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METHOD OF APPLYING PRESSURE TO THE SURFACE OF NEWLY FORMED CONCRETE OR LIKE CEMENTITIOUS PRODUCTS

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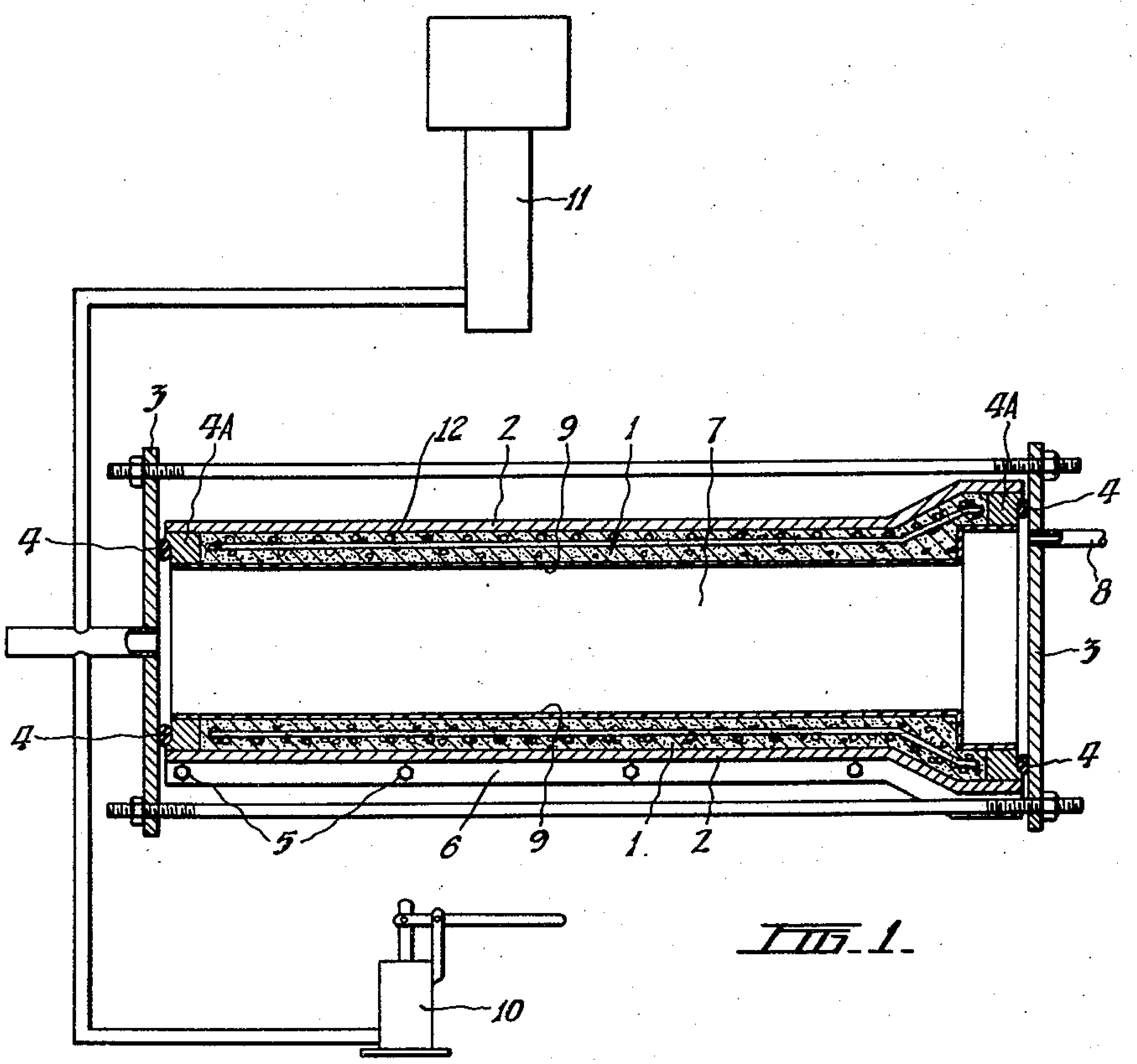

FIG. 1.

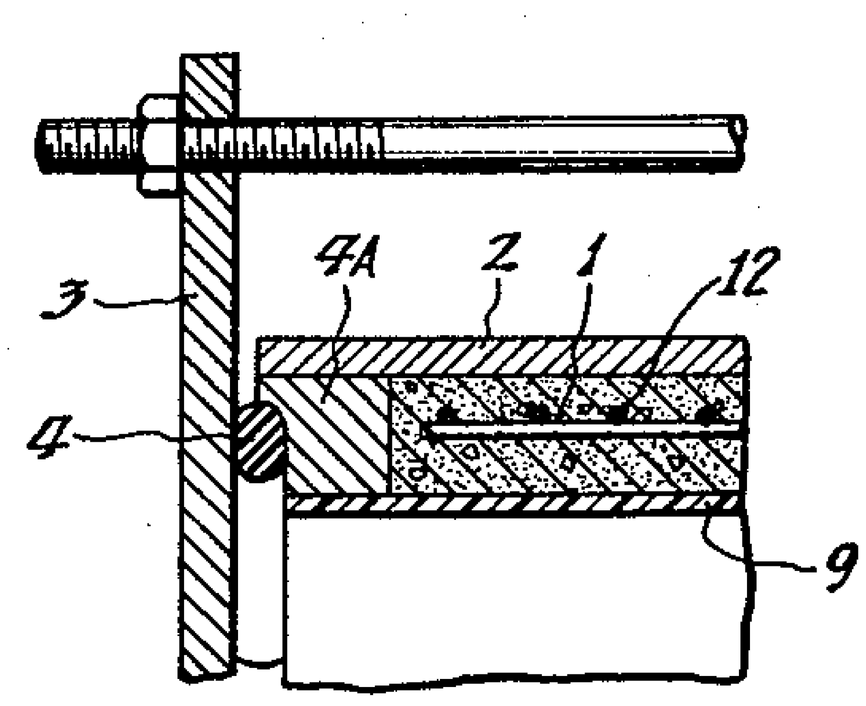

FIG. 2.

INVENTOR:
WILHELM SERKIN

By [signature]
Attorney

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METHOD OF APPLYING PRESSURE TO THE SURFACE OF NEWLY FORMED CONCRETE OR LIKE CEMENTITIOUS PRODUCTS

Wilhelm Serkin, Armadale, Melbourne, Victoria, Australia, assignor to Rocla Pipes Limited, Melbourne, Victoria, Australia, a company of Victoria

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6 Claims. (Cl. 25—154)

When pressure is applied to a concrete mass, desirable results are known to ensue as to density and strength. Under certain conditions, as in the production of pre-stressed reinforced concrete pipes, pressure applied to the concrete can be used to fulfill the dual purposes of improving the strength of the concrete and pretensioning the reinforcements; thus, it is known to apply pressure from within a newly formed concrete pipe, while in the unhardened state, and while still encased in an outer mould. Sometimes the said mould is slightly relaxed. This pressure has been applied by the use of an expanding core which exerts pressure over the inside surface of the pipe, and so tensions the contained reinforcement as the latter resists the outward pressure exerted by the core. The concrete sets while the wire is in this condition, so producing a "pre-stressed" pipe. The expanding core so used has usually been operated by fluid pressure. There have, however, been great practical problems regarding the cores hitherto used, including:

(*a*) Rubber cores have tended to take a slight permanent set at each use, so that the core tends progressively to enlarge;

(*b*) Rubber cores are rather clumsy and inconvenient to handle in use;

(*c*) Rubber cores tend to deteriorate and to develop splits and faults after repeated use;

(*d*) Sheet metal cores tend to bulge in places and to go out of shape with repeated use and sometimes split along welded seams, and

(*e*) Sheet metal cores with the customary rigid end closure plates do not deliver an even pressure from end to end of the pipe, as they are not equally free to expand near these fixed ends.

Consequently, the excessive cost and difficulty involved in the use of cores of the known types have retarded the economical development of the pre-stressed pipe.

This invention provides a simple and cheap method of applying pressure to concrete without expensive apparatus, and of applying it more effectively than is achieved by the methods hitherto known. The term "concrete" is used herein to include calcareous cement mortar and mixtures of cement and asbestos as well as normal concrete.

The invention will be described primarily in relation to the treatment of a newly formed concrete pipe. Its application to other concrete products will be obvious.

According to this invention pressure is applied to the surface of a newly formed concrete pipe or other concrete product by forming a fluid-tight film or membrane (hereinafter termed a film) on said surface by reaction between one or more organic colloidal compounds and one or more water-soluble calcium or other metal compounds and applying a fluid under pressure to said surface. The organic colloids must be such that by this reaction they will produce a deposit of a continuous film not soluble in, or adversely affected by, the fluid by

which the pressure is applied. This process renders the use of a core unnecessary.

The invention resides primarily in the use of one or more water-soluble salts of alginic acid (as, for example, the sodium or ammonium salts). Preferably the said salts are allowed to react with soluble calcium compounds dissolved by the water of the mix from the cement itself; for example, water by which pressure is to be applied to a newly formed concrete pipe may contain sodium alginate in solution therein. This salt, by reaction with the calcium compounds above-mentioned forms on the inner surface of the pipe a film of insoluble calcium alginate or like insoluble compound. The film builds up by degrees and some lapse of time is desirable before pressure is applied. This film effectively separates the pressure liquid from the concrete.

Alternatively, prior to the introduction of the pressure fluid, the alginate solution may be applied to the concrete surface, thus producing the water-insoluble film.

As a further alternative, the concrete surface may first be treated with a solution of one or more water-soluble calcium compounds or with one or more water-soluble compounds of some other metal which will form an insoluble compound by reaction with the soluble alginate; for example, a water-soluble salt of calcium, chromium or zinc might be used. In this way an insoluble film can be applied to the inner surface of the pipe before the pressure water is introduced. Also when the insoluble film is formed in this way a pressure fluid other than water may be used. Normally, however, it is more convenient to use water as the pressure fluid.

The resultant film has substantial ductility and remarkable fluid-tightness; consequently the desired pressure can be applied to a newly formed concrete pipe by applying water or other fluid under pressure directly to the inner surface thereof. If a water-soluble alginate is dissolved in the pressure water as hereinbefore described, the film commences to form immediately at the surface of the concrete. The longer the alginate solution is in contact with the concrete, the thicker and more fluid-tight will be the film until the film prevents the passage of the reagents. Hence a waiting time of 30 to 50 minutes is desirable before pressure is applied on the film. Otherwise the film may be too thin to be effective. It has been found that a small percentage of sodium alginate in the water is adequate. Thus for example a solution in water of about 5% of sodium alginate has been found to be very effective. However, by the process known as "syneresis" some of the contained water is freed during or after its formation. It is desirable to keep this freed water as low as possible as it passes into the concrete. This is best effected by using the highest concentration of alginate salt that is practicable. If the alginate solution is used as the pressure fluid, a 5% solution of sodium alginate is about the limit that is pumpable. By the use of low rather than high polymer alginates, higher concentrates are possible without excessive viscosity. The syneresis freeing of water can be minimised—e. g. by incorporating some glue or gelatine in the solution.

By way of example, a suitable procedure for applying pressure to a newly formed concrete pipe is described in detail hereunder and is illustrated in the accompanying drawings, in which

Figure 1 is a somewhat diagrammatic longitudinal section through a pipe shown in position in a mould, and

Figure 2 is an enlarged view showing the sealing of the end caps to the end rings of the moulds by a rubber seal.

The newly formed pipe **1**, contained in an outer mould **2** only (as, for example, after manufacture by the centrifugal process), is sealed at both ends (as, for example, by iron end-caps **3** contacting rubber seals **4** of the two end-rings **4A** of the mould). Into the cavity **7** within the pipe a 5% sodium alginate solution is then pumped through one of the end-caps **3**, a vent **8** or other provision for the escape of air being provided in one of the end-caps. When the said sodium alginate solution contacts the inner surface of the pipe, it forms a ductile film **9** thereon. When the pipe is filled completely with the solution and sufficient time has elapsed for the building up of the film, the pressure within said solution in the cavity **7** is raised to whatever pressure is desired and is maintained as long as necessary, by known means (e. g. a pump **10** and a ram **11**).

If, as is normally desired, the pipe is to be pre-stressed, the pipe is provided with a steel reinforcement **12** and the concrete mixture is constituted so as to be capable of transmitting a pre-stressing effect to the reinforcement, for example, the concrete mix may contain aggregate composed of particles of sufficient size and irregular shape to interlock or jam each other and so act to transmit pressure from the interior of the pipe to the reinforcement. Prior to the application of pressure to the pipe, the mould **2** is relaxed slightly by loosening of the bolts **5** at the seam **6**, thereby to permit expansion of the pipe when pressure is applied to the interior thereof. Such expansion of the pipe causes the reinforcement **12** to also expand with the result that the reinforcement is placed under tension and remains under tension when the concrete sets.

When the procedure is carried out correctly the liquid does not pass through the film and penetrate the concrete. Even if, for some reason, some penetration into the concrete did occur, the formation and building up of a seal of the insoluble alginate-lime compound would effectively end the penetration of the liquid. In fact the film acts rather like a sheet of rubber between the liquid and the concrete. As previously mentioned, some water may be squeezed out from the film when syneresis occurs and may penetrate the concrete. When the concrete has set sufficiently, the pressure can be released, the end-caps removed and the liquid drained out. When later the film dries, it can be brushed out readily.

Of course, alternatively to filling the pipe with the sodium alginate solution, the pipe surface can be pre-treated therewith (e. g. by spraying) and ordinary water or other fluid can then be used as the pressure fluid. It is readily seen that only the minimum apparatus is necessary and the number of operations is small, whilst the pressure is applied directly and effectively over all surfaces with which the pressure fluid comes in contact.

In addition to the compression of normal concrete, this invention obviously provides a convenient means for compressing structures formed of mixtures of cement and asbestos.

Obviously, the qualities of the film can be modified and for certain purposes improved by the admixture of rubber latex, bitumen-bentonite emulsions, or even small amounts of oily substances, with the alginate solution.

I claim:

1. The method of forming concrete structures comprising applying an aqueous solution of at least one water-soluble salt of alginic acid to a surface of an unhardened calcareous concrete structure contained within a mold, allowing said solution to react with said surface to form a substantially fluid-tight water-insoluble film on said surface and then directly applying a fluid under pressure to said surface to compress said concrete structure within said mold.

2. The method of forming concrete structures comprising applying an aqueous solution of at least one water-soluble salt of alginic acid to a surface of an unhardened calcareous concrete structure contained within a mold, allowing said solution to react with said surface to form a substantially fluid-tight water-insoluble film of calcium alginate on said surface, and then subjecting said applied solution to pressure to compress said concrete structure within said mold.

3. The method of forming concrete structures, comprising applying a compound of a metal which forms a water-insoluble salt with alginic acid to a surface of an unhardened concrete structure contained within a mold, then applying an aqueous solution of at least one water-soluble salt of alginic acid to said surface, allowing said solution and said metal compound to react to form a substantially fluid-tight water-insoluble metal alginate film on said surface, and then subjecting said so-treated surface to fluid pressure to compress said concrete structure within said mold.

4. The method of forming concrete structures, comprising applying an aqueous solution containing about 5% by weight of a member of the group consisting of sodium and ammonium alginates to a surface of an unhardened calcareous concrete structure contained within a mold, allowing said solution to react with said surface to deposit a substantially fluid-tight ductile water-insoluble alginate film thereon, and then applying fluid pressure directly to said treated surface to compress said concrete structure within said mold.

5. The method of forming concrete structures, comprising applying, as a fluid pressure medium, an aqueous solution of a water-soluble salt of alginic acid directly on a surface of a calcareous concrete contained within a mold, allowing said solution to react with said surface to deposit a substantially fluid-tight, water-insoluble film of calcium alginate thereon, and then applying pressure to said medium to compress said concrete structure within said mold.

6. The method of forming pre-stressed concrete piping, comprising forming a concrete mixture into a pipe having a pressure-resistant steel reinforcement embedded therein the concrete mixture of said pipe being adapted to transmit radially outward directed forces from the inner surface of the pipe to said reinforcement, enclosing said pipe in a mold, applying an aqueous solution of at least one water-soluble salt of alginic acid to the internal surface of said pipe while said concrete mixture is in the unhardened condition, allowing said solution to react on said surface to form a substantially fluid-tight water-insoluble metal alginate film thereon, then applying fluid pressure internally of said pipe to expand the latter and thereby to tension said reinforcement, and allowing the concrete mixture of said pipe to set while under the fluid pressure so that said reinforcement is maintained under tension.

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