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[72] Inventor **Knox Ryan Burchett**
Virginia Beach, Va.
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[73] Assignee **Southern Block and Pipe Corporation**
Norfolk, Va.

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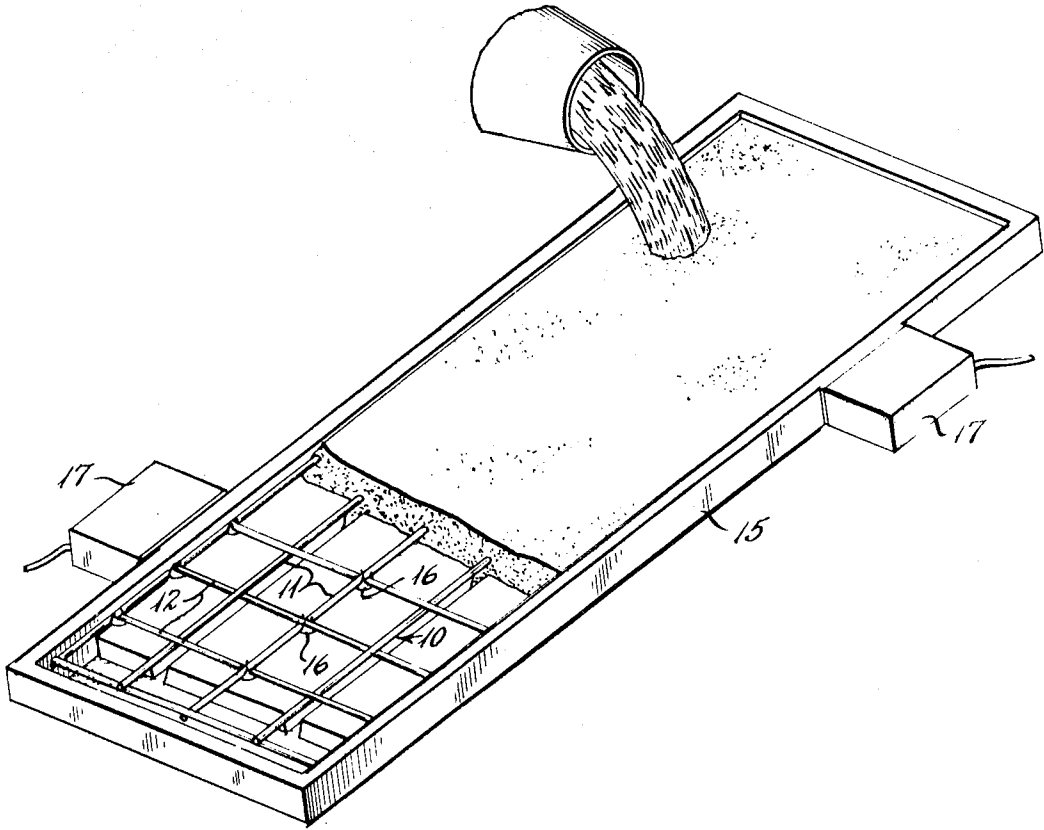
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Primary Examiner—Ralph S. Kendall
Attorneys—A. Yates Dowell and A. Yates Dowell, Jr.

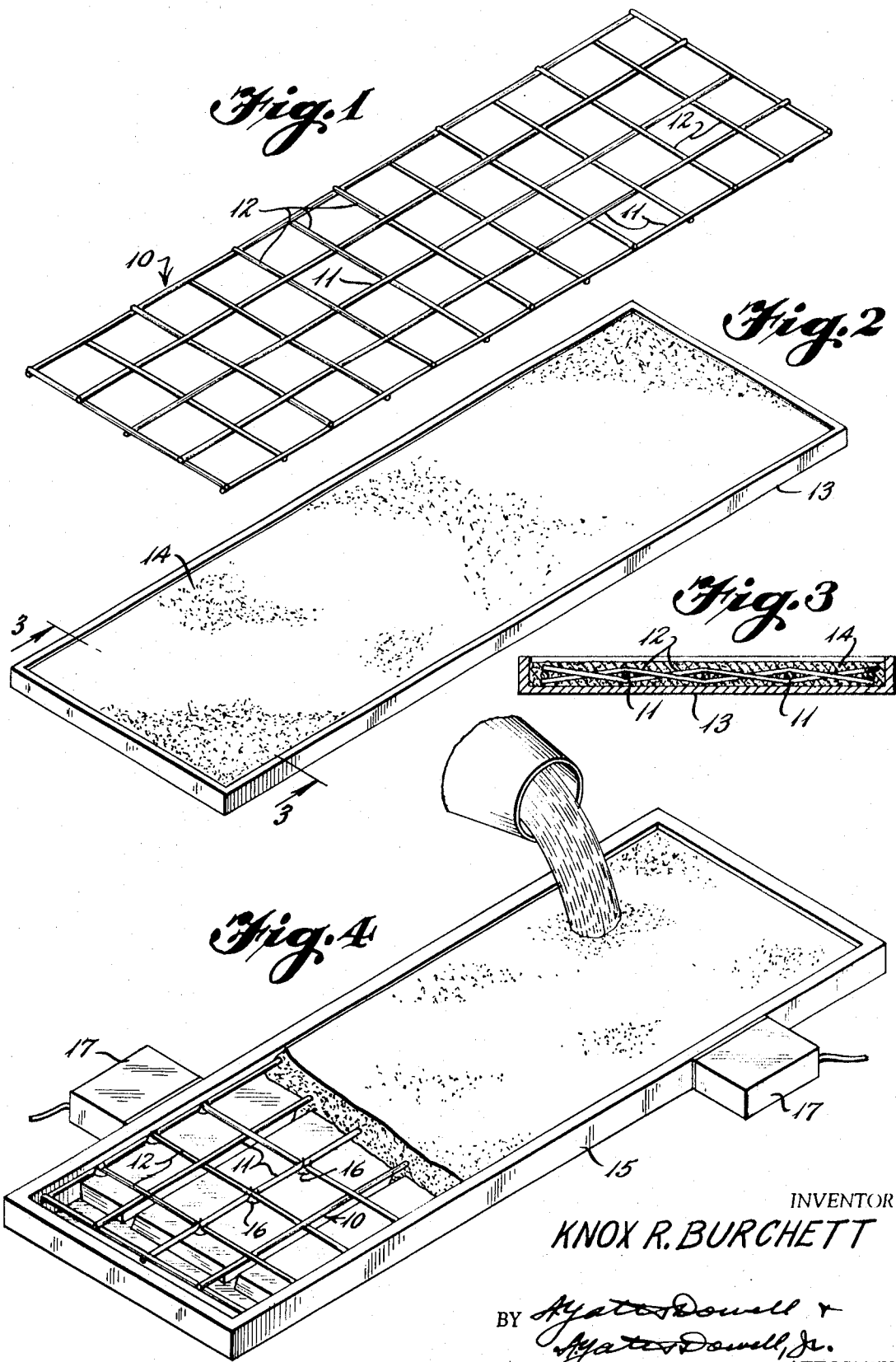
[54] **METAL TREATMENT TO PREVENT CORROSION
AND BLEMISHES IN METAL REINFORCED
CONCRETE STRUCTURES**
3 Claims, 4 Drawing Figs.

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ABSTRACT: Concrete reinforced with galvanized metal that has received a sodium chromate treatment that forms a protective coating on the galvanized metal to prevent blemishes in the finished concrete product caused by chemical reactions between the zinc and the alkalis of the concrete.





INVENTOR
KNOX R. BURCHETT

BY *Hyatt Dowell & Hyatt Dowell, Jr.*
ATTORNEYS

METAL TREATMENT TO PREVENT CORROSION AND BLEMISHES IN METAL REINFORCED CONCRETE STRUCTURES

BACKGROUND OF THE INVENTION

1. Field of the Invention. The invention is in the field of the concrete or masonry products of configurations and dimensions employed for general and specific uses in various locations and climates, above and below the surface of the earth, and in the presence of varying amounts of moisture, and which concrete or masonry products contain metal which serves to reinforce the same or for other purposes and includes galvanizing or added zinc.

2. Description of the Prior Art. Metal reinforced concrete has been used for a long time with such metal in various forms, such as rods, bars, mesh and the like, usually embedded beneath the surface and recently in slabs used to face modern buildings, and which slabs have been difficult to produce without blemishes notwithstanding extensive unsuccessful efforts to avoid such blemishes which necessitated the discarding and scrapping of concrete at a great loss of revenue.

SUMMARY OF THE INVENTION AND OBJECTS

The invention is concerned with the production of concrete masonry units reinforced with galvanized metal, such units including relatively large slabs which can be applied to the exterior surface of modern office buildings and the like. The invention is further concerned with the production of such units in which the galvanized metal surfaces are treated to avoid blemishes in the concrete which would mar the esthetic appearance units and weaken and render the same unsatisfactory. In order to do this it has been found that such blemishes which include bath texture and color and otherwise unsatisfactory appearance and structure may be overcome, and the strength and durability enhanced, by the treating of the galvanized material with a solution containing sodium chromate.

It is an object of the invention to produce concrete masonry units reinforced with embedded metal having a galvanized coating and with units free of blemishes or flaws.

Another object of the invention is to eliminate blemishes or flaws in precast or prestressed concrete masonry units reinforced with metal having a galvanized coating by the use of a chemical agent which will prevent chemical action between the concrete and the galvanized or zinc surface coating of the metal.

A further object of the invention is to produce concrete masonry units containing a reinforcing metal mesh with galvanized coatings which have been subjected to a bath in a solution of sodium chromate and water to prevent chemical reaction between the concrete and the reinforcement which would result in blemishes.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective of a metal mesh reinforcement;
FIG. 2, a perspective of a bath containing tank;
FIG. 3, an enlarged section on the line 3—3 of FIG. 2; and
FIG. 4, a perspective of a mold in which the concrete article is formed.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Nonferrous metals have been used extensively in concrete including copper, lead, zinc and aluminum, for many purposes including roof flashing, tank linings, sheathing for pipes, cables and various structural elements and the corrosion of such products has been substantial. This is particularly true of zinc coated metal used in concrete due to its being attacked by calcium hydroxide and other caustic alkalis in fresh concrete mortar. The undesirable effects of such chemical reaction have been indicated in an article in *Concrete Information* by the Portland Cement Association, 1961, and entitled "Nonferrous Metals in Contact with Concrete—Copper, Lead, Zinc,

Aluminum" which indicates that in order to avoid this chemical action the metal should be coated with plastic such as asphalt, pitch or varnish, the article specifying that corrosion of zinc will occur if the metal comes in contact with wet unseasoned concrete and since some of the corrosion may be removed by abrasion, rain or other means, pitting of the surface may result. The article further indicates that when flat or corrugated sheets of iron are used as linings the reaction will occur and consequently galvanized iron should be avoided. It also mentions, less importantly, that due to the fact that concrete may remain damp or become intermittently wet the reaction between aluminum and concrete can be avoided by using a coating of bituminous paint or a clear alkali-resistant lacquer. The article further specifies that unpainted aluminum when subjected to moisture in contact with concrete or mortar may result in corrosion and can be prevented by the use of a covering such as a moistureproof membrane plastic film or impregnated paper and felt. There is a summation note at the end of the article that metals of dissimilar composition should not be placed in direct contact or embedded in close proximity in moist concrete unless experience has shown that no destructive galvanic action will occur and where necessary the metal may be protected with coatings of asphalt, varnish, or pitch or a like substance.

The use of metal coated with asphalt, pitch or varnish probably would prevent corrosion but this would greatly reduce or prevent the bond between the metal and the concrete. Where the metal is used as reinforcement this bond must be developed for the reinforcement to be effective. Most embedded metal objects also would depend upon bond for anchorage.

In *The Chemistry of Cement and Concrete* by F. M. Lea and C. H. Desch, Edward Arnold (Publishers) Ltd., London, corrosion of nonferrous metals in concrete is discussed, including that lead when exposed to atmosphere develops a protective film of basic lead carbonate, but when embedded in cement mortar the protective film cannot form and corrosion occurs and can ultimately cause perforation of the metal and concludes with the statement, "It is therefore necessary to protect lead pipes embedded in concrete or cement mortar with a bituminous coating or by wrapping on bituminous felt." It further states that lead dampproof courses in thick walls, where atmospheric carbonation cannot penetrate far, also require protection with a coat of bitumen. This article likewise mentions that zinc and aluminum can be attacked by alkaline solutions with evolution of hydrogen. However, solid zinc plates or rods embedded in concrete are likely to cause cracking, etc. under damp conditions and should be protected with a bituminous coating. The article also specifies that the same is also true of aluminum resulting in cracking of concrete in which it was embedded. It is understood that in the Stadium in the Nation's Capital considerable damage resulted from the chemical reaction between the metal and the alkali of the concrete.

In another article, "Reactivity of Zinc and Aluminum in Fresh Concrete" 5th Scandinavian Corrosion Congress, I. Gukild, R. Husevag and A. Markestad, Cement and Concrete Research Institute, Technical University of Norway, there appears a Synopsis which specifies that the effect of cement brand, its chromate content and addition of chromate on reactivity is investigated. Reactivity is judged by the development of corrosion potential, by the galvanostatic polarization curves and by the anodic polarization when short-circuited to steel. This report does discuss the effect of chromate on reactivity of zinc only. It does not recognize the connection between the embedded metals and the surface blemishes.

It specifies by way of an Introduction, that:

"Fresh concrete is an imperfect dispersion of superficially hydrated cement particles and aggregate in a saturated water solution of calcium-hydroxide containing varying amounts of alkalisulphates and minor concentrations of other salts. The initial reaction between cement particles and water is extremely fast and leaves a rather "dead" dispersion with only slow dissolution and absorption processes."

"The fresh state is disrupted by the stiffening of the particle skeleton after 4-12 hours. During the setting and the further hydration, sulfates and water are consumed and the capillary porosity is gradually decreasing. In the final "envelope" of good quality concrete reactive metals can exhibit favorable polarization properties in contradiction to the conditions in the fresh state."

Further explanation of what might cause blemishes is clued from the statement:

"Aluminum is highly reactive in fresh concrete and is used industrially as powder for the production of light weight concrete. The hydrogen bubbles evolved by the reaction are entrapped by the fresh concrete and kept there as the stiffening occurs. The corrosion rate on an aluminum surface in fresh concrete shows a distinct peak in the first hours after the dissolution of the oxide film is ended. The superficial attack which can be observed on an aluminium sheet stored in concrete for quite a long time is essentially due to this attack."

"Aluminium and its alloys will however not endure all serious corrosive conditions in concrete. Cases of damage are reported when aluminium in galvanic coupling to steel is exposed to concrete with excessive amounts of chlorides present. Excessive amounts means in this connection chlorides not bound or absorbed by the cement gel."

"In Norway an Al/Si casting alloy, silumin, is in common use in concrete practice. More than a million single electrical coupling boxes are cast directly into the concrete without noticeable corrosion. Cases of serious corrosion attack followed by a spalling off of the concrete layer are nevertheless known. Investigations have shown that the susceptibility to corrosion is quite high and that the good experience in practice must depend on high polarization under the actual practical conditions. For the application of cast alloys of aluminum and zinc in the concrete practice, it is satisfactory to define the conditions under which the alloys can be placed in concrete without risk of spalling off the concrete layer after long time exposure. Galvanized steel and probably also aluminum can be used in construction elements which transfer considerable forces to the concrete. In order to keep the construction safe every detrimental effect on the concrete quality and bond performance of the reinforcement must be avoided. Hydrogen evolution and retarding effects of zinc ions on cement hydration cannot be tolerated."

The problems of surface finish experienced could likely have been the result of the retarding effects of zinc ions or particles which had settled to the bottom of the concrete underneath the zinc coated reinforcement.

In the present production of concrete units metal reinforcement is provided in the form of a mesh 10 of longitudinal and transverse rods 11 and 12 which have a galvanized or zinc coating of the character which causes blemishes in a concrete masonry unit due to chemical reaction between the zinc of the galvanized coating and the concrete.

In order to produce the product without blemishes, a tank 13 is provided which may be rectangular or of any desired configuration. As illustrated the tank is approximately 4 inches deep, 8 feet wide, and 25 feet long, although it may be of any desired size. It is filled to approximately 3 inches in depth by a bath formed of solution 14 to provide a bath of the mesh 10 and is capable of holding several sheets of mesh simultaneously.

The bath 14 is a solution of sodium bichromate or sodium dichromate and water; for example, 4 pounds of the relatively inexpensive sodium chromate powder to 100 pounds of water. Alternately any soluble material capable of furnishing the necessary chromate or dichromate ions could be used in place of the sodium salt; obvious materials would be ammonium dichromate, potassium dichromate, or any of the alkali metal chromates or dichromates, singly or in combination. After mixing the chromate salt and water thoroughly at ambient temperature, the mesh is put in the vat or tank 13 and allowed to remain long enough for the desired result or for the protective coating to form, as evidenced by a change in the color of the silvery zinc galvanized surface to light yellow. Although it

is believed that the color change is due to the formation of zinc chromate, or less likely zinc chromite, or even a mixture of zinc chromate and chromite, the present invention is not predicated upon any speculation as to the exact nature of the protective coating but rather its ability to achieve the desired effects. The mesh may be allowed to stay for 5 to 15 minutes on a hot day while greater time of treatment might be required, even up to 25 or 30 minutes or more on a cold day. In other words, at a temperature in the 90's (Fahrenheit) approximately 5 minutes may suffice while at a lower temperature a longer time may be required, even up to 25 or 30 minutes or more, so that the mesh will receive an adequate protective coating.

After the wired mesh is coated with chromate in accordance with conventional practice, it is removed from the tank 13 and put in a mold or form 15 and supported therein on small metal or plastic chairs or supports 16 distributed over the bottom of the mold. These chairs may be approximately 1 inch high and 2 inches wide and may be composed of wire with convolutions or raised portions to support the mesh so that it will be completely embedded in the concrete. If preferred, these chairs may also be made of plastic. After the concrete is poured, it is consolidated by a vibrator 17 of the rotary air type or otherwise as desired. Thereafter the concrete is allowed to harden and then it is removed from the mold.

Prior to the finding of a solution to the problem there was a great loss over a wide area by many producers of precast and prestressed concrete without being able to determine the cause of the blemishes or remedy thereof and much time and effort was expended to determine the cause. During the search for a solution applicant found that the blemishes did not occur when black metal or material which did not contain a galvanized coating was used, and after the cause was found considerable further development was necessary in order to find a remedy. In an effort to reach a solution a number of chemists were consulted, including a professor at a West Coast University who specializes in corrosion of metals, but all of whom were unable to supply the answer. Applicant tried numerous substances including a phosphoric acid dip to try to alter the surface of the metal or reduce its reactivity and finally tried sodium chromate and gradually evolved the method described herein which involves a sodium bi- or di-chromate solution consisting of approximately 1 pound of the chromate powder to 25 pounds of water and the immersion or subjecting of the galvanized mesh or reinforcing material in such solution. In order to do this there was evolved a vat or tank which would receive the entire sheet and in fact multiple sheets of galvanized mesh. For a concrete masonry slab approximately 8 feet wide and 25 feet long a vat or tank was provided large enough to receive the same and this tank was filled approximately 3 inches or sufficiently to allow the immersion of the mesh therein, it being observed that the mesh before being treated had a color somewhat like silver or stainless steel, but after being treated it had the color of the protective coating, or light yellow. The mesh was then removed from the chromate bath, placed in a mold and the mold filled with concrete the mesh being supported on chairs of metal or plastic so it would be in a proper position to be embedded in the finished product it being understood that these chairs could be of wire bent from end to end with raised portions that fit over the mesh. The production was in a continuous operation and after the concrete was supplied a vibrator was used to cause the proper settling of the concrete in the mold.

What is claimed is:

1. The method of producing a metal reinforced concrete masonry unit, said method comprising providing a galvanized metal reinforcing element, treating said galvanized metal reinforcing element with an aqueous solution containing chromate or dichromate ions to form a protective coating on the surface thereof, providing a mold, supporting said treated galvanized metal reinforcing element in said mold in spaced relationship to the bottom thereof, introducing a predetermined amount of concrete into said mold in accordance with the desired size of

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masonry unit being produced, vibrating the mold with concrete therein, allowing said concrete to set, and removing the masonry unit thus produced from said mold.

2. The method of claim 1 wherein said aqueous treating composition is constituted by 4 pounds of an alkali metal chromate or dichromate to each 100 pounds of water.

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3. The method of claim 1 wherein the alkali metal chromate or dichromate is selected from the class consisting of sodium bichromate, sodium dichromate, ammonium dichromate and potassium dichromate.

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