June 13, 1939. R. J. BORHEK 2,162,499

STREAM BED PROTECTION MEANS

Filed Nov. 17, 1938 2 Sheets-Sheet 1

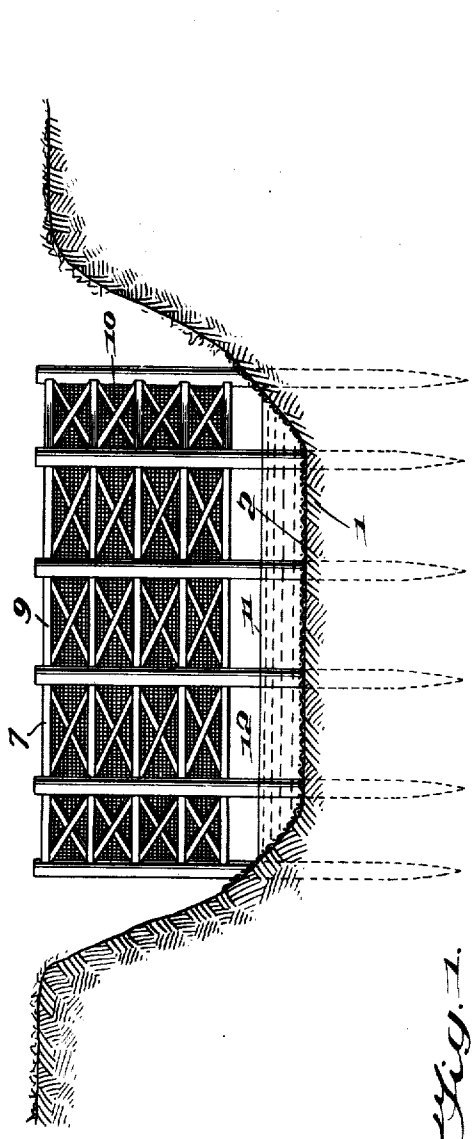


Fig. 2.

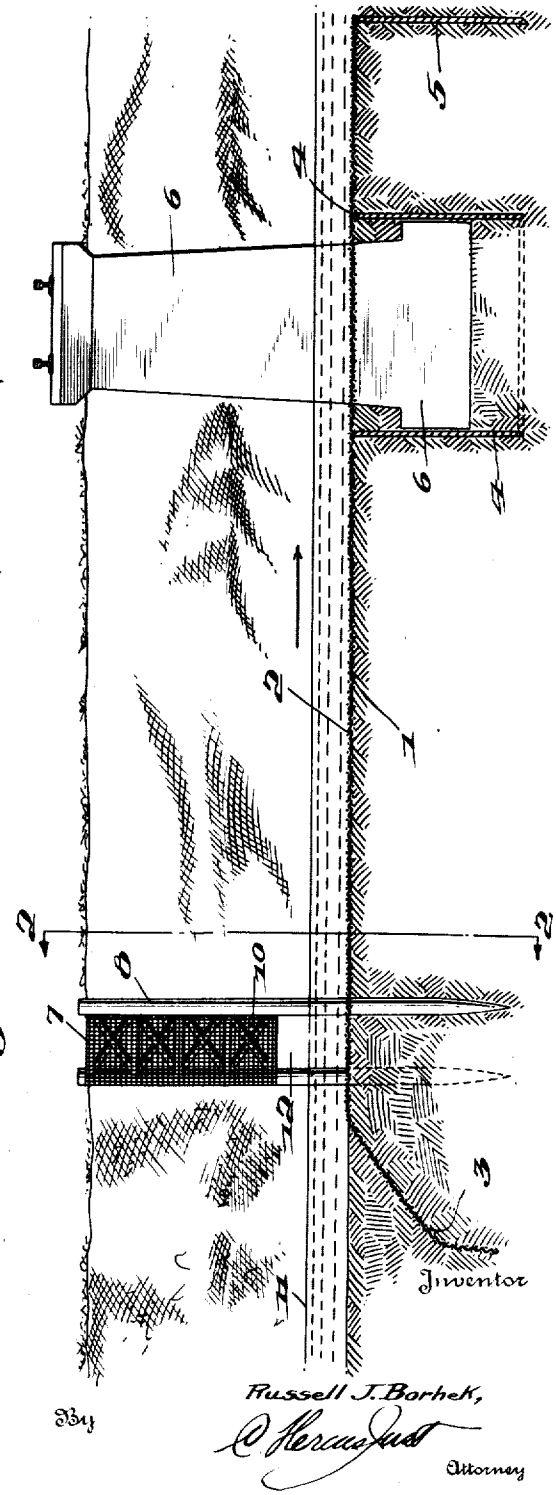


Fig. 1.

Inventor

Russell J. Borhek,

By

Attorney

June 13, 1939. R. J. BORHEK 2,162,499

STREAM BED PROTECTION MEANS

Filed Nov. 17, 1938 2 Sheets-Sheet 2

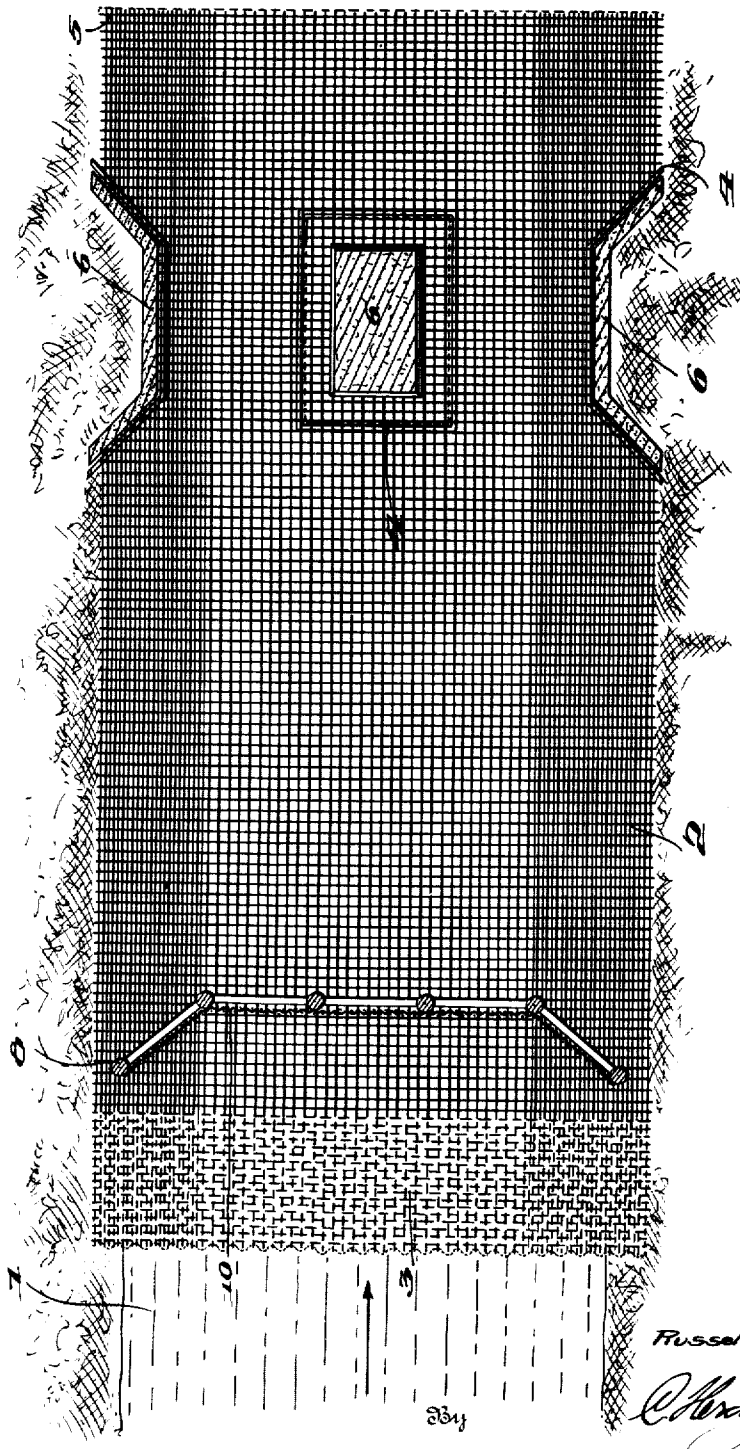


Fig. 3.

Inventor
Russell J. Borhek,
By
Attorney

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UNITED STATES PATENT OFFICE

2,162,499

STREAM BED PROTECTION MEANS

Russell J. Borhek, Washington, D. C.

Application November 17, 1938, Serial No. 241,032

13 Claims. (Cl. 61—46)

This invention relates to a method and means for protecting bridge piers, foundations, abutments, as well as superstructure connected therewith, from failures, particularly in times of flood.

Among the objects of the invention are the provision of means to prevent the erosion and scouring of stream beds and the adjacent banks and particularly to prevent such erosion and scouring in order to eliminate the undermining of bridge piers, supports, abutments and the like, which undermining results in bridge failures, especially under flood conditions of the river or stream.

Another object of the invention is to provide means in conjunction with the other associated structures to trap and retain drift material usually associated with flood conditions in order to prevent the drift from gouging out the stream bed or accumulating against, as well as forcibly striking, the bridge supports and superstructure and thus eliminating or substantially reducing the occurrence of eddy currents adjacent said supports, which eddy currents frequently result in an undermining action adjacent the foundations of such supports. Heavy drift, if allowed to forcibly strike against bridge supports and superstructure, often causes either displacement or removal of the same, and it is a purpose of this invention to provide means to eliminate such detrimental occurrences.

Among other objects of the invention are means to prevent bodily shifting of stream beds, particularly adjacent bridge supports, and thus prevent the persistent progress downstream of the materials comprising the stream bed.

Other objects of the invention will be apparent from study of the following detailed description of the invention in conjunction with the drawings, in which

Figure 1 represents a side elevation, partly in section, of a stream bed in which the elements of the invention have been arranged;

Figure 2 is an elevation, partly in section, taken crosswise of the stream bed along the line 2—2 of Figure 1; and

Figure 3 is a plan view, partly in section, of the stream bed, showing the elements of the invention.

The question of bridge failures has long been a problem of engineers and after every flood of any proportions, it has been found that numerous bridges have been washed out. It has been quite customary to explain such washouts by saying that the former bridge had not been strong enough or that unprecedented flood conditions had arisen, which the design of the bridge had not been calculated to meet. When a new bridge is built to replace the one removed by the flood, it is quite often built stronger and the foundations for the supports are placed a little deeper in the bed and it is then hoped that later unprecedented flood conditions will not arise to take out the new bridge.

In recent years there have been numerous large and substantially unprecedented flood conditions, particularly in the eastern portion of this country, and many hundreds of bridges have been washed out, ranging in all sizes, including both highway and railroad bridges. The causes of the flood conditions can be attributed to certain unusual occurrences of weather conditions all culminating at the proper time to produce situations that had never been calculated against when the bridges in the areas had been designed and constructed. In areas that have not been visited by such unusual flood conditions in this country, there is no doubt that there are many bridges now in use which, if subjected to such unusual conditions, would be taken out by floods occurring in these sections.

In the central continental basin in this country, for instance, which is drained by the Mississippi River and its tributaries, and especially in what is known as the "plains" country, there are many stream beds that normally have a mere trickle of water in them, but when intense rainfall occurs within the area drained by such streams, the same rapidly assume the proportions of raging torrents and within the space of relatively few hours, the torrents pass and the stream is back to its normal level again with a very small amount of water therein, but quite often with the bed and banks of the stream badly eroded as a result of the heavy passage of water carrying boulders, aggregate of all sizes, and debris along with it.

It has been observed by the applicant that stream beds also have a tendency, particularly where the bed is composed mainly of silt, to move bodily downstream, and flood conditions accelerate such movement. This movement occurs in a strata of the stream bed probably to a depth of even six or eight feet, depending upon such factors as the velocity of flow, the size of the stream, the thickness of the silt bed before coarser aggregate is reached, and the flood conditions causing such movement.

A channel change directly below a bridge site may cause "upstream" erosion and lowering of the stream bed. There is also a recession of the

bed where the channel contains humps of "hard pan" or cemented gravel. This is particularly noticeable in rapids, causing the rapids to recede or "flatten out".

Another observance of the applicant has been that drift material mainly at flood stage of the streams will lodge against bridge piers, abutments and other supports, as well as impinge and drag along the bottom, thus retarding the unobstructed flow of water around such support. This quite frequently results in the creation of eddy currents and whirl pool effects which play havoc with the stream bed adjacent the foundations of such bridge supports and, in view of the fact that frequently the bases of such foundations only extend as little as four or five feet below the level of the stream bed in smaller streams, undermining of such foundations by the eddy currents results in the support being undermined and collapsing, bringing the bridge down with it.

In a stream having a current flowing in a relatively straight line, as distinguished from oblique currents or whirl pool effects, less digging or scouring action takes place. Therefore, it is the object of this invention to eliminate as far as possible such oblique and detrimental currents from stream beds adjacent bridge supports so that such digging and undermining action from the current will be eliminated, the stream bed will be maintained substantially intact and unimpaired from scour, and bodily shifting and persistent progress downstream of the materials comprising the stream bed will be prevented.

The means by which such advantageous results are effected are shown in the drawings in which the stream bed is indicated at 1, and lying on the stream bed is a meshlike sheet 2 which may be of metal or any other suitable material and may be either flat, ribbed or undulating in shape. The shape of the mesh openings may be any of the conventional, square, diamond, triangular or other desired shapes. The upstream end 3 of the sheet 2 is anchored well within the stream bed and extends below the surface of the bed a distance in accordance with the character of the stream bed. The sheet, after being laid on the stream bed, may be further retained in place until it becomes adequately imbedded in the silt by boulders or coarse aggregate strewn over the surface of the sheet, which sheet, as shown in Figure 2, extends well up the banks of the stream bed. Such a sheet will prevent any appreciable scour and erosion of the stream bed, since it will act in the manner of a protecting surface to the bed to resist the action of rapidly moving flood water carrying aggregate and debris.

In order to prevent bodily shifting of the stream bed, sheet piling 4 of wood, concrete, steel or mixtures of any of these or of other similar materials are provided around the foundations of the various bridge piers, abutments and other supports to a depth well below said foundations as well as below that level of the bed at which any shifting might be expected, and will thus serve as an additional anchor for such foundations in the stream bed and a protection against undermining. The upper end of such piling extends only to the level of the stream bed and is flush therewith in order that no irregular surface will be afforded over which running water might set up detrimental currents.

Arranged across the stream bed downstream from said supports is a row of piling 5 similar to the piling 4 except that the row of piling extends across the stream for the full width, the upper edges of which are also flush with the level of the bed in order that here, too, no detrimental currents will be set up. This row of piling is particularly useful in preventing the downstream shifting of the stream bed or the materials comprising the same, and especially in the vicinity of the bridge support foundations. As shown in Figures 1 and 3, it will be seen that the downstream end of the sheet 2 terminates substantially at the row of piling 5.

To prevent any "upstream" erosion such as referred to in the foregoing from occurring adjacent the row of piling 5, as a modified structure, the sheet 2 may terminate downstream in a substantially cylindrical roll or "basket" extending across the stream adjacent the piling and filled with boulders, coarse aggregate and the like, and embedded in the stream bed to a distance below that at which any lowering of the bed could normally be expected from such "upstream" erosion and the upper surface of the roll not being above the bed level and the entire roll being filled over by the bed material so as to form an even surface on the bed. The sides of the sheet 2 may be similarly terminated if desired to prevent undercutting along the side edges of the sheet adjacent the stream banks.

It is to be understood that the pilings 4 and 5 may be composed of any of the materials mentioned in the foregoing and in shape may be of any suitable form and are interlocking, if desired, such as is commonly found in many of the commercial pilings on the market today. The essential feature of the piling is that it be strong enough and anchored sufficiently deep in the stream bed to resist bending moment which would be applied against it by the tendency of the bed to migrate downstream.

As stated in the foregoing, a common experience in the flood stage of streams is to have drift material lodge against the bridge supports 6 shown illustratively in Figure 1. Such lodgment creates undermining currents. It is the purpose of this invention, in conjunction with the cooperating elements already described, to have a further element to be used in conjunction with the same, consisting of a barrier 7 arranged across the stream on the upstream side from the bridge supports 6. The purpose of the barrier is to obstruct and retain drift material and thus save the bridge support from being contacted by such drift, as well as from the deleterious currents produced by such drift lodging against the support.

The barrier 7 is shown as being composed of long piles 8 and being of such size and driven into the stream bed a sufficient distance to adequately resist the bending moment imposed thereagainst by the drift material. Between the piles 8 cross members 9 are arranged which may be suitably braced and over such structure mesh material 10 is secured, the thus fabricated structure permitting relatively free flow of flood waters therethrough but retaining drift material against the upstream face of the barrier. The mesh 10 may be of any suitable type but should be quite heavy to withstand shock of impact of flood drift without failure.

One of the essential aspects of the barrier is that the lower edge of the mesh structure of the barrier is above the normal stream level shown at 11. This is to allow normal drift such as may occur in the natural condition of the stream when not in flood stage to pass beneath the

barrier and not be trapped thereagainst. The purpose of the barrier is primarily for use in flood stage and in this connection the lower edge of the mesh structure of the barrier is preferably arranged so that a space between one-quarter and one-third the distance from the top of the bridge support to the stream bed is provided between the stream bed and the lower edge of the mesh. This space is clearly shown at 12 in Figures 1 and 2. No definite formula can be given for computing the space 12 but the normal amount of water, the acre run-off of the surrounding water-shed in flood stage, and other similar factors must be taken into consideration in computing the space so that it will trap drift in flood stage but will let normal drift flow thereunder.

It will thus be seen that the applicant has provided interdepending means consisting of a mesh arranged on the stream bed extending both upstream and downstream with respect to bridge supports, pilings surrounding the bridge support foundations and across the stream downstream from the bridge supports and a barrier to catch drift material in flood stage arranged upstream from said bridge supports and extending across the width of the stream, whereby scouring of the stream bed adjacent said bridge supports, deleterious currents resulting from drift in the immediate vicinity of said bridge supports and the bodily shifting or migration downstream of the bed proper is prevented and thus eliminates the effects of these actions which cooperate to undermine or otherwise cause the failure of said bridge supports.

By the incorporation of such structures as come within the purview of this invention, within stream beds adjacent existing bridges, it is believed that subsequent failures of bridges which now are classified as being doubtful of resisting flood conditions could be saved, even in substantial flood conditions, and bridges which have been built to withstand normal flood conditions could be insured against failure in abnormal flood conditions. The construction contemplated by the applicant could be installed at considerably less expense than building new bridges washed out as a result of floods and thus would result in material savings in the flood damage costs normally experienced when bridges fail.

The foregoing sets forth the preferred embodiments of the applicant's inventive concept, but it is to be understood that the invention is not to be limited to the specific constructions herein described, which are merely intended to be illustrative, since the invention may be carried out in other ways.

I claim as my invention:

1. Means to maintain a stream or river bed at a desired level, comprising meshlike mat arranged substantially on the surface of the bed, the upstream end of said mat extending into said bed at an angle to the plane of the bed whereby the mat is securely anchored at its upstream end at a substantial distance below the normal level of said bed.

2. Means to maintain a stream or river bed adjacent bridge supports against shifting to maintain the foundation of the support intact, comprising a meshlike mat arranged on said bed and extending upstream and downstream adjacent said supports, the upstream end of said mat being embedded in said stream bed below the normal level of said bed and anchored therein.

3. Means to maintain a stream or river bed at a desired level, comprising a meshlike mat arranged on the bed, the upstream end of said mat being embedded in the stream bed below the normal level of said bed and anchored therein, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed.

4. Means to maintain a stream or river bed adjacent bridge supports against shifting, comprising a meshlike mat arranged on said bed and extending upstream and downstream adjacent said supports, the upstream end of said mat being embedded in the stream bed below the normal level of said bed and anchored therein, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed.

5. Means to maintain a stream or river bed against erosion adjacent a support in said bed, comprising a mat extending up and down stream with respect to said support, positioned on said bed, the upstream end of said mat being embedded in the stream bed below the level of said bed and anchored therein and a barrier arranged across said bed between the upstream end of said mat and said support, adapted to catch and retain drift material the lowermost edge of said barrier being above the normal water level in the stream.

6. Means to maintain a stream or river bed against erosion adjacent a support in said bed, comprising a mat extending up and down stream with respect to said support, positioned on said bed, the upstream end of said mat being anchored below the level of said bed and a barrier arranged across said bed between the upstream end of said mat and said support, adapted to catch and retain drift material, said barrier being composed of spaced piles supporting a foraminous superstructure arranged with the lowermost edge spaced above the normal water level.

7. Means to maintain a stream or river bed against erosion adjacent a support in said bed, comprising a mat extending up and down stream with respect to said support, positioned on said bed, the upstream end of said mat being anchored below the level of said bed, a barrier arranged across said bed between the upstream end of said mat and said support, adapted to catch and retain drift material, said barrier being composed of spaced piles supporting a foraminous superstructure arranged with the lowermost edge spaced above the normal water level, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of the piling being flush with said bed.

8. Bridge support protecting means comprising spaced piles arranged across a stream bed, upstream from said support, foraminous superstructure arranged between said piles, said superstructure extending to a height substantially that of the bridge support and being spaced at its lower edge above the normal level of the stream where normal drift may pass beneath said barrier while flood drift will be retained by said barrier to prevent its lodgment against said bridge or supports, a meshlike mat arranged on said stream bed extending from upstream above said barrier to downstream below said support, whereby said stream bed is retained substantially at a desired level, said mat also assisting in preventing eddy currents that may result from flood drift at said barrier from materially scouring said bed between said barrier and support.

9. Bridge support protecting means comprising spaced piles arranged across a stream bed, upstream from said support, foraminous superstructure arranged between said piles, said superstructure extending to a height substantially that of the bridge support and being spaced at its lower edge above the normal level of the stream where normal drift may pass beneath said barrier while flood drift will be retained by said barrier to prevent its lodgment against said bridge or supports, a meshlike mat arranged on said stream bed extending from upstream above said barrier to downstream below said support, whereby said stream bed is retained substantially at a desired level, said mat also assisting in preventing eddy currents that may result from flood drift at said barrier from materially securing said bed between said barrier and support, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed.

10. Means to maintain a bridge support foundation against movement in a substantially level stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, and another row of piling arranged substantially transversely across said bed, downstream from said support, the upper edge of which is flush with said bed to prevent bodily shifting of the stream bed, said row of piling extending sufficently below the depth of shiftable media to provide secure anchorage for the piling whereby it will resist bending moment resulting from downstream pressure of said shiftable media, said row of piling around said foundation being arranged with the upper edge flush with the stream bed level and serving to prevent displacement of said foundation and protect the same against undermining.

11. Means to maintain a stream or river bed at a desired level, comprising a meshlike mat arranged on the bed, the upstream end of said mat being embedded in said stream bed and anchored below the normal level of said bed, a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed to prevent bodily shifting of the stream bed, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, the upper ends of which terminate flush with the level of the stream bed, said row of piling around said foundation serving to prevent displacement of said foundation and protecting the same against undermining.

12. Means to protect a stream or river bed against erosion adjacent a support in said bed, comprising a mat extending up and down stream with respect to said support, positioned on said bed, the upstream end of said mat being anchored below the level of said bed, a barrier arranged across said bed between the upstream end of said mat and said support, adapted to catch and retain drift material, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend below the foundation so as to be anchored in the bed therebeneath, said row of piling around said foundation serving to prevent displacement of said foundation and protect the same against undermining.

13. Bridge support protecting means comprising spaced piles arranged across a stream bed, upstream from said support, foraminous superstructure arranged between said piles, said superstructure extending to a height substantially that of the bridge support and being spaced at its lower edge above the normal level of the stream whereby normal drift may pass beneath said barrier while flood drift will be retained by said barrier to prevent its striking and lodgment against said bridge or supports and forming eddy currents or a digging action adjacent said supports, a meshlike mat arranged on said stream bed extending from upstream above said barrier to a position downstream below said support whereby said stream bed is retained substantially at a desired level, said mat also assisting in preventing eddy currents resulting from flood drift at said barrier from materially scouring said bed between said barrier and support, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, said row of piling around said foundation serving to prevent displacement of said foundation and aid in protecting the same against undermining.

RUSSELL J. BORHEK.

CERTIFICATE OF CORRECTION.

Patent No. 2,162,499. June 13, 1939.

RUSSELL J. BORHEK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 17, claim 9, for the word "securing" read scouring; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of July, A.D. 1939.

(Seal)

Henry Van Arsdale
Acting Commissioner of Patents.

9. Bridge support protecting means comprising spaced piles arranged across a stream bed, upstream from said support, foraminous superstructure arranged between said piles, said superstructure extending to a height substantially that of the bridge support and being spaced at its lower edge above the normal level of the stream where normal drift may pass beneath said barrier while flood drift will be retained by said barrier to prevent its lodgment against said bridge or supports, a meshlike mat arranged on said stream bed extending from upstream above said barrier to downstream below said support, whereby said stream bed is retained substantially at a desired level, said mat also assisting in preventing eddy currents that may result from flood drift at said barrier from materially securing said bed between said barrier and support, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed.

10. Means to maintain a bridge support foundation against movement in a substantially level stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, and another row of piling arranged substantially transversely across said bed, downstream from said support, the upper edge of which is flush with said bed to prevent bodily shifting of the stream bed, said row of piling extending sufficently below the depth of shiftable media to provide secure anchorage for the piling whereby it will resist bending moment resulting from downstream pressure of said shiftable media, said row of piling around said foundation being arranged with the upper edge flush with the stream bed level and serving to prevent displacement of said foundation and protect the same against undermining.

11. Means to maintain a stream or river bed at a desired level, comprising a meshlike mat arranged on the bed, the upstream end of said mat being embedded in said stream bed and anchored below the normal level of said bed, a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed to prevent bodily shifting of the stream bed, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, the upper ends of which terminate flush with the level of the stream bed, said row of piling around said foundation serving to prevent displacement of said foundation and protecting the same against undermining.

12. Means to protect a stream or river bed against erosion adjacent a support in said bed, comprising a mat extending up and down stream with respect to said support, positioned on said bed, the upstream end of said mat being anchored below the level of said bed, a barrier arranged across said bed between the upstream end of said mat and said support, adapted to catch and retain drift material, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend below the foundation so as to be anchored in the bed therebeneath, said row of piling around said foundation serving to prevent displacement of said foundation and protect the same against undermining.

13. Bridge support protecting means comprising spaced piles arranged across a stream bed, upstream from said support, foraminous superstructure arranged between said piles, said superstructure extending to a height substantially that of the bridge support and being spaced at its lower edge above the normal level of the stream whereby normal drift may pass beneath said barrier while flood drift will be retained by said barrier to prevent its striking and lodgment against said bridge or supports and forming eddy currents or a digging action adjacent said supports, a meshlike mat arranged on said stream bed extending from upstream above said barrier to a position downstream below said support whereby said stream bed is retained substantially at a desired level, said mat also assisting in preventing eddy currents resulting from flood drift at said barrier from materially scouring said bed between said barrier and support, and a row of piling arranged across said bed adjacent the downstream end of said mat, the upper edge of said piling being flush with said bed, and means to maintain a bridge support foundation against movement in a stream bed, comprising a row of piling arranged around said foundation, the lower ends of which extend sufficiently below the foundation to be well anchored in the bed therebeneath, said row of piling around said foundation serving to prevent displacement of said foundation and aid in protecting the same against undermining.

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