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(54) UNIVERSAL PIPE JOINT

(71) We, KUBOTA LIMITED, A Japanese body corporate, formerly of No. 64 Ishizukita-machi, Sakai-shi, Osaka-fu, Japan, and now of 2-22 Funade-machi, Naniwa-ku, Osaka-shi, Japan, 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:—

This invention relates to a universal pipe joint for connection to a plastics pipe, so that a pipe line can be deflected through an angle. More particularly, the subject of the invention is a universal pipe joint comprising an adaptor capable of being inserted into a part-spherical shell through an open mouth in the shell, in which the force required to remove the adaptor from the shell when the pipe joint is in use can be more than the insertion force.

Heretofore, a curved sleeve joint is used when a deflection is necessary in a pipe line. However, since the curved sleeve joint has a fixed angle, there is the inevitable disadvantage of requiring many kinds of the curved sleeve joint corresponding to necessary angles.

A prior art universal joint illustrated in Figure 5 and 6 of the accompanying drawings is disclosed in Japanese publication No. 81413/1975 (laid open utility model application), in which each end of two plastics sleeves 100 is formed as a part-spherical shell 20 or 30, respectively, the shell 30 being inserted into the shell 20. The angle between the sleeves 100 can be changed by virtue of relative rotation of the coupled shells. However, the forward edge 200 of the outer shell 20 contacts a point P′ on the root of the inner shell 30 when it is arranged at the largest angle (in Figure 6). In this state, a rotating force M′ applied thereto depress the forward edge of the inside shell 30 by a contact pressure f', and also expands the corresponding edge of the outer shell 20 by the same contact pressure f', so that these two shells may be easily separated by the cooperative deformations both of the depression and expansion arised therebetween. The thickness of the shells could be increased for the purpose of preventing such separation, but this increase is limited to the thickness beyond which it is impossible to couple them. In other words, so far as a cooperative deformation both of expansion and reduction at the two shells is necessary for inserting the inside shell into the outside shell, such separation can take place by the same cooperation deformation as arises upon coupling.

The present invention provides a universal pipe joint for connection to a plastics pipe, comprising a sleeve formed at one end with a part-spherical shell having an open mouth, and an adaptor rotatable within the part-spherical shell, the adaptor having a part-spherical surface between two opposite ends, each defining a plane, and a through-hole communicating between the two ends for receiving a plastics pipe, the part-spherical surface and the ends of the adaptor and the open mouth of the part-spherical shell being so dimensioned that, when the adaptor is inserted through the open mouth into the part-spherical shell, outward deformation of the mouth edge corresponding to the part-sperical surface takes place together with inward deformation of the mouth edge towards at least one of the said ends.

The force required to insert the adaptor is less than the force required to disengage the part-spherical shell and the adaptor from each other after the adaptor has been turned within the shell so that one end thereof is exposed through the open mouth of the shell.

Preferably the part-spherical shell has a diameter 5 to 50% greater than that of the sleeve, the through-hole has the same diameter as the sleeve along most of its length (i.e., the pipe to be inserted into the through-hole has the same diameter as the sleeve), and the open mouth has a diameter equal to or greater than the pipe to be inserted into the adaptor.

In a preferred embodiment at least one annular channel containing a packing ring is formed in the part-spherical face of the

adaptor but not in the median zone thereof. This has the advantage that the channel can be exposed at the open mouth for insertion of the packing ring, the adaptor then being turned so that the packing ring is remote from the mouth.

To avoid abrupt changes of flow cross-section within the adaptor, the end of the through-hole adjacent the sleeve preferably has a conical surface widening to the circular edge of the end adjacent the sleeve.

The relation between the part-spherical surface and the ends of the adaptor and the open mouth of the part-spherical shell may be determined according to, for example, a method of graphic analysis as illustrated in Figure 7 of the accompanying drawings, in order to allow insertion of the adaptor into the shell through the open mouth. In this figure, a sleeve 1 and a part-spherical shell 2 are illustrated as their interior shapes, and a part-spherical adaptor 3 as the exterior shape. The analysis is here drafted with respect to the open mouth similar to the diameter of the sleeve 1. After a minimum size of the open mouth 2' through which the adaptor 3 can be passed is obtained according to the analysis, this mouth is preferably made with a diameter greater than the determined minimum size, thereby permitting a pipe inserted in the adaptor to change its angle to the part-spherical shell in a range of the increased diameter. Otherwise, a pipe with a diameter smaller than the sleeve 1 can be inserted in the adaptor in place of such increasing of the mouth diameter, in order to provide for the desirable angular adjustment.

The spherical diameter of the shell 2 and the adaptor 3 increases in Figure 7 according to the following equations I, II, III, IV, and V, assuming that the sleeve 1 is 50 mm diameter:

I: $50 \times 1.05 = 52.5$ mm
II: $\times 1.10 = 55.0$
III: $\times 1.20 = 60.0$
IV: $\times 1.30 = 65.0$
V: $\times 1.40 = 70.0$

Corresponding to these diameters, projection charts I, II, III, IV, and V are illustrated with respect to each part-spherical shell 2, in which is further projected and marked by lines inclining from the left upward to the right, the corresponding adaptor 3 having circular end faces 3' and 3' similar to the mouth shape 2'. From combination of the mouth 2' and the adaptor 3 in each projection chart, a spherical portion of the adaptor 3 which naturally fits inside the mouth 2' is marked by lines inclining from the left downward to the right. This portion is drafted in the chart by a pair of points X on the shell's circle 2, at which crosses a corresponding dotted arrow standing at the point on the mouth's circle 2' at the longest distance AI, AII, AIII, AIV, and AV(zero) spaced from the plane face 3' of the adaptor 3, because the shell's circle 2 is the same as the part-spherical surface 3" of the adaptor 3 in this drawing. In the projection chart V, there is no distance between the plane face 3' and the mouth's circle 2'.

Referring to the combination of the adaptor 3 and the part-spherical shell 2 as drafted in the projection chart III, deformation of the mouth edge 2' takes place as illustrated in Figure 8, when the adaptor 3 is inserted into the part-spherical shell 2 through the open mouth. In this state, outward deformation of the mouth edge 2' takes place corresponding to the part-spherical surface 3" of the adaptor 3, and at the same time, inward deformation in direction to the plane faces 3' and 3' of the adaptor 3. So that only a little expansion and/or depression in the plastics material of the shell is necessary to distort the circular edge of the mouth 2' into the oval for passing the adaptor 3 therethrough. After the adaptor 3 has been inserted into the shell 2, the adaptor 3 is turned to align the two end faces 3' and 3' with the sleeve 1 or the open mouth 2', respectively. Accordingly, the whole surface area of the part-spherical surface 3" of the adaptor 3 can be surrounded by the spherical shell 2, forming a circumferential engagement, so that the coupling has increased resistance against a force tending to separate the parts. On the other hand, there is a through-hole communicating between the end faces 3' and 3', into which a plastics pipe 10 is inserted for connecting a fluid conveying line to the sleeve 1.

In practice, the open mouth should preferably be formed with a diameter greater than the fundamental diameter determined above, in order to permit a pipe inserted in the adaptor to change its angle in the mouth range. Therefore, an effective coupling range D should be considered, which is defined by the difference between the spherical diameter of shell and the diameter of the open mouth. The fundamental coupling range refers to DI, DII, DIII, DIV, and DV in the respective projection chart. The actual diameter of the open mouth will be determined as having a coupling range D effective to resist a corresponding separation force. Moreover, this coupling range D is also in relation to the longest distance spaced between the end face 3' and the mouth edge 2' in that the range D should be equal to or smaller than the distance AI, AII, AIII, etc. mentioned above for avoiding excessive deformation of the mouth edge 2' during insertion. According to various relations, an angle of possible adjustment less than 45° will be balanced with a sufficient separation resistance, preferably limiting the angle of possible adjustment to

from 10° to 20°.

As a result, taking into consideration many differences in kinds of plastics, size of sleeve, requirements for separation resistance, and angles of possible adjustment of the adaptor, the actual structure of the universal pipe joint is determined such that the outward deformation of the mouth edge corresponding to the part-spherical surface of the adaptor can place together with the inward deformation of the mouth edge towards one or both of the end faces of the adaptor, when inserting the adaptor into the part-spherical shell through the open mouth of the shell.

The invention will be described further, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a universal pipe joint in section;

Figure 2 shows an embodiment of an adaptor in section;

Figure 3 shows another embodiment of an adaptor in section;

Figures 4A, 4B and 4C diagrammatically illustrate the process of inserting an adaptor into a part-spherical shell through an open mouth of the shell;

Figure 5 shows a prior art universal joint in section;

Figure 6 illustrates the universal joint of Figure 5 arranged at the largest angle;

Figure 7 illustrates a method of graphic analysis for determining a fundamental relationship in the structure of a universal pipe joint according to the invention; and

Figure 8 illustrates the outward and inward deformation of the mouth edge corresponding to the shape of adaptor represented by projection chart III of Figure 7.

In Figure 1, a plastics pipe 1 is given the form of a sleeve formed with a part-spherical shell 2 at one end, the rigidity of this shell being made less than that of the sleeve. The forming of shell 2 can be carried out by, for example, blowing the corresponding end of the plastics pipe 1. Otherwise, an injection process can be applied to form the shell 2 when making the pipe 1, the wall of the shell 2 being made thinner than the pipe wall.

An adaptor 3, to which another pipe 10 is to be connected, is made from a plastics resin. The adaptor 3 is shaped with a part-spherical surface 3″ between two plane end faces 3′ defining mutually parallel planes. The adaptor 3 has a through-hole 3*a* communicating between the two end faces 3′, and one end of this hole 3*a* is provided with a conical surface 3*b* for assisting smooth fluid flow. An outer channel 4 and an inner channal 5 are provided in the part-spherical surface 3″ and the wall of the hole 3*a*, respectively, for mounting packing rings 12 and 13 respectively.

The adaptor 3 is intended to have rigidity greater than that of the shell 2, and the forming of the adaptor is carried out by an injection process. In order to remove thermal distortions remaining from the injection process, channels 6 and 7 are preferably made in on the wall of the hole 3*a* and in the part-spherical surface 3″, respectively (Figures 2 and 3). In this connection, rib elements at positions 8 may be provided in the channels 7, if they are necessary to maintain the shape of the channels. The adaptor 3 illustrated in Figure 3 include a rib element 9 in the channel 6 in the cylindrical wall of the hole 3*a*.

A hard polyvinyl chloride pipe 1 is used and is formed by a blowing process (simultaneously forming the shell 2), while the adaptor 3 is formed by injecting a hard polyvinyl chloride resin. However, since the shaping both of the pipe and of the adaptor can be practised by either blowing or injection, any suitable kind of synthetic resin can be used, preferably a resin having flexibility.

Referring to Figures 4A, 4B, and 4C, the manner in which the universal pipe joint can be coupled and assembled is explained as follows:

In Figure 4A, the adaptor 3 is offered up the the mouth of the shell 2 with the axis *a* — *a* of the former perpendicular to the axis *b* — *b* of the latter, and then, the adaptor is forced into the inner space of the shell 2 (Figure 4B). In this state, the planes defined by the two end faces 3′ and 3′ of the adaptor 3 are perpendicular to the open mouth 2′ of the shell 2, so that the length of the mouth edge corresponding to the part-spherical surface 3″ of the adaptor is reduced by the presence of the end faces 3′ and 3′, the mouth edge being deformed to admit the adaptor 3. This advantage will be seen from a comparative test, in which the adaptor is offered up to the open mouth 2′ of the shell 2 with the axes *a* — *a* and *b* — *b* being coincident. In this test, the circular edge of the open mouth 2′ must be deformed by the full circumference of the part-spherical surface 3″ of the adaptor 3, so that it is impossible to insert the adaptor into the shell 2.

The forcible insertion of the adaptor 3 into the shell 2 is easily achieved as illustrated in Figure 4B, because the necessary deformation of the open mouth only takes place in a small range of the area surrounding this mouth as mentioned hereinbefore. Besides, the rigidity of the shell 2 less than that of the adaptor 3, also facilitating insertion. The adaptor is subsequently turned within the shell to align the axis *a* — *a* with the axis *b* — *b* of the latter, and then the pipe 10 has its end 11 inserted into the cylindrical hole 3*a* of the adaptor 3. The universal joint is thus completed. The close contact of the part-spherical shell 2 and the

part-spherical surface 3″ of the adaptor 3 connects the shell 2 and adaptor 2 by the effective coupling range D mentioned hereinbefore. The force required to separate the coupling is greater than the force necessary to insert the adaptor into the shell.

Figure 1 shows the universal pipe joint arranged at the largest angle by a rotating force M, that is the mouth edge 20 of the shell 2 is contacting at the point P the insertion pipe end 11. In this state, a contact pressure *f* acts both on the shell 2 and the adaptor 3 in reaction of the rotation moment at the point P. However, little depressive-deformation can take place at the adaptor 3 because the adaptor is rigid, its rigidity having been increased by insertion of the pipe end 11. As the result, deformation can only take place at the corresponding portion on the shell 2 as expanded by such force, but not substantially at the adaptor, so that a cooperative deformation can be prevented.

When a pulling force F acts on the universal pipe joint, this force can be absorbed by a sliding movement of the pipe end 11 relative to the cylindrical hole 3*a* of the adaptor 3, so that a separation of the adaptor from the shell 2 is not possible.

The universal pipe joint described above is successful in that the coupling force between the shell and the adaptor is more than the force necessary for inserting the adaptor into the shell, and that the adaptor is shaped in a structure for permitting it to be inserted into the shell through the open mouth of the shell, thereby facilitating coupling.

WHAT WE CLAIM IS:—

1. A universal pipe joint for connection to a plastics pipe, comprising a sleeve formed at one end with a part-spherical shell having an open mouth, and an adaptor rotatable within the part-spherical shell, the adaptor having a part-spherical surface between two opposite ends, each defining a plane, a through-hole communicating between the two ends for receiving a plastics pipe, the part-spherical surface and the ends of the adaptor and the open mouth of the part-spherical shell being so dimensioned that, when the adaptor is inserted through the open mouth into the part-spherical shell, outward deformation of the mouth edge corresponding to the part-spherical surface takes place together with inward deformation of the mouth edge towards at least one of the said ends.

2. A universal pipe joint as claimed in claim 1, in which the open mouth of the part-spherical shell has a diameter greater than those of the ends of the adaptor.

3. A universal pipe joint as claimed in claim 1, in which the part-spherical shell has a diameter 5% to 50% greater than that of the sleeve, the through-hole in the adaptor has the same diameter as the sleeve along most of its length, and the open mouth of the part-spherical shell has a diameter equal to or greater than that of the pipe to be inserted in the adaptor.

4. A universal pipe joint as claimed in any of claims 1 to 3, in which at least one annular channel containing a packing ring is formed in the part-spherical surface of the adaptor but not in the median zone thereof.

5. A universal pipe joint as claimed in claim 1, in which the end of the through-hole adjacent the sleeve has a conical surface widening to the circular edge of the end adjacent the sleeve.

6. A universal pipe joint as claimed in claim 1, substantially as described herein with reference to the accompanying drawings except Figures 5 and 6.

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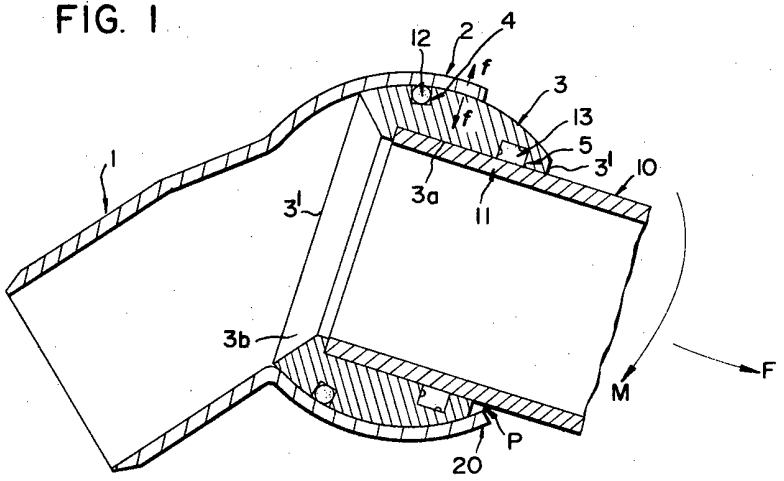
5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1



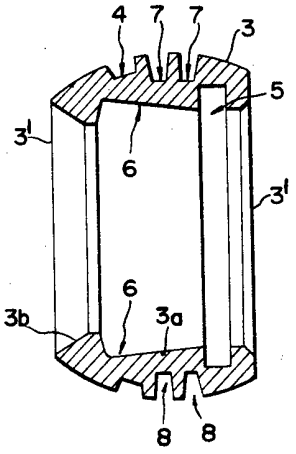


FIG. 2

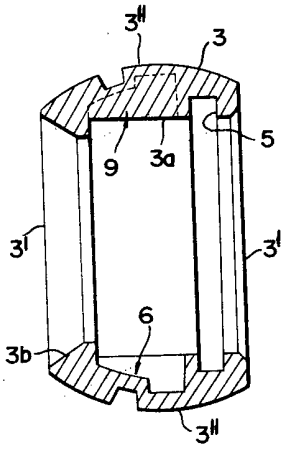


FIG. 3

FIG. 4A

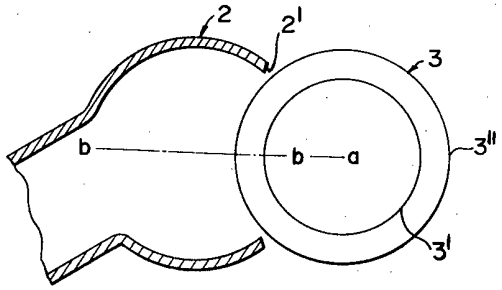


FIG. 4B

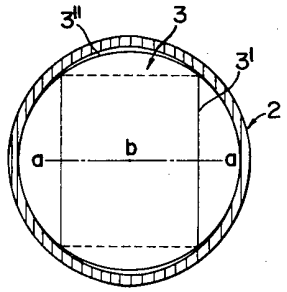
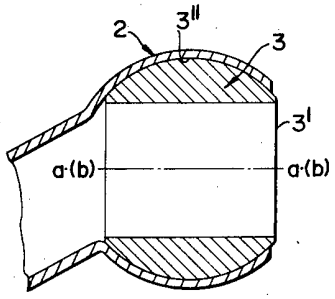


FIG. 4C



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Sheet 3

FIG. 5

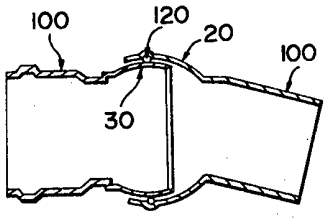


FIG. 6

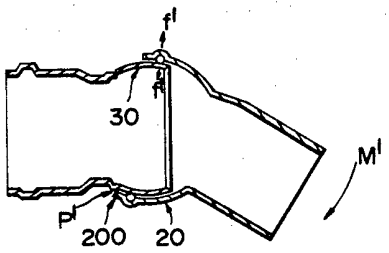
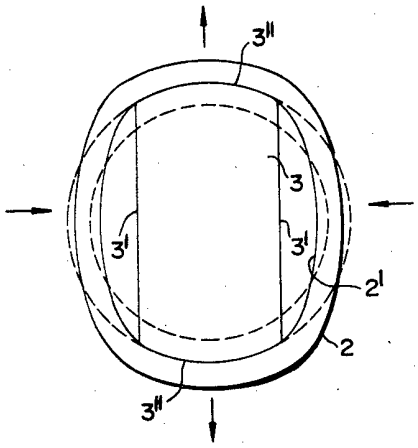


FIG. 8



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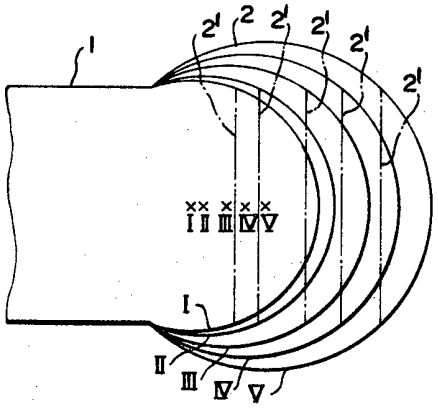

FIG. 7

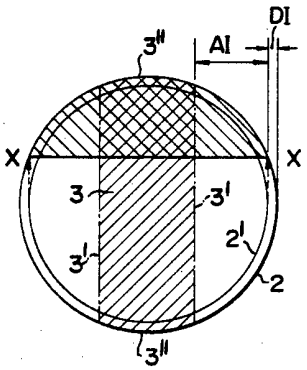

FIG. 7-I

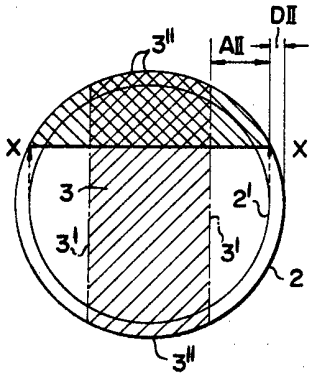

FIG. 7-II

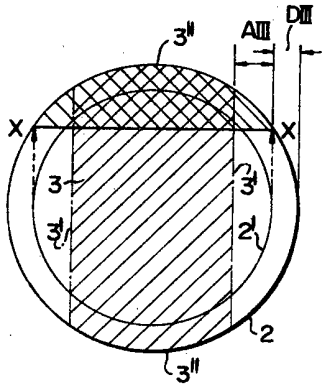

FIG. 7-III

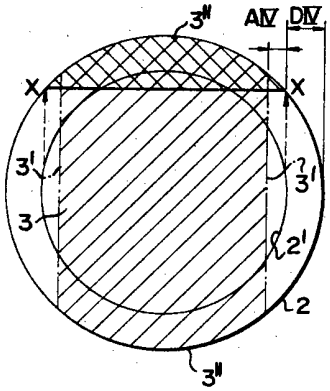

FIG. 7-IV

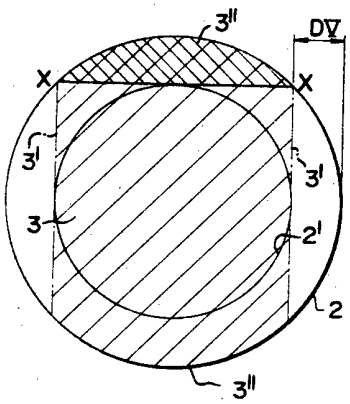

FIG. 7-V