C. C. CONKLING.

METAL SHEET PILING.

APPLICATION FILED APR. 22, 1911.

1,012,124.

Patented Dec. 19, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

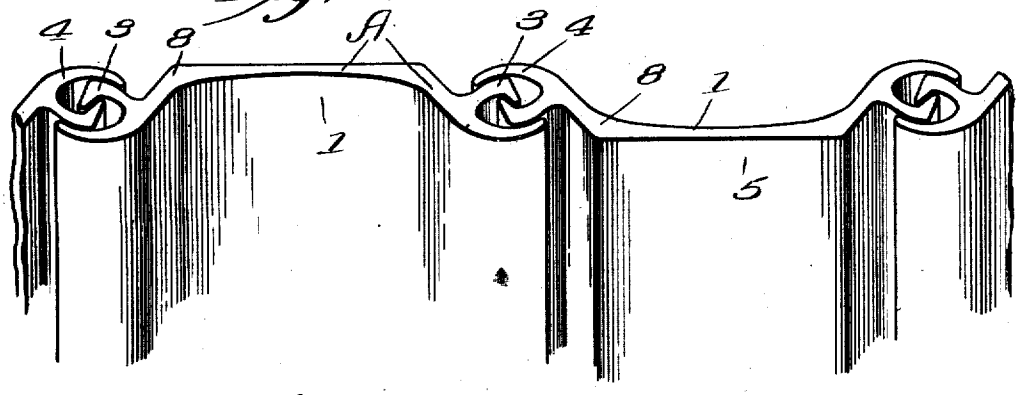


Fig. 2.

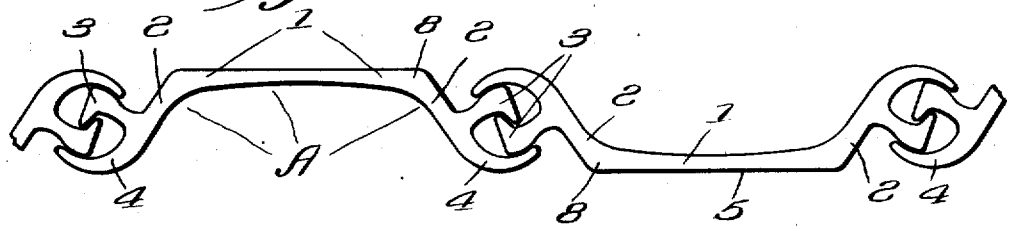
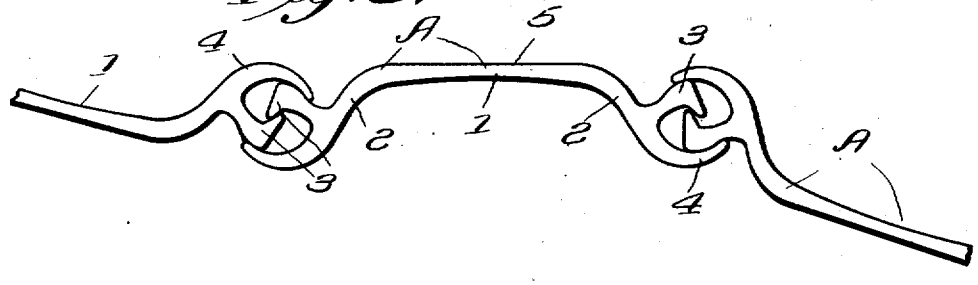


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

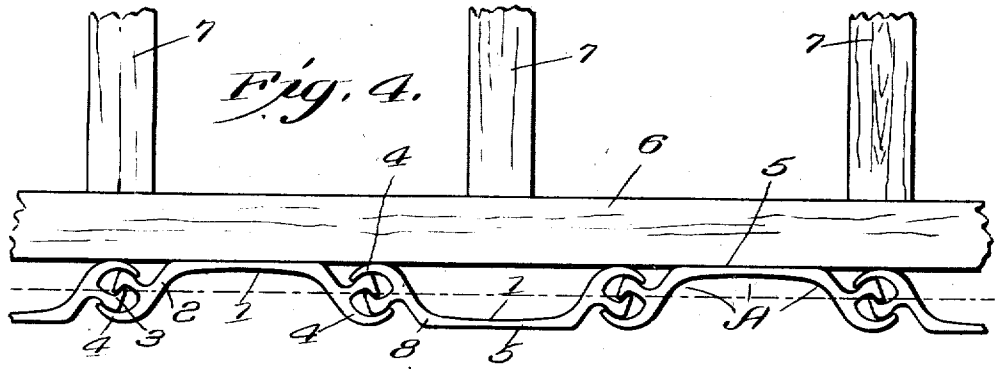

Fig. 5.

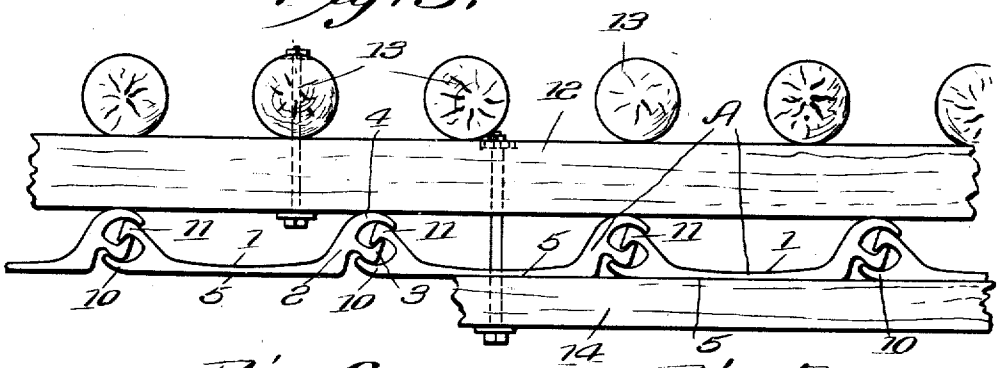

Fig. 6.

Fig. 7.

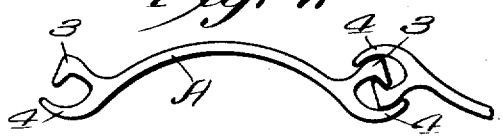

Fig. 8.

Fig. 9.

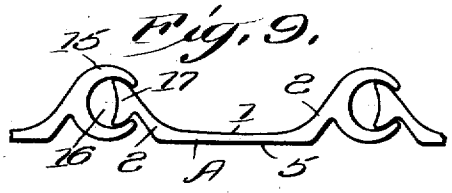

Fig. 10.

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UNITED STATES PATENT OFFICE.

CLOUD C. CONKLING, OF BUFFALO, NEW YORK, ASSIGNOR TO LACKAWANNA STEEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

METAL SHEET-PILING.

1,012,124. Specification of Letters Patent. Patented Dec. 19, 1911.

Application filed April 22, 1911. Serial No. 622,766.

To all whom it may concern:

Be it known that I, CLOUD C. CONKLING, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Metal Sheet-Piling, of which the following is a specification.

My invention relates to steel sheet piling having interlocking members on the edges of the sections, and consists in a new form of section whereby the modulus and moment of resistance of the section are greatly increased without diminishing the strength of the interlock.

Steel sheet-piling structures may be divided into two main classes.

First, the self contained, such as the coffer-dam now being constructed around the wreck of the *Maine* at Havana, where the coffer-dam wall is composed of a series of separate units or closed pockets, each to be filled with dredgings or other suitable material. In such case interior cross-bracing cannot be used on account of the great width of the coffer-dam and of the type of work done in the interior thereof. The resistance to pressure is afforded by the strength of the filled units alone. In case of such filled pockets, the stresses on the joints and webs of the individual pile sections are mostly tensional. Therefore this tensional strength of the interlock and web is the more important feature, and the resistance of the section to lateral stresses secondary.

Second, braced or tied, structures in which the pressure is applied to continuous or longitudinal walls of interlocked pile sections from the exterior by the retained material and is sustained by the said sections reinforced by interior bracing, or by exterior tie-rods or cables. In such structures the lateral strength of the individual sections is the important feature, and the strength of the interlock less important, as in this case the piles act as simple, continuous or cantaliver, vertical beams with one or more points of support, though the strength of the interlock must not be diminished for it is of great importance during installation, as in case of closing a pocket or striking an obstacle, to prevent the wall tearing apart.

My new pile section is particularly adapted for use in structures of the second class. Its characteristic features are the curving, or arching, of the web between the interlocking members so that the mass of the web will lie on one side of the neutral axis of the section; the outer surface of the arched web is preferably flattened, and the extent of the side deflection of the web is such that when the sections are assembled in the wall in the desirable alternate arrangement the outer surfaces of the webs of the sections will be substantially in line with the outer surfaces of the interlocking members of the joints, in other words the total thickness of the wall at the center of the web will not be greater than, but will equal the total thickness of the wall at the interlocked joint. I have thus produced a section with a web made on the principle of a flat arch in which the external pressure on the outer surface of the arch will be transmitted through the sides of the arch to the interlocking members and thence to the bracing timbers, at the same time the distribution of the metal in the section is such as to give a high section modulus and consequent great relative strength to each pile between and on its supports. The wall composed of such sections will therefore oppose great resistance to lateral stresses; this increased strength is obtained without increase in the weight of the completed wall per square foot. Furthermore sections of my new form are comparatively easy to roll so that the cost of manufacture is not increased.

The complete wall will be thin and compact in proportion to its lateral strength for the total thickness will not exceed but will substantially equal the thickness of the interlock, that is the thickness of the wall will be no greater than that of a wall composed of similar piles having straight webs. Another important result of such arrangement is that the surface of the wall has no series of somewhat sharp projections, but affords substantially flat surfaces to receive the walling timbers set against the inside of the wall.

My invention is illustrated in the drawing herewith in which it is shown used in different manners and applied to different types of piling.

Figure 1 is an isometric view of pile sections of the preferred form. Fig. 2 is a plan of the same. The sections are here shown with normal clearance in the inter-

lock, being the position from which the amount of steel required for a given length and depth of wall is calculated. In Fig. 3 the interlocked joints are shown pulled out to their full limit, a common condition in driving, and the possibility of angular adjustment is indicated. Fig. 4 shows the use of interior bracing in connection with a wall of this arched piling. The desirable alternate arrangement is illustrated in the preceding figures. Fig. 5 shows my peculiar piling with slightly modified interlocking members arranged in a structure where it is desirable to have a continuous, smooth surface of wall. Figs. 6 and 7 show modifications of piling embodying my invention. In the foregoing figures my invention is shown as applied to the "Lackawanna" type of piling, but it may be applied to other well known types, such as the ball-and-socket type as shown in Figs. 8, 9 and 10.

Referring particularly to Figs. 1, 2 and 3, in which is shown the preferred form of piling embodying my invention, the central portion 1 of the web A is made in a flat curve merging into the more abruptly curved sides 2 of the arch. Said sides are short, solid and rigid, and arranged so that they receive all the stresses from the flattened portion of the arch and transmit them to the bracing, through the interlocking members, here consisting of the inner hook 3 and the outer guard 4. The web thus formed is preferably flattened on its outer surface as shown at 5, and the extent of lateral displacement of the metal in the web so proportioned that this flat surface will be substantially in line with the outer surfaces of the interlocking members, when the sections are assembled in the wall, thus producing a wall without projections against which the horizontal walling timbers etc. may be firmly set. At the same time the metal is so distributed in relation to the neutral axis of the section as to get a relatively high moment of resistance and consequent increased beam strength, as against a pile having the same width and interlocking jaws, but with a straight web. The object in so forming the sections is best illustrated in Fig. 4. Here are indicated five sections assembled in a wall and arranged alternately, so that the arched webs of the alternate sections extend on opposite sides of the neutral axis of the wall indicated by the dotted line. The flat outer surface 5 of the web of each section is in line with the outer surfaces of the guards 4 of the adjacent sections, producing a wall particularly adapted for the walling timbers 6, set against the inside. There are no projections which would tend to cut, or crush, into the walling timbers, as a large proportion of the inner face of the wall affords a series of relatively long bearing surfaces for the contact of the horizontal timbers, each of these larger bearing surfaces being formed of the flattened outer face of the web of the inwardly arranged section and of the adjacent guards 4 of the interlocked joints.

The webs of the inwardly turned sections transmit the pressure of the retained earth or water on the outside directly to the walling timbers 6 against which the sections lie snug and thence to the cross braces 7. So far as the alternate outwardly turned sections are concerned, these act as strong steel arches, and the interlocking members thereof act as skew-backs and side walls, so that the thrust of the retained material on the outer surface of the arch is transmitted at the points of support by the short sides (which must be rigid) of the arches to the walling timbers and thence to the cross braces.

It will be understood that in certain locations it is not convenient to arrange braces on the back of the wall, but the wall is tied by ropes or rods extending from the walling timbers to anchors on the front.

The wall made of my new and peculiar pile section is comparatively thin and compact, with such a proportion of the metal uniformly arranged on both sides of the neutral axis of the wall and at such distance therefrom, as to produce high lateral strength in the wall and in the individual units thereof. This is obtained without weakening the strength of the interlock or diminishing the flexibility thereof, whereby sufficient longitudinal and angular adjustment is permitted.

The thickening of the web at the haunches 8 8, as shown in Figs. 1 and 2, may be of importance, as the addition of a comparatively small amount of metal at those points increases the inertia and modulus and therefore greatly strengthens the individual section and the completed wall; it also increases the length of the bearing for the interior bracing timbers. At the same time such addition of metal does not increase the width of the wall and tends to prevent deformation of the arch when under pressure. This lateral strength may be also further increased by the addition of metal to the web and joint guards with a corresponding increase in the rise of the arch and in the width of the wall.

Fully to comprehend what I have accomplished, account should be taken of certain fixed factors which necessarily limit commercial and practical pile sections. These are that the section must be an integral section produced in one piece by rolling; the web must be sufficiently solid to withstand the blow of the hammer and must have no thin joint where it might split; all the sections in the wall must be the same; the high lateral strength must not be obtained at the expense of jaw strength, that is the inter-

lock must be strong; finally, as a commercial question the weight must not be substantially increased, and the width of the section must not be so great as to increase the cost of production and the difficulties of handling and driving.

My invention lies not merely in a new form of section, but in discovering that, subject to all these limitations, I could greatly increase the section modulus and the lateral strength over a straight web pile section, and this increase is obtained without increasing the total thickness of the wall over the necessary joint thickness, and with the other described advantages. I have thus produced a section of greatly increased lateral strength, and much superior in lateral strength to any other piling of similar weight, with which I am acquainted, and also much stronger in the interlock than said other pilings. Thus my section has a wider scope and is in fact adapted to new uses.

Lateral strength is of vital importance. For instance, in the case of a wall of piling supported by two or more horizontal sets of bracing timbers, the portion of each pile between its supports acts as a vertical beam. In such a vertical beam, the lateral strength of the pile as represented by the modulus of its section is the important factor, whatever may be the particular outline of its section.

In the form of piling having an arched cross section, a great increase of lateral strength in the pile, as a beam, is obtained as fully described herein, for the reason that the metal in the arched web and in the interlocking jaws of the section is so distributed, with reference to the neutral axis, as to give a high moment of inertia of the section, with a comparatively short distance from the neutral axis to the extreme fiber of said section, thus producing a high section modulus and consequent high lateral strength.

Referring to the ends, or intermediate points, of the beam, where it is supported by the horizontal timbers and where all the stresses on the beam are received and transmitted to said timbers:—here the arched form of the beam section performs another important function, that is, it prevents the flattening out or deformation of the section on such points of support. Thus my new form of section produces great lateral strength throughout the length of the beam, and, at the same time, is particularly adapted, at the points of support, to receive the stresses and transmit them to the timber supports, with great resistance against deformation of the section at such points of bearing on the supports; that is, it affords great resistance against the flattening out or breaking down of the section on such points of support, which latter would reduce the strength of the beam as a whole. This need of increase in lateral strength has become understood of late years, and has been obtained to a certain extent in well known types of piling by very wide interlocking members and therefore by a great increase in metal at these points, involving also a great thickness in wall at those points. The particular types referred to are those in which the sections are built-up, or else interlocking members of a special form are necessary to connect the main pile sections. In all these types, the timbers rest against comparatively thin and widely separated bearing surfaces with the disadvantages thereof, instead of against wide flat surfaces; also the interlock is comparatively weak.

It will be understood that the arrangement and form of my sections may be varied and modified without departing from the spirit of my invention. For instance—for most purposes, the above described alternate arrangement of the sections is preferred, but there are a class of permanent structures, such as ferry-slips and mine-shafts, where a smooth flat facing, or lining, is desired, and for such structures my new piling is particularly adapted, for the arches of the sections may be arranged to extend all on the same side of the neutral axis of the wall as shown in Fig. 5. To permit this arrangement of the sections the interlocking members must be reversed from the arrangement of the preceding figures, that is the guards on the respective edges must extend on opposite sides instead of on the same side. As shown in the ferry-slip wall of Fig. 5, at one edge the hook 3 and guard 4 are formed exactly as shown in Fig. 4, but at the other edge, the guard 10 is almost continuous with the web and the hook 11 on that edge of course extends on the opposite side of the web from the other hook. The facing wall thus formed is practically smooth. Here 12 indicates the walling timbers and 13 the bearing piles back of the steel piling.

14 indicates a front timber arranged near the top of the sections whereby they may be bolted back against the walling timbers, all as used in ferry slip constructions.

Modifications in the form of the sections is shown in Figs. 6 and 7 where the entire web is formed in a continuous rather flat arch. In Fig. 7 the web is shown of uniform thickness, but in Fig. 6 the section is strengthened by thickening the web at its center.

In Figs. 8, 9 and 10 my invention is shown applied to the so called U. S. type of piling, in which the interlocking members are the flanges 15 15 along one edge forming the groove or socket 16 to receive the ball, or head, 17 on the opposite edge of the adjacent section. In Fig. 8 is indicated the usual and desirable alternate arrangement of the piling. In Figs. 9 and 10 the sections are

shown with the arched webs all turned in the same direction to form a substantially smooth facing wall. Sections of the same form are shown in Figs. 8 and 9 but in Fig. 10, shown slightly modified with one of the flanges made almost continuous with the guard, analogous to the special form of Fig. 5, to diminish the external groove in the face of the wall at the joint and thereby produce a wall that is more nearly absolutely smooth and continuous.

Having described my invention I claim,

1. An integral, metal, sheet piling section having a web and interlocking members on the edges of the web, said web being outwardly curved between said members to form an arch extending on one side of the neutral axis of the pile, the central portion of the arch being a flat curve and the sides more abrupt curves arranged to receive the stresses imposed on the outer surface of the arch and to transmit the stresses to said members.

2. A metal sheet-piling section having a web and integral interlocking members on the edges of the web, said web being outwardly curved between said members to form an arch extending on one side of the neutral axis of the section, the center of the arch being formed in a flat curve and the sides being thicker than the center and formed in more abrupt curves, the central flat curve merging into the curves of the sides, and the sides being rigid columns arranged to receive the stresses imposed on the flat curve and transmit them to the said members.

3. An integral, steel, sheet-piling section having interlocking members on the edges and the web between said members formed in an arch arranged on one side of the neutral axis of the section, the center of the outer surface of the arch being at such a distance from the axis that it will be substantially in line with the outer surface of the interlocking members when the sections are assembled in a substantially straight wall.

4. An integral, steel, sheet-piling section having a web and interlocking members on the edges of the web, said web being outwardly curved between said members to form an arch extending on one side of the neutral axis of the section, the central portion of the arch being formed in a flattened curve having a straight, flat outer surface, and the sides being thicker than the central portion and formed in more abrupt curves, to act as rigid columns, receiving all the stresses imposed on the outer surface of the arch and transmitting them to the interlocking members.

5. An integral, steel, sheet-piling section having a web and integral interlocking members on the edges of the web, said web being outwardly curved between said members to form an arch extending on one side of the neutral axis of the section, said arch having a flat outer surface, the side deflection of the web being such that said flattened outer surface will be substantially in line with the outer surface of the adjacent interlocking members, when the sections are assembled in the wall.

6. An integral, steel, sheet piling section having a web and integral interlocking members on the edges of the web, said web being outwardly curved between said members to form an arch extending on one side of the neutral axis of the section, the central portion of the arch being formed in a flattened curve having a flat outer surface, the sides of the arch being thicker than the central portion and formed in more abrupt curves, said flat curve merging into the curves of the sides, the haunches of the arch being made thicker by the addition of metal, and said sides being arranged to act as rigid columns to receive all the stresses imposed on the outer surface of the arch and transmit the same to the interlocking members, the side deflection of the web being such that the extreme outer surface of the arch will be substantially in line with the outer surface of the adjacent interlocking members when the sections are assembled in the wall and the extreme thickness of the wall will be substantially equal to the thickness of the wall at the joints.

7. In a braced wall of steel sheet piling, the pile sections consisting of a web and of integral interlocking members on the web edges, said web being outwardly curved between the members to form an arch, said curvature being of such extent laterally that when the sections are assembled in the wall the extreme, outer surfaces of the arches will be substantially in line with the outer surfaces of the interlocking members, said sections being arranged with their arches alternately extending in and out and in combination therewith bracing members set on the inside against the said outer surfaces of the arches and interlocking members.

8. A braced wall of metal sheet piling composed of sections consisting of a web and of integral interlocking members on the edges of the web, the web being outwardly curved between the members to form an arch having a flat, outer surface, the side deflection of the web being such that said flattened outer surfaces of the arches will be substantially in line with the outer surfaces of the interlocking members, said sections being alternately arranged with their arches extending alternately on opposite sides of the neutral axis of the wall, and in combination therewith walling timbers arranged on the inside against said outer sur-

faces of the arches and of interlocking members and bracing timbers set against the walling timbers.

9. A braced wall of steel sheet piling composed of sections each consisting of a web and of integral interlocking members on the edges of the web, said web being outwardly curved on one side to form an arch extending on one side of the neutral axis, and in combination therewith bracing timbers arranged on the inside of the wall and set in contact with the interlocking members.

10. In a braced wall of steel sheet-piling, the pile sections consisting of a web, and of an inner interlocking hook and an outer interlocking guard on each edge, said web being outwardly arched between the members to such extent that when the sections are assembled in the wall, the outer surfaces of the arch on each section will be substantially in line with the outer surfaces of the guards on alternate sections, said sections being arranged with their arches alternately extending on opposite sides of the neutral axis and in combination therewith timbers, set on the inside in contact with the outer surfaces of the arches and the outer surfaces of the guards on adjacent sections.

11. A braced wall of steel sheet-piling having a substantially smooth face and composed of sections consisting each of a web and of integral interlocking members on the edges of the web, said web being curved to one side of the neutral axis of the section in the form of an arch having a flattened outer surface, said sections being arranged in the wall with the arches extending on one side of the neutral axis of the wall, the outer surfaces of the arches being in line with the outer surfaces of the interlocking members, and in combination therewith suitable supporting timbers for the wall.

12. A braced wall of metal sheet piling composed of sections consisting each of a web and of interlocking members on both edges, the web of each section being outwardly deflected between the members to form an arch having a flattened outer surface, the extent of the deflection being such that said outer surfaces will be substantially in line with the interlocking members of the assembled sections, said sections being arranged with their arches extending alternately on opposite sides, and longitudinally extending timbers arranged on one side in contact with the outer surfaces of the alternate sections, arranged to extend on that side, and with the outer surfaces of the interlocking members on that side.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CLOUD C. CONKLING.

Witnesses:
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