PATENT SPECIFICATION

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761,208

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COMPLETE SPECIFICATION

Improvements in Pipes

We, SHARP, JONES & COMPANY LIMITED, a British company, of Bourne Valley Works, Parkstone, Dorset, 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:—

The present invention relates to an improved construction for pipes.

It is already known to make a pipe from synthetic resin bonded material, for example glass fibres in the form of a mat, rovings or a woven or felted cloth bonded with polyester resin. Whilst such a pipe is capable of withstanding high internal pressure it has two drawbacks. In the first place, it has a low beam strength with the result that if it is of any considerable length it becomes difficult to handle. In the second place, the synthetic resin bonded material does not have a very high wear resistance with the result that, if the pipe is employed for conveying fluids, the internal surface of the pipe becomes worn quite quickly by fluid borne grit.

The object of the present invention is the provision of a composite pipe which does not have the above mentioned drawbacks.

According to the invention a composite pipe comprises an external layer of synthetic resin bonded material and an internal layer of concrete.

A composite pipe acording to the invention may be made by one of two methods.

According to the first method a pipe of synthetic resin bonded material may be provided with a concrete lining by any of the methods normally used in the manufacture of concrete pipes, for example it may be cast into the pipe with the latter stationary or it may be centrifugally spun into the latter. The concrete lining is made sufficiently thick to give the composite pipe sufficient beam strength for handling purposes and adequate resistance to wear.

In a typical 24″ internal diameter composite pipe made by this first method, the synthetic resin pipe was made from polyester resin bonded glass fibre mat the pipe having an internal diameter of 25″ and a thickness of $^{3}/_{16}$″. Into this pipe a layer of concrete having a thickness of ½″ was centrifugally spun, the concrete mixture having the following composition by volume:—

	Parts
Portland cement - - - - -	1
Sand ($^{3}/_{16}$″ down graded) - -	1½
Granite chippings (¼″ single size) - - - - - - -	2½

This first method, is not of course, limited to the particular size of pipe mentioned above, or to the particular material used. The synthetic resin bonded pipe used may be made from any suitable fibres (such as asbestos or glass fibres), the fibres being bonded with any suitable thermoplastic or thermosetting synthetic resin. The concrete lining may have any suitable composition, for example the Portland cement in the mixture mentioned above may be replaced by sulphate resisting or aluminous cement. If desired the concrete lining may be reinforced.

To facilitate the ~~assembly~~ of pipes end to end, the concrete lining may project slightly from one end of the synthetic resin bonded pipe and terminate just short of the other end of the pipe. Any other standard jointing method may, however, be used.

According to the second method of manufacturing a composite pipe in accordance with the invention, synthetic resin impregnated fibrous material is applied to the outside of an existing concrete pipe and the resin allowed to set.

The concrete core pipe may be manufactured by any normal method, for ex-

[*Price 3s. 0d.*]

Price 3s. 6d.

ample, centrifugal spinning, tamping or vibration casting, and should have adequate dimensions to withstand handling stresses. The concrete pipe may have any suitable composition and if desired it may be reinforced.

After the concrete pipe has matured synthetic resin impregnated fibrous material is applied to the outside of the pipe, for example by winding it on. After hardening, the resulting synthetic resin bonded sheath performs the functions of (a) sealing the concrete pipe against the seepage of high pressure fluid from the inside thereof, (b) pre-stressing the concrete pipe by virtue of the contraction of the resin on setting and the tension applied to the resin impregnated material during its application and (c) strengthening the concrete core pipe to withstand greater internal pressures without bursting. As regards this last function the synthetic resin bonded material can be made to strengthen the core pipe to such an extent that reinforcement of the latter can, if desired, be dispensed with.

The synthetic resin bonded material may consist of any suitable fibres, such as glass or asbestos in the form of rovings, mat, tape or cloth, bonded with any suitable thermoplastic or thermosetting synthetic resin, for example polyester resins, allyl compounds, phenolic resins, silicone resins, melamine resins, epoxide resins and furane resins all of which may be moulded using very low pressures from contact pressure upwards and cured at comparatively low temperatures. These latter factors are of considerable importance since high temperature and/or pressure may cause damage to the concrete core pipes.

Although circumferentially positioned fibres only are required to resist the hoop stress due to the internal fluid pressure in the concrete core pipe, the longitudinal beam strength of the concrete core pipe may be increased by:—

(1) Application of fibres parallel to its axis, for example by the use of woven cloth, mat, tape or rovings applied in the longitudinal direction; or

(2) The application of rovings at a controlled helix angle. By applying rovings at a controlled helix angle a balance may be struck between the hoop stress and beam stress resistances of the finished pipe. For example, if the rovings are wound on with a zero helix angle, i.e. parallel to the diametrical axis of the concrete core pipe, the hoop stress resistance would be at a maximum and the beam stress resistance of the composite pipe would be that of the concrete core pipe only. An increase in helix angle of the wound rovings would decrease the hoop stress resistance using the same quantity of fibre but there would be an increase in the beam stress resistance over and above that of the concrete core pipe. Thus, using a helix angle of approximately 30° to the diametrical axis, the beam stress resistance would be half of the hoop stress resistance over and above that of the concrete core pipe.

Further by winding alternate layers of the rovings with opposite helix angles, diametrical axis, cleavage planes between successive rovings are avoided, so reducing the risk of porosity at high fluid pressures.

Also, since it is more convenient to manufacture comparatively short lengths of concrete core pipe, two or more such lengths may be joined together by simple rebated joints and the composite length wound with rovings at a suitable helix angle so that the beam stress at the joint can be resisted. This allows existing plants, for example plants capable of manufacturing concrete pipes in lengths of 3′, 4′, 6′ and 8′ to produce pressure pipes of any reasonable multiple or combination of these lengths, so reducing site joints to a minimum.

One form of apparatus for manufacturing composite pipes in accordance with the present invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic side elevation of a part of the apparatus, parts being broken away for the sake of clarity.

Figure 2 is a sectional view along the line II—II of Figure 1, and

Figure 3 is a partly sectioned detail view.

Referring to the drawings, the apparatus illustrated comprises a lathe bed 1 mounted on the floor 2, the lathe bed being provided with a headstock and tailstock of normal construction. In the drawings only the face plate 3 at the headstock end and the tailstock screw 4 at the tailstock end have been shown.

Along one side of the lathe bed 1 there is a recess 5, and along the other side a recess 6. The two recesses 5, 6, the axes of which are substantially parallel to the axis of rotation of the face plate 3, receive roller chains 7 and 8 respectively. Each of these chains is mounted on sprockets at each end of the lathe bed, one of these sprockets being designated 9 in Figure 1. One of the pair of sprockets 9 associated with each of the chains 7, 8 is driven through suitable gearing and a reversing mechanism (not shown), at a speed pro-

portional to the speed of rotation of the face plate 3.

Rail tracks 10 and 11 are arranged on the floor 2 at the sides of the lathe bed, these rail tracks being substantial parallel to the axis of rotation of the faceplate 3. Two substantially similar carriages 12 and 13 provided with running wheels 14 are adapted to move along the rail tracks 10 and 11 respectively. The carriage 12 has a sprocket 15 mounted thereon which engages the chain 7 and which can either rotate freely on the carriage or can be locked relative to the latter by means not shown. The carriage 13 has a similar sprocket 16 which engages the chain 8.

Each of the carriages 12 and 13 supports a number of shafts 17 (Figure 1) on each of which a bobbin 18 of glass fibre rovings is rotatably mounted. In the apparatus illustrated there are forty-two such bobbins on each carriage. Each carriage also supports a plurality of polished guide rods 19, two alignment combs 20, 21, a vessel 22, a fixed die block 23, containing forty-two ceramic or similar dies and an angularly adjustable die block 24 mounted on an adjustable supporting arm 25 and also containing forty-two ceramic or similar dies. For the sake of clarity in the drawings Figure 1 shows only a few of the teeth of the comb 20 of carriage 12 in detail, the remaining teeth are indicated by chain lines. The combs 20 and 21 of the carriage 13 have been omitted in Figure 1.

When it is desired to apply synthetic resin impregnated glass fibre rovings to a concrete pipe 26 in the above described apparatus, the pipe is fitted with two end rings 27 (see Figure 3) one at each end of the pipe, these end rings being held in position by a tie bolt 28 passing through the pipe. An assembly, generally designated 29, is then bolted to the tailstock screw 4 and another such assembly is bolted to the face plate 3. Each assembly 29 comprises two circular discs 30, 31 spaced apart by a cylindrical member 32. The length of member 32 is a little greater than the winding pitch X (Figure 1) with which it is desired to wind the glass fibre rovings on to the pipe. The disc 30 has a flanged peripheral edge portion 33 and a ring 34 of friction material. A thin cylindrical sleeve 35 is slidably mounted on the discs 30 and 31, the external diameter of this sleeve being substantially equal to the diameter of the concrete core pipe 26.

To place the pipe in the apparatus an eyebolt 36 is screwed into each of the end rings 27. The pipe is then lifted into a position between the assemblies 29 at the headstock and tailstock. The tailstock screw 4 is then advanced towards the headstock so that the end rings 27 are centred between the edge portions 33 of the two assemblies 29 and are clamped against the rings 34 of friction material. The eyebolts 36 are then removed and the sleeves 35 are slid towards the pipe ends leaving a narrow gap 37 between each sleeve and the adjacent pipe end (position shown in Figure 1).

The glass fibre rovings 38 from the bobbins 18 on each carriage are then threaded as shown in Figures 1, 2, a sufficient number of rovings being used to evenly cover one pitch length X of the pipe being wound. Each roving 38 passes from its bobbin around guides 19, through the alignment combs 20 and 21, around polished guides 39 in the vessel 22 and through the ceramic dies in die blocks 23 and 24. With one carriage adjacent to the headstock end of the lathe bed 1 and the other carriage adjacent to the tailstock end of the lathe bed, the ends of the rovings 38 are led from the die block 24 and tied to the sleeves 35 at each end of the pipe 26.

The vessel 22 on each carriage is then filled with liquid synthetic resin, the sprockets 15 and 16 are locked against rotation and the faceplate 3 and the driving sprockets 9 are set in motion.

As the pipe 26 rotates the carriages 12 and 13 travel in opposite directions along the rail tracks 10 and 11. The rotation of the pipe causes glass fibre rovings to be drawn from the bobbins 18, through the resin in the vessels 22 on to the pipe, to apply two layers of synthetic resin impregnated glass fibre rovings on the latter. The ceramic dies in die block 23 remove surplus resin from the rovings after their passage through the vessels 22 and the ceramic dies in die block 24 determine the spacing of the rovings before they are applied to the pipe. In Figure 1 the spacing apart of the rovings on the pipe 26 has been somewhat exaggerated for the purpose of clarity in the drawing.

The gear ratio between the sprockets 9 and the face plate 3 is chosen to give the desired helix angle to the impregnated rovings (usually about 30 degrees).

When the carriages reach the opposite ends of the pipe the sprockets 15 and 16 are unlocked and, with the carriages stationary, a layer of resin impregnated rovings is wound on to each sleeve 35. The sprockets 15 and 16 are then relocked after reversing the direction of rotation of the driving sprockets 9. This causes the two carriages to move back along the pipe to apply a second pair of layers of resin impregnated rovings to the pipe at opposite helix angles.

The above process is repeated until sufficient layers of resin impregnated rovings have been supplied to give the desired

beam and hoop stress resistance to the concrete core pipe. The purpose of the one layer of resin impregnated rovings wound with zero helix angle on the sleeves 35 at the end of each travel of the carriages along the pipe is to prevent slip back of the rovings when the carriages reverse to give the opposite helix angle.

After the final layers have been applied the machine is stopped, after a full pitch of resin impregnated rovings has been wound on each of the sleeves 35, and the sprockets 15 and 16 are unlocked. Then by revolving the pipe through one revolution whilst holding a cutting tool against the layers of resin impregnated rovings opposite each gap 37 the pipe is freed from the sleeves 35. The sleeves may then be slid back to enable the eyebolts 36 to be screwed back into the end rings 27. After supporting the weight of the pipe the tailstock screw 4 is released and the pipe is then lifted out of the machine and passed to an oven (not shown) where the resin is cured.

A fresh concrete pipe is then placed in the machine, the resin impregnated rovings being ready in position on sleeves 35 at each end for winding on the fresh pipe.

During the whole winding operation a paddle 40 (shown only in Figure 2) of wood, rubber or other suitable material, stretching the length of the pipe, bears on the outer surface of the coating removing surplus resin and smoothing the finished product.

Concrete core pipes having a range of different diameters can be accomodated in the above described apparatus simply by using end rings 27 and assemblies 29 of suitable dimensions and by adjusting the position of the die blocks 24 and paddle 40.

It will of course be appreciated that a composite pipe in accordance with the invention may be made by the above mentioned second method in other forms of apparatus than that described with reference to the accompanying drawings. For example, the concrete core pipe may be rotated and moved laterally with respect to a stationary carriage or carriages similar to the carriage 12 shown in the drawings. Again the core pipe may be arranged to rotate with its longitudinal axis substantially vertical, there being relative vertical movement between the pipe and the means for applying the synthetic resin impregnated rovings.

What we claim is:—

1. A composite pipe comprising an external layer of synthetic resin bonded material and an internal layer of concrete.

2. A composite pipe according to Claim 1, in which the synthetic resin bonded material consists of fibrous material, such as glass or asbestos fibres, bonded with any suitable thermoplastic or thermosetting synthetic resin, for example polyester resin, phenolic resin, silicone resin, melamine resin, epoxide resin or furane resin.

3. A composite pipe according to Claim 2, in which the fibrous material is in the form of rovings, mat, tape or cloth.

4. A composite pipe according to any of Claims 1 to 3, in which the concrete layer is reinforced.

5. A method of manufacturing a composite pipe of the kind claimed in any of Claims 1 to 4, in which a pipe of the synthetic resin bonded material is lined internally with a layer of concrete.

6. The method claimed in Claim 5, in which the concrete layer is cast into the pipe of synthetic resin bonded material with the pipe stationary.

7. The method claimed in Claim 5, in which the concrete layer is applied to the interior of the pipe of synthetic resin bonded material by a centrifugal casting process.

8. A method of manufacturing a composite pipe of the kind claimed in any of Claims 1 to 4, in which fibrous material impregnated with liquid synthetic resin is applied to the outside of a concrete core pipe, after which the resin is allowed to set.

9. Apparatus for manufacturing a composite pipe by the method claimed in Claim 8, comprising means for rotating the concrete core pipe about its longitudinal axis, with the said longitudinal axis either vertical or horizontal, and means for applying simultaneously to the rotating pipe a plurality of fibre rovings impregnated with liquid synthetic resin.

10. Apparatus according to Claim 9, in which the means for applying the impregnated fibre rovings is moved in the longitudinal direction of the pipe so that the rovings are applied helically to the pipe.

11. Apparatus according to Claim 9 in which the means for applying the impregnated fibre rovings is maintained stationary whilst the rotating pipe is moved in the direction of its longitudinal axis so that the rovings are applied helically to the pipe.

12. Apparatus for manufacturing a composite pipe of the kind claimed in claim 1 constructed and arranged substantially as herein described and as shown in the accompanying drawings.

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beam and hoop stress resistance to the concrete core pipe. The purpose of the one layer of resin impregnated rovings wound with zero helix angle on the sleeves 35 at the end of each travel of the carriages along the pipe is to prevent slip back of the rovings when the carriages reverse to give the opposite helix angle.

After the final layers have been applied the machine is stopped, after a full pitch of resin impregnated rovings has been wound on each of the sleeves 35, and the sprockets 15 and 16 are unlocked. Then by revolving the pipe through one revolution whilst holding a cutting tool against the layers of resin impregnated rovings opposite each gap 37 the pipe is freed from the sleeves 35. The sleeves may then be slid back to enable the eyebolts 36 to be screwed back into the end rings 27. After supporting the weight of the pipe the tailstock screw 4 is released and the pipe is then lifted out of the machine and passed to an oven (not shown) where the resin is cured.

A fresh concrete pipe is then placed in the machine, the resin impregnated rovings being ready in position on sleeves 35 at each end for winding on the fresh pipe.

During the whole winding operation a paddle 40 (shown only in Figure 2) of wood, rubber or other suitable material, stretching the length of the pipe, bears on the outer surface of the coating removing surplus resin and smoothing the finished product.

Concrete core pipes having a range of different diameters can be accomodated in the above described apparatus simply by using end rings 27 and assemblies 29 of suitable dimensions and by adjusting the position of the die blocks 24 and paddle 40.

It will of course be appreciated that a composite pipe in accordance with the invention may be made by the above mentioned second method in other forms of apparatus than that described with reference to the accompanying drawings. For example, the concrete core pipe may be rotated and moved laterally with respect to a stationary carriage or carriages similar to the carriage 12 shown in the drawings. Again the core pipe may be arranged to rotate with its longitudinal axis substantially vertical, there being relative vertical movement between the pipe and the means for applying the synthetic resin impregnated rovings.

What we claim is:—

1. A composite pipe comprising an external layer of synthetic resin bonded material and an internal layer of concrete.

2. A composite pipe according to Claim 1, in which the synthetic resin bonded material consists of fibrous material, such as glass or asbestos fibres, bonded with any suitable thermoplastic or thermosetting synthetic resin, for example polyester resin, phenolic resin, silicone resin, melamine resin, epoxide resin or furane resin.

3. A composite pipe according to Claim 2, in which the fibrous material is in the form of rovings, mat, tape or cloth.

4. A composite pipe according to any of Claims 1 to 3, in which the concrete layer is reinforced.

5. A method of manufacturing a composite pipe of the kind claimed in any of Claims 1 to 4, in which a pipe of the synthetic resin bonded material is lined internally with a layer of concrete.

6. The method claimed in Claim 5, in which the concrete layer is cast into the pipe of synthetic resin bonded material with the pipe stationary.

7. The method claimed in Claim 5, in which the concrete layer is applied to the interior of the pipe of synthetic resin bonded material by a centrifugal casting process.

8. A method of manufacturing a composite pipe of the kind claimed in any of Claims 1 to 4, in which fibrous material impregnated with liquid synthetic resin is applied to the outside of a concrete core pipe, after which the resin is allowed to set.

9. Apparatus for manufacturing a composite pipe by the method claimed in Claim 8, comprising means for rotating the concrete core pipe about its longitudinal axis, with the said longitudinal axis either vertical or horizontal, and means for applying simultaneously to the rotating pipe a plurality of fibre rovings impregnated with liquid synthetic resin.

10. Apparatus according to Claim 9, in which the means for applying the impregnated fibre rovings is moved in the longitudinal direction of the pipe so that the rovings are applied helically to the pipe.

11. Apparatus according to Claim 9 in which the means for applying the impregnated fibre rovings is maintained stationary whilst the rotating pipe is moved in the direction of its longitudinal axis so that the rovings are applied helically to the pipe.

12. Apparatus for manufacturing a composite pipe of the kind claimed in claim 1, constructed and arranged substantially as herein described and as shown in the accompanying drawings.

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PROVISIONAL SPECIFICATION
No. 32785 A.D. 1954

Improvements in Pipes

We, SHARP, JONES & COMPANY LIMITED, a British company, of Bourne Valley Works, Parkstone, Dorset, do hereby declare this invention to be described in the following statement:—

The present invention relates to an improved construction for pipes.

It is already known to make a pipe from synthetic resin bonded material, for example glass fibres in the form of a mat or a woven or felted cloth bonded with polyester resin. Whilst such a pipe is capable of withstanding high internal pressures, it has two drawbacks. In the first place, it has a low beam strength with the result that if it is of any considerable length it becomes difficult to handle. In the second place, the synthetic resin bonded material does not have a very high wear resistance with the result that, if the pipe is employed for conveying fluids, the internal surface of the pipe becomes worn quite quickly by fluid-borne grit.

The object of the present invention is the provision of a synthetic resin bonded pipe which does not have the above drawbacks.

According to the invention a synthetic resin bonded pipe is provided with a lining of concrete. This concrete lining may be applied inside the synthetic resin bonded pipe by any of the methods normally used in the manufacture of concrete pipes, for example it may cast into the pipe with the latter stationary or it may be centrifugally spun into the latter. The concrete lining is made sufficiently thick to give the pipe sufficient beam strength for handling purposes and adequate resistance to wear.

In a typical 24" internal diameter pipe made in accordance with the invention, the synthetic resin pipe was made from polyester resin bonded glass fibre mat, the pipe having an internal diameter of 25" and a thickness of $^3/_{16}$". Into this pipe a layer of concrete having a thickness of $\frac{1}{2}$" was centrifugally spun, the concrete mixture having the following composition by volume:—

	Parts
Portland cement - - - - -	1
Sand ($^3/_{16}$" down graded) - -	1½
Granite chippings ($\frac{1}{4}$" single size) - - - - - - -	2½

The invention is not, of course, limited to the particular size of pipe mentioned above, or to the particular materials used. The synthetic resin bonded pipe used may be made from any suitable fibres (such as asbestos or glass fibres and the like), the fibres being bonded with any suitable thermoplastic or thermosetting synthetic resin. The concrete lining may have any suitable composition, for example the portland cement in the mixture mentioned above may be replaced by sulphate resisting or aluminous cement. If desired the concrete lining may be reinforced.

To facilitate the assembly of pipes end to end, the concrete lining may project slightly from one end of the synthetic resin bonded pipe and terminate just short of the other end of the pipe. Any other standard jointing method may, however, be used. The joining together of two lengths of pipe made in accordance with the invention may be effected by wrapping one or more layers of fibre cloth around the abutting ends of the pipes and bonding with synthetic resin.

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PROVISIONAL SPECIFICATION
No. 4589, A.D. 1955.

Improvements in Pipes

We, SHARP, JONES & COMPANY LIMITED, a British company, of Bourne Valley Works, Parkstone, Dorset, do hereby declare this invention to be described in the following statement:—

The present invention relates to an improved construction for pipes.

In our co-pending application No. 32785/54 we have described an improved pipe construction according to which a synthetic resin bonded pipe is provided with a concrete lining. According to the said co-pending application this concrete lining may be applied inside the synthetic resin bonded pipe by any of the methods normally used in the manufacture of concrete pipes, for example it may be cast into the pipe with the latter stationary or it may be centrifugally spun into the latter.

According to the present invention a pipe consisting of an external layer of synthetic resin bonded material and an inner layer of concrete is manufactured by the

application of synthetic resin bonded material to the outside of an existing concrete pipe.

The concrete pipe may be manufactured by any normal method, for example, centrifugal spinning, tamping or vibration casting, and should have adequate dimensions to withstand handling stresses. The concrete pipe may have any suitable composition and if desired it may be reinforced.

After the concrete pipe has matured synthetic resin bonded material is applied to the outside of the pipe, for example by winding it on. After hardening, the synthetic resin sheath performs the functions of (a) strengthening the concrete pipe to withstand greater internal pressures without bursting, (b) sealing the concrete pipe against the seepage of high pressure fluid from the inside thereof, and (c) prestressing the concrete pipe by virtue of the contraction of the resin on setting and the tension applied to the resin bonded material during its application.

The synthetic resin bonded material may consist of any suitable fibres, such as glass or asbestos, bonded with any suitable thermoplastic or thermosetting synthetic resin, for example polyester resin. The fibres may be in the form of rovings, mat, tape or cloth.

Although circumferentially positioned fibres are only required to resist the internal pressure in the concrete pipe, the longitudinal beam strength of the concrete pipe may be increased by the application of fibres parallel to its axis, for example by the use of fibres in the form of cloth, mat or tape or by the use of rovings in the longitudinal direction.

In a typical example of the manufacture of a pipe by the method according to the invention, a concrete pipe having an internal diameter of 6" and an external diameter of 8" was mounted in a screw cutting lathe by means of tapered wooden plugs lightly driven into the ends. The plug at one end of the pipe was held in a jaw chuck at the headstock end of the lathe and the plug at the other end of the pipe was mounted on a normal centre at the tailstock end. A continuous glass fibre thread (60 end rovings) was led from a storage reel over a series of fixed glazed porcelain pulleys to produce a tension in the thread, through a bath of polyester resin and on to the concrete pipe, the end of the thread being tied to the pipe. The tensioning pulleys and the resin bath were mounted on the saddle of the lathe so that when the pipe was caused to rotate the glass fibre thread could be wound on to the pipe at any desired pitch. Four layers of glass fibre thread were applied to the pipe, the pitch of the turns of thread in each layer being $^3/_{16}$". When the polyester resin had hardened it was found that the completed pipe was capable of withstanding an internal pressure of 275 lbs. per sq. inch before seepage occurred.

The process which has just been described may of course be varied in several ways. Thus more than one resin impregnated glass fibre thread could be applied to the concrete pipe at the same time and instead of mounting the pipe for rotation in a lathe the pipe could be mounted non-rotatably and the tensioning device arranged to move around the pipe. Instead of traversing the thread applying device along the pipe the latter could be traversed relative to the thread applying device, and the pipe could be arranged vertically instead of horizontally.

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