July 19, 1949. A. B. PICKETT 2,476,682

METHOD FOR PRODUCING AND LAYING OUT REVETMENTS

Filed July 24, 1947 4 Sheets-Sheet 1

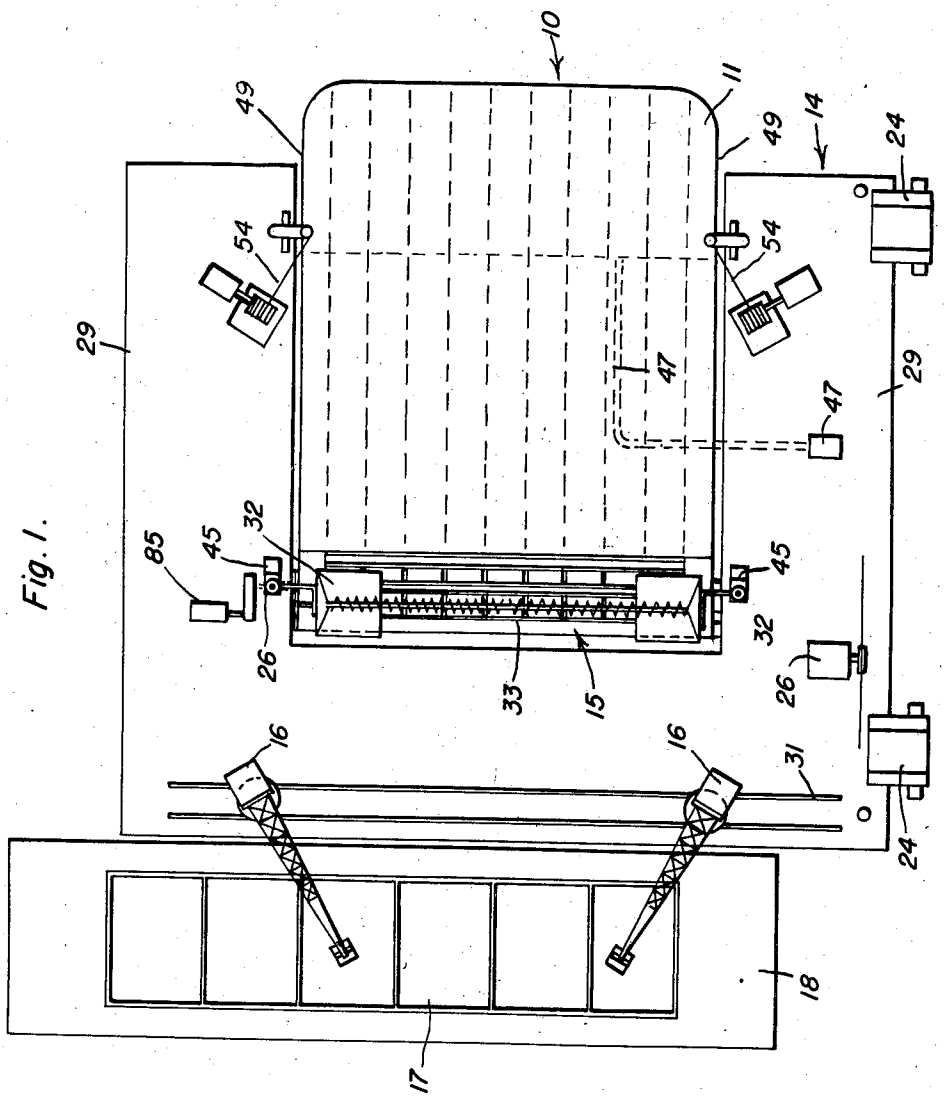


Fig. 1.

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METHOD FOR PRODUCING AND LAYING OUT REVETMENTS

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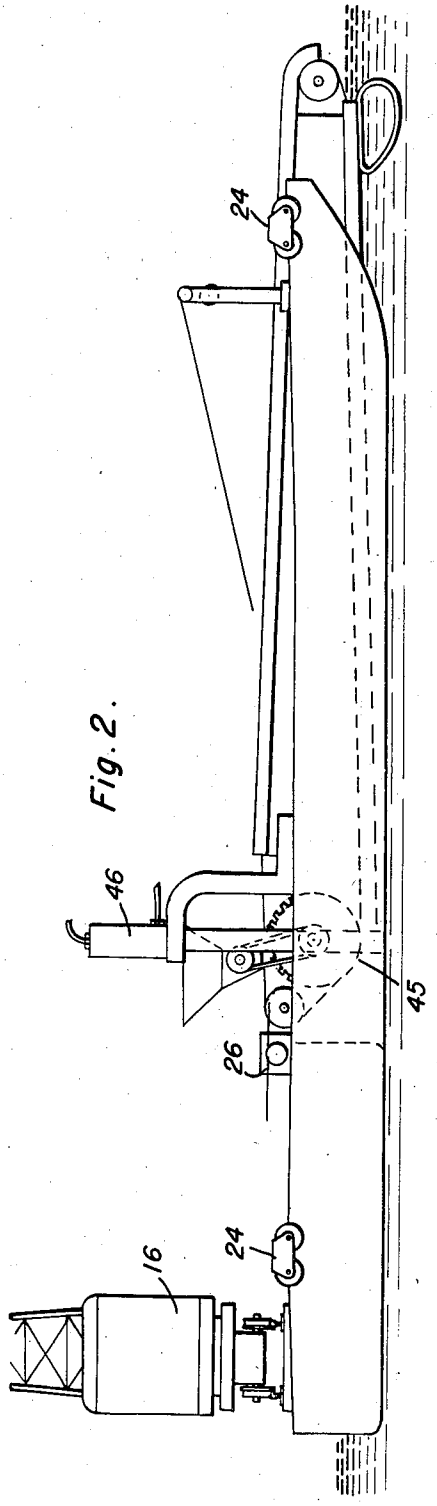


Fig. 2.

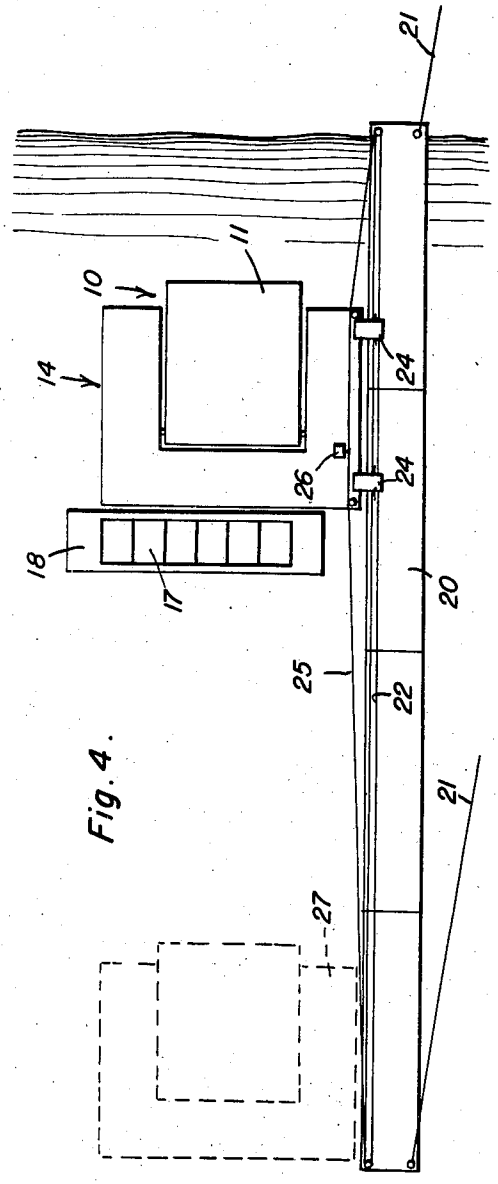


Fig. 4.

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METHOD FOR PRODUCING AND LAYING OUT REVETMENTS

Filed July 24, 1947 4 Sheets-Sheet 3

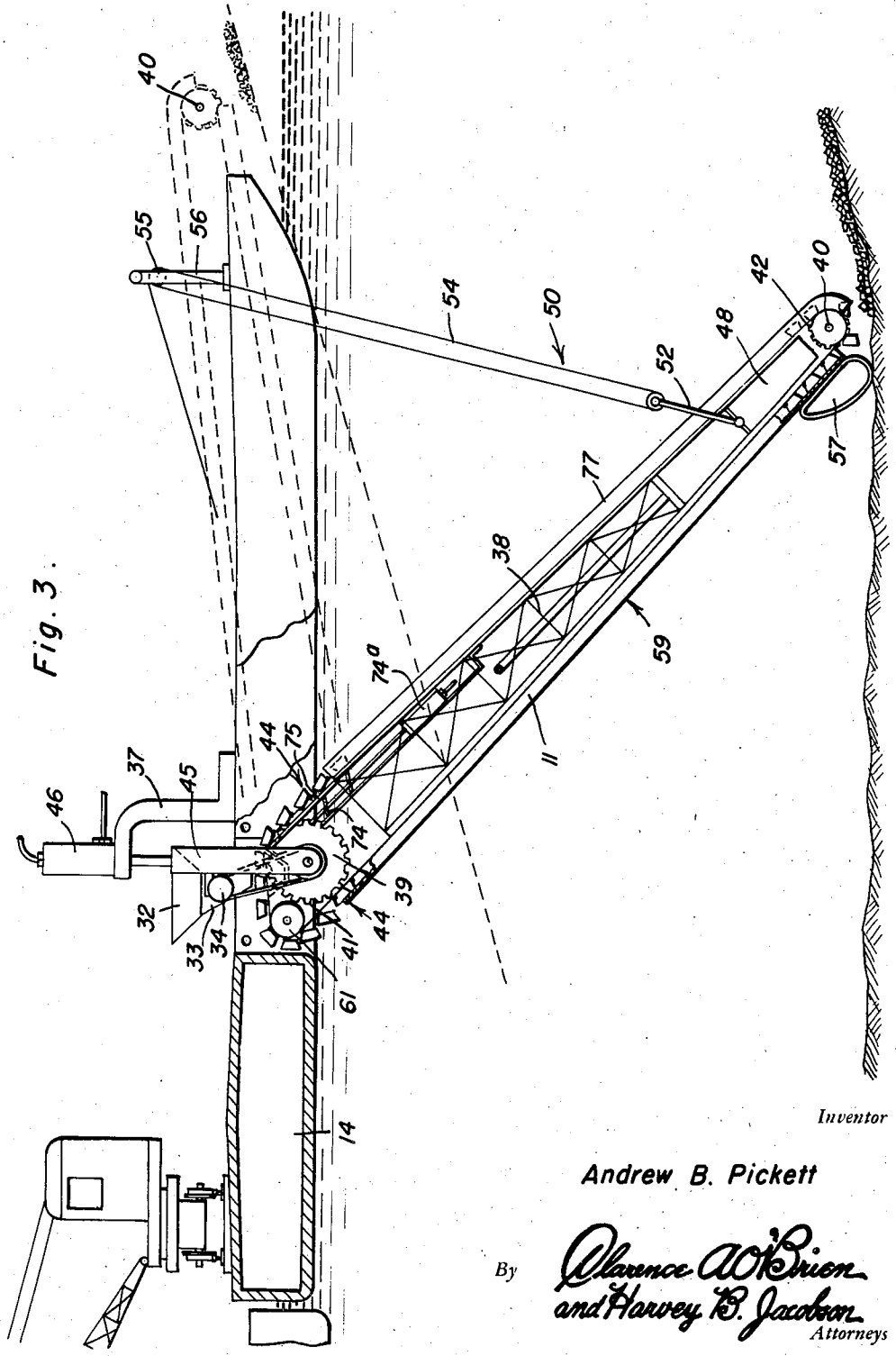


Fig. 3.

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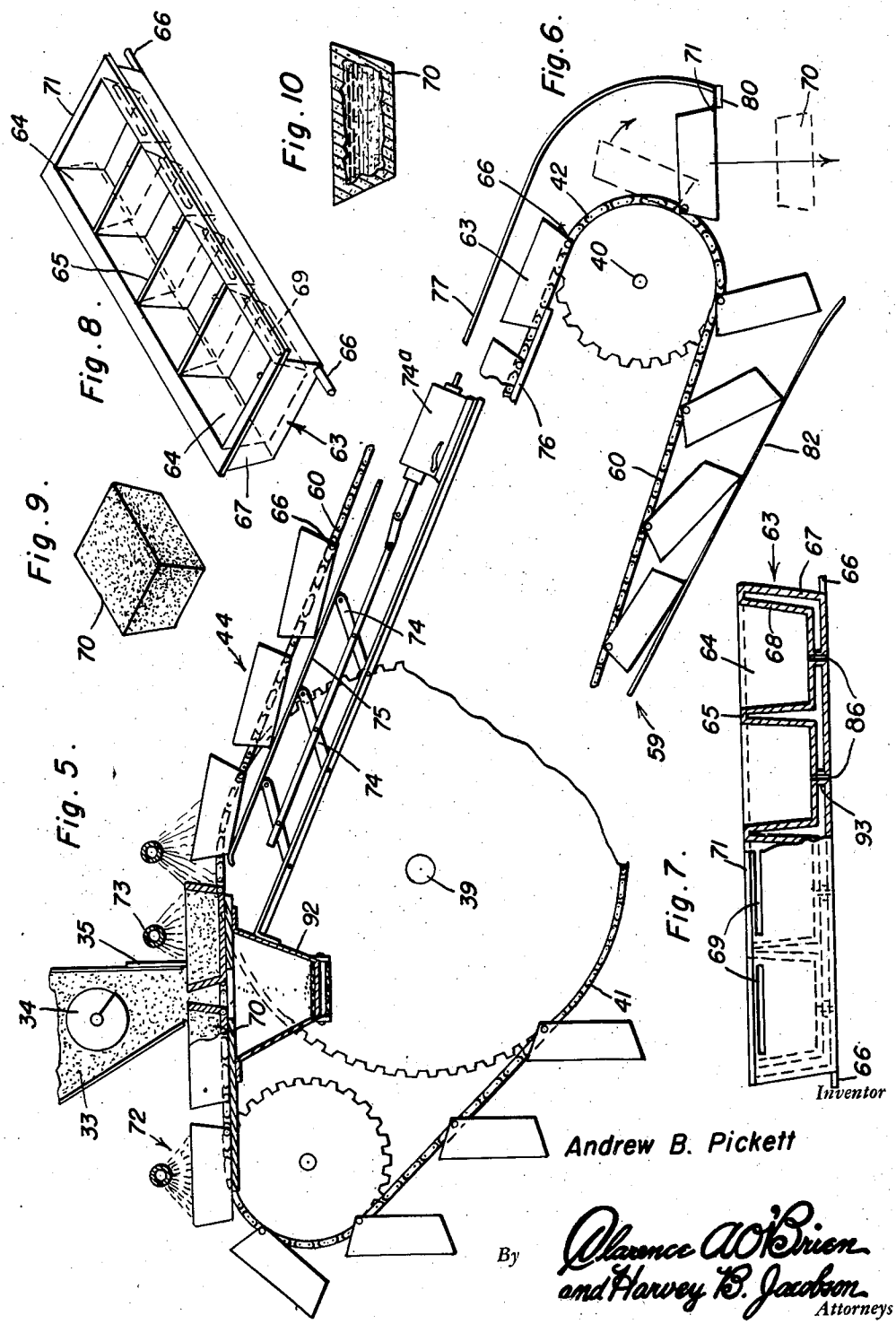
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METHOD FOR PRODUCING AND LAYING OUT REVETMENTS

Filed July 24, 1947 4 Sheets-Sheet 4



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2,476,682

METHOD FOR PRODUCING AND LAYING OUT REVETMENTS

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Application July 24, 1947, Serial No. 763,202

5 Claims. (Cl. 61—38)

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This invention relates to the production and to the laying of revetments protecting the banks of streams, rivers, canals or lakes and it has for its main object to provide a method and an equipment for producing a substantially cohesive but flexible revetment consisting of separate elements or blocks in a state of adhesion.

The embankment protections hitherto proposed or in actual use consist either of a pavement made of separate superposed elements, or of a continuous monolithic surface or of a continuous mattress formed of slabs joined by wires or other flexible mechanical means permitting a limited relative movement of the slabs. All these systems have great disadvantages and their construction and maintenance causes extremely heavy expenses.

One of the primary objects of this invention is therefore to provide a flexible continuous revetment adapted to accommodate itself automatically to the irregularities of the river bank, existing when the revetment is laid or formed in the course of time after the revetment has been laid.

A further object of the invention consists in a method of producing the said flexible continuous mattress from separate elements without using mechanical means joining said elements.

A still further object of the invention consists in a method by means of which a cohesive mattress is produced from separate elements by utilizing adhesive properties imparted to the said separate elements, said properties being the result of a proper selection of the material of which they are made and of the temperature with which they are laid.

A further object of the invention consists in using elements for producing a continuous flexible mattress capable of adapting their shape to that of adjacent elements or to the shape of the river bank and capable of firmly adhering to each other by virtue of the temperature with which they are laid and by virtue of a source of heat which maintains them at a suitable temperature for some time after they have been laid.

A further object of the invention consists in using elements of a material of sufficient plasticity which adapts itself slowly to the configuration of the river bank and of the adjacent elements to which they adhere, even after cooling, in the event of a change of such configuration due to the continuous action of the flowing water.

A further object of the invention consists in continuously and simultaneously producing a number of the said elements at a relatively high

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temperature at which these elements are in a viscous semi-fluid or fluid state, in laying out these elements continuously and in cooling them between these operations to a sufficient extent so as to secure sufficient shape retaining properties while at the same time keeping the temperature sufficiently high to obtain adhesion and a sufficient extent of plasticity.

A further object of the invention consists in producing elements hardened at the surface but with a hot core, forming a source of heat, active for some time which secures added plasticity at the time of forming the mattress.

A further object of the invention consists in producing the said elements from a hot fluid or semi-fluid mixture and in cooling the outer portion of said elements directly and by the action of the water in the river while transporting them to the point at which they are laid.

A still further object of the invention consists in moving the conveyor, discharging the elements, along the revetment laid and in regulating the speed at which it is moved so as to adjust the thickness of the mattress.

Further objects of the invention will be apparent from the following detailed specification.

The invention is illustrated in the accompanying drawings in which the method and means used in a specific case are shown schematically and by way of example. It is to be understood however that this specific example is illustrative and serves mainly the purpose of forming the base for an explanatory description of the invention; it is neither to be regarded as limitative regarding the nature of the means employed nor as exhaustive as regards the possible modifications of the invention. In fact no survey of the modifications of the invention suggesting themselves which are within the province of the expert skilled in this art is attempted and modifications of the method or means shown are therefore not necessarily departures from the essence of the invention.

In the drawings:

Figure 1 is a diagrammatic plan view of the plant for laying or forming revetments.

Figure 2 is a diagrammatic elevational side view of the same plant with its parts in position for water transportation.

Figure 3 is a diagrammatic elevational side view partly in section of same plant when in working position.

Figure 4 is a diagrammatic plan view of the general layout of the installation used.

Figure 5 is a diagrammatic view of the upper

portion of the conveyor and boom illustrating the filling operation of the pans.

Figure 6 is a similar view of the lower or tail end of the conveyor illustrating the dumping and depositing operation.

Figure 7 is an elevational partly sectional view of a pan.

Figure 8 is a perspective view of a pan.

Figure 9 is a perspective view of an asphalt black or slab forming an element of the revetment.

Figure 10 is a cross section through an asphalt block.

The laying of protective revetments under water presents a number of difficult problems on account of the widely varying seasonal and local conditions along the river banks and the high costs of construction. The laying of pavements made of rip rap or of a matting woven out of willow strips or the like and covered with riprap is considered as outmoded and as very imperfect. Likewise the laying of slabs made of sacks containing concrete is considered as unsatisfactory. These methods have been replaced to a certain extent by the method of laying prefabricated mats consisting of strips of articulated or otherwise permanently connected slabs of concrete which hang together by mechanical means, allowing a certain extent of relative movement, and permitting accommodation to the sinuosities of the river bed. These prefabricated mats are very expensive and can be laid merely with complicated, cumbersome and very expensive equipment. They do not have the durability which was expected, because eddy currents are formed between the slabs and wash away the bed material on which the mat is laid out. The mat is suspended in the midst of the water at many places and is completely surrounded by water. This leads to a rapid disintegration of the mat at these places. The protection given to the bank is therefore imperfect. In some cases the slabs of these mats have been made of asphaltic concrete and other bituminous material.

The method according to this invention aims at producing a revetment consisting of a more or less continuous layer of elements adhering to each other, formed out of separate elements or blocks dumped separately into the river bed in a systematic fashion; the adhesion between said blocks is produced by the way in which the said blocks or elements are manufactured and are laid, and especially by the intimate connection between the manufacturing and laying process. According to the invention an asphalt or bituminous mixture is used to form the elements hereinafter called blocks and the process of manufacturing the said blocks is carried out by means of cooled pans into which the asphalt mixture is filled immediately before the dumping of the elements into the river in an orderly fashion. The result of this process is a block of asphalt bonded material formed and molded in the pan which, at the time when it is laid, is cooled at its surface so as to be almost solid, while still hot in its interior. Preferably the process is so timed that the block is cooled to the required and desirable extent by the combined action of the cooling in the pan and the downward travel of the block through the water to the river bed during the lay out.

The blocks therefore are sufficiently warm to stick to each other when laid and have a sufficient amount of plasticity left to bend and to conform themselves to the shape of the base they find, as the hot core will keep them warm for some time, and maintain a certain amount of plasticity while the hardening crust gives them a sufficient amount of rigidity for the laying operation and for maintaining a block shape in a general way.

In this way a continuous layer or mat with a rather uneven or irregular surface is formed, which is preferable to a smooth surface. The blocks, being made of asphalt bonded material, retain a certain amount of plasticity even after having cooled down completely. The mat formed of blocks adhering to each other therefore adapts itself readily to changes of the river bed, with the elements changing their shape accordingly.

This method has also the great advantage that the mattress which is thus formed from asphalt blocks may have any thickness, as the blocks will stick to other blocks on all sides and that this thickness may vary according to conditions; for instance, in a river bend certain parts of a sloping bank are much more under the destructive influence of the water than other parts or than the bottom of the water and the blocks may be laid out accordingly to form a thick mat or layer of increased thickness at points and a mat or layer of normal or reduced thickness at other points.

The above described process may preferably be carried out in such a way that the blocks after having been produced and formed in cooled pans are conveyed through the water to the place of the river bed at which they are laid by mechanical means, the speed of which is so regulated that the desired cooling action is produced. But although this process is preferable it is not indispensable. The process may be carried out without any such conveying means, by producing the blocks in cooled pans above the water level, in a barge for example, by spraying the blocks with water in the event that a cooling action is required and by dumping them into the water and allowing them to sink by gravity, the cooling to which they are subjected during their downward movement being taken into account by selecting the temperature of the crust at which they are dumped in accordance with the expected cooling action during dumping.

The process and equipment in the event that the first named preferred method is carried out is diagrammatically illustrated in Figures 1 to 4. These figures show a method and an equipment for the continuous production of the blocks and for their transport to the point at which they are to be deposited.

Practically the entire process is carried out by means of an endless conveyor. The general arrangement of the block producing and revetment laying plant therefore comprises the said endless conveyor 10 which is mounted on a swingable boom 11 to be described below pivotally mounted on a U-shaped barge 14, and a feeding arrangement for the raw materials, generally indicated at 15. To supply the feeding arrangement 15 with raw materials, a number of cranes or derricks 16 are mounted on the barge 14 having feeder arms with buckets dipped into the bins 17 of a bin barge 18 which has been moored alongside the U-shaped barge 14.

The U-shaped barge 14 with the block producing and revetment laying plant is arranged alongside a row of mooring barges 20 anchored opposite the river bank by means of cables 21. The said barges are provided with a track or tracks 22 while the U-shaped barge is provided with outriggers or brackets, carrying trolleys 24 running on said tracks. The movement of the barge 14 is preferably obtained by means of a cable 25

running along the row of moving barges 20 and over the barge 14 where it runs over and through a travel winch 26 by means of which the barge 14 may be hauled along the cable. The winch 26 may be driven by an electric motor (not shown). The construction of the mechanism for moving the barge 14 along mooring barges is not part of this invention and is well known in the art, so that it need not be described or illustrated further.

It will be understood however that the revetment laying plant on barge 14 may be moved away from the river bank outwardly to a point 27 indicated in dotted lines, where the end of the boom is above the toe of revetment. It will also be understood from the foregoing description that the revetment is essentially produced on and by the boom 11 on barge 14, and that when the latter is moved outwardly a revetment strip of the width of the boom 11 will be produced. When the toe of the revetment has been reached the row of mooring barges 20 is advanced and a further revetment strip is laid adjacent the first strip the entire revetment being thus built up or formed by aligned strips.

From the above general description it will be seen that the formation and production of the revetment strips essentially takes place on the U-shaped barge 14 and the process and means used to carry it into effect may therefore be described in detail.

The U-shaped barge 14 comprises a longitudinal section 28 and two spaced transverse sections 29 between which the boom 11 is inserted. The longitudinal section carries tracks 31 on which the cranes or derricks are moved in order to empty the bins 17 of the barge 18. Between the sections 29 the boom 11 and the feeding device 15 is mounted, into which the cranes 16 empty their buckets.

The material supplied by the bin barge is a hot mixture of asphalt, cement, sand and gravel, of varying proportions, according to the materials used and to the requirements of the case; the average composition will approximately contain about 94% of aggregates (sand, gravel and the like) and 6% asphalt cement. The materials used for producing the mixture are dried and heated in the conventional manner and the mixture is then loaded into the bin barge, the whole process being not different from the process used for repairing roads or the like. The mixture, sometimes, in addition to sand and gravel, contains a mineral filler or powdered loess. It is prepared at a temperature of approximately 300° F. according to the usual practice.

The loaded bin barge 18 is then moored along section 28 of the barge 14 where its bins are within reach of the jib arm of the derricks. The feeding arrangement of the boom consists in a number of hoppers 32, two being shown in Figure 1. The hoppers discharge the mixture into a feeding or screed box 33. This box is of elongated shape and runs across the entire width of the boom with its discharge end close to the conveyor carried by the boom. It contains a distributor 34 in the shape of a screw conveyor running along the box, in order to distribute the hot mixture received from the hoppers evenly over the entire length of the box. A movable screeding plate 35 is attached to the rear end of the box in order to screed off the mixture filled into the conveyor at the desired level. The screeding plate may be vibrated or other well known vibrating or tamping equipment may be used to secure a perfect screeding off action.

Below the feeding box 33 the conveyor boom 11 is arranged which consists of a tapering supporting body 38 filling the space between the two sections 29 of the barge. It supports the conveyor shafts 39, 40 carrying sprocket wheels 41, 42 for the conveyor 44. The shaft 39 of the sprocket 41 also serves as a pivot for the boom 11 and is suspended and journalled in a frame 45. This frame is slidably carried by the two sections 29 of the barge and is movable in a vertical direction by means of a hydraulic lifting device 46 diagrammatically indicated in Figure 2.

At the end of the conveyor boom 11 float and ballast tanks 48 are provided which may be manipulated by means of an air compressor 47 and air conduits 47a and by means of valves not shown in order to furnish the required load or the required buoyancy to keep the boom firmly on the bottom or to raise it to the desired extent.

The edges 49 of the body of the boom are preferably rounded and provided with a bull nose streamlined in order to offer as little resistance as possible to the water flowing around it.

The boom is moreover provided with a hoisting device 50 consisting of cables 54 running over rollers 51 fixed on a sheaf 52 which is pivotally connected with the boom. The cables 54 are leading to winches 55 mounted on the barge 14 on posts 56 of a certain predetermined height permitting to lift the end of the boom above water level. Lifting of the boom above water level is required during the transport of the barge 14 and in this case it is preferable to lift the lower end of the boom along with the pivoted end. The latter is lifted by lifting the frame 45 by means of the hydraulic device 46. Simultaneously the frame holding the feed box has been lifted. The boom after the lifting operation has been completed is then held between the sections 29 of the barge above water level.

Raising of the tail end of the boom above water level—with the pivoted end in working position—is moreover required at the start of the operation and when starting a new strip, this position being indicated in dotted lines in Figure 3. The laying of the revetment, as well known, starts at a point above the water level of the river, so that the boom has to be brought into the position shown in Figure 3 at the start of each new strip.

At its lower tail end the boom is provided with skidding applicances 57 supporting this end of the boom on the bottom of the river during work and while trailing the barge 14 when the latter is moved outwardly.

Moreover a perforated casing 59 permitting free circulation of the water is provided around part of the conveyor and around other appliances to be described. This casing may cover the boom on all sides and is in this case provided with streamlined ends encircling the nose of the boom to reduce the resistance to flowing water.

The conveyor 44 consists of endless chains 60 trained over the two sprocket wheels 41 and 42 and over the idler wheel 61. The latter is located at the upper end of the boom and is positioned in such a way that the conveyor chain 60 runs over a horizontal stretch when it passes below the feed box 33. On the conveyor chain the pans 63 are pivotally supported. These pans which are shown separately in Figures 7 and 8 consist of elongated double walled containers of oblong shape with slightly tapering walls 67, 68. They are subdivided into compartments 64 forming buckets or molds for the asphalt tiles or blocks

70. The partitions 65 between the buckets or molds are formed by double walls as shown in Figure 7 so that, between the outer and inner walls 67 and 68 respectively of the pan and the double walls of the partitions 65, a water jacket is formed surrounding the container and its subdivisions on all sides.

The pans are provided with pivot axles 66 near their foremost ends with which they are pivotally mounted on the chains 60. They have therefore a tendency to tilt around said pivots in a loaded as well as in an empty condition on account of the eccentric location of the pivot. Near their forward end in the direction of motion the outer walls 67 are provided with slots or openings 69 through which water may enter during the movement of the pans along the chains.

The upper end of the pan may be surrounded by a flange 71 on which the screeding plate may slide during the passage of the pan beneath the feeding body.

These flanges are of such size that between flanges of adjacent pans only a very small space will remain. Therefore hot material dropping from the feed box or screeded off by the screed plate will not penetrate to a large extent below the pans but will be pushed into the next pan during the passage below the screed plate. However a trough 92 may be provided below the pans with a belt conveyor which collects the material falling through the gaps and conveys it outside. The interior of the pan may communicate with the outside by means of tapering bores 86 passing through sleeves 93 joining the walls of the water jackets. These bores prevent the formation of a vacuum which may tend to interfere with the removal of the blocks from the pan.

As seen from Figure 5 the arrangement is such that the pans 63 pass closely below the feeding box while conveyed on the horizontal stretch of the chains between the idler 61 and the main sprocket wheel 41. The pans 63 on this stretch are held in a horizontal position by means of a guide 75.

Above the pans and in front of the feeding box 33 an oil spraying tube 72 may be arranged which permits to provide the pan passing beneath it with a thin oil film, facilitating the detaching of the hot asphalt block formed in the molds. The screed plate rests on the flange of the pans and screeds off the material which has been emptied into the pans in such a manner that every pan is just filled up to the flange and an even and smooth upper surface is formed. A number of water spraying tubes 73 are arranged behind the feed box to spray water on the upper surface so as to accelerate the hardening of the mixture at this point.

Behind the horizontal stretch a further guide 75 is arranged which, as shown in Figure 5, is so arranged that the pans occupy a position inclined with respect to the chains and not deviating very much from the horizontal position. This guide is preferably adjustable by means of levers 74 and by means of a hydraulic piston 74a and may be of a limited length. The purpose of this guide is to hold the pans in such a position that the tendency of the still somewhat fluid, viscous hot mixture to flow out of the pan is not very marked. The spraying of water hardening the crust at the surface will contribute to build up resistance against the pouring out of the mixture at the forward end. After a short while however the water in the water jacket and the water covering the surface have hardened the entire outer surface of the asphalt block to a sufficient extent, and the pans may therefore be guided again by a guide 76 which is parallel to the chain movement and close to the chain so that the pans may occupy a position on the chain in which their bottom is aligned with the chain. A suitable transitional guide piece (not shown) may be inserted between the adjustable guide 75 and the fixed guide 76.

The perforated conveyor casing 59 already mentioned above surrounds mainly the middle portion of the conveyor. The upper section 77 of this casing reaches around the sprocket 42 and terminates approximately at a level with the lower portion of the said sprocket. It is wider at this end and is provided with a bumper plate 80 near its edge. Said bumper plate may be made of rubber and is preferably supported by springs (not shown). When a pan moves down on the chain and leaves the guide 76 it is overturned, while its pivot on the conveyor chain follows the sprocket wheel and it will drop with the open side looking downwardly while overturned. Its flange 71 will however be arrested by the bumper plate 80 and therefore the pan suffers a sudden concussion or shock, detaching the asphalt blocks carried in the pan and projecting them downwardly out of the pan. As the flange of the pan always reaches the bumper plate in a certain position of the pivot the shock occurs in a definite direction and in a definite position of the pan, say when its open end is in a horizontal plane. The asphalt blocks are thus always projected downwardly in a vertical direction.

The further movement of the pivoted pan along the sprocket 42 withdraws the flange 71 from the bumper plate 80 and the bucket will then drop completely and hang on the pivot in a position which is prescribed by gravity. The lower section 82 of the casing is preferably formed as a guide which will bring the pans again into a position in which their bottoms are aligned with the conveyor chain. If the jacket should not be filled completely with water or if some water should have been thrown out during the shock, the jacket will be refilled while the pan is dragged upwardly with the slot 69 in front.

The casing 59 on the lower side ends approximately abreast with the sprocket wheel 41 and the pan 63 when leaving the casing is suspended freely on the chain by means of its pivot and travels around the idler wheel 61 with its slot 69 directed upwardly. Therefore, the water cannot leave the jacket but is retained in the same. The pan jacket is thus permanently kept filled with water.

The sprocket wheel 41 as well as the screw conveyor 34 in the screed box 33 are driven by a motor 85 the speed of which can be regulated. The motor is diagrammatically indicated in Figure 1. Likewise the winches are driven by either the same motor or by separate winch motors (not shown).

The operation of the revetment plant is the following.

The laying of the revetment starts as a rule above the water line. For starting operations the boom 11 is first lowered into the water by means of the winches 55 and cables 56 and by manipulating the buoyancy and ballast tanks 48. The boom, when in transport position, has of course first to be brought into working position by means of the hydraulic cylinders 46. This preliminary lowering of the boom is however only necessary at the start of operations and is not repeated each

time when the plant is shifted and the laying out operations start above the water level.

The preliminary lowering of the boom at the start is necessary in order to fill the jackets of the pans with water and to produce a series of blocks cooled to the right point.

The preparation of the mixture proceeds in the customary asphalt plant and does not differ from the preparation of a mixture of bituminous matter for other purposes. The mixture, as already mentioned, consists of asphalt and sand or of asphalt, sand and gravel to which mixture a mineral filler or powdered loess may be added. Ordinary bar run sand dug from the sand bars of the river in the vicinity of each revetment may be used so that the greatest part of the materials are drawn from local sources.

The mixture after having been prepared in the customary manner is delivered to and filled into the bins 17 of the bin barge and may be kept there in a heated condition.

From the bins 17 the hot mixture is delivered to the hoppers 32 by means of the derricks 16, is distributed uniformly and evenly within the feeding box by the screw conveyor 34 and drops into the water cooled pans 63 when they pass under the screed box, the screed plate 35 keeping the pans level full, but removing any surplus so that a smooth and even upper surface results. The pans have been sprayed with oil from oil pipe 72 and on account of the oil film and of the difference in the temperature between the water cooled walls and the hot mixture the mixture will not adhere while cooling in the pan. The exposed surface which is not cooled directly by the jacket is sprayed with water from tubes 73 and is therefore cooled as soon as the pan emerges from the screed plate.

The pans then are conveyed further and enter the water where they are further cooled to the desired extent. The length of the boom and the speed of the conveyor are so selected that the blocks are cooled to the desired degree when arriving at the lower end of the boom.

After the pans on the upper section of the conveyor have all been filed, so that a series of blocks has been made while the boom was submerged and all the jackets of the pans have been filled with water, the laying out operation starts above water level by lifting the boom and bringing it into the position shown in Figure 3. The operation may then continue in air for a short time, using the blocks which have been cooled in water. As a rule this phase of the operation is short and the boom will very soon be again submerged below water level. If necessary the submerging and hoisting operation may be repeated.

During regular operation the blocks with a firm crust but with a hot core arrive at the lower end of the conveyor, where the pans are overturned and strike against the resilient plate 80 throwing out the block in a substantially vertical direction. The adhesive properties of the blocks have not disappeared as they are still heated from within, the blocks therefore will arrange themselves in such a manner that they overlap and, on account of the fact that they are still warm, they stick together and firmly adhere to each other. This adhesion and a certain amount of plasticity does not disappear when cooling sets in this being mainly due to the asphalt material used. Therefore a continuous mat or layer of firmly adhering blocks is formed merely by dropping the blocks in such positions that they will adhere to each other.

It will be clear that there are two means for regulating the laying of the revetment. One of these means is the regulation of the speed of the conveyor which is mainly used to regulate the temperature of the blocks discharged at the end of the boom. The second means consists in the regulation of the speed of the outward travel of the barge along the mooring barges, which is performed as a rule by regulating the speed of the motor driving the travel winches. The regulation of this speed controls the thickness of the layer which is deposited and it is therefore seen that the thickness of the layer in the same strip may vary in any desired way.

The ease with which a variation of the thickness of the revetment is obtained helps greatly in producing a revetment of great durability .

When the barge 14 has arrived at the point in which the submerged end of the boom has reached the toe of the revetment, a strip has been completed. The conveyor is then stopped and the boom is lifted, the barge 14 travels inwardly and the mooring barges are moored in a new position in which the boom starts again to lay out the revetment in its lifted position on the river bank above water level. However in this case no preliminary lowering of the boom is necessary as a sufficient number of cooled blocks is available on the conveyor when the boom is lifted and as all the water jackets are filled. Operations may therefore continue immediately after the maneuvering with the barges is completed. It is advisable to make consecutive strips overlap to a certain extent to obtain perfect continuity of the revetment.

It will be clear that although it may be advisable in many cases to make the submerged end of the boom rest on the bottom of the river, this is by no means a requirement which has to be fulfilled under all conditions. The boom may adopt any position above the bottom and a revetment of good quality may be produced even if instead of a boom a fixed installation of the type described dropping the blocks from the air into the water is used. The blocks cool down during their journey to the bottom and if preliminary cooling by water jackets and spraying is used the described effect will be obtained under many conditions. The equipment as illustrated is however more reliable than the above mentioned simplified equipment as the action of the streaming water is subject to constant changes and in the event of a long travelling distance the exact spot where the blocks hit the bottom will not be as well defined as is in the case when the blocks are dropped directly on the place where they are required at short distance.

The revetment made of asphalt bonded blocks in the manner described has a much greater durability than the known revetments and requires less maintenance. It has been found that the adhesion of the element is sufficient to prevent the water from rolling them along, as is the case with stones, concrete slabs or riprap. The flexibility of the mat formed of blocks not only manifests itself at the time at which the protective covering is laid at which time this covering will conform itself to the irregularities of the bank. It also manifests itself during the subsequent changes of the bottom or of the slope and especially in the case of the deepening at the toe of the revetment which is a more or less regular phenomenon in streams and rivers. This phenomenon leads as a rule to the destruction of the revetment at this point with most known revetments.

In revetments according to the invention, however, as long as they are under the influence of a raised temperature, a mattress of strongly adhering elements conforming their shape to that of the adjacent elements and to the river bank is quickly produced after the laying operation takes place. The plasticity of the elements however does not disappear when the temperature has gone down and has reached the water temperature, this being due to the nature of bituminous material. Therefore the adaptation of the shape of the mattress and its elements to the change of the river bank and to the internal changes continues and the revetment always covers the river bank and never floats or is suspended in the midst of the water, notwithstanding the constant changes.

It has also been found that the rather rough and somewhat irregular surface and structure of the revetment is of a marked advantage as it induces the deposit of silt and sand in the interstices and retains such deposits, which will assist in the protection of the banks.

The revetment method and plant as above described is also useful for repairing and restoring existing revetments. It is one of the outstanding advantages of the method and plant as above described that it permits repairs of existing revetments, by covering them with a further flexible continuous mattress which will give the desired protection either directly or by reinforcing covering and utilizing the existing revetment or whatever is left of it. The method may therefore be used as a repair and restoration method for other revetments such as it is and without specific adaptation to the revetment originally laid.

It will finally be clear from the foregoing that the invention resides in the features as above described and as claimed and is not connected with specific constructive details of minor importance for the principles as described. Such minor constructive changes will therefore not affect the invention.

Having described the invention, what is claimed as new is:

1. A method of making revetments consisting of a continuous flexible protective mattress of separate elements adhering to each other, which comprises the production, from a hot viscous asphalt containing mixture, of separately formed asphalt bonded blocks, close to the point at which the revetment is laid, in subjecting said blocks to cooling by means of water acting on their surface to the extent that a hardened crust is formed around a hot core, capable of preserving substantially the general shape of the still deformable block, said cooling taking place while conveying the blocks to the point at which the revetment is laid and in juxtaposing and superposing the separate block elements so as to form a continuous mattress of blocks in contact with each other.

2. A method of making revetments under water, consisting of a continuous flexible protective mattress of separate block elements molded in pans of substantially prismatic shape provided with a water jacket, which method comprises, the filling of a hot asphalt containing mixture into the water jacketed pans at a point close to the water level and close to the place at which the revetment is laid, in conveying said blocks and pans through the water to the said laying place and in discharging them from the pans in a regular and orderly succession so as to form a continuous layer of juxtaposed and superposed blocks in contact with and adhering to each other.

3. A method of making revetments under water, consisting of a continuous flexible protective mattress of separate asphaltic block elements molded in pans, provided with water filled jackets, said pans being substantially of prismatic shape and of a width corresponding to the strip to be laid and holding a plurality of block molds, said method comprising the simultaneous filling of the block molds within a pan with an asphalt containing hot viscous mixture, the screeding off of the surplus material to form a smooth upper block surface, the controlled submerging and conveying under water of the pans and molds to the place at which the revetment is laid, to obtain a cooling action producing a hardened crust around a hot core to the extent that the block is capable of a limited deformation and bending as a unit, while substantially preserving its shape and is provided with an internal source of heat maintaining the temperature of the crust at a point at which adhesion to other blocks may take place, the simultaneous depositing of rows of molded blocks corresponding to the number of molds in a pan in ordered succession at the laying place of the revetment on the river bank so as to form a continuous mattress of juxtaposed and superposed blocks adhering to each other.

4. A method of making revetments under water, consisting of a continuous flexible protective mattress of separate asphaltic block elements molded in pans provided with water filled jackets, said pans being substantially of prismatic shape and of a width corresponding to the strip to be laid and holding a plurality of block molds, said method comprising the spraying of the water jacketed pans with oil, the simultaneous filling of the block molds of a pan with an asphalt containing hot viscous mixture, the screeding off of the surplus material to form a smooth upper block surface, the spraying of said surface with water to promote the formation of a crust on this surface, the controlled submerging and conveying under water of the pans and molds to the place at which the revetment is laid, to obtain a cooling action producing a hardened crust around a hot core to the extent that the block is capable of a limited deformation and bending as a unit, while substantially preserving its shape and is provided with an internal source of heat maintaining the temperature of the crust at a point at which adhesion to other blocks may take place, and the simultaneous depositing of rows of molded blocks corresponding to the number of molds in a pan in ordered succession at the laying place of the revetment on the river bank, so as to form a continuous mattress of juxtaposed and superposed blocks adhering to each other.

5. A method of making revetments under water, consisting of a continuous flexible protective mattress of separate asphaltic block elements molded in pans provided with water filled jackets, said pans being substantially of prismatic shape and of a width corresponding to the strip to be laid and holding a plurality of block molds, said method comprising the simultaneous filling of the block molds within a pan with an asphalt containing hot viscous mixture, the screeding off of the surplus material to form a smooth upper block surface, the controlled submerging and transportation under water of the pans to the place at which the revetment is laid,

to obtain a cooling action, producing a hardened crust around a hot core, to the extent that the block is merely capable of limited deformation and bending as a unit while substantially preserving its general shape, and is provided with an internal source of heat maintaining the temperature of the crust at a degree at which adhesion of the crust to other blocks may take place, the simultaneous depositing of rows of blocks at the place at which the laying of the revetment on the river bank takes place, the permanent shifting of the point at which depositing takes place, and the control of the extent of such shifting between successive depositions in order

to regulate the thickness of the continuous mattress consisting of juxtaposed and superposed blocks adhering to each other.

ANDREW B. PICKETT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,359,575	Chenowith	Nov. 23, 1920
2,047,197	Fordyce	July 14, 1936