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Automatic Removal
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by
Application of natural Forces.

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by

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The difficulties, dangers and delays attending the transshipments of ocean freights during the past century, in consequence of the obstructing bars on alluvial coasts; the rapidly increasing dimensions of vessels and growth of the tonnage; the failure of the twin jetty system in many cases, especially in tidal estuaries, to create and maintain adequate channels and the great expense and uncertainty attending the dredging of artificial channels in the open seas have all conspired to direct attention to the necessity of providing a more rational and satisfactory method of securing and maintaining capacious harbor entrances.

To this end the autor has devoted himself to the study of this problem, not only from the history of Continental works where many illustrious examples are of record, but also to the investigations of the physical forces operating to produce certain typical results in nature and to personal examinations of many localities where works have been more or less successful, which has led to the evolution of a system which is designated as The Reaction Breakwater for the utilisation of the energy of currents to produce erosion where desired accompanied by a deposition of the eroded material where it may not become an obstacle to navigation.

The basis of this improved method is the well known fact that the best (deepest) channel is, as a rule, found under the concave bank of every stream and that it is the resultant of impact, head, volume and velocity resulting in reaction, erosion and restored equilibrium.

These activities are developed by a fluid mass impinging on a resisting medium of such form as to cause a continuous change of direction and generate bottom, cross-currents to restore the equilibrium. Thus the concave bank becomes the directrix of the stream and the convex bank the dump for the material ejected from the pool, while the cross-section is automatically adjusted to the regimen of the discharge and varies with the stage.

In applying these several elements to the creation of a deep channel in the open sea it was the purpose to design a simple structure of minimum dimensions, but so placed with reference to the land and sea forces as to change sensibly their conditions of equilibrium without interposing any obstacle to tidal ingress, and at the same time to defend the proposed channel from littoral drift and develop the potential energy of the effluent tide by confining it to a narrower path across the crest of the bar.

In the application of this tool to the cutting out of the channel it is necessary to ascertain first the character of the bar and the prevailing direction of the littoral drift, if any, composing it; that is whether it is composed of littoral drift or of upland sediment, or whether it is a wave or a delta bar so that the form and position of the breakwater may be modified accordingly. Numerous errors have resulted from a failure to observe these conditions in designing works at harbor entrances with the inevitable sequence of bar advance and great increase of cost without improved depths by scour.

In general, tidal inlets should not be obstructed by a continuous structure projected out from the shore-line which would act as a partial dam to intercept tidal currents and thus reduce the only force available for scour at ebb. The better plan would detach the work entirely from the shore leaving a large gap for the free admission of the tide and also placing the breakwater on the „windward“ side of the channel to protect it from drift. It is also important that the radii of curvature should be adjusted to the volume of the flow, the depth desired and the length of the crossing. The curve may be compounded at its outer end to provide for the loss by friction but no groins should be permitted, to prevent undermining, as is too often done, since their effect is to destroy the very continuity of reaction necessary to maintain a uniform channel and because the erosion caused at their ends will ultimately involve their destruction. Sufficient protection can best be obtained by the construction of an apron entending along the inner toe of the breakwater, of suitable width to revet the new slope, as was done at Aransas Pass Texas, with such excellent results, and where although the work was left for some years in an uncapped condition the deterioration as officially reported was only about two percent per annum, while the cross sections show no tendency to undermine.

Another special feature to which attention should be particularly directed in the adaptation of this „tool“, so as to produce the best results, is that if beginning the work on the outer slope of the bar and building landward progressively, care having been taken to first lay a sill well in advance of the body of the work, to prevent erosion from cross-currents. By this means the outer contours of the bar are caused to recede instead of to advance whilst the curved form causes a helicoidal or latteral instead of a longitudinal displacement. By this means an artificial jetty or spit is built up which still further confines the effluent and maintains the depth of the crossing.

At the mouth of sedimentary rivers having delta bars, the form of the breakwater is different and it may then be connected with the fast land, but the order of construction should still be rigorously observed especially when the annual deposits may reach many millions of cubic metres.

So much has already been published concerning this method and its results that it would seem superfluous to encumber this paper by a long description of the theory of the invention as a full account may be found in the numerous papers and discussions enumerated in the accompanying references but the author will be pleased to respond to any request for further information by mail, gratuitously.

The principal elements embodied in this invention may therefore be summarized as follows;

I. The determination of the prevailing direction of the drift as essential to the proper design and location of the works.

II. The interposition of a permanent barrier between this littoral drift and the channel to be created, (or to windward) which shall subserve the double purpose of arresting this drift and at the same time of confining the currents at ebb to a definite path.

III. The construction of a line of work which, while fulfilling the above conditions, does not materially reduce the volume of the tidal prism throughout the ocean sector at flood but does concentrate it at ebb upon a definite path.

IV. The reduction of the length and consequent cost of the structure, to less than one-half of that of the two jetty system.

V. The ability to „compress“ and develop the potential energy of a current, by a single curved directrix, which also produces a lateral transportation of eroded materials, without dredging, and the prevention of deposits in the channel, while the protrusion of the bar is avoided.

VI. The reversal of the usual mode of construction, by which the force of gravity is employed to assist in the erosion of the channel, thus rolling the material down instead of up hill, by building from the outer end shoreward.

VII. The construction by natural agencies of a counter-levee or jetty which is automatically adjusted to the regimen of the stream, without additional cost.

VIII. The automatic flushing of the channel, at every tide and the dispensing with the constant use of dredges which obstruct navigation and increase the cost of maintenance.

IX. The placing of a well defined aid to navigation, which distinctly defines the limits of the channel and renders it navigable at all times and in any weather.

The results already obtained by the single Reaction Breakwater, under unusually difficult circumstances in the United States, are an earnest of the great economy which may result from the more general adaptation of this method to the problem of improvement of ocean bars since it is estimated that in this country alone at least $ 50 000 000 might have been saved by the general introduction of the system. It has so far passed the experimental stage as to have merited the highest awards of the American Philosophical Society, the National Export Exposition; the Paris Exposition of 1900; and the Franklin Institute, as well as of some of the most distinguished engineers of both Continents. The present U. S. Congress has determined to complete the plan at Aransas Pass, on the Gulf of Mexico at the Government expense.

On the other hand, it is but proper to add, that, like all inventions, it has not escaped criticism, conservative opposition, and even official denunciation, calumny and misrepresentation which have retarded its progress and prevented the earlier demonstration of its utilities so necessary to establish its *raison d'être.* Nevertheless the testimony of Nature has more than justified the predictions of its designer as to its great economy and results, in securing and maintaining channels.

These economies will in most cases exceed fifty percent of the usual cost of the two jetty plan while giving much better and more permanent depths, preventing silting due to overcontraction or overexpansion of the artificial channels created by present methods.

The above brief description is respectfully submitted with the hope that it may lead to a further improvement and application of natural forces for the creation of channels of sufficient dimensions to keep pace with the growth of ocean carriers, since the channel is a necessary supplement to the ship in the problem of economic transportation.

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