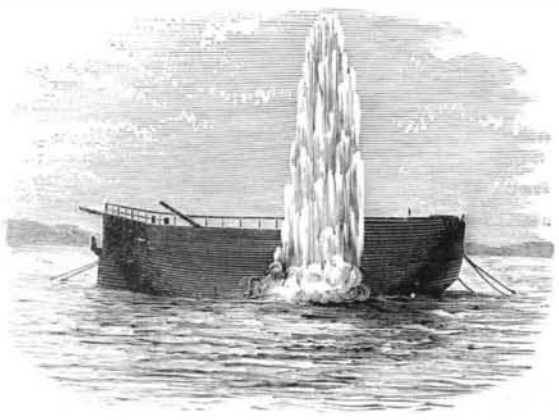
MODERN TORPEDO WARFARE.

The torpedo is one of the most efficient agents in modern warfare, and the application of electricity and new explosive compounds have made it a foe greatly to be dreaded. No less than twenty-five ships were sunk by the Confederates during the rebellion by the use of the electric torpedo, and the recent execution they have accomplished on the Danube is well known. Within twenty years great changes have been made in the torpedo. The infernal machines strewn in the Baltic by the Russians twenty years ago were small can-

Fig. 1.



isters of powder, ignited by concussion. These were dangerous to friend and foe alike, and the explosion of gunpowder was insufficient to effect any material injury. All this has been remedied. Electricity is nowadays employed as the igniting agent, and those terribly violent explosives, gun cotton and dynamite, are used. We copy the following interesting matter from *Nature:*

Electric torpedoes may be broadly divided into two classes, offensive and defensive torpedoes. The latter are employed for the protection of harbors, channels, and roadsteads; the former, in the shape of drifting or spar torpedoes, are carried to the attack in small swift-sailing steam launches. In England compressed gun cotton is generally used, but on the continent dynamite is the favorite. The gun cotton is pressed into cakes of disk-like form, and while still wet the slabs are stored away in the magazines. In this moist condition the compressed pulp is not only non-explosive, but actually non-inflammable, except one possesses the key to its detonation. This is nothing more than a dry cake of the same material, which on being detonated by a few grains of fulminate brings about the explosion of any wet gun cotton in its immediate neighborhood. The possibility of communicating explosion in this way by vibration instead of by spark or flame is the germ of a system of counter-mining, or torpedo annihilation, which bids fair to develop into a particularly effective means of defense against these terrible machines. Dynamite is similarly exploded to gun cotton.

Dynamite and gun cotton explode with something like four or five times the force of gunpowder, and for this reason a very destructive charge may be confined within a comparatively small space. In the case of moored torpedoes there is no limit to size, but for a spar torpedo the charge must be considerably smaller, or it would destroy both the attacking and the attacked. A big moored torpedo of 500 lbs. of gun cotton has been found, when sunk in forty feet of water, to be fatal to a strong ironclad if the latter happens to be within this distance. Probably no ironclad could withstand this terrible volcano if it were to erupt in contact with the vessel's sides. Such a torpedo throws up a cone of water 60 feet in height, with a diameter at its base of no less than 220 feet. Its general form is shown in Fig. 2.

The fish torpedo is of very elaborate construction. The long tube is divided into three compartments: the head, which contains the explosive charge, the reservoir, in which the compressed air is stored, and the machinery by means of which the stored-up energy is converted into a propelling force. The air is compressed to the extent of 600 lbs. on the square inch. The torpedo, when properly charged, will do a journey of a mile or mile and a half under water, the first 1,000 yards being got over at a rate of no less than 20 miles an hour, and if unaffected by tide or current, the machine will proceed in a perfectly straight direction. It floats at any distance under water that may be desirable, but is usually made sufficiently buoyant to swim at eight feet from the surface; it explodes on striking any object, but the machine is so contrived that if it fails to strike, then it floats to the surface, and a trigger guard renders the fish at the same time innocuous, and permits of its recapture without risk. Ingenious as the little creature is, there has been no authenticated employment of it during the present war.

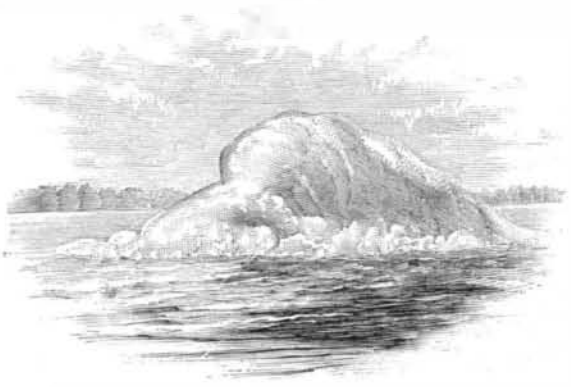
On the Danube the spar torpedo alone seems to have been used against Turkish monitors. The Turkish ironclad at Matchin was the victim of two torpedoes of this class, the first of which was ignited by the crew of the launch by electricity, and the other on concussion with the vessel attacked. These Russian torpedoes are said to be innocuous at a distance of ten feet from the seat of explosion, and hence those in the launch do not suffer much except from the water that is thrown into the air. From the fact that small batteries in the boat are used to fire the charges, we may safely conclude that their explosion is brought about by a platinum wire fuse, which, together with a few grains of fulminate, would determine the detonation of dynamite or gun cotton.

In the case of moored torpedoes depending for their ignition upon electricity, many points of scientific interest have recently been brought to light. Some experiments undertaken in Denmark two or three years ago showed most conclusively that dynamite torpedoes cannot be placed close together without incurring the danger of one charge bringing about the explosion of others. A dynamite torpedo of 150 lbs. ignited in 10 feet of water was found capable of exploding other charges at a distance of 300 feet by the mere vibration imparted to the water; so that in constructing coast defenses with dynamite torpedoes it is absolutely necessary to keep them far apart from one another. Another point was also noted. A current of electricity, if it emanates from a powerful frictional electric machine, traversing one of a bundle of wires, will induce a current in the other wires, and thus bring about the explosion of torpedoes other than that which the operator on shore desires to ignite. It is these facts particularly which have led to the development of a system of counter-attack, and have enabled our sailors to devise a means of defending themselves from the terrible sea monsters. Both dynamite and gun cotton are peculiarly sensitive to vibration—indeed their detonation, as we have seen, is brought about by no other cause—and hence a captain of a man-of-war by exploding counter mines in his vicinity may soon get rid of any lurking torpedoes lying in wait for him, at any rate if they contain a nitro-glycerin compound, and so speedily clear a way for his ship.

A crinoline of spars and wire rope may be employed to catch the fish torpedo, provided it is not a very large one, and the net is at some distance from the ship; but heavy moored torpedoes have been hitherto considered too dangerous to approach, so that marine countermining must prove invaluable. The spar or drifting torpedo cannot be dealt with by nets or booms alone, and in this case the only plan would seem to be to meet attack with attack and beat off launches with other small boats. That all ironclads in time of war will have to be surrounded by lesser craft as a protection is a matter that we may now take for granted, as also that such vessels must be provided with some powerful means of illumination—the electric light, for instance—to prevent swift, low-lying torpedo launches from approaching unperceived at night time.

Special schools of instruction for acquainting officers with the science of electricity and explosives have for some time past been established, and there is indeed scarcely a naval power which has not paid attention to submarine warfare; consequently we may expect to see future battles upon the sea carried on just as much under the water as above it. In England, at the Royal Naval College at Greenwich, instruction in the experimental sciences now forms one of the most important items in the curriculum. France has its naval torpedo school at Boyardville, where both officers and seamen are made acquainted with the principles of submarine warfare. Germany practiced torpedo warfare to such good purpose seven years ago that the magnificent fleet of the French never once ventured to visit the coast of the Fatherland. Both at Kiel and at Wilhelmshaven are to be found torpedo depots and a well organized staff of instructors. Lastly the news comes to us from Russia that the Czar has

Fig. 2.

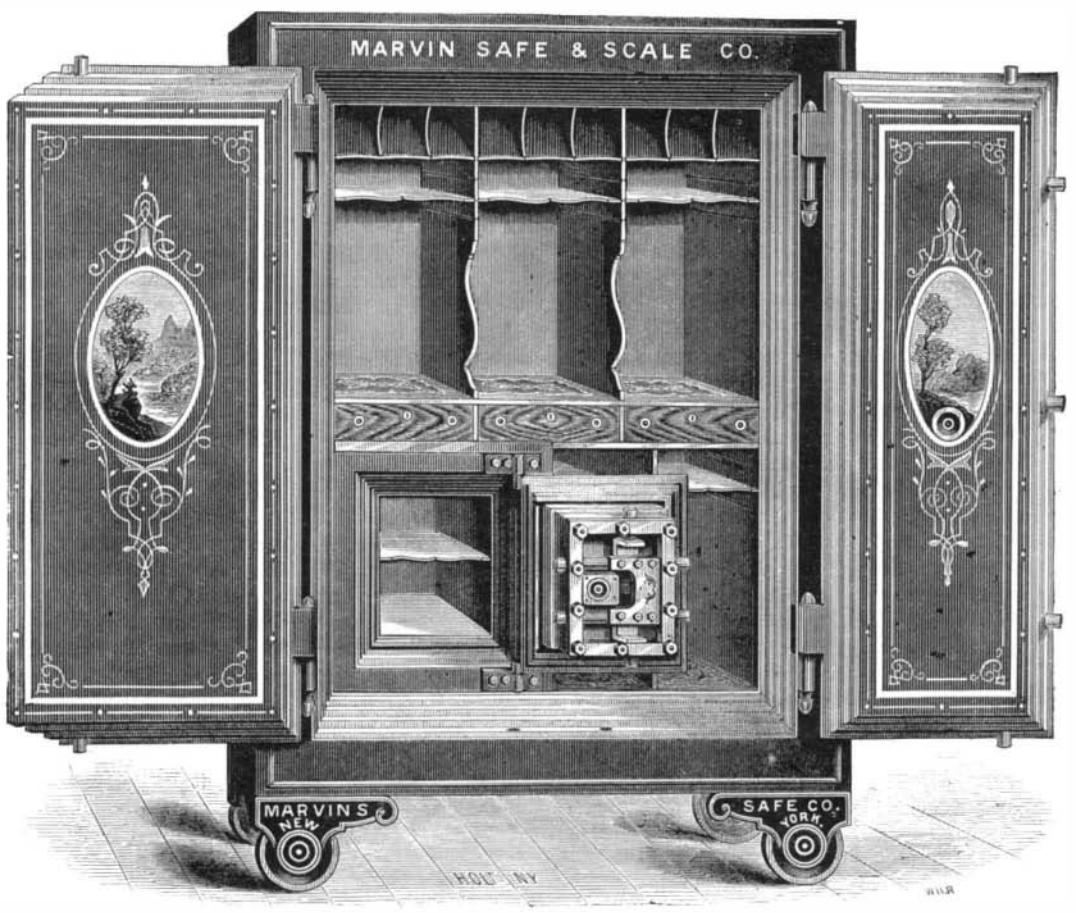


sanctioned the organization of a distinct torpedo service, and two depots and instructional schools are to be formed.

FOLDING-DOOR FIREPROOF SAFE.

The engraving represents a folding-door fireproof safe, with bankers' chest, and is similar to one recently placed in the extensive office of the SCIENTIFIC AMERICAN, being an additional one to others there of the largest size by the same makers. There are few documents more valuable than those pertaining to patents, patent records and cases. Their preservation and security are of the utmost importance to both solicitors and clients, and we may be pardoned for seeming egotism if we say that in the selection of this safe the best security against fire was taken into consideration.

Safes constructed after the manner represented are not only remarkable for the great strength obtained by a disposition of steel and iron plates, but more particularly for the means employed to render them fireproof. The filling between the plates, or safe lining, consists of alum and dry plaster. By chemical analysis it is found that alum contains over fifty per cent of water of crystallization; this water is given off into steam when subjected to 212° Fah. The moisture is absorbed by the plaster of Paris, setting the same into a hard wall. Experiments prove that the length-of time necessary to evaporate a given quantity of water into steam, as compared to an equal quantity of alum, is as one is to eight, or that alum-filling (water in crystallization) will resist heat eight times longer than any filling containing water in suspension or in liquid. The association of alum with plaster is such that the atmosphere cannot evaporate the water, and it is held subject only to heat, and that only can cause it to change into liquid form. The alum is distributed in small lumps all through the calcined plaster, and in such combination is packed tightly between the outer and inner cases of iron. With safes filled in this manner and with these ingredients there can be no deterioration. They remain fireproof for any number of years, or, in fact, until subjected to withstand a test, be that period sooner or later.



FOLDING-DOOR FIREPROOF SAFE.

Another feature that should receive attention is that this filling being a steam generator, the iron of the door casing cannot become a conductor of heat in case of fire, as the steam impinges upon the iron and keeps the temperature reduced. The filling being perfectly dry (rendering rust and dampness impossible) is of immense advantage. Messrs. Marvin & Co. have had many years' experience in the construction of safes, and have succeeded admirably in the practical application of principles essential to safety and security.

Where these safes have been subjected to severe tests, as in the case of the Chicago and Boston conflagrations, in the Bond street and the recent Barclay street fires, in this city, besides many others, they have proved to be absolutely fireproof. The warerooms of the manufacturers are at 265 Broadway, New York, and 627 Chestnut street, Philadelphia. Their celebrated "Centennial Safe," which contains a great number of memorial articles, portraits of celebrities, etc., and which is not to be opened until 1976, is now under the rotunda of the Capitol at Washington.