United States Patent [19]

Tolliver

[11] 3,831,890

[45] Aug. 27, 1974

[54] **METHOD AND FABRIC FOR FORMING PIPE REINFORCEMENT**

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[73] Assignee: **New York Wire Mills Corp.**, Tonawanda, N.Y.

[22] Filed: **Feb. 8, 1973**

[21] Appl. No.: **330,607**

[52] **U.S. Cl.** ..... **245/2**, 52/653, 138/174, 138/175, 140/3 R, 245/1, 245/11

[51] **Int. Cl.** **B21f 27/00**

[58] **Field of Search** ..... 140/3 R, 107, 112; 138/174, 175, 176; 52/645, 653, 669, 670, 671, 664; 245/1-5, 8, 10, 11

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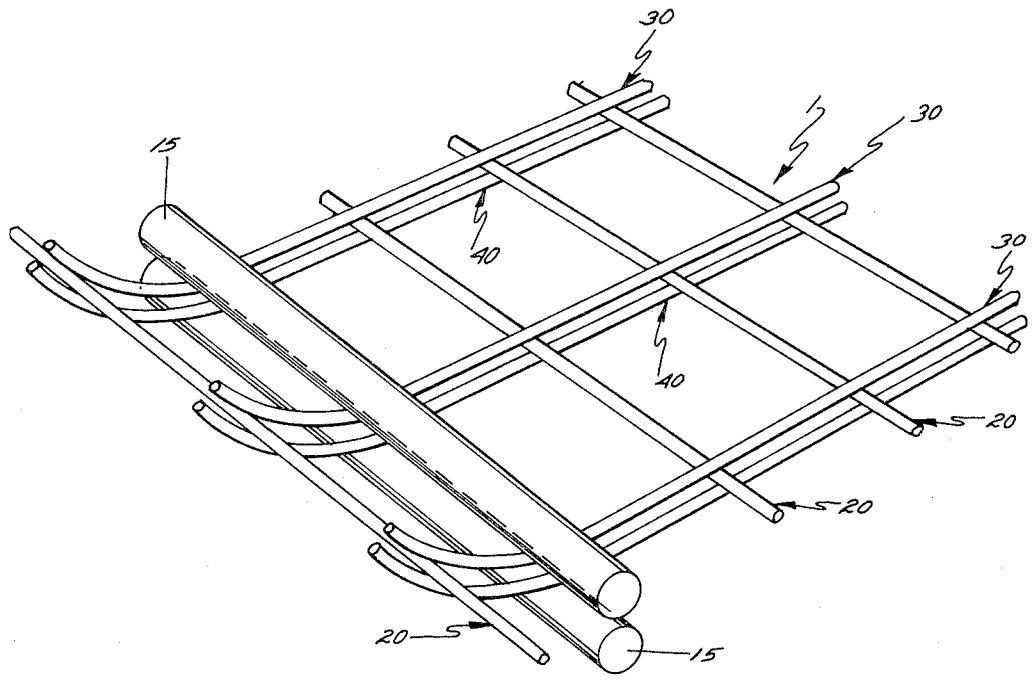
Assistant Examiner—Joseph A. Walkowski
Attorney, Agent, or Firm—Price, Heneveld, Huizenga & Cooper

[57] **ABSTRACT**

A generally planar fabric for forming into cylindrical reinforcing cages for concrete pipe includes a set of wire strands for forming the longitudinal wires of the cage, a first set of transverse strands for forming the cage circumferentials welded onto one side of the longitudinal defining strands, and a second set of transverse wire strands for forming cage circumferentials welded on the other side of the longitudinal defining strands. Each of the second set strands is preferably but not necessarily, in line with a corresponding first set strand on the opposite side of the longitudinal defining strands. This fabric is formed into a cylindrical cage, and in one embodiment, the inside circumferential strands are narrower in diameter than their corresponding outside circumferential strands.

12 Claims, 11 Drawing Figures



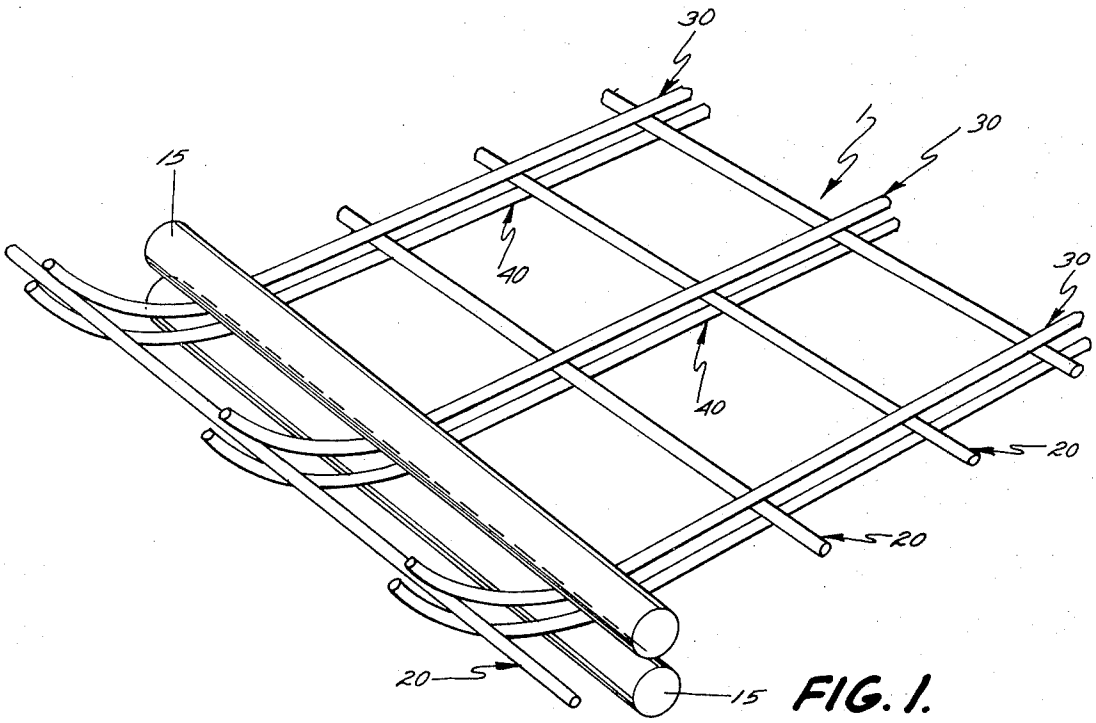


FIG. 1.

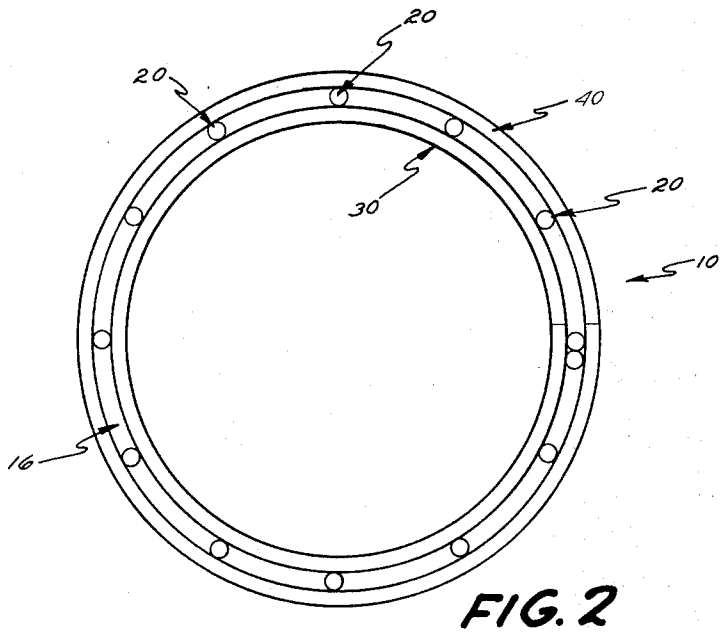


FIG. 2

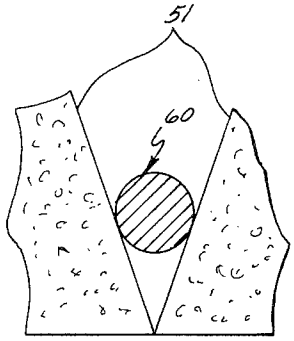


FIG. 5.

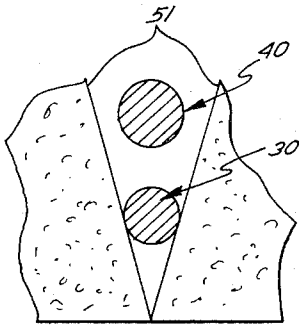


FIG. 6.

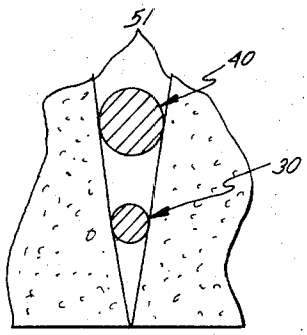


FIG. 7.

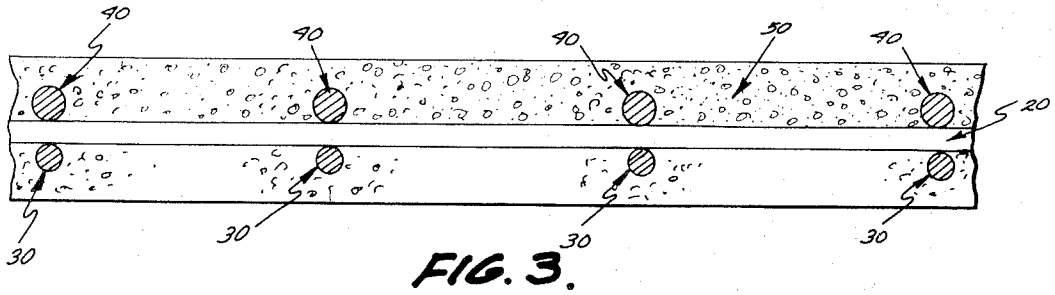


FIG. 3.

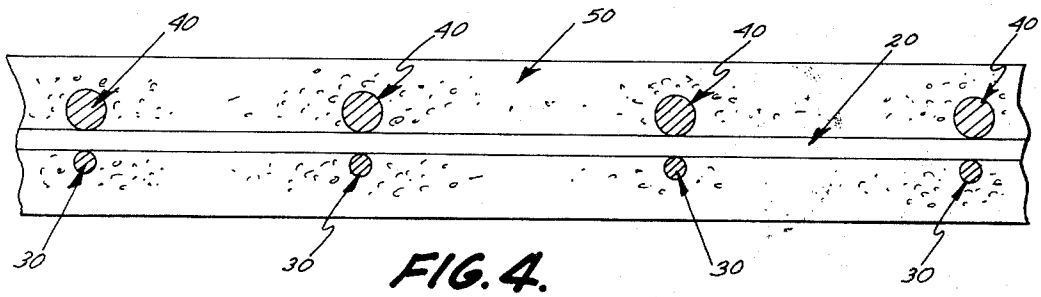


FIG. 4.

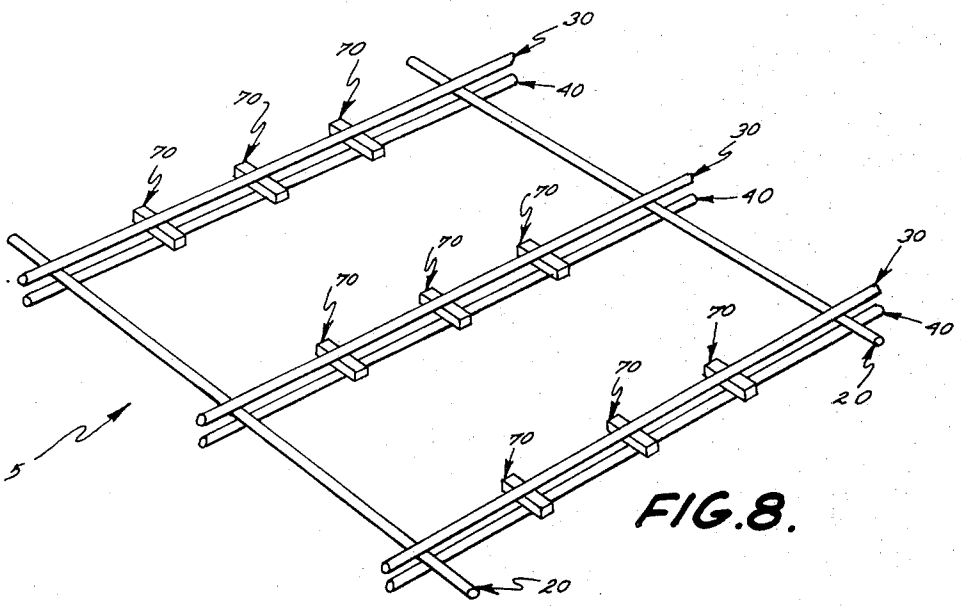


FIG. 8.

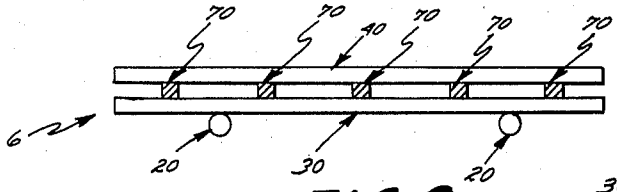


FIG. 9.

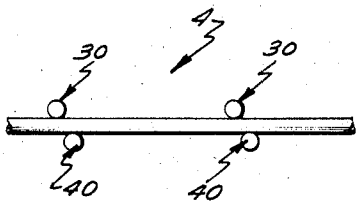


FIG. 11.

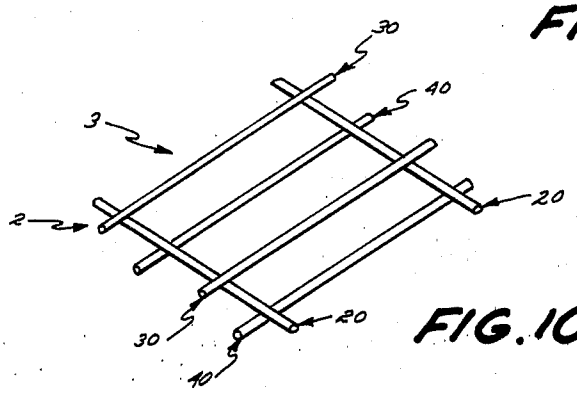


FIG. 10.

METHOD AND FABRIC FOR FORMING PIPE REINFORCEMENT

BACKGROUND OF THE INVENTION

The present invention relates to fabric for forming pipe reinforcing cages. These cages could be used to reinforce pipe made of any material, for example synthetic plastic; but concrete is the material which is most commonly reinforced. Reinforcing cages have a number of circumferential wires joined to a number of longitudinal wires. Some refer to the circumferentials as "warp" wires and the longitudinals as "weft" wires.

It has been found that in order to reinforce concrete pipe most effectively, the combined cross-sectional area of the circumferential wires must be a particular total sum per lineal foot of pipe. For pipes of larger diameter, the combined area per lineal foot must be greater.

The need for circumferential wire strands of larger diameter in larger pipes increases the cost of the cage. For one thing, the price of fabric increases as the diameter of wire increases. In addition, it is significant that a pipe designer cannot rely on getting uniform high tensile strength wire with larger diameter strands, because it is more difficult to control high tensile strength when drawing larger diameter strands of wire using present drawing techniques.

The use of larger diameter strands of wire also creates difficulty when concrete is cast around the cage. In packer head operations, for example, concrete pipes are cast from the inside, concrete being forced to the outside by a packer head device or the like. Concrete must be forced in around the circumferential wires. The employment of larger diameter strands makes this job more difficult. Referring to the cross-sectional area to the outside of a circumferential wire into which concrete must flow as the "packing cone," it is apparent that a larger wire has a larger packing cone or area into which concrete must be forced (see FIG. 5).

Of course, there are other such drawbacks to the employment of larger diameter wire; but because the greater cross-sectional area is required, the industry has lived with these drawbacks for many years.

SUMMARY OF THE INVENTION

In the present invention, fabric is employed for forming cages which have the required combined circumferential cross-sectional area per lineal foot, but for which the above difficulties are minimized. The fabric of the present invention replaces a single circumferential defining wire with two circumferential defining wires of smaller diameter. The fabric is generally planar, having a set of longitudinal defining strands, a set of first circumferential defining strands joined thereto and a second set of circumferential defining strands rigidly joined to the longitudinal defining strands on the side opposite the first set of circumferential defining strands. While it may not be essential that every circumferential be welded to every longitudinal, it is necessary that at least some longitudinals be joined to at least some circumferentials in each set of circumferentials. Also, all circumferentials must be joined to some longitudinals.

Preferably, corresponding circumferential defining strands are positioned directly opposite one another on opposite sides of the longitudinal defining strands.

However, some slight offset may be necessary to facilitate welding. By using two circumferential defining strands in place of one, one can use strands having at least half the area of the single strand. Actually, because of the increased area of contact between concrete and wire, and because of the increased rigidity of the cage, one can employ circumferential wires having less than one-half the area of a corresponding single strand. The cost of providing two circumferential strands in the place of one can actually be less. The use of a wire of smaller diameter also allows the cage designer to count on a higher tensile strength per wire. He can also count on better packing of concrete in behind the wire, since the packing cone for the smaller wires would be smaller (FIG. 6).

This generally planar fabric is formed into cylindrical cages, generally either circular or elliptical in cross section. While difficulty would be anticipated in forming such fabric due to the increased rigidity of fabric having opposed top and bottom layers of circumferential defining strands, it has been surprisingly found that such fabric can in fact be formed into a cylindrical cage using conventional forming equipment. One technique which facilitates such formation is to form the cages on the center line radius of the longitudinal, i.e., on a line passing through the center of the longitudinal defining strands. Where the opposing circumferentials are of two different diameters, it is preferable to strive for rolling the cage on the neutral axis between the two cages, i.e., on an imaginary line on a radius directly intermediate the radii of the centers of the circumferentials.

Preferably, the inside circumferential defining strand is smaller in diameter than the outside circumferential defining strand. This creates an even smaller packing cone, as indicated in FIG. 7. The employment of two wires of different diameters to achieve the equivalent reinforcing area of a single diameter strand also enables a manufacturer to maintain a lesser variety of strand diameters in stock. One can achieve a great number of effective cross-sectional areas through the use of various combinations of strands of wire having differing diameters.

In another aspect of the invention, each of two opposing circumferential defining strands are joined together by short tie bars positioned between adjacent longitudinal defining strands. These ties act as additional anchors, or shear steel, in the completed pipe. In some applications, these will eliminate or at least partially eliminate the need for stirrups. Also, they make it possible to construct a fabric so that only one of the two circumferential defining strands is joined to the longitudinals, the other circumferential defining strands being spaced above the longitudinals and being joined to the first circumferential defining strand by the tie bars.

These and other aspects, features and advantages of the invention will be more fully appreciated and understood by reference to the written specification and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the fabric of the present invention as it is started through a set of forming rollers;

FIG. 2 is a lateral cross-sectional view of a generally circular cage formed in accordance with the present invention;

FIG. 3 is a longitudinal cross-sectional view of a concrete pipe formed in accordance with the present invention;

FIG. 4 is a longitudinal cross-sectional view of an alternative embodiment concrete pipe formed in accordance with the present invention;

FIG. 5 is a schematic view illustrating the packing cone encountered through the employment of a single large diameter wire strand;

FIG. 6 is a schematic view of the packing cone resulting from the employment of two smaller diameter strands;

FIG. 7 is a schematic view of the packing cone resulting from the employment of two smaller diameter strands, the inside circumferential strand being of lesser diameter than the outside circumferential defining strand;

FIG. 8 is a perspective view of an alternative embodiment fabric in which the inside and outside circumferentials are joined by tie bars as well as the longitudinals;

FIG. 9 is a cross-sectional view of yet another alternative embodiment fabric in which the inside and outside circumferentials are joined together by tie bars and only the inside circumferential in each pair of circumferentials is joined to the longitudinals;

FIG. 10 is yet another alternative embodiment fabric in which the inside and outside circumferentials are staggered, rather than being disposed directly opposite one another; and

FIG. 11 is a cross-sectional, side view of another fabric embodiment wherein the individual strands of pairs of inside and outside circumferentials are each slightly staggered from the respective strands of the opposing pair,

PREFERRED EMBODIMENT

In the preferred embodiment, the generally planar fabric **1** (FIG. **1**) for forming into generally cylindrical cages **10** (FIG. **2**) includes a plurality of longitudinal defining wires **20**, a plurality of inside circumferential defining wire strands **30** welded to longitudinals **20** on one side thereof, and a plurality of outside circumferential defining strands **40** welded to longitudinals **20** on the opposite side thereof (FIGS. **1** and **2**). Planar fabric **1** is formed into a generally cylindrical cage **10** by passing through a set of forming rollers **15**. Once formed, cage **10** is cast in concrete **50** to form a pipe (FIGS. **3** and **4**).

The longitudinal defining strands **20**, inside circumferential defining strands **30** and outside circumferential defining strands **40** all comprise material for forming pipe reinforcing cage **10**. Typically, this material is a strand of steel wire. Although longitudinal elongation of outside circumferential strand **40** during rolling does not appear essential, it is preferable that strand **40** be sufficiently ductile to allow some longitudinal elongation when cage **10** is formed. Yet, strand **40** must have a sufficiently high tensile strength to meet accepted industry standards.

Inside circumferential defining strands **30** and outside circumferential defining strands **40** are rigidly joined to longitudinal defining strands **20**. When the strands are of wire, this rigid joining is achieved by welding. Preferably, each inside circumferential defining strand **30** is positioned directly opposite its corresponding outside circumferential defining strand **40**. By thus placing the strands in direct opposition, the rigidity of cage **10** is increased. However, such is not absolutely essential, and the fabric could be constructed as illustrated by alternative fabric **3** shown in FIG. **10** or by fabric **4** shown in FIG. **11**. In FIG. **10**, the circumferential defining strands **30** are staggered from the outside circumferentials **40**. The spacing between a given pair of strands **30** and **40** is one-half that between adjacent pairs of strands in the fabric of FIG. **1**. In FIG. **11**, circumferentials **30** are offset just slightly from circumferentials **40**, just enough to facilitate welding.

It is preferable from a strength standpoint that every circumferential strand **30** and every circumferential strand **40** be connected to every longitudinal strand **20**. However, this is not an absolutely essential requirement. It is essential only that all of the various strands "hang together" in the finished fabric. Thus, all circumferentials **30** must be joined to some longitudinals **20**. All circumferentials **40** must be joined to some longitudinals **20**. Finally, at least some longitudinals **20** must be joined to at least some circumferentials in each of the two sets of circumferentials, i.e., circumferentials **30** and circumferentials **40**.

The use of two smaller strands **30** and **40** in place of one larger strand results in a far superior packing cone, as has been heretofore explained. This is illustrated by comparing FIGS. **5** and **6**. In FIG. **5**, a single circumferential strand **60** is shown with the packing cone **51** being schematically represented. With concrete being forced outwardly generally from the apex of packing cone **51**, it must pour in behind strand **60** through the sides of the imaginary packing cone **51**. As can be seen by reference to FIG. **6**, the use of two smaller diameter strands **30** and **40** having the same combined cross-sectional area as the larger strand **60** results in a packing cone **51** having a smaller angle, thereby making it easier for concrete **50** to pour in behind the circumferential strands.

Preferably, the inside circumferential defining strand **30** is of smaller diameter than the outside circumferential defining strand **40** (FIGS. **4** and **7**). In this embodiment the packing cone **51** can be made to have even a smaller angle. The strands **30** and **40** shown in FIG. **7** have the same combined cross-sectional area as do those shown in FIG. **6** and as does the single strand **60** shown in FIG. **5**. Yet, packing cone **51** in FIG. **7** is even smaller in angle than packing cone **51** shown in FIG. **6**.

To form fabric **1** into cage **10**, fabric **1** is passed through a set of forming rollers **15**. Forming proceeds most easily if rollers **15** were set as though they were forming fabric having a single strand circumferential falling on center line **16** (FIG. **2**). Center line **16** is an imaginary line passing through the centers of all of the longitudinal defining strands **20**. If inside circumferential **30** and outside circumferential **40** are of two different sizes, it is preferable to strive to form the cage on an imaginary line passing halfway between the centers of the two circumferentials. This is referred to herein as forming the cage on the neutral axis of the inner and outer circumferentials. Once cage **10** is formed into such a cylinder, either elliptical or circular, it is placed in a packer head casting machine and concrete **50** is cast therearound (FIGS. **3** and **4**).

FIG. 8 shows an alternative embodiment fabric 5 in which several short lengths of steel or tie bars 70 are welded to each circumferential strand 30 and circumferential strand 40 in a given pair of circumferential strands 30 and 40. There are three such tie bars located between the two longitudinals 20 in the specific configuration shown in FIG. 8. Tie bars 70 aid the longitudinals 20 in joining circumferentials 30 to circumferentials 40. Also, they act as anchors or shear steel when the fabric is formed into a cage and embedded in concrete. In some pipe configurations, such tie bars 70 at least partially eliminate the need for additional stirrup fabric. While tie bars 70 are shown as short one inch bars of generally square cross section, they could be longer or shorter than one inch and they could have a different cross-sectional configuration without departing from the spirit and broader aspects of the invention.

Tie bars 70 also make possible the alternative configuration fabric 6 shown in FIG. 9. In the fabric 6, each inside circumferential 30 is joined to its outside circumferential 40 by means of a plurality of tie bars 70. The longitudinal strands 20 are then welded to the inside circumferentials 30. In this construction, the outside circumferentials 40 make no direct contact with longitudinals 20.

As noted in connection with the joining of longitudinals to inner and outer circumferentials, it is not absolutely essential that all tie bars 70 be joined to all circumferentials 30 and 40 in each set of circumferentials. It is necessary only that there be enough cross joining that the fabric "hang together." Thus, it is necessary that, in the case of the baric 5 shown in FIG. 8, all of the circumferentials 30 be joined to at least some longitudinals 20 or tie bars 70. Also, all of the circumferentials 40 must be joined to at least some of the longitudinals 20 or tie bars 70. Finally, it is necessary that all of the longitudinals 20 and tie bars 70 be joined to at least some circumferentials 30 or circumferentials 40 and at least some longitudinals 20 or tie bars 70, or both, must be joined to at least some circumferentials 30 and 40 in each set. In the case of the fabric 6 shown in FIG. 9, at least some of the tie bars 70 must be joined to at least some of the circumferentials 30 and 40 in each set thereof.

EXAMPLES

The following examples illustrate the advantages of making pipe reinforcing cages in accordance with the present invention through employing fabric of the present invention. In each example, the fabric is to be used in constructing cages for class V pipe having a diameter of 54 inches. The fabric examples employed are for forming the inside cage of such a pipe.

Example 1: In order to form such a cage using conventional fabric having single strand circumferentials spaced 2 inches apart, ASTM standards require that each circumferential wire strand have a diameter of 0.369 inches.

Example 2: If one were to employ fabric made in accordance with the present invention, having two circumferential strands in place of one, each set of strands being spaced 2 inches from each other set, the same ASTM standards would require circumferential strands having a diameter of only 0.261 inches.

Example 3: If the fabric of the present invention utilizing an inner circumferential of lesser diameter than the outer circumferential were employed to make the cage, each set of inner and outer circumferentials being spaced 2 inches from the other, the same ASTM standard would require that the inner circumferential have a diameter of only 0.211 inches and the outer circumferential have a diameter of only 0.302 inches.

Example 4: ASTM standards also include a performance standard, which allows one to vary from the wire diameter requirements referred to above, so long as the concrete pipe performs in the same manner as pipe made in accordance with the fixed diameter standards. Thus it is estimated, in view of the increased rigidity of the cage resulting from the use of fabric of the present invention, and in view of the increased surface area of strands per given cross-sectional area, that the inner cage of class V 54 inch diameter pipe could be made by employing inner and outer circumferential strands, each pair being spaced on 2 inch centers, having diameters of only 0.206 inches, rather than the 0.261 inch diameters called for in Example 3. The ability to use a pair of strands having even a smaller combined area than would be required for single circumferential strand fabric actually enables one to save on material costs. Fabric having two circumferential strands at 0.206 inch diameters for an 8 foot long, class V 54 inch diameter pipe would cost 40 to 45% less than single circumferential strand fabric having the required circumferential strand diameter of 0.369 inches.

CONCLUSION

Accordingly, fabric made in accordance with the present invention may actually result in less expensive cages which will pack better in the packer head machine and which can be designed to higher tensile strength requirements. Such generally planar fabric can be formed into generally cylindrical cages, particularly if the cages are formed on an imaginary center line passing through the centers of the longitudinal defining strands or on the neutral axis of the inner and outer circumferentials. In the tie bar aspect of the invention, these advantages are multiplied in that the need for stirrups is in some applications at least partially eliminated.

Of course, it is understood that the above are merely preferred embodiments of the invention and that various alterations and deviations may be made without departing from the spirit and broader aspects of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands, of material suitable for and having sufficient thickness for reinforcing pipe, lying generally in a common plane; a plurality of first circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on a first side thereof and lying generally in a common plane; a plurality of second circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on the side opposite said first side and lying generally in a common plane; all of said longitudinal defining strands being joined to at least some

circumferential defining strands in either said first or second plurality thereof and at least some of said longitudinal defining strands being joined to at least some of said circumferential defining strands in each said plurality of first and second circumferential defining strands; each of said second circumferential defining strands is positioned generally opposite a first circumferential defining strand; each of said first circumferential defining strands is smaller in diameter than its corresponding second circumferential defining strand.

2. The fabric of claim 1 in which each said second circumferential defining strand has sufficient ductility to elongate longitudinally slightly during formation of a cylindrical cage.

3. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands, of material suitable for and having sufficient thickness for reinforcing pipe, lying generally in a common plane; a plurality of first circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on a first side thereof and lying generally in a common plane; a plurality of second circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on the side opposite said first side and lying generally in a common plane; all of said longitudinal defining strands being joined to at least some circumferential defining strands in either said first or second plurality thereof and at least some of said longitudinal defining strands being joined to at least some of said circumferential defining strands in each said plurality of first and second circumferential defining strands; each of said second circumferential defining strands is positioned generally opposite a first circumferential defining strand; each of said second circumferential defining strands is joined to a first circumferential defining strand by a plurality of short tie members interposed between said first circumferential defining strand and said second circumferential defining strand said tie members being substantially shorter than said longitudinal defining strands.

4. The fabric of claim 3 in which several of said tie members are interposed between adjacent longitudinals.

5. The fabric of claim 1 in which said longitudinal defining strands are joined to all said circumferential defining strands in each of said sets of said first and second circumferential defining strands.

6. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands, of material suitable for and having sufficient thickness for reinforcing pipe, lying generally in a common plane; a plurality of first circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on a first side thereof and lying generally in a common plane; a plurality of second circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on the side opposite said first side and lying generally in a common plane; all of said longitudinal defining strands being joined to at least some circumferential defining strands in either said first or second plurality thereof and at least some of said longitudinal defining strands being joined to at least some of said circumferential defining strands in each said plurality of first and second circumferential defining strands; said first set of circumferential defining strands are staggered with respect to said second set of circumferential defining strands, the spacing between each said first circumferential defining strand and an adjacent second circumferential defining strand being approximately half of the spacing between circumferential defining strands in comparable single circumferential defining strand fabric and the cross sectional area of each circumferential defining strand in each of said first and second sets being less than the cross sectional area of the circumferential defining strands in comparable single circumferential defining strand fabric.

7. The fabric of claim 6 in which said longitudinal defining strands are joined to all said circumferential defining strands in each of said sets of said first and second circumferential defining strands.

8. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands, of material suitable for and having sufficient thickness for reinforcing pipe, lying generally in a common plane; a plurality of first circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on a first side thereof and lying generally in a common plane; a plurality of second circumferential defining strands, of a material suitable for and having sufficient thickness for reinforcing pipe, joined to at least some of said longitudinal defining strands on the side opposite said first side and lying generally in a common plane; all of said longitudinal defining strands being joined to at least some circumferential defining strands in either said first or second plurality thereof and at least some of said longitudinal defining strands being joined to at least some of said circumferential defining strands in each said plurality of first and second circumferential defining strands; said first set of circumferential defining strands are staggered with respect to said second set of circumferential defining strands, each of said first circumferential defining strands being only slightly offset with respect to an adjacent second circumferential defining strand.

9. The fabric of claim 8 in which said longitudinal defining strands are joined to all said circumferential defining strands in each of said sets of said first and second circumferential defining strands.

10. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands of material suitable for reinforcing pipe lying generally in a common plane; a plurality of first circumferential defining strands lying generally in a common plane on one side of said longitudinal defining strands; a plurality of second circumferential defining strands lying generally in a common plane on the opposite side of said longitudinal defining strands; a plurality of short tie members, substantially shorter than said longitudinal defining strands, lying between oppositely disposed first and second circumferential defining strands, said tie members lying generally in said common plane of said longitudinal defining strands; said

first circumferential defining strands being joined to at least some of either said longitudinal defining strands or said tie members; said second circumferential defining strands being joined to at least some of either said longitudinal defining strands or tie members; all of said longitudinal defining strands and said tie members being joined to at least some of said circumferential defining strands in either said first or second plurality thereof and at least some of said longitudinal defining strands or said tie members being joined to at least some of said circumferential defining strands in each said plurality of first and second circumferential defining strands.

11. The fabric of claim **10** in which all of said tie members and all of said longitudinal defining strands are joined to all of said circumferential defining strands in each said first and second plurality thereof.

12. Fabric for forming reinforcing cages for pipe, said cages having longitudinal and circumferential strands, said fabric comprising: a plurality of longitudinal defining strands of material suitable for reinforcing pipe lying generally in a common plane; a plurality of first circumferential defining strands lying generally in a common plane on one side of said longitudinal defining strands; a plurality of second circumferential defining strands lying generally in another common plane on said one side of said longitudinal defining strands, said second circumferential defining strands being farther from said longitudinal defining strands than said first circumferential defining strands; each of said first circumferential defining strands being joined to a corresponding second circumferential defining strand by a plurality of tie members positioned between said first and second circumferential defining strands and being joined to each; said first circumferential defining strands being in turn joined to said plurality of longitudinal defining strands.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,831,890 Dated August 27, 1974

Inventor(s) Wilbur E. Tolliver

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 33:
Please change "baric" to ---fabric---.

Signed and sealed this 3rd day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.