that not one of the deadly shafts struck her. It may be useful for alarmists to know that the Polyphemus would have had very little chance of ever reaching the boom, as she was blown up at least three times by the contact mines before she attempted to cut through the defenses.—*The Graphic*.

THE TORPEDO CURTAIN.

WHATEVER may be said of torpedoes, this engine of destruction is still in its infancy, and the probability that it will revolutionize all future naval warfare is still on the tapis, whatever may be the uncertainty that still follows the erratic movements of some of these destructive missiles. However we may sneer at the curious behavior of the present torpedoes, science is ever at work, and therefore it is necessary to keep a vigilant watch, and to protect our ships as much as possible from a too close acquaintance with those "Davy Jones' locker" persuaders. The majority of the ships with the late Evolutionary Squadron were protected with wire netting sufficiently strong, and with resisting power to explode the Whitehead torpedoes. Booms working on hinges moving outward from the ship's sides support curtains composed of stout iron rings. The booms are worked by pulleys from inboard, and can be hauled up or down at pleasure. When up they form festoons like a mosquito curtain round an Indian bedstead, but with meshes that would defy even the mosquitos of Mark Twain's Florida story. In a few minutes, at a given signal, the curtain can be submerged to a depth of fifteen feet, a distance sufficient to intercept the rush of a Whitehead. My sketch represents H. M. S. Sultan casting round her this nautical zeriba. The blue jackets, with their usual agility and adaptability to any kind of novel undertaking, almost hang on by their eyelids and toes while they spin their net to catch the lively torpedo.—*The Graphic*.

TORPEDOES AND TORPEDO BOATS CONSIDERED AS A SOLE MEANS OF DEFENSE FOR SEABOARD CITIES.

By M. P. HAYES.

THE article in the SCIENTIFIC AMERICAN of June 6, inviting discussion on the above subject, leads me to give you a description of a plan by which a vessel at anchor may be effectually protected from the attacks of torpedo boats.

We will take the case of any of the large ironclads of European navies which you have enumerated, say, for instance, the British ship *Inflexible*. Let us suppose her to have come up into soundings near enough to Sandy Hook or Coney Island to enable her to throw shells into Brooklyn, New York, or Jersey City. I am not presuming that she could do this if the harbor were properly protected, but it is certain that under existing circumstances she could do so; and the question is, to consider whether a numerous fleet of small, swift torpedo boats, without the aid of powerful land and floating batteries, would be sufficient to prevent her from so anchoring in the first place, or, after she had anchored, to blow her up or sink her.

With regard to the first condition, that is, of a hostile fleet approaching the coast for the purpose of bombardment, I am of opinion that the large vessels of the fleet can be effectually protected from torpedo boats by a numerous convoy of small steam launches kept circling round the ships, armed with short breech loading guns, sufficiently powerful to penetrate with shells the sides of ordinary torpedo boats at short range. These steam launches would also carry small spar torpedoes, which could be used with good effect against the approaching torpedo boats of the coast. They would also be supplemented by a few small, swift, armored ram tenders, which could aid very materially in the defense of the large ships by running down the hostile boats.

I think, with such assistance as would be afforded by six or eight steam launches so armed, and three or four small ironclad rams of good steam power, one of the large ironclads would have no great difficulty in beating off any number of torpedo boats that might try to prevent her from anchoring. Of course the number, size, and power of the launches would have to be proportioned to the number and speed of the torpedo boats likely to come out, and the gun boats and rams would have to proceed sufficiently far in advance of the ship to meet and intercept such of them as might escape the shot of her own long range rifles. I have no faith in any machine guns to keep off torpedo boats; even the 55 mm. Hotchkiss or Gatling, though it may penetrate the sides of a boat, and do a good deal of mischief, will not stop her. The only way in which you can really stop a torpedo boat is by blowing up her boiler with a pretty heavy shell, or running her down with a ram; you might, of course, blow her up with another torpedo, but she may be going too fast for that to be possible. The launches, however, could be so placed that any approaching boat must pass within quite short range of their guns; and if they were numerous enough, the torpedo boats would stand a poor chance of passing with impunity, supposing any of them to have run the gantlet of the rams, which would be naturally stationed in advance of the launches.

It is, in fact, almost certain that a hostile fleet, approaching New York harbor could so completely blockade the front of the harbor, in advance of the heavy ships, with steam launches, small gunboats, and swift steam rams, that no torpedo boats could get out to sea at all, much less approach near enough to any of the heavy ships to attach torpedoes to them.

It comes, then, to this, that notwithstanding any number of swift torpedo boats that might be in the harbor, and ready to go out, the hostile ironclads could anchor off Coney Island near enough to shell the cities, if the defense were left to torpedo boats alone.

We will now consider the case of the *Inflexible*, as one of the ships so anchored and engaged in bombarding the city. Is it possible to so protect the ship that she would be reasonably safe from the attacks of torpedo boats that might escape the vigilance of her outlying sentries and picket guards of launches, gunboats, and rams?

The *Inflexible* is, say, 325 feet long and 72 feet wide, or thereabout. She is at anchor in, say, 10 fathom water. At a distance of 200 feet in front of her bows

she drops two small kedges or mushroom anchors, 472 feet apart, in a straight line across her bows; each of these anchors has a floating buoy attached. A similar pair of buoys are anchored at the same distance astern. Intermediate buoys are anchored 200 feet off the ship's sides amidships; all these buoys are now connected with a pretty stout wire cable, the buoys having sufficient displacement to float the cable close to the surface of the water. At intervals of ten feet all the way round on these cables small torpedoes are placed, and so connected to each other by suitable wires that any boat attempting to cross the cable must explode at least two of the torpedoes close under her bows. These torpedoes would also be connected by wires to the ship, so that any one or more of them could be exploded at will. This forms the outer line of defense against torpedo boats.

The next line is formed of a similar line of buoys and torpedoes, placed at a distance of one hundred and twenty feet from the ship's side, and having its torpedoes so placed that they come in the intervals between those of the outer line, thus presenting a cordon of torpedoes only five feet apart, all round the vessel, at a distance of one to two hundred feet.

It would be extremely difficult for any torpedo boat, however swift she may be, to run through such a line without exploding some of the torpedoes to her own destruction.

Supposing, however, for the sake of argument, that she does get through this line, or that a second or third boat gets in where their predecessors had exploded the torpedoes and broken the line, they would only do so to encounter the real circle of defense, which I would make as follows:

At distances of twenty to thirty feet all round the ship, I would have very stout swinging booms sixty feet long by twelve to eighteen inches in diameter, suspended by suitable tackle to the masts. From the ends of these booms I would have suspended a deep and very heavy netting of flexible steel wire rope of one inch to one and a half inches diameter, and having at short intervals stout wire cables attached to mushroom anchors, so placed as to keep the netting perpendicular at sixty feet from the ship all round.

IMPROVED SLOT-DRILLING MACHINE AT THE INVENTIONS EXHIBITION.

The netting should be deep enough to reach several feet below the bottom of the ship, to resist submarine boats or torpedoes. Then a close line of automatic exploding torpedoes should be attached to the upper line of this netting in such way that no boat could touch the netting without being exposed to an explosion at very close quarters.

The dimensions of the ship being as stated, it will be seen that the material for this system of defense could quite easily be carried on board the ship, and would not seriously interfere with her other loading or equipment. The large booms would be the most cumbersome part of the equipment; twenty of them would have to be carried on the spar deck or slung alongside under the channels; they would weigh ten tons. The wire cables for the two outer lines would be stowed in coils in the hold; they would weigh seven tons. The wire rope for the inner netting would weigh from thirty to fifty tons, according to the size rope that was used; the mushroom anchors would weigh, say, ten tons. The torpedoes for the cable and netting would weigh, say, fifty pounds each, or about twelve tons in all. Thus the extra weight the system would require to be carried would be approximately eighty tons. If this were found to interfere with the distribution of the weight on board, the whole equipment could be carried in a steam tender.

You will thus see that a hostile fleet could not only blockade your torpedo fleet with an equally numerous and effective fleet of launches, gun boats, and rams, of as good power and speed as your torpedo boats, but each vessel of that fleet could be so effectually protected, by some such devices as I have described as to be practically unassailable by torpedo boats while at anchor in hostile waters.

As to defenses by means of any kind of submarine torpedoes, unprotected by powerful armor-piercing guns on shore or afloat, I think it may be considered almost an axiom that they are of small value, since they can be removed or exploded by countermining and dragging with small boats.

I would not be understood as arguing against the value of torpedoes and torpedo boats as means of defense. On the contrary, they are among the most efficient and powerful of such means, but they are only auxiliaries, just as artillery on land. He would hardly

be considered a very wise general who would trust the fate of battle to his artillery alone, particularly if he knew that the enemy were likely to have at least as good artillery, and several "heavy battalions" of infantry besides.

So with regard to torpedo boats; they would be invaluable as aids in the defense, if you had some powerful floating batteries, armored and armed with long range rifle guns, to drive off the auxiliaries of the enemy and clear the way for the torpedo boats; but to depend on torpedo boats alone for the defense of a harbor like New York would be, to say the least, a species of mild Chinese insanity. It would doubtless result in a similar catastrophe to the city as that which befell the Celestial Admiral's flag ship, so graphically described in your editorial of the 6th.

On the subject of rifled guns, it is quite possible to get very powerful guns cast of solid steel and rifled in this country. There are several companies in the United States who would be willing, and are quite able, to manufacture excellent rifled steel guns of large caliber and great power, if the government would guarantee sufficient orders to warrant the necessary outlay for plant. Recent improvements in steel casting render it perfectly possible to produce guns up to twelve inch caliber of a solid steel mass, in a single casting, having tensile strength abundantly sufficient to resist any strains they are likely to be subjected to. A good battery of such guns placed behind heavy earthworks at Coney Island would be a real protection to your harbor. There is no armor afloat that can successfully resist the repeated impact of steel shells from such guns, and no vessels that could anchor or approach with safety within their range.

THE INVENTIONS EXHIBITION, LONDON.

Improved Slot Drilling Machine.—At the Inventions Exhibition, London, Hulse & Co., of Salford, show a horizontal slot-drilling machine, which is designed, says *Engineering*, for making cotter holes in connecting rods, keyways, etc. Circular work is held in a vise with V jaws at one end, and at the other is supported by a movable headstock. Both of these are shown in

the illustration. Work of other descriptions may be bolted to a grooved table which is placed along the bed, the movable headstock and the vise being removed. There are two drilling headstocks as shown. These operate at both sides of the work, and are provided with self-acting feed and disengaging motions. The sliding carriage is moved along the bed by a crank placed under it, and this is actuated by the elliptical spur-wheels plainly shown in the illustration. The wheels being elliptical give a uniform traverse throughout, whereas if circular wheels were used the angular motion of the connecting rod would affect the speed of travel. The self-acting feed motion to the drilling headstocks is obtained by means of a cam motion above the elliptical driving wheel as shown. The self-acting disengaging motion to each drilling headstock is obtained by means of a sliding rod and claw-clutch, which is also to be seen by reference to the illustration, and which is brought into operation by means of a stop on the headstock.

Paper Bag Machine.—There are few more interesting and ingenious objects in the Inventions Exhibition than the paper-bag making machinery shown by Mr. F. D. Bumsted, of Hedgesford, in the West Gallery. We give an illustration of this apparatus, which is capable of turning out thirty-eight 1 lb. sugar-bags per minute, the whole operation being automatic, an attendant only being required to remove the bags when made and fill the hoppers with paste at intervals. It would be clearly impossible to give more than an outline description of the apparatus without the help of numerous diagrams. At one end of the machine a continuous roll of paper is placed as shown to the right of the illustration, and as this is unrolled it is carried to the first pasting roller (shown under the hopper above the table), which lays on a continuous strip of paste near one edge. The motion by which the web of paper is unrolled is intermittent, it being stopped in order that another strip of paste may be applied to make the bottom joint of the bag. This is done by a lifter rising and pressing the paper against the transverse pasting roller. Both rollers and the hoppers by which they are fed are shown in the illustration. The paper again passes on until the proper length to form a bag has been unwound, when it is again brought to rest, and a knife descends, cutting off the requisite quantity. The