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(Illustrated articles are marked with an asterisk.)

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SCIENTIFIC AMERICAN SUPPLEMENT

No. 571.

For the Week Ending December 11, 1886.

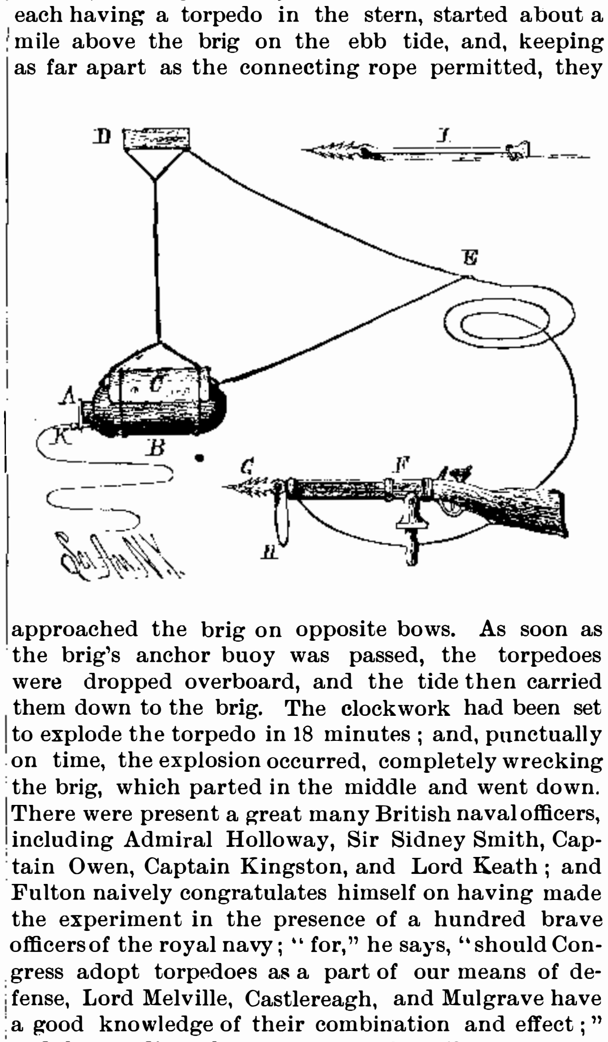
Price 10 cents. For sale by all newsdealers.

TORPEDOES EIGHTY YEARS AGO.

Among the rare books catalogued for sale in the Brinley collection is one entitled "Torpedo War and Submarine Explosions," by Robert Fulton, published in 1810 by William Elliot, of No. 114 Water Street, New York. The text of the book appears in the form of a letter addressed "To James Madison, Esq., President of the United States, and to the Members of both Houses of Congress;" but it is not dated, and its date can only be surmised as having been 1808 to 1810. In size the book is a quarto cap, bound in a thin marbled paper. It contains 60 pages and five full page plates, and it is in a well preserved condition. It was evidently an author's presentation copy, for though some autograph hunter has cut off the upper right hand corner of the title page, there yet remain, in Fulton's handwriting, the words "From the author."

After referring to some torpedo experiments he had made in the presence of Mr. Jefferson, Mr. Madison, and others, at Kalorama, the residence of Joel Barlow, Fulton proposes to show that a system of harbor defense based on stationary and movable torpedoes is the surest, quickest, and cheapest plan for protecting our maritime cities against the naval forces of an enemy.

He first tells how, in October, 1805, he blew up the brig Dorothea in Walmer Roads, near Deal, within a mile of Walmer Castle, the residence of Mr. Pitt, then Prime Minister of Great Britain. He says that two torpedoes were prepared, one containing 180 pounds of powder. They were united by a rope 80 feet long, and were made to float about 15 feet below the surface, the brig drawing 12 feet of water. Two boats, each having a torpedo in the stern, started about a mile above the brig on the ebb tide, and, keeping as far apart as the connecting rope permitted, they



approached the brig on opposite bows. As soon as the brig's anchor buoy was passed, the torpedoes were dropped overboard, and the tide then carried them down to the brig. The clockwork had been set to explode the torpedo in 18 minutes; and, punctually on time, the explosion occurred, completely wrecking the brig, which parted in the middle and went down. There were present a great many British naval officers, including Admiral Holloway, Sir Sidney Smith, Captain Owen, Captain Kingston, and Lord Keath; and Fulton naively congratulates himself on having made the experiment in the presence of a hundred brave officers of the royal navy; "for," he says, "should Congress adopt torpedoes as a part of our means of defense, Lord Melville, Castlereagh, and Mulgrave have a good knowledge of their combination and effect;" and he predicts that none of the officers present would feel much disposed to "enter the waters of a nation who should use such engines with energy and effect." In a footnote he says: "The morning of my first interview with Earl St. Vincent he was very communicative. I explained to him a torpedo and the Dorothea experiment. He reflected for some time, and then said Pitt was the greatest fool that ever existed, to encourage a mode of war which they who commanded the seas did not want, and which, if successful, would deprive them of it."

Fulton then goes on to describe two or three styles of torpedoes, both fixed and movable. Even thus early in the history of torpedoes he realized the necessity of protecting fixed torpedoes by heavy ordnance fire, since otherwise, he says, "the enemy might send out boats to sweep for and destroy the torpedoes." He proposed to provide fixed torpedoes with a clock attachment which could be set for any period, during which they would be exploded by the contact of any heavy body. At the end of the desired term, the clockwork would allow them to come to the surface, and at the same time would lock their exploding apparatus, so that they could be handled without fear.

But Fulton's torpedo designs were not limited to merely defensive purposes. He elaborated and described a very ingenious offensive torpedo, a cut of which is herewith reproduced. The torpedo consists of a copper case, B, to contain 100 pounds of powder, or more; a cork cushion, C, to give the torpedo such buoyancy that it will weigh only two or three pounds more than the water it displaces; a cylindrical brass box, A, seven inches in diameter and two inches deep, in which there is a gun lock and short pistol barrel to be loaded and used to fire the charge in B; in A there is also clockwork, which, when wound up, may be set to pull the lock trigger and explode the torpedo within any desired number of minutes; at K is a pin, which holds the clockwork inactive, and a light line is attached to this pin; a pine box, D, floats on the surface, and from it the torpedo is suspended at a depth proportionate to the draught of the vessel to be attacked. To the torpedo and the float are attached two lines about 20 feet long, united at E, and thence one line, about 30 feet long, extends to the harpoon. The harpoon is two feet long, having a barbed point at one end and a butt one inch in diameter, exactly the caliber of the swivel gun. The line is spliced into an eye in the harpoon, just abaft the barb, and is then fastened to a copper ring, or traveler, on the harpoon. The line hangs in a loop when loaded, but slips back to the butt when fired, and keeps the harpoon true to its aim. The harpoon gun, F, is a heavy swivel gun for boat service, and Fulton says of it: "I have harpooned a target six feet square 15 or 20 times, at the distance of from 30 to 50 feet, never missing, and always driving the barbed point through three inch boards up to the eye." He proposes to approach a ship in a boat, shoot the harpoon into her bow, and then either the vessel's headway or the tide, if she be at anchor, will draw the torpedo under her; and as the pin, K, will be withdrawn when the torpedo leaves the boat, the clockwork will explode the torpedo when it is snugly pressed against the ship's bottom.

In 1805, Fulton, being in England, induced some of the British naval officers to make practical trials of his torpedoes. Accordingly, October 1, 1805, Captain Siccombe took a galley, manned by eight men and a coxswain, and ran across the bows of a French man-of-war lying at anchor off Boulogne. He placed his torpedoes successfully, and although fired at by the French crew, he escaped without harm. But when the torpedoes exploded, the ship was apparently uninjured; and Lieutenant Payne's similar attempt upon another French vessel was no more successful, although the torpedoes exploded according to expectation. Fulton then discovered that the torpedoes, though carried alongside the ships, did not come in contact with the hulls, but hung nearly vertically alongside, at a distance of from ten to twenty feet from the bottom. To obviate this difficulty, he hung the torpedo in a bridle, with one leg longer than the other, so that it would stand at an angle with the keel and be pressed in against the ship's bottom.

Fulton then made an elaborate calculation to show how much better and cheaper it would be to depend upon torpedo boats to protect our harbors than up on large and expensive men of war. He assumed that an 80 gun ship would cost $400,000, and would require a crew of 600 men. He allowed twelve men to each of his proposed torpedo boats, and thus 600 men would man 50 boats. These 50 boats with torpedoes and all other equipments would cost only $24,300, or $375,700 less than the 80 gun ship; and he would thus be able to fit out 839 torpedo boats for the cost of one 80 gun ship. Having then calculated just how close the boats would have to come to a ship, how fast they could row, and the length of time after discovery that they would be under fire, Fulton reached the conclusion that 50 torpedo boats would be able to destroy one ship before all of them were destroyed by the ship.

Fulton seems to have overlooked the possibility of his harpoon lines being cut as fast as they were fixed; but his general ideas in favor of torpedoes were, like most of his other inventions, considerably in advance of his time. In one chapter of his pamphlet he treats of "Thoughts on the Probable Effect of this Invention," and, among other things, says: "Convince the people of Europe of the power and simple practice of these engines, and it will open to us a sublime view of immense economy in blood and treasure." Just think of the enormous outlays of Europe on navies of the present day, in spite of the general belief in the "power and simple practice" of torpedoes!

In another chapter he reviews the condition of the English navy for two centuries previous. Thus in 1602 it contained only 42 ships, carrying 180 guns and 8,376 men. At the death of James I., in 1665, it contained 62 sail, and its annual cost was £50,000 sterling. At the death of King William, in 1701–02, there were 256 ships, carrying 9,300 guns and 52,000 men, the annual cost being £1,046,397 sterling. In 1801 the royal navy contained 945 ships, carrying more than 100,000 men and costing £13,654,013 sterling per annum. Fulton thence argues that if the United States should adopt the policy of creating a sufficient navy to protect ourselves against Great Britain, we should involve ourselves in constantly augmenting expense; and even though we increased our navy to the utmost that our revenues would permit, we should still be inferior to many other nations. He estimated—on the basis of a population of about 5,000,000 in 1800 and of a doubling every 30 years—that in 1890 we should have a population of 40,000,000; and he allowed England and Scotland about 18,000,000 by the end of this century.

Then he makes a calculation that even in time of peace the British navy must cost £10,000,000 a year, which would amount to £250,000,000 sterling in twenty-five years. This sum, he says, which the United States would have to spend to keep up a navy equal to England's, could be laid out in building twelve canals, each 1,500 miles long, running north and south, and thirty canals, each 600 miles long, running east and west, at distances of 50 miles apart. These, at the rate of £3,000 sterling per mile, would cost £108,000,000. Then he suggests 2,000 bridges at £30,000 each, equal to £60,000,000, and 2,050 public schools at £40,000 each, making £82,000,000. This would exhaust the £250,000,000, and he thinks this would be a far better use for the money. "Say, legislators," he continues, "you who direct the destinies of this great nation, shall Americans, like servile creatures of established habits, imitate European vices, or copy them because they are familiar? Shall they nourish a useless marine, lay the basis for its increase, and send it down the currrent of time to futurity with all its complicated evils?" Fulton's anxiety on this point would have been greatly increased if he could have looked down the current of time far enough to see the United States navy in 1886. But, as already stated, Fulton was almost wise enough to be a prophet, and this little book proves it.

A CONVENIENT AND CERTAIN MODE FOR TEMPERING STEEL.

Mr. James A. Peck, of Brewsters, N. Y., mechanical engineer of the N. Y. Condensed Milk Co., gives us the following method discovered by him, and which he uses with great success for tempering all kinds of tools, knives, razors, steel dies, and other implements.

Take a suitable quantity of muriatic acid, dissolve all the zinc the acid will take.

Prepare a tempering bath composed of one part of the above zinc acid and one part water.

Heat the steel according to its hardness.

If high or hard steel, heat until just red and then temper in the acid bath.

If low steel, heat it as hot as you would to temper in water, then temper in the acid bath.

After immersing in the acid bath, cool off in water.

For lathe and planer tools draw no temper; but for other tools draw temper. Unlike water tempering, the colors that appear under this method give no clew to the hardness.

By this process, steel is readily hardened to any desired degree, and may be made to cut glass like a diamond.

If desired, an acid bath composed of two parts of muriatic acid and one part water may be used. Mr. Peck, however, prefers the zinc acid, as being more dense.

A prominent advantage of this method of tempering is the certainty and excellence of its results. It never fails to yield the temper required. It can be relied upon for every description of steel or tool.

Destruction by Nitro-glycerine Explosions.

An "old oil operator" in the Bradford oil region thus rehearses in the New York *Times* some facts as to glycerine explosions which are certainly mysterious, and have been observed many times:

"Attending the frightful deaths that so frequently follow the handling of nitro-glycerine in the oil regions, there is one feature the mysterious nature of which is startling. It has puzzled scientific observation and study, and I do not believe to-day that any satisfactory explanation can be given of it. This singular feature is the almost complete annihilation of matter, especially of the human body, which in a majority of cases results from a fatal explosion of this compound. I have noticed that in many instances. I had a teamster in our employ once named Henry France. Like all men of his kind in the oil country, there was nothing either above, below, or on the earth that he feared. He was in the habit of carting nitro-glycerine to any well where I wanted to use it, and he and his partner Warren Jack actually got so reckless in handling the deadly stuff that no other help I had would remain at work when they knew France and Jack were coming in with a load of glycerine. These two men were so callous to fear that they used to unload the stuff as they would a load of bricks, France standing in the wagon and throwing a can to Jack, who stood some feet away, and Jack catching it and placing it on the ground in time to catch the next one his companion tossed him.

"As it takes a man with a good set of nerves to even ride in a wagon when he knows there is nitro-glycerine under the seat, this manner of handling a compound that the slightest jar frequently explodes will give an idea of the sort of nerves these two men had. One day in 1880 France was coming in with a load of glycerine, and when he was within a quarter of a mile of the well we heard an explosion. No one ever knew how it happened, but it was one of the most complete cases of nitro-glycerine annihilation I ever saw. We found the usual cellar that a few cans of glycerine always digs in the ground when it goes off, and the usual area of timber felled. Over 300 ft. off in the woods, to the right of the road, we picked up a wagon tire. We found the tail of one horse and the hoof of another. In another part of the woods a man's knee was picked up, and that was all we ever found, except Henry France's greasy cap lying by the side of a stump and his silver watch hanging on the limb of a tree.

"George Doran was blown to pieces by a nitro-glycerine explosion at Red Rock a few years ago. He was a man that weighed 200 pounds. All that the most thorough search ever recovered of that 200 pounds of flesh and bone was a part of one of the poor man's feet—less than one pound. Charles Berridge, a well known oil man, was blown up by nitro-glycerine one winter in Allegheny County, The ground was covered with newly fallen snow. On either side was a high and abrupt hill only a few rods apart. Berridge was a very tall man, and his weight was 180 pounds. The remains of the poor fellow were searched for carefully, but less than 15 pounds of them could be found. The most curious part of the case, and one showing how completely annihilation accompanies an explosion of nitro-glycerine, was this: The greatest force of the explosive is always expended upward. However infinitesimal the atoms to which Berridge's body might have been reduced by this explosion, in falling back upon that spotless snow some trace of them must have been seen, but the snow remained as spotless as before. Besides human bodies, the iron frames of wagons, and even the ponderous nitro-glycerine safes, have been removed from human vision by an explosion as effectually as if they had never been formed, and the mystery of their utter annihilation cannot be explained."

Heating Water Rapidly.

In the SCIENTIFIC AMERICAN, October 30, is a communication from Mr. Thos. Pray, Jr., referring to his use of studs on steam and water boilers. It is evident from the wording of his remarks that he has not read the full report of my experiments. Projecting studs, such as he sketches, have been used in this country, to a limited extent, for over twenty years, but they were, like his, so proportioned as not to permit of the possibility of flame contact, which was shown by my experiments to exist only with studs not less than four diameters long, if the studs were made of copper.

The extraordinary increase of duty with properly proportioned studs was measured, and proved to be, surface for surface, six times that of an ordinary flat surface, and as a matter of actual practice we are now making simple boilers to boil any quantity of water in any specified time, almost without limit to the speed. The inclosed extract from *Industries* will, I think, establish my position as to the originality of the experiments, and also show their possible commercial value.

THOS. FLETCHER, F.C.S.

Warrington, England.

The following paper explains Mr. Fletcher's views more fully:

THE IMPENETRABLE COLD ZONE IN STEAM BOILERS.

BY T. FLETCHER, F.C.S.

During my experiments on the state of things in that almost unknown space between a flame and a vessel containing water, some most extraordinary facts have come to light, which are not only of the greatest importance to steam users and boiler makers, but explain many curious points in connection with the heating of water.

It is well known that a flame does not come in contact with any ordinary vessel containing water, and that a paper label will remain on the bottom of a tin or copper kettle placed on a sharp fire, until by drying it gradually becomes loosened, and loses its contact with the metal, and so becomes burnt. I have myself seen labels on the bottoms of ordinary kettles and pans, the labels being quite perfect after some weeks' use over gas burners and fires. The work obtained from any source of heat by a limited surface is in direct proportion to the difference between the temperature of the vessel and that of the source of heat in absolute contact with it, and it therefore becomes a matter of serious importance to discover what the actual temperature of this cool and flameless zone is, and whether it can be removed. As is no doubt well known, my efforts to remove this, which is practically a wet blanket, from between the vessel and the fire have been partially successful by the use of projecting studs or webs of definite proportions, and the experiments already published prove that at the ends of copper rods four diameters long, flame contact exists, at all events sufficient to char paper, and to multiply the available duty, surface for surface, six times as compared with either water tubes or ordinary boiler plates, and that the evaporating power of any properly proportioned studded or ribbed plate has no limit except the practical one of removing the steam quick enough to prevent it lifting the water bodily out of the boiler.

After proving beyond doubt that under ordinary conditions flame does not come in contact with a vessel containing water, I endeavored to get this contact, and the corresponding increase in evaporating power, by directing flame against the water vessel with the assistance of a powerful blast, the result being, much to my surprise, that I found an impenetrable cold zone surrounding the vessel, absolutely impassable, not only to a powerful blowpipe flame, urged with an air blast of 1¼ lb. per square inch pressure (the heaviest blast a gas blowpipe will stand under ordinary conditions), but that it was equally impassable by radiant heat from a sheet of white hot platinum, held as close as possible without absolute contact. In making these tests, the result was proved by the fact that sheets of paper pasted on the water vessels were exposed to both the direct impact of the blowpipe flame and also to the radiant heat from the platinum, until the water in the vessel boiled, the paper being perfectly free from charring or discoloration at the end of the test.

Another important fact came out as the result of these experiments. Not only can the maximum temperature be determined by the presence or absence of charring of known organic substances, but also the thickness or depth of the cold zone can be measured by using paper of different thickness pasted to the surface of the vessel. When the paper used is thicker than the depth of the cold zone, the surface is charred or completely burnt to an invariable depth by each source of heat; but if this charred surface is cleared off with glass paper, the under part will be found perfectly white and clean, and on again directing the flame on this clean surface, it remains untouched.

This cold zone, although impassable by flame, hot air, or radiant heat, is powerless to resist the carrying of heat through it by solid bodies; and while the blowpipe flame is being directed on the paper without the slightest effect, a wire passing through the flame and touching the paper will burn it instantly and completely, although the actual temperature of the wire must of necessity be far below that of the blowpipe flame.

The extraordinary part of the whole series of experiments seems to be the existence of a zone of cold against all surfaces of metal having water behind them, this space being, to radiant heat and flame, almost as impenetrable as the metal itself is to the water. Some heat certainly does pass, or the water would never boil; but the quantity which does make its way through is very trifling as compared with what would pass, and, in fact, what does pass, under such conditions as permit of direct flame contact with the metal.

The result of these experiments does not fit the ordinary accepted theories of radiation and absorption of heat. The fact is that the high temperature stops suddenly at a very clearly defined distance, the division line being sharply drawn. It cannot be said that the heat is absorbed at a sufficient speed to produce this cold zone, because, as a matter of fact, the heat rebounds and is dissipated to a large extent sideways, and this rebound takes place at an invariable distance from the vessel, irrespective of the angle at which the flame is driven, and depending only on the force of impact of the flame. If we could imagine the surface of the vessel covered with a layer of elastic material which is compressed by a torrent of small shot driven steadily against it, we get a mechanical representation of the actual state of things between a flame and a cold vessel, additional force of impact reducing the thickness of the elastic layer, but being powerless to annihilate it.

The Mechanical Engineers' Convention.

During the week ending December 4, the Convention of Mechanical Engineers was held in New York. The headquarters were at the New York Academy of Medicine. At the business session on November 30, the following officers were elected: President, George H. Babcock, New York; Vice-Presidents, Joseph Morgan, Jr., Johnstown, Pa., Charles T. Porter, New York, and Horace S. Smith, Joliet, Ill.; Managers, Frederick G. Coggin, Lake Linden, Mich., John T. Hawkins, Taunton, Mass., and Thomas R. Morgan, Sr., Alliance, O.; Treasurer, William H. Wiley, New York.

During the week visits were made to different places of interest, to Clark's Thread Works and other factories, and Edward Weston's private laboratory, in Newark; to Bedlow's Island and the statue of Liberty; and on December 2 a meeting was held in Stevens Institute, Hoboken. One of the most suggestive papers read treated of Capital's Needs for High Priced Labor. It was read by W. E. Partridge, Esq. The author took the ground that a cheapening of the product could be obtained by the use of high priced operatives.

The paper was discussed, and in the main the members coincided with the author in his views. Among the other subjects may be mentioned the following: Prof. Francis Ruleaux on "Friction of Toothed Gearing," Prof. Thurston on "The Friction of Non-Condensing Engines," and Thomas D. West on "Casting Aluminum Bronze and other Strong Metals." A large number of papers in addition to the above were read, and many discussions of the subjects were indulged in. The attendance was large, 150 members participating in the visit to the Newark factories.