

them in a suitable form. A field of work of great extent and promise is open, and there seems to be an opportunity to erect to the name of Dr. Henry Draper a memorial such as heretofore no astronomer has received. One cannot but hope that such an example may be imitated in other departments of astronomy, and that hereafter other names may be commemorated, not by a needless duplication of unsupported observatories, but by the more lasting monuments of useful work accomplished.

EDWARD C. PICKERING,

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*Cambridge, Mass., U. S. A., March 1, 1887.*

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THE USE OF OIL FOR STILLING WAVES: WITH A DESCRIPTION OF A NEW OIL DISTRIBUTOR FOR THE USE OF MARINERS.

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BY T. F. TOWNSEND, of Philadelphia.

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[*A Paper read before the FRANKLIN INSTITUTE, at the Stated Meeting held Wednesday, April 20, 1887.*]

JOSEPH M. WILSON, President, in the Chair.

MR. TOWNSEND: The stilling of waves by means of oil, was known to the Ancients, and is mentioned in the writings of Plutarch, Pliny and Aristotle.

Its application for quieting rough waters, has long been practiced by whalers, fishermen, and divers in their avocations, but its more general use, continuously applied in small quantities during severe storms, by merchantmen, for securing their comfort and safety, is of comparatively recent date.

Had there been no potency in "pouring oil on troubled waters" it is hardly likely that the saying would have become so well known and so often used as a comparison. The origin of the maxim I am unable to give, as I have never seen it used, except as a quotation.

Owing to so many recent publications of the experience of those who have tested the action of oil on high seas, the public is becoming much interested in the subject, and is curious to know

if it is a fact, that so simple a means will produce such decided results.

If we can believe the evidence of the many competent judges, who have made practical experiments, its efficacy is established almost beyond a doubt.

The subject possesses also much interest from a scientific point of view.

Franklin, who was ever on the alert for those things which escape the observation of ordinary persons, did not fail to notice the peculiar effect of oil on water, and his philosophical mind did not rest until he had investigated the subject.

Some of the results of those investigations are embodied in the following extracts of papers read before the Royal Society, June 2, 1774. They are so thorough and clear, as to cause and effect, that I cannot do better justice to the subject, than to reproduce them before the Society bearing his honored name.

Extract of a letter from the Rev. Mr. Farish to Dr. Brownrigg :

I sometime ago met with Dr. Dun, who surprised me with an account of an experiment you had tried upon the Derwent Water, in company with Sir John Prindle and Dr. Franklin. According to his representations, the water, which had been in great agitation before, was instantly calmed upon pouring in only a very small quantity of oil, and that to so great a distance round the boat as seemed incredible.

I have since had the same accounts from others, but I suspect all of a little exaggeration.

Pliny mentions this property of oil as known particularly to the divers, who made use of it in his days, in order to have a more steady light at the bottom.

The sailors, I have been told, have observed something of the same kind in our days, that the water is always remarkably smother in the wake of a ship that has been newly tallowed than it is in one that is foul.

Mr. Pennant also mentions an observation of the like nature made by the seal catchers in Scotland.\* When these animals are devouring a very oily fish, which they always do under water, the waves above are observed to be remarkably smooth, and by this mark the fisherman know where to look for them.

Old Pliny does not usually meet with all the credit I am inclined to think he deserves. I shall be glad to have an authentic account of the Keswick experiment, and, if it comes up to the representations that have been made of it, I shall not much hesitate to believe the old gentleman in another more wonderful phenomenon he relates, of stilling a *tempest* only by throwing up a little vinegar into the air.

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\* *Brit. Zool.*, vol. iv, article "Seal."

Extract of a letter to Dr. Brownrigg, from Dr. Franklin, dated London, 7 November, 1773.

*Dear Sir* :—I thank you for the remarks of your learned friend at Carlisle. I had, when a youth, read and smiled at Pliny's account of a practice among seamen of his time, to still the waves in a storm by pouring oil into the sea, which he mentions, as well as the use made of oil by the divers; but the stilling a tempest by throwing vinegar into the air had escaped me. I think, with your friend, that it has been of late too much the mode to slight the learning of the Ancients. The learned, too, are apt to slight too much the knowledge of the vulgar.

The cooling by evaporation was long an instance of the latter. This art of smoothing the waves by oil is an instance of both.

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In 1757, being at sea in a fleet of ninety-six sail bound against Louisbourg, I observed the wakes of two of the ships to be remarkably smooth, while all the others were ruffled by the wind, which blew fresh. Being puzzled with the differing appearance, I at last pointed it out to our captain, and asked him the meaning of it. "The cooks," says he, "have, I suppose, been just emptying their greasy water through the scuppers, which has greased the sides of those ships a little." And this answer he gave me with an air of some little contempt, as to a person ignorant of what everybody else knew. In my own mind, I at first slighted his solution, though I was not able to think of another; but recollecting what I had formerly read in Pliny, I resolved to make some experiment of the effect of oil on water, when I should have opportunity.

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An old sea captain told me he had heard it was a practice with the fishermen of Lisbon, when about to return into the river (if they saw before them too great a surf upon the bar, which they apprehended might fill their boats in passing) to empty a bottle or two of oil into the sea, which would suppress the breakers, and allow them to pass safely.

A confirmation of this I have not since had an opportunity of obtaining; but discoursing of it with another person, who had often been in the Mediterranean, I was informed that the divers there, who, when under water, in their business, need light, which the curling of the surface interrupts by refractions of so many little waves, let a small quantity of oil now and then out of their mouths, which, rising to the surface smooths it, and permits the light to come down to them. All these informations I at times revolved in my mind, and wondered to find no mention of them in our books of experimental philosophy.

At length being at Clapham, where there is, on the common, a large pond, which I observed one day to be very rough with the wind, I fetched out a cruet of oil, and dropped a little of it on the water. I saw it spread itself with surprising swiftness upon the surface, but the effect of smoothing the waves was not produced; for I had applied it first on the leeward side of the pond where the waves were largest, and the wind drove my oil back upon the shore.

I then went to the windward side, where they began to form; and there the oil, though not more than a teaspoonful, produced an instant calm over a space several yards square, which spread amazingly, and extended itself gradually till it reached the lee side, making all that quarter of the pond, perhaps half an acre, as smooth as a looking-glass.

After this I contrived to take with me, whenever I went into the country, a little oil in the upper hollow joint of my bamboo cane, with which I might repeat the experiment as opportunity should offer, and I found it constantly to succeed.

In these experiments, one circumstance struck me with particular surprise. This was the sudden, wide and forcible spreading of a drop of oil on the face of the water, which I do not know that anybody has hitherto considered.

If a drop of oil is put on a highly polished marble table, or on a looking glass that lies horizontally, the drop remains in its place, spreading very little. But, when put on the water, it spreads instantly many feet round, becoming so thin as to produce the prismatic colors, for a considerable space, and beyond them so much thinner as to be invisible, except in its effect of smoothing the waves at a much greater distance.

It seems as if a mutual repulsion between its particles took place as soon as it touched the water, and a repulsion so strong as to act on other bodies swimming on the surface, as straw, leaves, chips, etc., forcing them to recede every way from the drop, as from a centre, leaving a large, clear space.

The quantity of this force, and the distance to which it will operate, I have not yet ascertained; but I think it a curious inquiry, and I wish to understand whence it arises.

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Our friend, Sir John Pringle, being soon after in Scotland, learned there, that those employed in the herring fishery could at a distance see where the shoals of herrings were, by the smoothness of the water over them, which might possibly be occasioned, he thought, by some oiliness proceeding from their bodies. A gentleman from Rhode Island told me it had been remarked that the harbor of Newport was ever smooth while any whaling vessels were in it, which probably arose from hence, that the blubber which they sometimes bring loose in the hold, or the leakage of their barrels, might afford some oil, to mix with that water, which from time to time they pump out, to keep their vessel free, and that some oil might spread over the surface of the water in the harbor, and prevent the forming of any waves.

This prevention I would thus endeavor to explain:

'There seems to be no natural repulsion between water and air, such as to keep them from coming into contact with each other. Hence we find a quantity of air in water, and if we extract it by means of the air pump, the same water, again exposed to the air, will soon imbibe an equal quantity.

Therefore, air in motion, which is wind, in passing over the smooth surface of water, may rub, as it were, upon that surface and raise it in wrinkles, which, if the wind continues, are the elements of future waves.

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Thus, the small, first-raised waves, being continually acted upon by the wind, are, though the wind does not increase in strength, continually increased in magnitude, rising higher and extending their bases, so as to include a vast mass of water in each wave, which, in its motion, acts with great violence.

But if there be a mutual repulsion between the particles of oil, and no attraction between oil and water, oil dropped on water will not be held together by adhesion to the spot whereon it falls; it will not be imbibed by the water; it will be at liberty to expand itself; and it will spread on a surface that, besides being smooth to the most perfect degree of polish, prevents, perhaps by repelling the oil, all immediate contact, keeping it at a minute distance from itself; and the expansion will continue till the mutual repulsion between the particles of the oil is weakened and reduced to nothing by their distance.

Now, I imagine that the wind, blowing over water thus covered by a film of oil, cannot easily *catch* upon it, so as to raise the first wrinkles, but slides over it, and leaves it as smooth as it finds it. It moves a little the oil indeed, which, being between it and the water, serves it to slide with, and prevents friction, as oil does between those parts of a machine that would otherwise rub hard together.

Hence, the oil dropped on the windward side of a pond proceeds gradually to leeward, as may be seen by the smoothness it carries with it, quite to the opposite side. For the wind being thus prevented from raising the first wrinkles—that I call the elements of a wave—cannot produce waves, which are to be made by continually acting upon and enlarging those elements, and thus the whole pond is calmed.

Totally, therefore, we might suppress the waves in any required place, if we could come at the windward place where they take their rise. This, in the ocean, can seldom if ever be done. But perhaps something may be done on particular occasions to moderate the violence of the waves when we are in the midst of them, and prevent their breaking, where that would be inconvenient.

For, when the wind blows fresh, there are continually rising on the back of every great wave a number of small ones, which roughen its surface and give the wind hold, as it were, to push it with greater force. This hold is diminished by preventing the generation of those small ones. And possibly, too, when a wave's surface is oiled, the wind in passing over it may rather in some degree press it down, and contribute to prevent its rising again, instead of promoting it. This, as mere conjecture, would have little weight if the apparent effects of pouring oil into the midst of waves were not considerable, and as yet not otherwise accounted for.

When the wind blows so fresh as that, the waves are not sufficiently quick in obeying its impulse; their tops being thinner and lighter, are pushed forward, broken, and turned over in a white foam. Common waves lift a vessel without entering it; but these, when large, sometimes break above and pour over it, doing great damage.

But that this effect might in any degree be prevented, or the height and

violence of waves in the sea moderated, we had no certain account, Pliny's authority for the practice of seamen in his time being slighted.

Discoursing lately on this subject with his excellency, Count Bentinck, of Holland, his son, the Honorable Capt. Bentinck, and the learned professor, Allemand, a letter was mentioned, which had been received by the Count from Batavia, relative to the saving of a Dutch ship, in a storm, by pouring oil into the sea. I much desired to see that letter, and a copy of it was promised me, which I afterward received.

Extract of the letter from Mr. Tegnagel to Count Bentinck, dated Batavia, 5 January, 1770.

Near the islands Paul and Amsterdam, we met with a storm, which had nothing particular in it worthy of being communicated to you, except that the captain found himself obliged for greater safety in wearing the ship, to pour oil into the sea, to prevent the waves breaking over her, which had an excellent effect, and succeeded in preserving us. As he poured out but a little at a time, the East India Company owes perhaps its ship to only six demi-ames of olive oil.

I was present upon deck when this was done; and I should not have mentioned this circumstance to you, but that we have found people here so prejudiced against the experiment, as to make it necessary for the officers on board and myself to give a certificate of the truth on this head, of which we made no difficulty. \* \* \*

Coming down to a later period, Capt. Anthony Jerome, ship *Black Warrior*, whaler, in the Arctic seas, makes the following statement :

The oil escaping through the lance wounds of a whale, always makes a slick to leeward, and it is well known to whalers that the pumping of bilge water from their ships, which is always more or less impregnated with oil will produce a slick.

In the year 1852, at the entrance of Behring's Straits, experienced a fearful gale and sea, soon after fastening to two sperm whales. Secured the ship to them with 600 feet of line, and rode out the gale with dry decks, in the smooth caused by the oil from the whales.

At another time was caught out in a heavy gale in a whale boat. Could not return to the ship. Made fast to a dead whale, with 100 feet of line, and laid in slick all night perfectly dry.

Capt. John Ward, ship *Electra*, off Tristan d'Acunha, South Atlantic, put long line to dead sperm whale, and rode out a fearful gale, with perfectly dry decks. Again, when on ship *General Williams*, he rode out a gale of four days' duration, while attached by long line to a large right whale, no water coming on deck during the whole gale.

The smooth sea, or slick, always to leeward of a dead whale is vouched for by numerous captains, and many cases can be cited of whalemens who have taken advantage of the smooth sea thus formed and have been saved much discomfort, alarm and danger.

The array of facts establishing the efficacy of oil in smoothing rough seas is so numerous, that the question naturally arises; Why has its general use been so long delayed?

I think there are several reasons.

Until recently, there were many who had never heard of the use of oil for quieting waves, though their whole lives had been spent at sea. Some were skeptical and indifferent, and others supposed that in order to derive any beneficial result, the oil must be used in large quantities. A few, perhaps, would have used it, had they been provided with proper appliances for its distribution. Very few ships have been in the habit of carrying as stores, a sufficient quantity of oil to spare for wave oiling, not even the small amount necessary to use through one storm. No doubt, many shipwrecks have occurred, which might have been prevented, had the oil at hand been used, instead of letting it remain securely sealed up.

The Hydrographic Office deserves much credit for the interest created in the use of oil, and the information it has given to mariners regarding its application and effectiveness, by collecting and publishing the experiences of those who have experimented with it. A portion of its monthly *Pilot Chart* has been devoted to these reports, thus keeping the subject constantly before those most interested. These reports have since been published in book form by the Hydrographic Office for general distribution.

From pamphlet No. 83, entitled "The Use of Oil to Lessen the Dangerous Effect of Heavy Seas," I quote the following :

Experience seems to demonstrate that the thick and heavy oils are generally the best for this purpose. Mineral oils are not so effective as vegetable or animal, and, therefore, the use of the first-named is not recommended when either of the latter is available. It may be remarked in this connection that crude petroleum probably gives good results in smoothing heavy seas, but its usefulness in this direction decreases in proportion to the degree to which it has been refined.

It would be well to remember that soft oils, such as fish oils, cocoanut oil and others of a like nature, become thick and useless when exposed to a very cold temperature, and if it becomes necessary to use them under this condition, it is advisable that they be mixed with some mineral oil, which has a much lower cold-test.

A comparatively small amount of oil, say two quarts per hour, properly used, is sufficient to prevent great damage both to vessels and small boats in heavy seas.

The greatest effect from oil is obtained when in deep water. In a surf, or where water is breaking on a bar, the effect of the oil is not so certain, but even in this case it may be of benefit, and its use is recommended.

In order to get the best possible effect from oil, it must be applied in such a way as to spread to windward.

It is effective when scudding, when lying-to, when wearing, and when lowering and hoisting boats in a heavy sea.

The best results seem to be secured by pouring it into the bowls of water-closets in which oakum has been placed, whence it slowly leaks out; and by means of canvas bags, having a capacity from one to two gallons. Oakum is stuffed in these bags, and they are punctured with a coarse sail-needle to facilitate the escape of the oil. In running before the wind, these bags should be suspended by lanyards from each cat-head and allowed to drag in the water. In lying-to, the weather-bow and mizzen-chains seem to be the best places for the bags, with sufficiently long lines to allow them to tend to windward while the ship drifts. In crossing a bar on a flood tide some oil should be put overboard and allowed to float in ahead of the boat, which should follow with an oil-bag towing astern. In crossing a bar against an ebb tide, no advantage can be obtained by using oil from the boat. For boarding a wreck, a vessel should run as close as possible under the lee of the wreck and put the oil over. The wreck will soon drift down into the oil, when a boat can be sent alongside of her most favorably. In the case of a boat riding to a sea-anchor in heavy weather, the oil-bag should be secured to an endless line rove through a block at the sea-anchor, by means of which the oil is spread well ahead of the boat, and when the bag is empty, it can be hauled on board and replenished. A similar system could be employed to advantage by the fishermen on the banks.

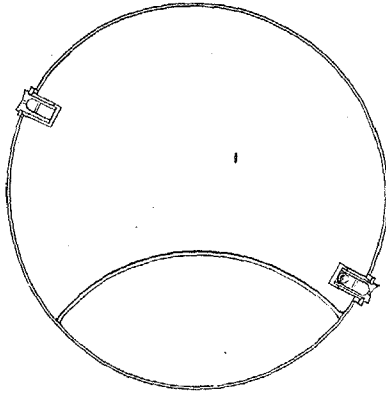
Those who have made practical tests seem to be unanimous in their belief in the efficacy and practical utility of oil for lessening the dangerous effect of heavy seas. They differ somewhat in opinion in regard to the minimum quantity required per hour.

This amount cannot be definitely ascertained until some better mode of distribution is adopted. A perforated bag containing oakum or waste, saturated with oil, will always give an uncertain and irregular flow. Even if the necessary amount were known, it would be an impossibility to so perforate a bag that it would give forth a pre-determined quantity.

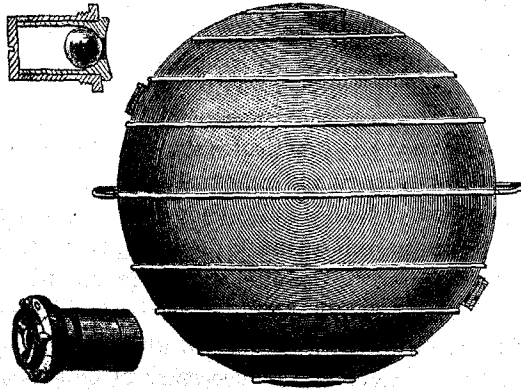
This uncertainty makes the bag objectionable, especially for use at night. Excessive quantities of oil are apt to be used in order to be on the safe side, and on this account, the use of the bag



ceases to be economical. After using, it is apt to be stowed away out of sight, in some locker, to save for future use, and it then becomes quite as dangerous as heavy seas, by the possible and probable danger of its becoming a fire-brand from spontaneous combustion.



In view of these facts and the many inquiries for some better mode for distributing the oil, I have devised an oiler, which, I believe, to be philosophic in principle, simple in construction and adapted for the purpose in question. My device (*see engravings*) consists



of a hollow metal globe, ten inches in diameter, and about one and one-half gallons capacity. To protect it from injury and to add to its strength, heavy wire rings are soldered around the outside.

It has an air chamber to float it in an upright position, and an upper and lower valve to regulate the flow of the contents. By

means of a ball in the upper valve, the flow of oil is stopped automatically, when action is not desired.

When filled with oil, the upper valve is adjusted to give vent to the oil in any desired quantity, and the lower valve is set to admit the water. When placed in the sea, the water coming in at the lower valve, by reason of its greater specific gravity, steadily and regularly displaces the oil, which flows out through the upper graduated valve.

After the vessel has emptied itself of oil, it should be taken in and refilled, or replaced by another. When it is not practical or desirable to put it in the sea, it can be placed in the bowl of the water closet, or used as a drip by securing it to any portion of the ship. The flow will be regulated by the valves.

A piece of tubing leading from the valve to the water may be used to prevent the oil from blowing to leeward.

The portability of this oiler adapts it for use in any part of the ship, or for small boats. As it is buoyant, it can be anchored to protect any place or wreck while landing passengers or crew.

Its capacity for distribution ranges from one pint to two gallons per hour in a continuous and regular flow. When not in service, it can be put away and is always ready for immediate use.

Its small cost, its economical use of oil, its certainty of action, and its adaptation to all the conditions in which wave oiling can be made beneficial, make it a desirable distributor.

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