larger diameter a coating layer equalling in thickness the layer deposited on the remaining pipe portion. It is sufficient for the purpose to conveniently reduce the rate of feed at the socket end.

The apparatus for coating the pipe with two distinct protecting layers can be carried out other than just described.

Figures 8 and 9 show an apparatus based on the principle of arranging the successive delivery conduits for the thermoplastic material in two opposite elements. The apparatus then comprises but three elements, of which the top element **200** contains one half of the system of delivery conduits for the first material, to lower element **201** which contains half the system of delivery conduits for the second material, to intermediate element **202** containing in its two opposed faces the other halves of the two systems of delivery conduits. In the figures, the delivery conduits are provided with the same reference numerals as the corresponding delivery conduits of the machine shown in Figures 1 to 7.

A quite obvious modification of this second embodiment of the machine consists in subdividing the intermediate element into two elements, one of which contains half the delivery network for the first thermoplastic material, while the other contains half the delivery network for the second thermoplastic material.

Figure 10 is a diagrammatical axial sectional view of a third embodiment of the apparatus according to this invention. The apparatus comprises two superposed elements, in one of which the delivery of the first thermoplastic material is effected in a quite similar manner as in the apparatus illustrated in Figures 1 to 7, while in the second half of the apparatus the material adapted to form the outer protecting layer is delivered.

The three embodiments of the apparatus according to this invention are based on the same theoretical principle but solve in practice different problems. The first apparatus solves the problem of coating middle-sized pipes, the second embodiment serves for coating small diameter pipes, and the third embodiment is more particularly suitable for coating large diameter pipes.

By making obvious modifications to the apparatus described above, coated articles of a special character can be obtained. When an article having a striped outer lining is desired, it will be sufficient to limit the slot, through which the material forming the outer layer issues, to a plurality of discontinuous sections conforming with the desired strips on the outside of the pipe. These strips can take helical shape by combining with the feed of the pipe along the apparatus axis a rotation of the pipe about its axis. The pitch of the helix depends in this case upon the ratio between the rate of feed of the pipe along the axis of the apparatus and the rotational speed of the pipe.

The apparatus according to this invention, the bore of which exceeds the outer diameter of the coated pipe, permits of providing the ends of the coated pipe with a tubular section of two-layer thermoplastic material exceeding in diameter the pipe lining. With this object in view, a cylindrical disassemblable member M is fitted (Figure 11) on the end of the pipe L, the member M being larger in diameter than the pipe. By feeding the pipe the axis of the machine, the section M is likewise coated with a two-layer lining. Since the member M is disassemblable, it can be easily removed from the two-layer lining, which is then cut along the connecting line between the two linings differing in diameter. The section of two-layer protecting tube of larger diameter is used for protecting joints between two pipe sections according to a special technique which is described in a copending application.

The materials used for coating the pipe can be of widely different types. A very advantageous combination for protecting pipes against wandering currents comprises an inner polyethylene layer and an outer layer of polyvinyl chloride. The polyethylene layer has a high insulating power, while the polyvinyl chloride layer is very strong against abrasion. Further advantageous combinations result from the use of a layer of high insulating power with an outer layer of nylon which is highly abrasion-resistant.

In the field of pipes with a three-layer lining, highly satisfactory results have been obtained by an inner tar layer, an intermediate polyethylene layer and an outer polyvinyl chloride layer.

The various elements of the machine are held together by means of bolts **150** seated in holes **151** bored in the apparatus elements. The contact surface of the various

component parts of the apparatus are shaped and machined to avoid escape of material under pressure between the machine elements.

What I claim is:

1. Apparatus for coating with plastic material articles, more particularly tubes and pipes, comprising a plurality of discs each having a central bore, said discs being connected together with their central bores in axial alignment to define a tubular body, through the central bore of which the article to be coated can be advanced, a branched conduit system in said tubular body comprising axially spaced annular slots opening at the inner wall of said tubular body shaped to direct the synthetic material in a direction normal to the surface of the article to be coated, each of said slots being cut between two contiguous discs, sets of arcuate conduits for supplying synthetic material to each of said slots, said conduits being defined by mating grooves in the contiguous faces of said discs and terminating in end bores for connecting the arcuate conduits between pairs of successive discs, and wherein said conduits in any horizontal plane forming a part of one said conduit system are approximately of equal length whereby a system of branching conduits is obtained through which the slots may be uniformly supplied with the plastic material.

2. Apparatus as claimed in claim 1, in which the central bore in the tubular body is cylindrical and is appreciably larger in diameter than the tube to be coated, so as to permit of coating variable diameter tubes.

3. Apparatus as claimed in claim 1, in which the arcuate conduits and the connecting bores for said conduits are arranged with their axes situated on co-axial cylindrical surfaces.

4. Apparatus as claimed in claim 1, in which the arcuate conduits and connecting bores for said conduits are arranged on parallel cross planes extending through the extrusion slots.

5. Apparatus as claimed in claim 1, in which the arcuate conduits in any one horizontal plane and the connecting bores for the latter said conduits are arranged with their axes on the same cylindrical surface.

6. Apparatus for coating elongated articles such as pipes and tubes with a plastic material comprising a tubular body through which a tube may be advanced, said body defining a plurality of annular radially directed extrusion slots opening in axially spaced relationship on the inner tubular surface of the body, said body further defining an inlet opening for the material and a conduit system associated with each of the slots for supplying the material thereto, each said system comprising a set of pairs of conduits radially opening within the slot, a further peripheral set of pairs of conduits with the conduits of each pair branching to form each a pair of conduits of the said first named set, and at least one further set of conduits connecting the pairs of said second set to the said inlet opening, and wherein the conduits of any single set are of approximately the same length.

7. Apparatus as claimed in claim 6, wherein the inner diameter of the tubular body is substantially larger than the diameter of the article.

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