of the jetty.) Mr. Raymond's report says: "Along the edges of the jetty and immediately beyond the end, the deepening produced by cross currents has been from three to four feet." The deepest fill to the westward is along that portion of the jetty where the curve of nine feet depth is close upon the jetty and where it pushed seaward 2,150 feet. In fact, Prof. Haupt's ramp has only existed in imagination; I do not urge this as material to the issue, for the ramp theory may be dispensed with perhaps, now that the deposit is learned to be mud.

It would have weakened the force of the statement that "the crest of the bar had been moved seaward 1,900 feet" somewhat, had the report been quoted; "the crest of the bar, as determined by a line joining the points of the six-foot curve nearest together has advanced into the gulf 1,900 feet." But "the points of the six-foot curve nearest together" were 1,750 feet farther apart on this new "crest" than on the old, and the depth was greater; what had been the crest was scoured away.

There are several allusions in Prof. Haupt's reply, which seem to relate more particularly to his theory of harbor dynamics, and I pass them by without entering into controversy.

The context of the paper, "Jetties for Improving Estuaries," and his summary relative to Sabine Pass, most unfairly made it appear that a certain principle, condemned as vicious, had been there adopted and persisted in, and his statement was incorrect. I combat the incorrect statement. I have no intention of questioning his veracity; I should be exceedingly sorry to doubt it. I think, however, that his errors are due to haste, perhaps, also, to eagerness, which caused him to seize upon sentences without proper examination of their neighbors or due consideration of their relations to those portions overlooked.

I desire to add for the information of your readers that it is not and never has been the intention to bring about the improvement of the Sabine bar by the use of one jetty; the plan requires two high jetties. The work, while anyone may express condemnation of it in advance, must eventually stand or fall with its results.

Very respectfully,

THOMAS TURTLE,

Captain of Engineers.

WASHINGTON, D. C., May 21, 1888.

REPLY OF PROF. HAUPT TO CAPT. TURTLE'S COMMUNICATION
OF DATE MAY 21, 1888, RELATIVE TO SABINE PASS.

To the Committee on Publications of the FRANKLIN INSTITUTE.

Gentlemen:—In the reply of Capt. Turtle, he alludes to two of my statements, which he desires to correct, the first being that referring to the west jetty being "built first;" the second, that it had made a shoal on its east side. To these points I have the honor to submit a brief reply.

The difference of interpretation as to the use of the expression "was built" is not of sufficient importance to warrant the space devoted to it, since

the quotations show that at the time of Mr. Raymond's report, from which the extracts were made, the *east* jetty had not been begun, and whatever changes had occurred were due to so much of the *west* jetty as was then built. I used the verb in the proper tense, the past, not the "perfect," as has been stated. It was not intended to convey the idea of completeness. The verb itself does not mean this, but a progressive development.

In speaking of the present jetties, as they exist to-day, although *not finished*, I do not believe it would "convey a most unfair impression" to say they *were built*, as indicative of their existence, just as I used the term "*was built*," for the west jetty in its then incomplete state, to express *its* existence. Should any one assert that the jetties now existing at Sabine Pass were "*not built*," I think the statement would be at once denied as untrue.

Moreover, in recommending the jetties at Sabine Pass, the Board of Engineers said, "the western jetty as proposed by Capt. Heuer, should be *built first* (but without shore openings) and its effects observed."

The work was conducted accordingly, and I cannot understand the sophistry which would object to my use of the verb to build, and not to that of the Board.

(2) The fact that the west jetty made a shoal on its eastern side, will not be doubted after a reading of the reports of Mr. Raymond. It is not *my* statement which Capt. Turtle attempts to explain, but that of his own engineer, who says: "The line of deepest water over the bar has moved somewhat to the eastward by the formation of a shoal opposite the Clifton and extending from the jetty 1,000 feet east," etc. The point Capt. Turtle desires to make refers more particularly, however, to the direction of the movement of the material of which this shoal was composed, and he quotes some additional statements of *opinions*, and asks, "why should Prof. Haupt omit to quote the lines above," etc. In reply I would submit that my entire original reference to this work was of necessity very short, and the quotation I made covered but two lines. It was, therefore, impossible to say all that the report contained. I merely called attention to a few salient facts. The quotation from Mr. Raymond, which Capt. Turtle makes, is an *opinion* expressed in rather dubious terms, and not an observed fact, and as I did not endorse it, I did not quote it, for I believe the material of the shoal to have come chiefly from the eastward. (I used the term "sand," as Capt. Turtle has supposed, inadvertently, for material, although Mr. Raymond calls it sand.) The importance of the changes that are so minutely detailed in the reports will be better understood from the following statements of the character of the bottom as given in Major Howell's Report of February 4, 1875, containing this extract from a report by Lieutenant Smith, U.S.E., made as early as February 15, 1853:

"Although the charts represent the bar as having but a little over five feet at low water, yet, on account of the softness of the mud, a steamship can readily pass drawing ten feet. In case of a southeast blow, it would be safe to venture over with a draught of ten feet. It is asserted that a vessel drawing twelve feet of water has crossed the bar in a blow."

Again, in the plan proposed by Major Howell for improvement, it was intended that "the material * * be carried to the *westward* a distance of at least half a mile, and dumped in from six to fifteen feet depths, so as to form a ridge to cut off sand that may drift from that direction toward the excavation. It is thought that this channel may fill so slowly from material washed in from its *eastern* side as to only make occasional dredging necessary to maintain it."

What is the experience?

The report of 1885 says: "In 1878, a channel, 12 feet deep, was dredged across the bar; another was dredged in 1880; both soon refilled." * * "The amount of money spent * * aggregated about \$167,000."

These quotations show the recognized or suspected existence of littoral drift in both directions. It is not stated whether the cuts were filled by material from the Pass or from the adjacent shores, neither is it important. The fact remains that the material is very mobile, and that there is a lateral movement, the resultant of which I believe tends to the westward along this portion of the coast. It does not follow from this that violent southwest gales might not move sand eastwardly—to be returned by opposing storms.

That this sand would lodge on the outer or *up-hill* slope of the bar, if from the outside, rather than on the inner or down-hill slope, is natural.

My belief in this movement is founded upon such statements as these taken from Major Heuer's report of January 28, 1882:

"The bar at Sabine Pass is composed of a sticky, soft, blackish-blue mud to a depth of thirty feet." * * "The bar is probably a drift and wave bar and is certainly not a delta bar. * * * It is thought that the mud of which this bar is composed is eroded from the soft alluvial soil forming the coast for several hundred miles to the eastward, and is brought here by the wind waves and tidal currents.† * * * We are, therefore, almost justified in stating that the bar is composed of soft mud to a depth of thirty feet below the water surface, as no traces of clay, sand, nor shell were found. * * * It was found that the flood tide in its first quarter, and sometimes extending nearly through its second quarter, came in on the Louisiana (east*) side; * * the current would frequently run out on the Texas side for two hours after the tide had commenced to run in on the Louisiana side. The ebb tides acted almost exactly opposite. The first of the ebb current was always on the Texas side," etc. * * * "Outside of Sabine Pass there is an undoubted littoral current whose general direction is from the east towards the west."

It would seem from these physical conditions that the conclusions as to a resultant westward drift are more than probable, and as it has been nowhere stated that a deposit or pocket of *sand* exists in the Pass or lake basin whereby to account for that found on the bar, the omission of a doubtful opinion as to its origin cannot have been a serious matter.

The references to the opposition of Galveston and to the trenches on both sides of the jetty, cut out by the cross currents due to the submerged condition of the work, appear to me irrelevant, and hence to require no answer.

The above quotations from Major Heuer's report do, however, appear to

* L. M. H.

Aug., 1888.]

Bache Safety Car Heater.

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sustain fully my "theory of harbor dynamics" to which Captain Turtle has alluded.

Respectfully submitted,

LEWIS M. HAUPT.

UNIVERSITY OF PENNSYLVANIA,

PHILADELPHIA, *June 7, 1888.*

REPORTS OF THE COMMITTEE ON SCIENCE AND THE ARTS.

THE BACHE SAFETY CAR HEATER.

[No. 1383.]

HALL OF THE FRANKLIN INSTITUTE,

PHILADELPHIA, January, 1888.

The Sub-Committee of the Committee on Science and the Arts, constituted by the FRANKLIN INSTITUTE of the State of Pennsylvania, to which was referred for examination

MR. R. MEADE BACHE'S SAFETY CAR HEATER,

Report: That the object of the invention is to provide a car heater that shall afford safety to the occupants of a railway car in the event of the overturning of the same. To accomplish this object, the inventor provides for the automatic extinguishment of the fire by means of water carried for the purpose in a reservoir forming part of the stove.

The principal features of construction are as follows:

The heater body is made of wrought iron, to insure ample strength against crushing, and its general form is that of a tubular boiler with a domed top.

The water reservoir forms an important feature, being firmly attached to the heater. The top is also fastened on by numerous screw bolts, and the orifice through which the water is admitted is closed by a disc which screws into the top. The whole is so firmly fastened that it cannot be detached without violence.

The smoke-pipe issues from a strong steel dome, and suitable provision is made to prevent the escape of coal from the smoke-vent, by a peculiar construction of the flue inside of the top of the heater. As an additional precaution, there is also provided a grating to receive the coal, placed inside the smoke-flue.

The door is strongly made, and of the same material as the heater body, especial care being bestowed upon the locking