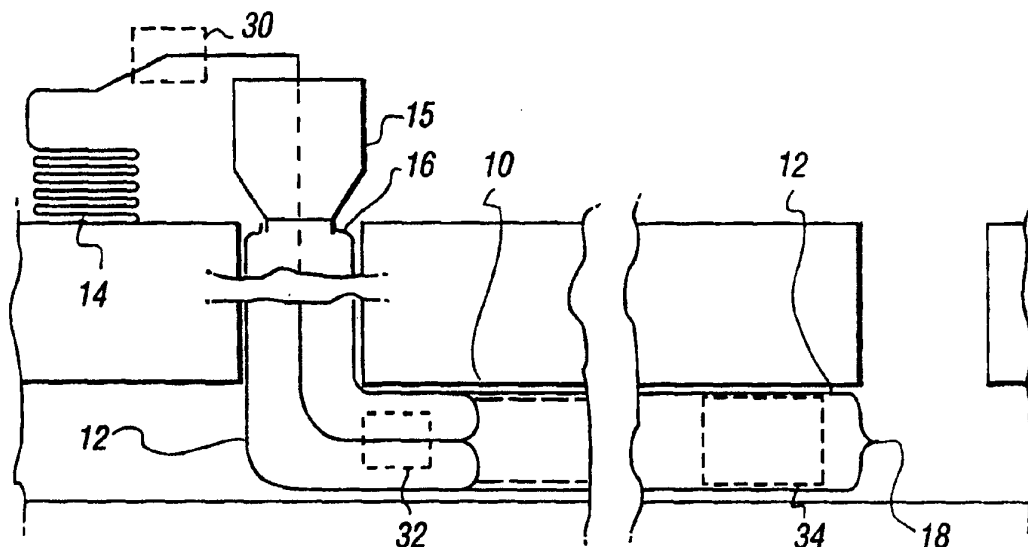


PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B29C 35/02, 63/36, F16L 55/165, C08K 9/10		A1	(11) International Publication Number: WO 95/01860
			(43) International Publication Date: 19 January 1995 (19.01.95)
(21) International Application Number: PCT/GB94/01288			(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 15 June 1994 (15.06.94)			
(30) Priority Data: 9313692.7 5 July 1993 (05.07.93) GB			
(71) Applicant (for all designated States except US): SOUND PIPE LIMITED [-/-]; P.O. Box 156, Hibiscus Square, Pond Street, Grand Turk (TC).			
(72) Inventor; and (75) Inventor/Applicant (for US only): CHANDLER, Brian, Burnett [GB/AT]; Steinermark, A-8933 St Gallen 60 (AT).			
(74) Agent: BAILEY WALSH & CO.; 5 York Place, Leeds LS1 2SD (GB).			Published <i>With international search report.</i>

(54) Title: APPLYING LININGS TO PIPELINES AND PASSAGEWAYS**(57) Abstract**

This invention concerns the lining of pipelines and passageways by the cured in place method in which a lining tube of flexible absorbent material is impregnated with a curable synthetic resin and is held on the surface of the pipeline or passageway until the resin has cured so that a hard lining pipe is formed. Commencement of the cure conventionally is effected by filling the pipe with hot water, but in the present invention curing is "kick" started as the lining is being fed from ground level into the pipeline or passageway the resin having a cure time which is not too much greater than the lining insertion time so that the time for performing the insertion and curing is reduced to a minimum. The resin may be conditioned so that it can effectively be "kick" started for example by sonic energy.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

APPLYING LININGS TO PIPELINES AND PASSAGEWAYSBACKGROUND OF THE INVENTION

This invention relates to the application of linings to pipelines and passageways. The invention is concerned with those linings which are referred to as "soft linings" or "cured in place" linings, which involve at least one resin absorbent layer which is impregnated with a curable synthetic resin. The technology concerning the manufacture and installation of these linings is now well developed, and is based upon original patents of the USA Nos 4009063 and 4064211 to which reference is made for details. This technology has found wide application in the application of these linings to underground sewer pipes, but there are still aspects of this technology in relation to which improvement might be made. Thus, the practised methods involve the impregnation of the lining tubes under factory conditions, and after the tubes have been impregnated, it is desirable that they should be taken to site and put in position over the pipeline or passageway surface as soon as possible so that there is no premature curing of the resin before the lining is put in position. When the lining is in position, it then is desirable that curing should take place as quickly as possible so that the workmen on site can complete the operation in the shortest time and can vacate the site promptly so that there is minimum inconvenience to the general public and to traffic movement, it being mentioned that underground sewer pipes are usually located under and extending in the direction of roads, thoroughfares, highways and the like.

Much attention has been directed therefore to the resin which is used and the curing arrangements, because there is the desirability that the resin should have a long shelf life

after application to the lining, so that it will not cure prematurely, and on the other hand should have a short cure time so that when cure finally is initiated, it can be completed as quickly as possible.

In the majority of contracts which are performed using the techniques set forth in said US patents, heat is used for effecting the cure of the resin, and a heat cure resin is used for the impregnation of the lining. Other suggestions in relation to resin technology have been that light cure resin may be used so that initiation of the cure can be effected by shining high intensity light which is Ultra Violet light at the lining when it is in place in the pipeline or passageway. Other suggestions have involved using ferromagnetic particles in the resin so that the resin can be cured selectively by exciting the ferromagnetic particles using a magnetic field, and other arrangements have suggested the use of ultrasonic radiation for; causing the resin to heat up; up to cause the rupturing of microcapsules in the resin, such microcapsules including a catalyst and/or promoter to initiate the resin cure; or to cause catalyst and/or promoter to desorb from adsorbent particles in which the said catalyst and/or promoter is adsorbed.

Generally speaking, a solution to the problem has not been satisfactorily discovered, and heat curing is still the most popular method practised.

The problem with heat curing is that it requires the heating up of a large volume of water or other liquid which fills the lining when it is in place on the pipeline or passageway surface. Heating apparatus has to be provided on site in order to heat the water, and generally the use of hot water tends to slow up the curing process.

In a co-pending British Patent Application No 9304465.9 we have made some general suggestions as related to the use of microcapsules in the resin, whilst in British Patent Application No 9320498.0 we have suggested the use of adsorbent particles, such as clay particles - which the catalyst and/or promoter is asorbed.

The invention the subject of said prior UK Applications Nos 9304465.9 and 9320498.0 relate generally to curable resins and more particularly to resins which have been conditioned in order that they may be cured to produce rigid articles in a most convenient and efficient manner.

The use of curable synthetic resins to produce rigid articles is extensive, and indeed nearly all plastics, whilst too numerous to mention here, are synthetic resins initially, which means that they go through a liquid or plastic phase before being shaped and hardened into the final article.

In the majority of uses, the processing of the resin including the curing of same is performed under controlled conditions according to manufacturing methods established over many years, but circumstances do arise wherein it is required to control the hardening or curing of the resin until the appropriate instant in time to ensure best utilization of the resin.

A particularly good example of this situation arises as discussed above in connection with the curing of a resin which is used to impregnate a resin absorbent tubular structure (herein the "lining tube or pipe") which is to be used for lining an underground pipeline or passageway such as a sewer. In such utilization, which is now practiced widely throughout the world, the impregnated lining tube is inflated (by gas such as air, steam and/or liquid such as water)

against the pipeline or passway surface whilst the resin is uncured, and whilst the lining tube is so held in position, the resin is allowed or caused to cure whereby the cured resin with the absorbent tubular structure embedded therein forms a self supporting rigid pipe, which may or may not bond to the pipeline or passageway wall. The purpose of this operation is to rehabilitate and/or repair the passageway or pipeline. A particular advantage of the provision of a self supporting rigid pipe is that bonding to the existing pipeline is not necessary, as is the case with some lining systems but it is to be mentioned that this invention can be applied to pipelining systems where the impregnated tube does bond to the existing pipeline or passageway, such systems being those wherein the lining tube is of relatively small thickness e.g. 5 mm or less and the resin acts like a bonding medium rather than an impregnating medium.

Also, the lining tube when the resin is in the uncured state may not strictly be a tube in that it may be a web folded into tubular form so that its edges overlap and such edges become fused or held relatively together only when curing in place has been effected. In fact, this arrangement provides the advantage that the overlapping edges can slip relatively as the tube is being inflated so that the tube will best fit to the passageway surface.

Examples of methods of lining of underground pipelines and passageways using impregnated lining tubes which are cured in place are contained in many patent specifications in addition to the said US Patents Nos. 4009063 and 4064211 to which reference has already been made.

All or by far the majority of the methods which are practised throughout the world using cured in place lining tubes for contracts for lining underground pipelines and passageways

use heat for the curing of the resin, the application of heat causing a catalyst and/or promoter (accelerator) in the resin to commence cross linking of the resin molecules and crystal formation; the curing reaction is exothermic and heat is internally generated and the curing process accelerates.

One disadvantage of this arrangement is that even if heat is not applied to the impregnated lining tube, under ambient conditions the resin will eventually cure in a matter of days and of course if curing takes place before the lining tube is in place on the passageway of pipeline surface, the lining tube is completely lost and must be scrapped. This can represent a considerable loss if not complete loss of profit on a contract. Should the lining tube cure when it is part way inside the pipeline or passageway, then the consequences financially could be disastrous for the contractor. In order to avoid the problem of the resin curing too soon, i.e. before the lining tube is in place, contractors have resorted to extensive measures, in particular to keeping the impregnated tube refrigerated until it is to be used on site. This means that the tubes must be delivered to the site in refrigerated vehicles.

Also, when heat is applied it is applied usually by hot fluent medium e.g. water or steam which fills the inside of the inflated lining tube. If the pipeline is one which constantly carries a fluid or liquid such as sewage the normal flow must be diverted whilst the curing continues. Especially in the case of sewage, this represents a considerable inconvenience and more significantly extra costs which can mean in some cases the loss of contracts to cheaper methods.

Ironically, however, once the tubes have been put in place, it is desirable that the resin should be cured as fast as

possible, as the sooner the resin cures, the sooner the contractor can leave the site. It is to be noted that the contractor will often be given or will often quote a relatively short time for completion of the work, usually undertaken during the night. It is very important therefore that the work be completed in the shortest possible time, especially in these cases where the performance of the work involves the rendering inoperative (as it does in many cases) of a sewage system or the blocking or obstructing of traffic.

To perform the contract therefore the contractor must on the one hand have a factory or plant at which the tube is impregnated, a vehicle for keeping the impregnated tube refrigerated and a vehicle with a heating means for heating the fluid which inflates the tube when in place, in order to effect the curing of the resin, as well as the necessary equipment for putting the tube into place.

There is also the dilemma concerning the resin. On the one hand it is desirable that it should have as long a shelf life as possible to give the contractor plenty of time to place the tube in the pipeline or passageway before curing. On the other hand, when the tube is in place, it is desirable that curing should take place as quickly as possible. Unfortunately this dilemma has proved so far to be insoluble as the additives such as retarders for the resin which can increase shelf life of the resin also increase the cure time of the resin.

Consequently, when a contractor has to perform a contract, he must have the lining tube manufactured, and, immediately before he is to insert the lining tube, he impregnates the tube with the resin, transports it to site (which may be remotely located) as quickly as possible, and inserts the lining tube and cures it as quickly as possible. As soon as

the resin is mixed with its catalyst for impregnation of the lining tube, there is a time countdown, and the contractor is racing against time.

The industry is aware of this problem and some attempts have been made to solve it by developing special resins which are curable by light radiation, and examples of such resins are disclosed in European Patent Specification No 0007086, and methods of cured in place lining with impregnated lining tubes using light radiation are disclosed in U.S. Patent No. 4,581,247 and 4,680,066.

Light radiation curable resins however include catalysts which are activatable by the suns rays and therefore the impregnated lining tubes must be contained in opaque wrappings during storage and transportation to avoid premature curing.

Light radiation curable resin does however have the advantage that curing of same can be controlled and theoretically the resin has an infinite shelf life. When it comes to curing the in place impregnated tube however, problems arise. Firstly, special ultra violet light sources are needed to cure the resin; secondly, when, as is often the case, the inflating medium is water, that water may be dirty in which case light curing cannot be performed, and in any case waterproof light sources have to be designed and manufactured as no such sources are commercially available. When the flowing liquid in the pipeline or passageway is opaque, as sewage is, it must be diverted and the use of light curing equipment suffers from the same disadvantage in this respect as heating methods. For these reasons, in practice, light curing of in place impregnated lining tubes has not been successful and has not replaced the traditional heating methods.

The invention the subject of International Patent Application No. PCT/GB93/00107, of which I am joint inventor, seeks to provide curable resin systems for the production of rigid articles wherein the resin can be cured readily and quickly, but retains a long to infinite shelf life (e.g. one year or more) making it particularly suitable for use in cured in place lining systems for pipelines and passageways; that invention and the present invention are not however to be considered as limited to this field of application and they are useable in any circumstances as appropriate where resin is to be formed into a rigid article.

According to the invention the subject of said International Application in its most general aspect the resin includes or is located adjacent inert matter which is not affected by ambient conditions such as ambient heat and light, but such matter is susceptible to applied radiation to such an extent to cause curing or commencement of curing of the resin.

There are various forms which the said matter can take, and such forms can be used singly or in combination.

In one specific example, the matter comprises microencapsulation shells in which is contained a catalyst for the resin, or a promoter (accelerator) or both, the shells being susceptible to the ultrasonic radiation to rupture the cells to release the catalyst/promoter, and hence cause commencement of the cure.

The invention the subject of said UK Application No 9304465.9 is concerned with the use of micro-encapsulated materials in synthetic resin matrixes. As indicated above, the micro encapsulation may include the catalyst and/or the promoter (accelerator) or both, but the concept is that the micro

encapsulation shells are ruptured in order to release the contents to cause initiation of the cure of the surrounding resin matrix.

As explained in the said co-pending International Patent Application, this initiation system using micro encapsulated substances can be used in conjunction with other initiation systems referred to in the International Application, such as magnetically excitable particles or microwave activatable materials.

In one aspect, the invention the subject of said UK Application provides that an ultrasonic mechanical impactor is used in order to contact a lining tube which is impregnated with the synthetic resin matrix and the matrix contains the micro encapsulated materials.

The mechanical ultrasonic impactor may be an ultrasonic resonator which is arranged to shoot hardened steel balls at the lining tube. This resonator which is of known type shoots the steel balls without losing hold of the balls, insofar as the balls are held in slots as they are fired ultrasonically so as to impact the lining tube. The impacting of the balls on the lining tube has the effect of rupturing the microcapsules to release the contents thereof to commence the curing of the resin and matrix. The resonator can be used at any stage in the lining process as described in said International Patent Application, and as explained hereinafter, or the resonator can be used in any appropriate circumstances for resin curing. Ultrasonic resonators heretofore have been used for surface hardening of steel pipes.

It is set forth in said UK application that the ultrasonic impacting may be effected on the lining tube before it is

introduced into the underground passageway which it is to line, so that it would be easier to perform, and this would be followed by the feeding of the lining tube with the fractured micro capsules into the underground passageway to be lined.

The concept of treating the impregnated lining tube more or less immediately prior to its insertion into the pipeline or passageway and preferably above ground, has general application insofar as it is not necessary that the initiation of the cure at this time should necessarily be by ultrasonic impacting as described in said UK application. It could be any cure initiating step such as heat cure ultrasonic, light or electromagnetic, or any combination of these steps, the advantage being that when curing is initiated, there is a lifetime between the initiation of the cure and when the lining becomes hard. It will be up to the installer therefore to ensure that the lining is placed in position on the pipeline or passageway during this lifetime. The advantages which follow are that the curing apparatus can be much smaller, and can be much more easily controlled and examined and repaired, because suitably it can be located above ground. High intensity of curing application can be effected also, whether this be by heat, light or radiation or ultrasonic.

Installers have not previously addressed the matter of initiating cure immediately before the lining is moved underground but rather have stuck to traditional methods which involve placing the lining on the pipeline or passageway surface and then taking steps to initiate the cure. The technology of installing the linings has now developed so far and has now become so efficient that the installer can more or less be sure that he will be able to install the lining within a preset time, and therefore there

should be no difficult in calculating that time and deciding when to initiate the cure and how to initiate the cure by a means located above ground. The installation time should be capable of significant reduction which will represent a tremendous advantage to installers because the sooner the installation has been completed, the sooner expensive labour can be removed from the site and deployed in other areas.

Typically, the lining as it is fed from the ground level into the pipeline or passageway (and typically it will be everted into the pipeline or passageway) may pass through a device which is cure initiating, such as a heating ring or ultrasonic vibrator or mechanical impactor, depending upon the resin which is used for the system.

Should it be desired, additional curing initiating or completing steps can be performed on the lining when it has been placed on the pipeline or passageway, in accordance with established practise, but it is believed that such additional curing initiation or effecting will be much reduced compared to using curing after installation exclusively.

Where heating is used for initiating cure above ground, the heating means may be specially designed, and may comprise for example hot rollers or other heating means which is a different approach from using hot water in accordance with the established method.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, wherein:-

Fig. 1 is a sectional side elevation showing a lining operation in progress, the operation being for the application of a flexible lining tube to an underground

passage;

Fig. 2 is an enlarged sectional elevation of the lining tube which is adopted for the process of Fig. 1;

Fig. 3 is a perspective view illustrating how the lining tube is everted into position in the pipeline or passageway; and

Fig. 4 is a view similar to Fig. 2 but showing the use of a sonic generator to desorb catalyst and/or promoter to cure the resin.

The first embodiment which is described herein uses microcapsules and it is to be mentioned at this time that the materials which are used i.e. the resins, micro capsules, lining tube materials, may be as described in the said co-pending International Patent Application to which reference is made, and/or as described in U.K. Patents 1,340,068 and 1,449,445 to which reference is also made.

Referring to Fig. 1, an underground passageway in the form of a sewer pipe 10 is being lined by means of a flexible tube 12 supplied from a supply 14 of such tube. The tube is delivered and everted into the sewer 10 by means of a pump unit 15 which is of the design construction and function as set forth in International Patent Application PCT/GB91/01603 and US Patent 5154936. This unit 14 serves to pump and evert the tube 12 as shown in Fig. 1. A leading end 16 of the tube may be anchored to the outlet of the unit 15.

The right hand portion of Fig. 1 shows the tube 12 fully positioned and it is illustrated as having a closed trailing end 18. To said end 18 there may be attached a hold back rope, cable or the like in order to prevent the end 18 from rupturing under the eversion pressure.

It is convenient now to refer to Fig. 2 which shows the lining tube 12 in greater detail. Tube 12 will be seen to comprise a core section 20 which is made up of one or more layers of an absorbent material such as a fibrous felt or woven fabric or a combination of these materials or other suitable absorbent materials, and surrounding layer 20 is an impermeable layer 22 which typically in the case of the layer 20 being of polyester felt is of polyurethane film which is bonded to the outer layer of the felt 20.

The felt 20 in practise is impregnated with a curable synthetic resin, and also contained in the resin matrix in this example are the micro encapsulated catalyst and/or promoter, the micro capsules being indicated by reference 24 and being shown in enlarged scale for clarity. These capsules will be much smaller, and will be distributed throughout the resin matrix.

In the arrangement of Fig. 2, the tube 12 is shown in its manufactured condition i.e. before application to the sewer surface, and it will be understood that when the tube 12 is everted as shown in Fig. 1, the outer skin or membrane 22 will eventually lie to the inside of the applied tube. This is illustrated more particularly in Fig. 3 which shows the tube 12 in the process of eversion. A portion 12A has been everted, and the felt surface soaked with resin is turned outwardly whilst the membrane 22 is to the inside, whilst the portion 12B is the inwardly travelling portion, in that it moves in the direction of arrow 26 during eversion.

The above described is also set forth in the aforesaid International Patent Application, but in accordance with the present invention illustrated in the drawings, an ultrasonic resonator is used to apply energy to the lining tube 12

whilst it is still in the flexible state in order to rupture the microcapsules 24, and the ultrasonic resonator is applied to the tube at the location 30 which is ahead of the pump unit 15. Optionally, a second resonator 32 may be used on the inwardly travelling portion 12B of the lining tube and/or at 34 which shows that the ultrasonic resonator is applied to the lining tube after it has been everted on to the surface of the sewer 10.

The present invention identifies that the step of initiating the cure, for example using the resonator 30 as shown in Fig. 1, has general application insofar as instead of using a sonic resonator as described, other resin initiating apparatus can be adopted as related to the type of resin system used. Thus, instead of a resonator 30 one might use a heater, or a light source, or a radiation source. Indeed, depending upon the resin composition, these cure initiators may be used in combination. There may for example be some advantage in using a heating device for preheating the lining with the resin system as shown in the accompanying figures insofar as preheating the resin in combination with the rupture of the microcapsules may provide enhanced curing when the lining is placed in the pipeline or passageway so that any additional underground curing device or step is not necessary. The inventive concept is the effecting of a precuring or curing initiation "kick" prior to the insertion of the lining on the pipeline or passageway surface. It is desirable to avoid having to introduce curing apparatus into the pipeline or passageway where it cannot be seen where it has to be monitored by television camera. If the precuring step of the present invention is sufficient to ensure that full cure will eventually be effected when the lining is placed in position, then best advantage is attained. It is believed certainly that there will be considerable reduction in curing time by adopting the method of the present

invention.

Reverting again to the drawings, the ultrasonic resonator as shown in Fig. 2 is designed to apply energy to the lining tube 12 in that the ultrasonic resonator applies energy as indicated by arrows 36 at the lining tube on the membrane surface 22. This energy fractures the micro capsules and releases the catalyst and/or promoter into the resin matrix initiating the cure and therefore this method has all the advantages of delayed and selective curing so that lining tubes can be pre-impregnated with the resin matrix and microcapsules and stored until ready for installation which is a considerable advantage.

An advantage of the ultrasonic resonator is that it can be used under water, and when it is used for example at location 34 it may well be that the lining tube 12 is simultaneously filled with water which serves to inflate the tube.

Referring now to Fig. 4, this figure shows the liner tube 12 comprising the inner core 20 and the outer membrane 22, but in this instance, at location 30 in Fig. 1, there is provided a sonic generator apparatus comprising a pair of vibratory plates or other components 50, 52 which in the arrangement shown are configured to follow the contour of the flattened liner tube 12. The plates are provided with transducers 54, 56 which are power driven in order to vibrate the plates. The plates may be vibrated ultrasonically or at audible frequencies, in order to apply the energy to the lining 12, in order to initiate the cure of the resin which impregnates the core 20. In this figure, particles 24 are shown as being embedded in the core 20 and in the resin which impregnates same, but these particles may be for example adsorbent particles which include catalyst and/or promoter or accelerator. It is preferred that the particles be arranged

in two groups namely a first group in which the catalyst is adsorbed, and a second group in which the promoter or initiator is adsorbed. The particles of each group may be clay, but the clay of the particles of one group may be different from that of the other group, as this has been found unexpectedly to have beneficial results. The resin may furthermore include an additive which enhances the desorbence of the catalyst and promoter when the lining tube is subjected to the sonic vibration. Such additive preferably comprises sodium hexametaphosphate when the catalyst is dibenzoyl peroxide, which has the effect as described in my co-pending British Patent Application 9320498.0.

The sonic generator exemplified by the the plates 50 and 52 may be driven in any convenient manner, and may for example be such that the respective plates 50 and 52 are driven at different frequencies in order to give sonic interference in the vicinity of the lining tube 12 which enhances energy application to the lining tube, and desorbence of the catalyst and promoter. With such desorbence, the cure of the resin which preferably is a polyester resin, is initiated or is "kick started".

As the lining tube 12 travels into the pipeline or passageway as indicated in Fig. 1, the curing time of the resin is selected or controlled so as to be slightly longer than the time it takes to install the liner so that curing will commence more or less immediately after the liner is in position, thereby minimising the time which the operator has to remain on site.

When use is made of an ultrasonic generator for initiating the resin cure, and a sufficient amount of energy is applied, enough heat can be generated in the resin matrix to initiate the cure without any catalyst being required, which

represents a considerable advantage. This method may require the use of certain monomers.

Accelerator or promoter may be used or not, as required.

Monomers with a low styrene contrast may be particularly useful in this regard.

Considerable advantage flows from the present invention as described herein, and the methods of the embodiments described can be used in conjunction with other resin activation methods for example as disclosed in said International Patent Application PCT/GB93/00107.

In a further modification, where an epoxy resin is used as the matrix in accordance with a latent cure system as produced by Shell Resin, the curing is triggered by raising the temperature to the order of 80°C, and therefore the micro encapsulated material may be a heat inducing chemical which causes heating up when the capsules are ruptured for example as hereinbefore described. Where a promoter is encapsulated, this preferably may be an amine.

The resin system employer may include ferrite or the like particles so that heat may be generated in the resin for initiating and/or effecting cure of the resin. In this connection, an alternating magnetic field may be used for the initiating step as described herein. Also, where an additional curing step is required for example by the use of a curing means in the pipeline e.g. at location 32 or 34 in Fig. 1, the step of final curing may be effected by the use of the apparatus set forth in UK patent application No 9409014.9 which employs a rotor having alternating north and south pole magnets which define magnetic fields of opposite flux direction around the periphery of the rotor so that

rotation of the rotor causes the application of an alternative magnetic field throughout the lining thickness and the ferrite particles contained in the lining are thereby heated enhancing the cure. The initiating step may be performed by means of an alternating magnetic field.

CLAIMS

1. A method of lining an underground pipeline or passageway, wherein a liner tube which is flexible, is sized to the pipeline or passageway to be lined and is impregnated with a curable synthetic resin in uncured state is placed on the pipeline or passageway surface by fluid pressure to line same, and the resin subsequently cures hard providing a rigid lining pipe on the pipeline or passageway surface, characterised in that the resin is of a type or formulation so that cure thereof can be initiated by a cure initiation step such as heat, impact, vibration, radiation or any combination of such steps, and in that the cure indication is effected immediately prior to the introduction of the liner tube into the pipeline or passageway and the liner tube is placed on the pipeline or passageway surface after said cure initiation but before completion of the cure.

2. The method according to claim 1, wherein said cure initiation is performed at ground level, as the liner tube is being fed into the pipeline or passageway.

3. The method according to claim 1 or 2, characterised by the step of assisting the cure of the resin after the liner tube has been placed on the pipeline or passageway surface.

4. The method according to any of claims 1 to 3 characterised in that the resin is selected or formulated to have a preset cure time after said cure initiation which takes place prior to insertion in the pipeline or passageway and the fluid pressure holding the liner tube to the pipeline or passageway is removed after said preset time.

5. The method according to any one of the preceding claims, including the step of feeding the liner from in the direction

of its length from ground level into the pipeline or passageway, characterised in that said cure initiation includes feeding the liner tube through a cure initiation means at ground level.

6. The method according to claim 5, characterised in that the cure initiation means comprises a "sonic" generator apparatus and the resin is susceptible to cure initiation by sonic energy.

7. The method according to claim 7, characterised in that the resin includes adsorbent particles containing catalyst and/or promoter which is desorbed under the influence of sonic energy in the ultrasonic and audible range.

8. The method according to claim 7 characterised in that the resin is a polyester resin and the catalyst is benzoylperoxide and the promoter is an amine.

9. The method according to claim 7 or 8, characterised in that the resin includes particles susceptible to magnetic and/or induction radiation.

10. The method according to any of claims 7 to 9 characterised in that the said particles comprise a first group containing the catalyst and a second group containing the promoter.

11. The method according to claim 10, characterised in that the particles of the first group clay particles of a type different from the second group, which are also clay particles.

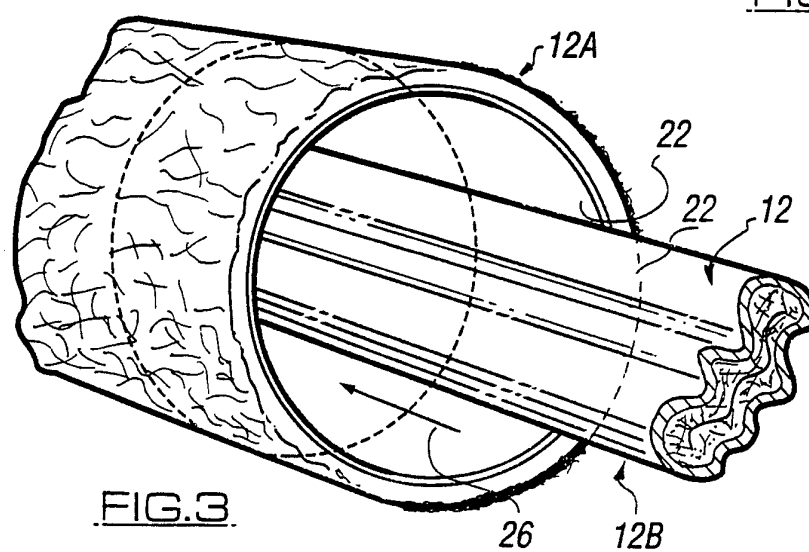
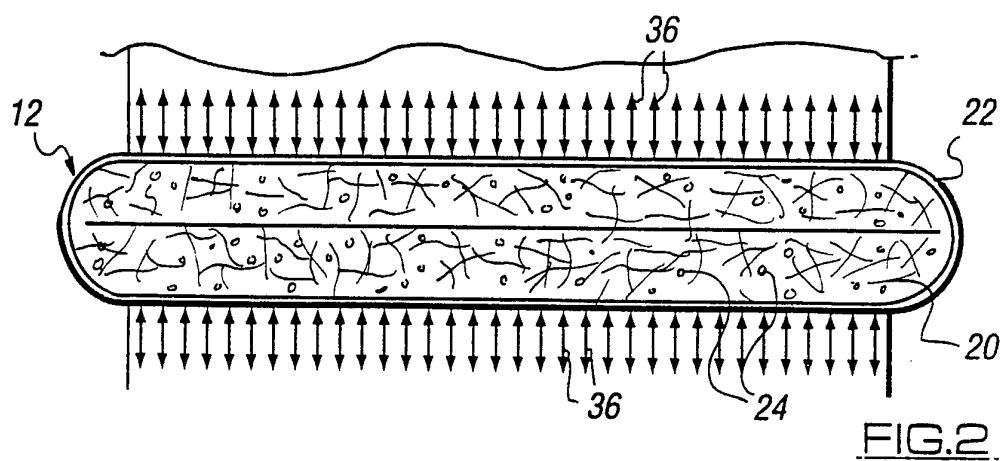
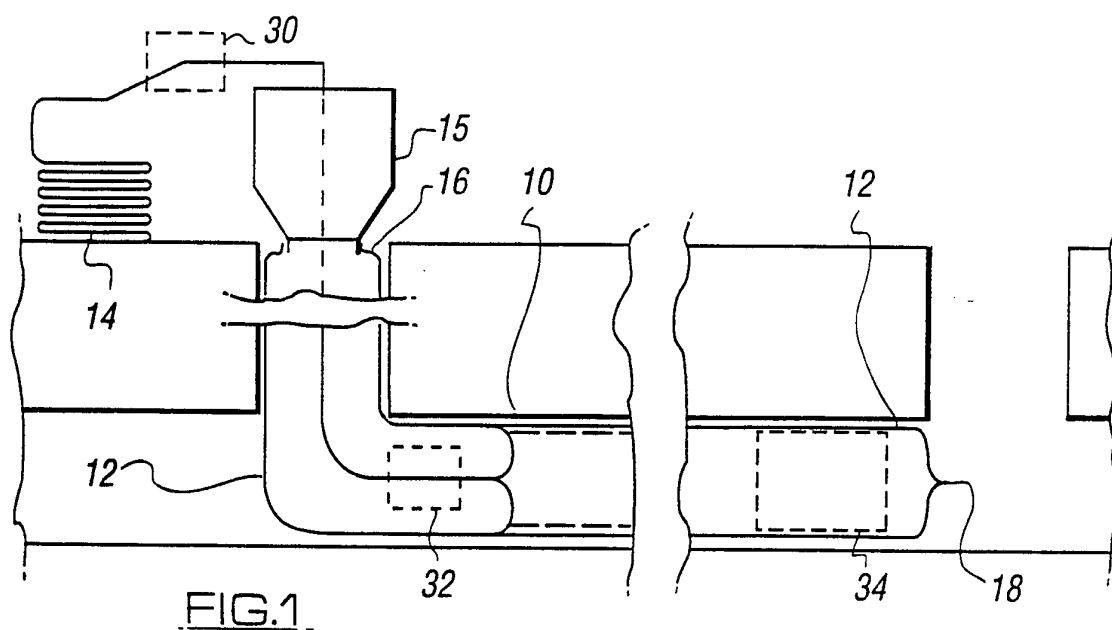
12. The method according to any of claims 5 to 12, characterised in that the cure initiation means includes

means for applying heat to the liner tube, and the resin is susceptible to cure initiator by heat energy.

13. The method according to any of claims 5 to 12, characterised in that the cure initiation means includes means for applying light energy to the liner tube and the resin is susceptible to cure initiation by light energy.

14. The method according to any of claims 5 to 13, characterised in that the cure initiation means includes means for applying mechanical impacts to the liner tube, and the resin is susceptible to cure initiation by mechanical impacts.

1/2



2/2

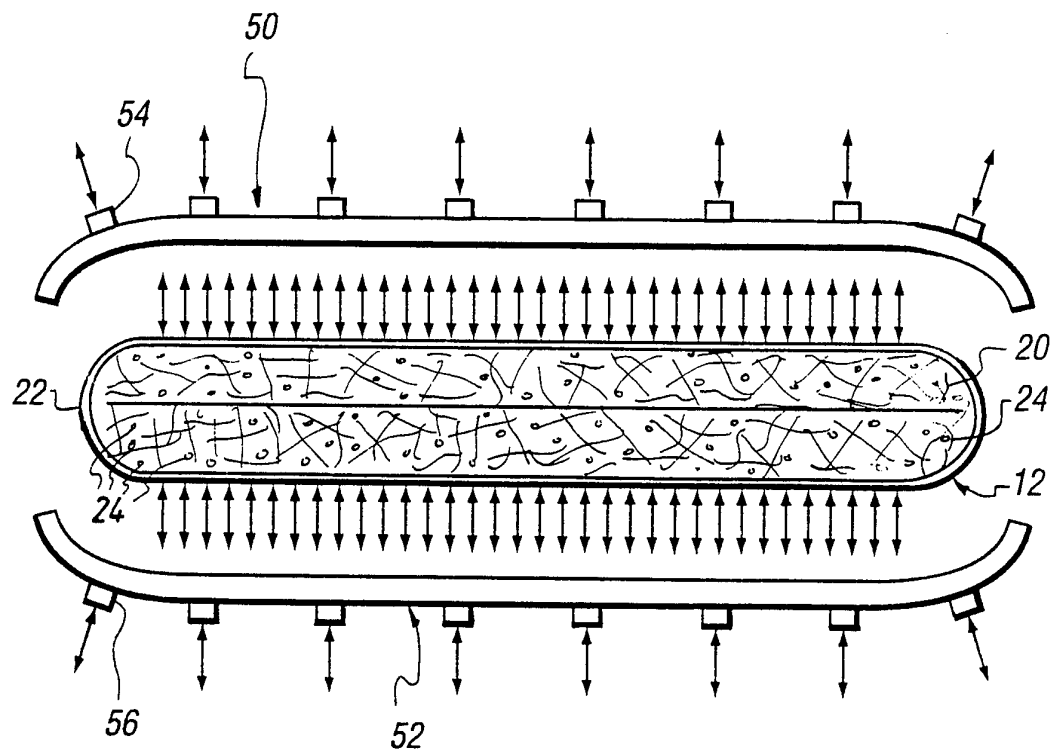


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 94/01288

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B29C35/02 B29C63/36 F16L55/165 C08K9/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B29C F16L C08J C08K C08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 768 562 (N.S. STRAND) 6 September 1988 see claims 2E-2H ---	1,3
Y	WO,A,87 05376 (UPONOR N.V.) 11 September 1987 see page 5, line 13 - line 19; figure 2 see page 6, line 19 - line 28; figure 6 ---	1-3,5-14
Y	WO,A,92 20504 (SONIC-CURING INC.) 26 November 1992 see abstract see page 2, paragraph 2 see page 5, paragraph 3 see page 6, paragraph 4 see page 7, paragraph 5 - page 8, paragraph 2 see claims 1,4,10,11 --- -/--	1-3,5-14

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

16 September 1994

Date of mailing of the international search report

113 -10- 1994

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+ 31-70) 340-3016

Authorized officer

Topalidis, A

INTERNATIONAL SEARCH REPORT

Intern. Appl. No.

PCT/GB 94/01288

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CH,A,676 029 (I & C INVESTMENT AND CONTROLLING AG) 30 November 1990 see column 3, line 15 - line 57 see column 4, line 39 - column 5, line 12; figure 1 see claim 6 ---	1,6
P,A	EP,A,0 551 790 (D.C. MITCHELL) 21 July 1993 see column 1, line 51 - line 56 see abstract; claim 1 ---	1,9
A	WO,A,92 20198 (METCAL, INC.) 12 November 1992 see page 14, line 22 - line 25; figure 2C see abstract; claim 1 ---	9
A	US,A,3 618 599 (L.E. BEIGHTOL) 9 November 1971 see abstract see column 2, line 8 - line 28 see claim 2 ---	6,7
A	US,A,4 876 296 (J. S. MILLER) 24 October 1989 see column 2, line 66 - column 3, line 11 see column 3, line 27 - line 40 ---	6,7
A	EP,A,0 287 288 (INTEROX) 19 October 1988 see page 2, line 32 - line 45 see page 4, line 42 - line 47 see page 5, line 10 - line 14 see claim 6 ---	7,10
A	WO,A,85 04886 (M.J. DOUGHERTY) 7 November 1985 see page 11, paragraph 3 see claim 1 ---	7,10
A	WO,A,90 10032 (PIPE & SEWER RENOVATIONS LTD) 7 September 1990 see claims 8,13 ---	11
A	US,A,3 607 830 (J.E. KEARNAN ET AL.) 11 May 1971 see column 2, line 41 see example 5 see abstract ---	11
A	US,A,5 186 987 (T. IMOTO ET AL.) 16 February 1993 see column 8, line 25 - line 29 ---	8

-/--

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 94/01288

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 145 654 (CIBA-GEIGY AG) 19 June 1985 see claim 1 -----	8

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Application No

PCT/GB 94/01288

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4768562	06-09-88	US-A- 4972880	27-11-90
WO-A-8705376	11-09-87	AU-B- 616377	31-10-91
		AU-A- 7081387	28-09-87
		DE-A- 3774272	05-12-91
		DK-B- 168241	28-02-94
		EP-A,B 0302061	08-02-89
		JP-T- 63502918	27-10-88
		SE-A- 8600964	05-09-87
WO-A-9220504	26-11-92	AU-A- 2184992	30-12-92
CH-A-676029	30-11-90	NONE	
EP-A-0551790	21-07-93	AU-B- 3359893	01-09-93
		WO-A- 9315131	05-08-93
WO-A-9220198	12-11-92	US-A- 5231267	27-07-93
		EP-A- 0581861	09-02-94
US-A-3618599	09-11-71	NONE	
US-A-4876296	24-10-89	NONE	
EP-A-0287288	19-10-88	AU-A- 1457288	20-10-88
WO-A-8504886	07-11-85	US-A- 4528354	09-07-85
		AU-A- 4237285	15-11-85
		CA-A- 1257729	18-07-89
		EP-A- 0178322	23-04-86
		JP-T- 61501997	11-09-86
WO-A-9010032	07-09-90	EP-A- 0461149	18-12-91
US-A-3607830	11-05-71	NONE	
US-A-5186987	16-02-93	JP-A- 3292127	24-12-91
		AU-B- 646851	10-03-94
		AU-A- 7404891	17-10-91
		EP-A- 0454309	30-10-91

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No

PCT/GB 94/01288

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0145654	19-06-85	DE-A- 3467803	07-01-88
		JP-B- 6009868	09-02-94
		JP-A- 60127134	06-07-85
		US-A- 4845234	04-07-89
		US-A- 4762585	09-08-88
