United States Patent [19]

Hilfiker

[11] **3,922,864**

[45] **Dec. 2, 1975**

[54] **STRINGER FOR RETAINING WALL CONSTRUCTION**

[75] Inventor: **William K. Hilfiker,** Eureka, Calif.

[73] Assignee: **Hilfiker Pipe Co.,** Eureka, Calif.

[22] Filed: **Feb. 25, 1974**

[21] Appl. No.: **445,233**

[52] **U.S. Cl.** **61/35;** 61/39; 61/47; 52/588; 52/592

[51] **Int. Cl.²** **E02D 17/00**

[58] **Field of Search** 61/47, 39, 35, 49, 37; 52/588, 592

[56] **References Cited**

UNITED STATES PATENTS

1,648,557	11/1927	McDaniel	61/47
1,843,041	1/1932	Nagel	61/47
2,879,647	3/1959	Hayden	61/39 X
3,342,033	9/1967	Crouch et al.	61/49
3,379,017	4/1968	Kusatake	61/47 X
3,739,588	6/1973	Schroter	61/39 X

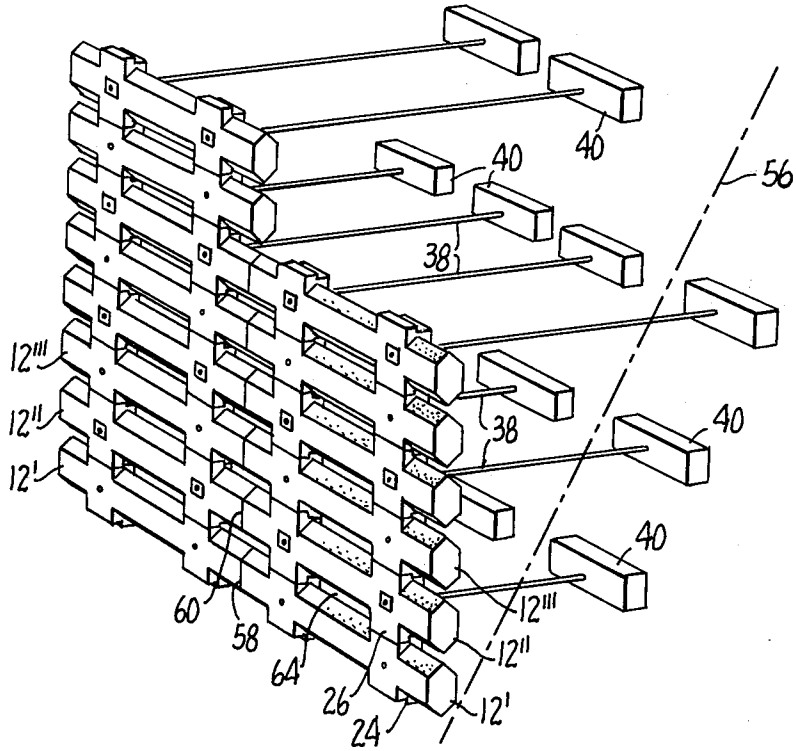
Primary Examiner—Jacob Shapiro

Attorney, Agent, or Firm—Naylor, Neal & Uilkema

[57] **ABSTRACT**

A stringer constructed of cast reinforced concrete. The stringer includes an elongate body having two spaced-apart stacking pads thereon. The stacking pads are arranged so that the pads of an upper stringer which is superposed on a lower stringer engage the pads of the lower stringer and retain the two stringers against substantial relative movement. Each stringer has two openings therein for engaging a stretcher rod, the opposite end of which is anchored to a deadman, or the like. Because the pads of adjacent stringers engage one another, only alternate rows of stringers are secured to stretchers.

13 Claims, 6 Drawing Figures



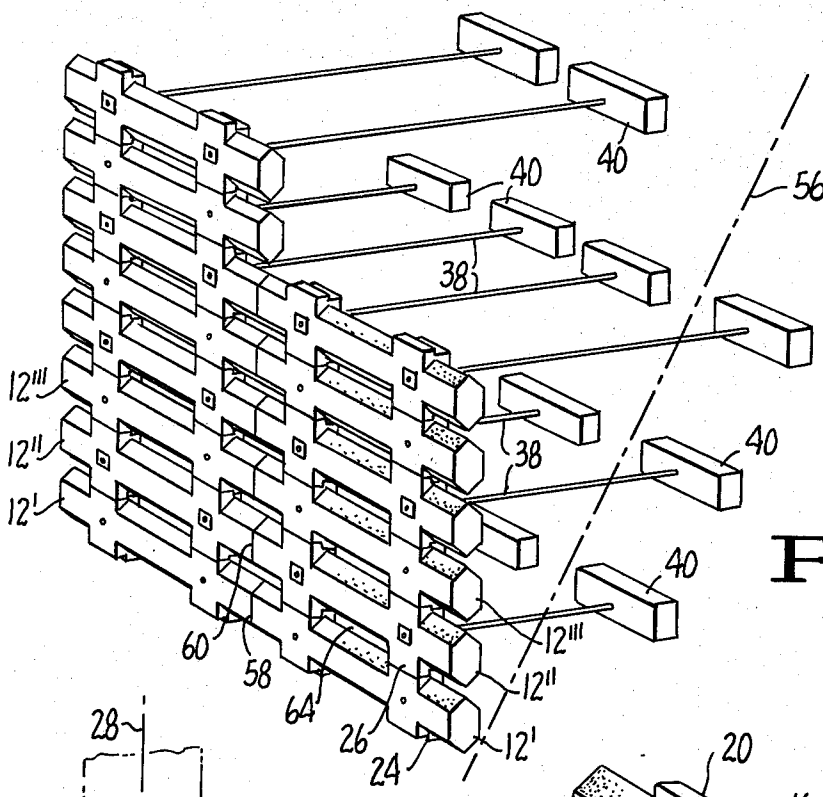


FIG. 1.

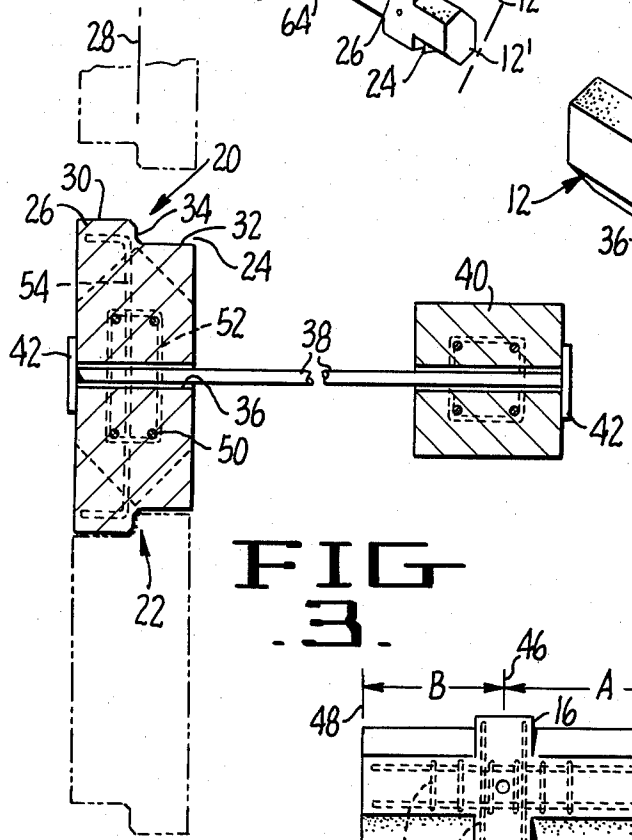


FIG. 3.

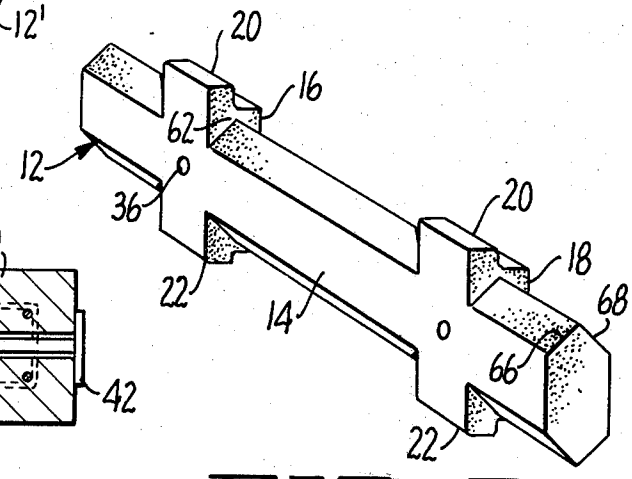


FIG. 2.

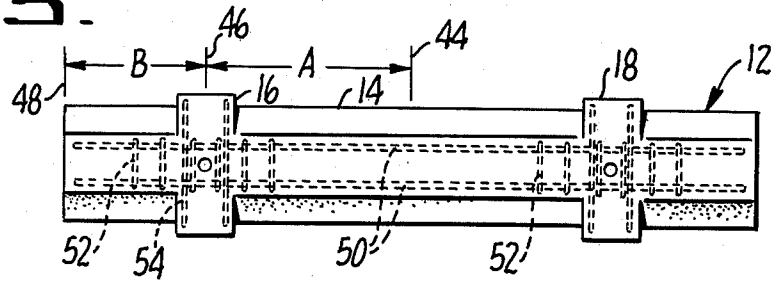


FIG. 4.

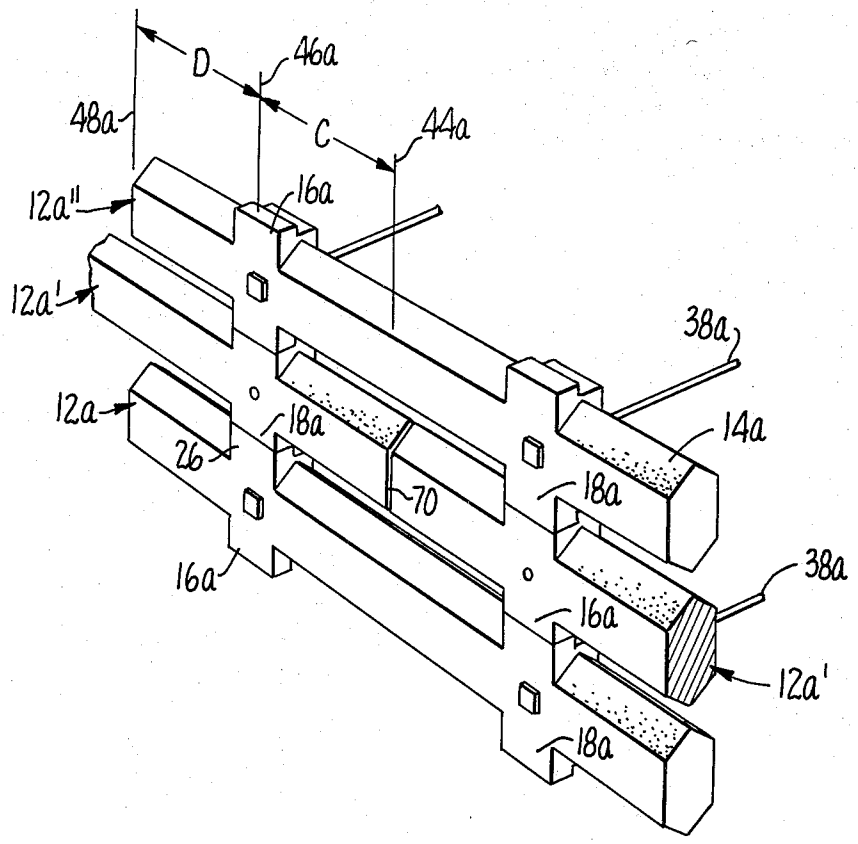

D
46a
48a
C
44a
12a''
16a
12a'
38a
12a
18a
14a
26
70
18a
38a
16a
16a
12a'
18a

FIG -5-

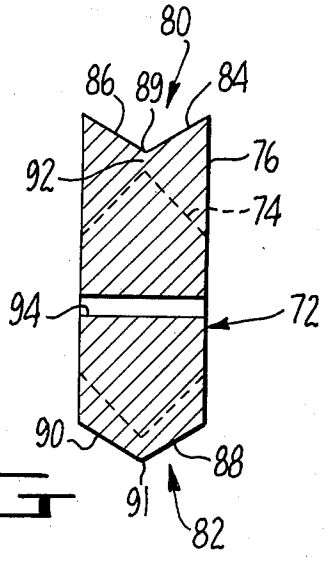

80
86
89
84
92
76
74
94
72
90
88
91
82

FIG -6-

STRINGER FOR RETAINING WALL CONSTRUCTION

FIELD OF THE INVENTION

This invention relates to a stringer for use with a plurality of identical stringers to construct an earth retaining wall of the type retained in place by attachment to buried "deadman" members.

Known retaining walls require substantial cutting and fitting on the job and/or a plurality of different shaped parts which must be fit together in a precise way on the job (e.g., see U.S. Pat. No. **3,631,682**).

SUMMARY OF THE INVENTION

The present invention provides a stringer so configured that a plurality of identically shaped stringers can be assembled in interlocking relationship to form a retaining wall. Because the stringers interlock with one another, the size of each individual stringer can be maintained relatively small so as to facilitate shipment of the stringers and manipulation of the same on the construction site. Because each stringer is a lower stringer will engage the same because the lower surface of the pad of production and inventorying are achieved.

A stringer according to the present invention includes an elongate body having two stacking pads extending therefrom. The stacking pads have upper and lower surfaces. The upper and lower surfaces are formed so as to be complemental with one another. Thus, an upper stringer when stacked on the pad of the upper stringer is complemental to the upper surface of the pad in the lower stringer.

A feature and advantage of a stringer of the type referred to above is that only alternate rows of stringers need be anchored to deadman members or the like.

One specific form of the invention affords the advantage of versatility in that the stringers can be constructed in vertically aligned tiers or, in the alternative, can be constructed in staggered relationship. The advantage of the former assembly technique is that relative movement between different parts of the retaining wall is afforded, a desirable condition in certain environments. An advantage of the latter construction configuration is that relative movement between elements of the retaining wall is avoided, a condition desirable in other environments.

The foregoing, together with other objects, features and advantages, will be more apparent after referring to the following specification and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a fragment of a retaining wall constructed with stringers of the present invention.

FIG. **2** is a perspective view of a single stringer constructed according to the present invention.

FIG. **3** is a cross-sectional view of a stringer according to the invention showing a deadman member and stretcher for retaining the stringer in place.

FIG. **4** is a front elevation view of a stringer according to the present invention showing a satisfactory arrangement of reinforcing steel bars therein.

FIG. **5** is a perspective view of an alternate mode of assembling stringers according to the present invention into a retaining wall.

FIG. **6** is a cross-sectional view of an alternate form of stringer embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings, reference numeral **12** indicates a satisfactory form of stringer constructed according to the present invention. The stringer is formed by an elongate body **14** of generally hexagonal shape and preferably formed of concrete reinforced with steel reinforcing bars. Integral with body **14** at locations spaced apart along the longitudinal axis of the body are stacking pads **16** and **18.** The stacking pads have upper and lower bearing surfaces **20** and **22** which are complemental with one another. In the embodiment shown in FIGS. **1–5,** surfaces **20** and **22** are identical to one another.

Bearing surfaces **20** and **22,** as seen most clearly in FIG. **3,** each include a concavity **24** and a convexity **26** which is complemental to the concavity. By "complemental" is meant that the convexity of a lower stringer engages the concavity in a stringer superposed on the lower stringer while the convexity of the upper stringer enters the concavity of the lower stringer. To assure alignment between stringers stacked as described next, both the concavity and convexity are disposed symmetrically of a centrally disposed longitudinal vertical plane of the body, such plane being indicated at **28** in FIG. **3.**

One satisfactory form for the bearing surfaces **20** and **22** is a rabbet formed by congruent horizontal surfaces **30** and **32** which are vertically spaced apart from one another and between which extends a vertical surface portion **34** that lies in plane **28.**

Each pad **16, 18** is provided with an opening **36** therethrough for affording engagement of one end of a stretcher rod **38,** the opposite end of which is engaged with a deadman member **40.** Opening **36** is substantially parallel with upper and lower bearing surfaces **20** and **22** and resides midway between the upper and lower bearing surfaces. Threaded flanges **42** or the like are fixed to opposite ends of stretcher rod **38** to retain the ends of the stretcher to stringer **12** and deadman member **40.**

In the embodiment of the invention shown in FIGS. **1–4,** pads **16** and **18** are disposed symmetrically of the midpoint line **44** of body **14.** Additionally, the centerline of the pads, such as the centerline **46** of pad **16,** is spaced from the midpoint **44** of the stringer by a distance A; the longitudinal extremity **48** of stringer **12** is spaced from pad centerline **46** by a distance B. Because the portion of body **14** outward of the pads is loaded as a caternary when the stringer is installed in the retaining wall, it is desirable that dimension B be less than dimension A, and such is the case with the embodiment of the invention shown in FIGS. **1 – 4.**

For reinforcing the concrete material of which stringer **12** is constructed, there is embedded in the stringer a plurality of longitudinally extending steel reinforcing rods **50** which are circumscribed adjacent the pads by saddles **52** formed of similar material. Finally, there is a plurality of U-shaped vertical bars **54** which reinforce the vertical extremities of pads **16** and **18.** Thus, the stringer has sufficient strength to retain the earth placed behind it and to support all stringers placed above it.

In constructing a wall employing stringers according to the present invention, the earth behind the site of the retaining wall is removed to a degree sufficient that deadman **40** can be installed behind the theoretical slip circle or slip line indicated at **56** in FIG. **1.** In the retaining wall shown in FIG. **1,** the lowermost row of stringers identified as **12'** are disposed at an appropriate height and are arranged with the concavities **24** facing the front, i.e., facing the exposed surface of the retaining wall. Superposed on stringers **12'** is a second row of stringers **12''** which are oriented so that their convexities face the front in order that such convexities engage the concavities in stringers **12'**. Because of the substantial surface area of contact between lower pad surfaces **22** of stringers **12''** with the upper pad surfaces **20** of stringers **12'**, the upper row of stringers remains in place during installation of stretchers **38** and deadman **40.** Flanges **42,** preferably threadably engaged with the forward end of stretcher **38,** can be installed loosely and not finally tightened until backfilling has covered the installed elements. It will be noted that in the embodiment of FIG. **1** the abutting extremities of stringers **12'**, indicated at **58,** are in vertical alignment with the abutting extremities of stringers **12''** indicated at **60.** This aligned relationship continues throughout the vertical extent of the wall in order that one row of stringers can move relative to adjacent rows in order to compensate for seismic phenomena or unequal settling behind the retaining wall. Forces on the lower row of stringers **12'** tending to push such stringers forward are resisted by the complemental interengagement of the pads and, more specifically, by engagement between respective vertical surfaces **34** of the respective superposed stringers.

A third row of stringers indicated at **12'''** is installed in vertical alignment with stringers **12''**. Stringers **12'''** are oriented as are stringers **12'** in order to afford interengagement between the respective pad-bearing surfaces. Forces tending to push stringers **12'''** outward are resisted because the convexities and concavities of the respective bearing surfaces engage one another. Installation of succeeding rows of stringers proceeds as described above and as shown in FIG. **1** with alternate stringers being secured to deadmen **40** by stretchers **38.** Only those stringers in which convexities **26** face forward need be secured to deadmen since all intermediate stringers are retained by the improved pad configuration of the invention. All stringers, however, can be secured to deadmen if conditions require. As construction and backfilling proceed, flanges **42** can be tightened in sequence so that the vertical position of the retaining wall is maintained.

In order to afford drainage of the earth behind the retaining wall, it is preferred that the upper and lower extremities of body **14** be spaced vertically inward by an interval from the bearing surfaces of the pads **16** and **18** to define a slit between adjacent stringers, such interval being indicated in FIG. **2** at **62** and the slit being indicated in FIG. **1** at **64.** It is further preferable that the upper and lower surfaces of body **14** be sloped to define outward diverging surfaces, indicated at **66** and **68** in FIG. **2,** to inhibit entry of rain water into the earth behind the retaining wall from the exposed surface of the retaining wall.

The stringer of the present invention can also be constructed in order to provide a retaining wall that is substantially interlocked against relative movement between laterally spaced elements. With reference to FIG. **5,** the stringers there shown and identified by reference numeral **12*a*** are substantially identical in details of construction to stringer **12** shown in FIG. **2.** Because of such identity in construction, the individual parts of the stringer **12*a*** will not be further defined. The principal critical relationship in the stringer of FIG. **5** is the spacing of pads **16*a*** and **18*a*** with respect to the midpoint and extremities of body **14*a*** of stringer **12*a***. The midpoint line of stringer **12*a*** is indicated by reference character **44*a*** of FIG. **5.** Pads **16*a*** and **18*a*** are symmetrical of the midpoint line **44*a*** and are spaced therefrom by a distance C. The opposite longitudinal extremities of stringer **12*a***, one of which is indicated by reference character **48*a*** in FIG. **5,** are spaced from the respective pads by a distance equal to D. In the embodiment of FIG. **5,** the dimension D is equal to or slightly less than C so that when the stringers **12*a*** are installed in staggered relation, there is a space **70** between the longitudinal extremities of adjacent stringers in the same row. In one stretcher designed according to FIG. **5,** dimension D is less than dimension C by one-quarter inch, thereby forming a gap **70** which has a horizontal dimension of one-half inch.

Installation of a wall employing the stringer of FIG. **5** proceeds more or less in the manner described above in conjunction with FIG. **1** except that vertically adjacent stringers are staggered from one another. More specifically, a stringer **12*a*** is installed in alignment with other stringers (e.g., **12*a*** '') and the next row of stringers indicated at **12*a'*** are placed thereupon in staggered relation and oppositely oriented. In other words, because lower stringer **12*a*** is secured by stretchers **38*a***, stringer **12*a*** is oriented so that convexities **26** face forward, and stringers **12*a'*** are oriented so that concavities **24** face forward for engagement with the convexities of the lower stringer. It will be noted that pad **18*a*** of stringer **12*a'*** engages pad **16*a*** of stringer **12*a*** and that pad **16*a*** of stringer **12*a'*** engages pad **18*a*** of stringer **12*a***. Accordingly, the two stringers **12*a'*** are interlocked with one another even though a space exists at gap **70.** Next, a row of stringers, one of which is indicated at **12*a''***, is superposed on stringers **12*a'*** and is oriented the same as stringer **12a** so that the respective bearing surfaces of the uppermost stringer engage with the bearing surfaces of the central row of stringers. Stringer **12*a''*** is anchored to deadmen (not shown) by stretchers **38*a*** and construction proceeds as described above in conjunction with FIG. **1.** The retaining wall of FIG. **5** is somewhat more rigid than the retaining wall of FIG. **1,** a characteristic that may well be desirable in certain environments. It will be noted that the stringers of FIG. **5** can be installed either as shown in that figure or as shown in FIG. **1,** a feature which demonstrates the versatility of stringers constructed according to the invention.

As shown in FIG. **6,** a stringer **72** has an elongate generally hexagonal body **74** that is identical to body **14** in the embodiments described hereinabove. Stringer **72** has two pads disposed along body **74** in the spatial relationship described above, one such pad being indicated at **76.** The pad has an upper surface **80** and a lower surface **82** that is complemental with the upper surface. Upper surface **80** is formed by two surfaces **84** and **86** that converge to a centrally disposed apex **87** to define a V-shaped concavity. Lower surface **82** is formed by two surfaces **88** and **90** that diverge to a centrally dis-

posed apex **91** to define a V-shaped convexity. The angle of convergence of surfaces **84** and **86** is equal to the angle of divergence of surfaces **88** and **90** so that surface **82** of an upper stringer **72** complementally engages a surface **80** of a lower stringer on which the upper stringer is superposed. Such complemental engagement precludes relative movement between superposed stringers in a direction normal to the longitudinal axes of the stringers.

An interval **96** can be provided between surfaces **80** and **82** and the upper and lower extremities of body **74** to provide a slit (such as identified at **64** in the embodiment of FIG. **1**) for drainage. Moreover, pad **76** has an opening **94** therethrough for receiving a stretcher, such as indicated at **38** in FIGS. **1** and **3**. The embodiment of FIG. **6** thus affords the advantage to which reference has been made hereinabove.

Thus, it will be seen that the present invention provides a retaining wall stringer that reduces construction and inventory costs, which is versatile in its mode of installation, and which affords expeditious erection because only alternate rows of stringers need be anchored. Because the pads on the stringers are provided with complemental interlocking bearing surfaces, relative movement between superposed stringers is highly unlikely.

Although three embodiments of the invention have been shown and described, it will be obvious that other adaptations and modifications can be made without departing from the true spirit and scope of the invention.

What is claimed is:

1. A stringer for a retaining wall comprising an elongate body having first and second spaced-apart stacking pads thereon, each said pad having an upper and a lower bearing surface thereon, one of said bearing surfaces having a concavity and the other said bearing surface having a convexity complemental to said concavity so that superposed stringers engage one another by engagement of the concavity and convexity in respective said bearing surfaces, said pads having a vertical extent exceeding the vertical extent of said bodies so that a space is defined between the bodies of adjacent stringers when vertically stacked with the pads thereon in engagement with one another.

2. A stringer, according to claim **1**, wherein said concavity and convexity are symmetrically spaced on opposite sides of a vertical midplane through said stringer so that oppositely oriented superposed stringers engage one another.

3. A stringer, according to claim **1**, wherein said upper and lower pad surfaces are identical, each said bearing surface having a concavity and convexity complemental to said concavity, said concavity and convexity being disposed on a plane normal to the central longitudinal axis of the body and symmetrical of said axis so that oppositely oriented superposed stringers engage one another by engagement of the concavity and convexity in the lower bearing surface of the upper stringer with the respective convexity and concavity in the upper bearing surface of the lower stringer.

4. A stringer, according to claim **3**, wherein said concavity and convexity are defined by a rabbet formed by two congruent horizontal surfaces at vertically spaced-apart levels, there being a substantially vertical surface extending between said horizontal surfaces, said vertical surface being in a vertical plane that extends through the central longitudinal axis of said body.

5. A stringer, according to claim **1**, wherein said concavity and convexity are of complemental V-shape, the apices of said V-shapes residing in the vertical midplane of said stringer.

6. A stringer, according to claim **1**, wherein said pads are disposed on opposite sides of the longitudinal midpoint of said body.

7. A stringer, according to claim **6**, wherein said pads are disposed symmetrically of the longitudinal midpoint of said body.

8. A stringer, according to claim **7**, wherein the distance between respective said pads and the midpoint of said body is at least as great as the distance from respective said pads to respective longitudinal extremities of said body.

9. A stringer, according to claim **1**, wherein each said pad defines an opening therethrough for receiving a stretcher therethrough, said opening being substantially parallel to and midway between said upper and lower bearing surfaces.

10. A stringer, according to claim **1**, wherein said body has upper and lower surfaces that define outward diverging surfaces to promote water run-off from the retaining wall.

11. A stringer, according to claim **1**, wherein said body and said pads are constructed of concrete including reinforcing steel therein.

12. A wall for retaining an earthen mass comprising a plurality of identical stringers each having an elongate body and at least two stacking pads disposed in spaced apart relation along said body, each said pad having an upper and lower bearing surface, said surfaces defining complemental concavities and convexities so that the upper bearing surface of the pad of a lower stringer engages the lower bearing surface of the pad of an upper stringer superposed on the lower stringer to resist relative movement in a direction normal to the longitudinal axes of the stringers, said plurality of stringers being arranged in stacked relation with the pad bearing surfaces of vertically adjacent stringers interengaged and said pads having a vertical extent exceeding the vertical extent of said bodies so as to define a space between the bodies of adjacent vertically stacked stringers, and means for securing alternate horizontal rows of stringers to the earthen mass.

13. A retaining wall, according to claim **12**, wherein said securing means comprises at least one tension member having a first end fixed to said stringer and a second end remote from said first end, and a deadman fixed to said second end, said deadman being buried in the earthen mass.

* * * * *