BULKHEADS FOR STEAMSHIPS.

One of the most important papers read at the recent meeting of the Institution of Naval Architects, London, was that by Mr. James Dunn, on the above subject. Our engravings are from the *Engineer*.

The author dealt with vessels of the mercantile marine, and submitted three propositions for consideration: (1) Is the subdivision of a merchant ship by watertight bulkheads practicable, and consistent with commercial requirements? (2) Can these bulkheads be made sufficiently strong to withstand the pressure of water under all circumstances? (3) Are bulkheads of any value in securing floating powers for the ship in the event of damage from collision or other causes? He began by sketching the history of bulkheads, and went on to consider the forces acting on bulkheads. He assumed one compartment laid open to the sea by the tearing of the side plating, and we shall have—(1) The statical pressure due to the given depth of water in the hold when the ship is at rest and no cargo on board. (2) That due to the pressure when the holds are wholly or partially filled with cargo, and the ship still at rest. (3) That due to the extra pressure when the ship is under way, or alternately rising on the crest or falling to the hollow of a wave. (4) That due to the rolling, pitching, and 'scending of the ship herself.

He then considered the effect of these strains, and said that in constructing bulkheads the very general practice is to adopt the rules laid down by Lloyd's Registry, which provide for plating $\frac{4}{16}$ in. in thickness for a 1,000 ton ship to $\frac{7}{16}$ in. in thickness for the largest class. In the smaller ship the plating is stiffened with vertical angle bars, with flanges of 3 in. and 2½ in. in width, and $\frac{5}{16}$ in. in thickness, placed 30 in. apart; and for the largest type of ship, with the thicker plating, these vertical stiffening bars are still placed 30 in. apart, but the flanges are each 4½ in. wide, and their thickness is increased to $\frac{7}{16}$ in.

Where a deck exists, it of course acts as a longitudinal stiffener or prop; and where the internal arrangements dispense with a deck, but where the distance between the horizontal angle bar at the head of the bulkhead and the floor exceeds 8 ft., an angle bar equal to the main frame of the ship is riveted to the bulkhead on the opposite side to that on which the vertical stiffeners are placed and arranged horizontally; and where this distance exceeds 12 ft., two such stiffeners are provided, and so on, the number of them being added to as the depth increases.

These arrangements, he submitted, if efficiently carried out, should be sufficient to enable the bulkheads to hold their own in ships of the narrower type; and, as a fact, we know they have actually withstood the test under severe trials. Three years ago 50 ft. was a great beam, but we have now an Atlantic liner with a beam of 57 ft.; and the time had come for us to consider what additional means must be adopted to secure the safety of bulkheads. He urged now for ships of great breadth, and for bulkheads of great area, that a vertical web-plate should be fitted at the middle line, say from 12 in. to 24 in. in depth, with angle bar flanges, and secured to the bulkhead and to the several decks and the floors; and some of the angle-bars between it and the sides of the ship replaced by good stiff bars of a Z section. He next contended that bulkheads are useless if not wisely placed, nor carried high enough, nor efficiently cared for; they are useless when found, as he had found them, with stiffeners cut, with rivets omitted, with calking neglected, with plates removed, with large holes cut for small pipes to pass through, with sluice holes and no covers, with doors and worthless securities, or with open doors rusted and unmanageable, or with doors in the holes fastened open in such a way that they cannot be closed without "handling," and are out of reach at the moment of danger.

He would go further, and say that they are not only useless, but that under some circumstances they are positively dangerous. This might, perhaps, be thought a serious and startling assertion; but he would take the case of a ship illustrated by Fig. 1—and there are many such ships now afloat—in which a good number, a really large number, of bulkheads are provided and distributed as shown, but three of which, it will be seen, are stopped at the deck, which is awash. The bottom gets damaged and springs a leak, say in No. 1 hold, or in No. 2 hold, or in both; and how many such cases had they known where the water enters and gains on the pumps, and slowly, but surely, rises to the top of the dwarf bulkhead, causing the ship to trim as indicated in Fig. 2. The water is then free to flow over the top of the bulkhead and pour into the next hold, the effect of which is inevitably to send her head first to the bottom.

The author held that such a ship would keep afloat with the water in No. 1 hold and in No. 2 hold, provided it is confined by the bounding bulkheads being carried a few feet higher than the natural level. What this natural level is, and to what height the bulkhead should be carried, are points readily determined by the navel architect. But if they are not carried up, but are left as shown—and in too many cases they are so left—then the author held they had better not be in the ship at all, as they would contribute to her loss by keeping the water at one end of the ship and carrying her bows under; whereas, if they are not fitted, the same volume of water entering as is indicated in the preceding diagram, and not being confined to one end, will distribute itself through the ship all fore and aft, in which case the trim is preserved, and she will still float in the position indicated in Fig. 3. Here, although the freeboard is reduced, she will still be seaworthy; the fires may be kept burning and the machinery going sufficiently long to bridge over the space dividing life from untimely death.

Taking two other cases, in one of which the bulkheads were well placed and cared for, and proved that under such conditions they may be of the greatest value; the other case is in all respects a contrast. In the first case they were placed in the positions and carried to the height indicated in Fig. 4. A steamer of nearly 5,000 tons ran into this ship in a fog, struck her abreast No. 3 bulkhead, opening up two compartments to the sea; but, fortunately, the bulkheads had been carried to a reasonable height, and the water could not get beyond them; they stood the test, she did not sink, but she kept afloat at the trim shown in Fig. 5, and in this condition steamed 300 miles safely into port.

Happily, they are now getting a number of such ships, and many similar facts giving actual beneficial results might be placed before them if time would permit, so he would consider the next case, where we have the same number and a similar disposition of bulkheads as in the previous case; but, unfortunately, some of them are rendered valueless by being stopped at or about the water line, as indicated in Fig. 6. This sketch represents a large number of first class steamers now afloat, and should such an accident happen to any of them as has just been described, they would certainly not have the good fortune to complete their journey, as in the last case; but the water, not being confined to the two holds numbered two and three, as it was in the previous case—which is an actual one—will pour over the top of the dwarf bulkhead into the foremost hold, and the ship will soon get into the position indicated in Fig. 7. Water will then be reported to be making in the engine room, if, indeed, she should not disappear before then.

The author then referred to models exhibited at Spring Gardens. The models are loaded with weighted wood blocks, the blocks being of a bulk to represent the cargo in a passenger ship floating at an ordinary load draught with each compartment below the upper 'tween decks appropriated to cargo, having one-half its space occupied—a condition ordinarily assumed at the Admiralty when determining whether a ship is qualified for the Admiralty list—and they fairly represent such a ship as regards their measure of stability. A hole is made through the bottom plating, to represent an actual hole about one square foot in area, and eight feet below the water surface in each compartment, and a plug is placed in it, so that by removing a plug any part of the model may be laid open to the water. The first, which we will call B, or the badly bulkheaded model, very soon disappears after the withdrawal of any one of the plugs, because the water rushing in soon rises to the level of the water outside, and is then, or before then, free to flow over the top bulkhead into the adjoining hold.

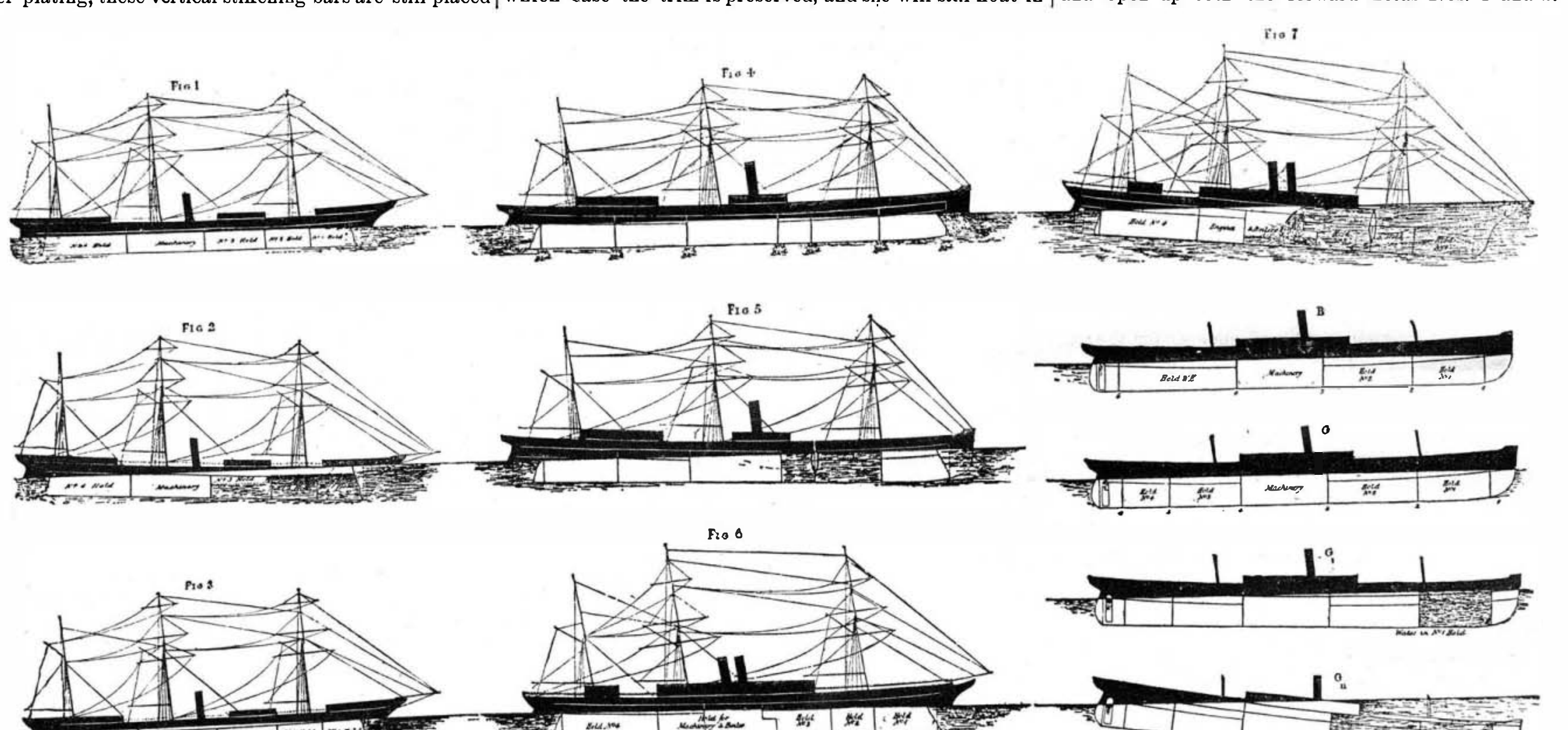
Take, for example, the plug out of the bottom in way of No. 1 hold. But if the corresponding hole in the good, or G, model is opened up, the water soon gets in and find its level, but it is then confined between the bulkheads, and the model remains afloat in the position indicated in G_1. Whatever experiment is made in this direction with the B model, the result is the same, viz., she goes down; so we will dismiss her from further consideration, and go back to the G model. Her position with the forward compartment filled is shown in sketch G_1, and that sketch also represents the trim she would take if the damage were to occur in the second hold from forward instead of the first, because although this No. 2 hold may be and often is the larger, it is nearer the center of gravity of the water plane, the leverage is less, and the effect on the trim is modified. Take another case, and open up both the forward holds Nos. 1 and 2. Of course, we expect that the ship will then go down, because the alteration of trim will be so great that the top of the boiler room bulkhead, although carried to the upper deck, is dragged below water, and the engine room becomes filled; and thus we have the forward three compartments full, which would undoubtedly sink her.

But suppose we keep the water out of the engine room, which we can do by making water tight the casing round the funnel and engine room hatch to, say, 8 feet above the deck. In smooth water the ship would have buoyancy and stability, even when in this damaged state, and would float, as indicated in sketch G_{11}. As an illustration of the great general importance of the subject of bulkheads in merchant steamers, the following statistical details and deductions should be of interest. The advantages of good subdivision are broadly indicated in the annexed table, showing the number of vessels and the losses for six years ending December, 1882:

	Number.	Losses.	Average loss per annum.
Ships qualified for the Admiralty list.....	157	1½	1 in 86
Ships not qualified for the Admiralty list,	3,483	136	1 in 25

These figures are very significant. It appears from them that the chances of loss from any cause are nearly four times as great for a ship not constructed to qualify for the Admiralty list as for a ship entered on that list. This proportion is greatly due to the almost absolute immunity from loss by collision of ships on the list, for during the first four and a half years of its existence not one ship was lost from it by collision, although a considerable number of the qualified ships had been in collision, and escaped foundering on account of the safety afforded by their bulkheads.

Within the last year, however, they had had six casualties to ships on the list, and among them was our only loss by collision. In that case the whole of the ship—a small one—



DIAGRAMS OF BULKHEADS FOR OCEAN STEAMSHIPS.

was flooded abaft the engine room, the two after holes being opened to the sea. This was a case such as they have no merchant steamers afloat capable of surviving. During this time the whole of the losses from the Admiralty list—eleven in number—have been from drifting on rocks, or otherwise drifting on shore, with the solitary exception above quoted. In the same period seventy-six ships have been lost which had been offered for admission to the Admiralty list, but had not been found qualified; of these, seventeen, or 22½ per cent, were lost by collision, and ten, or 13¼ per cent, were lost by foundering; most of the rest stranded or broke up on rocks. That the general superior character of the ships on the list is of no value in reducing the risk of collision is shown by the following comparison.

It can be proved that of the entire British mercantile fleet of steamers about 1 per cent, without distinction, receive damage of a fatal character by collision during the year. Of the number thus damaged, those on the list remain afloat, while those not on the list are lost. This is deduced from the following figures: Referring to the table given above, he would take only those cases of collision to ships on the list which would have proved fatal but for their compliance with Admiralty requirements. These are 9, or an average of 1½ per year, giving 1½ in 157, or 1 per cent of prevented fatal cases. Again, the average number of ships sunk by collision per year from the unqualified part of the fleet is 35, and the average annual record of the fleet for the six years is about 3,500, also giving 1 per cent of—in this case—fatal cases. Thus the risk of fatal collision is about 1 to 100, irrespective of the class of ship, and thus ships on the Admiralty list enjoy almost absolute immunity from loss by this cause. It is therefore proper to consider that the vessels on the list have no natural advantages with regard to their safety beyond that due to their bulkheads.

Two New Gelatine Emulsions.

F. Knebel offers the following formula: 20 parts of hard gelatine (Winterthur) are soaked in 200 parts of distilled water (1 in 10 by weight) and afterward dissolved by heating. He then adds 24 parts of potassium bromide and ¼ part of potassium iodide in solution, and 3 or 4 drops of acetic acid or 0·1 part of citric acid. Secondly, he dissolves 30 parts of crystallized silver nitrate in 100 of water. Thirdly, a gelatine solution for subsequent use is made of 14 parts of hard gelatine and 6 parts of soft gelatine, for summer use; but if it is to be used in winter, 10 parts of each are taken. They are softened first, and then dissolved in 250 parts of water. The silver nitrate solution is *gradually* poured into the first gelatine solution and the vessel rinsed with half as much water (50 parts), which is also added. The emulsion is now digested for two hours on a water bath at 65° or 70° C. (150° or 160° Fahr.). It is quickly cooled to 30° C. (86° Fahr.) by placing it in cold water. Next, 6 or 7 parts of ammonia (specific gravity, 0·920) are added to No. 3, which must be nearly cold and not very fluid. It is well stirred and then poured into the emulsion, which is at 30° C., shaken thoroughly, and filtered through flannel and afterward in Braun's apparatus, after having first been pressed through canvas and well washed. It is now ready to be poured upon the plates to dry. Another method, by Pizzighelli and Hubl, is called the cold method.

No. 1. One part of gelatine, 50 parts of water, 2 parts of ammonium carbonate, 15 parts of ammonium bromide, 2 parts of potassium iodide solution (1 to 10), 140 parts (by volume) of 92 per cent alcohol, from 1 to 5 of ammonia water.

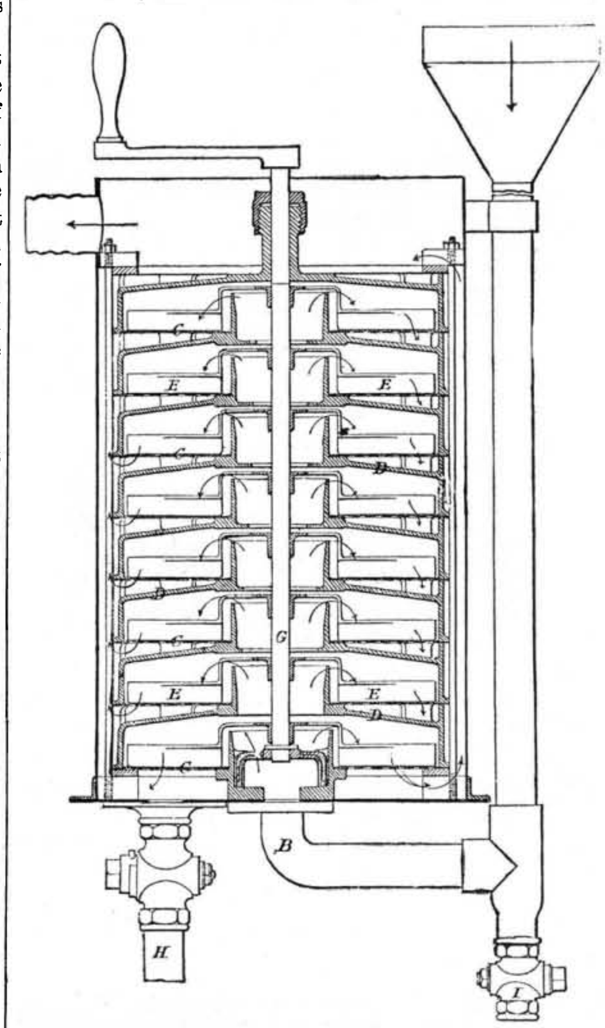
No. 2. Silver nitrate, 20 parts in 100 parts of water.

No. 3. Hard gelatine, 24 to 30.

The constituents of No. 1 are mixed in the order there given, except the gelatine, which is softened and dissolved, then added. The more ammonia the softer and more sensitive the photographic film. The emulsion is formed as usual by adding No. 2 to No. 1, under the well known precautions. They are digested as usual about five hours, then the emulsion is poured into a beaker glass and No. 3 stirred in, allowed half an hour to soften, and completely dissolved on a water bath. It is now rapidly stirred and 500 parts (by volume) of strong alcohol added, which precipitates the emulsion. The lumps that form are melted in small portions and poured into cold alcohol, where it is stirred with a glass tube, two inches in diameter, closed at the lower end. The emulsion attaches itself to the tube, and is then washed half an hour in flowing water.

PIEFKE'S FILTER.

The filtration of water is, from both a sanitary and manufacturing point of view, one of daily increasing importance; our rivers are becoming more and more polluted, and the value of space is increasing too rapidly to admit of large sand filtering beds and settling tanks being adopted for the purification of water for domestic and manufacturing purposes. The filter which we illustrate from *Engineering* is designed to combine in the smallest possible space the largest and most effective filtering surface, and differs not only in construction but also in the material used from any previously employed. It is the invention of Mr. Carl Piefke,

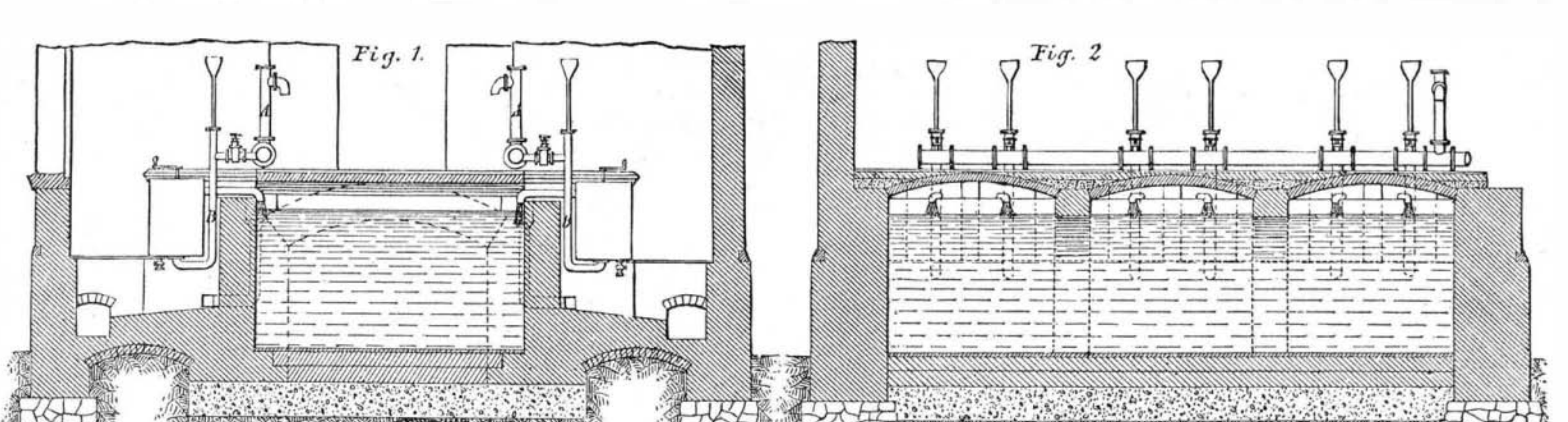


PIEFKE'S IMPROVED RAPID FILTER.

chief engineer of the Berlin Water Works, and is manufactured by Messrs. G. Arnold & Schirmer, engineers in Berlin; it has been adopted in several large industrial establishments on the Continent on an extensive scale.

Our illustrations, Figs. 1 and 2, show a general arrangement of a filtering plant, consisting of twelve of these filters, each capable of purifying 1,100 gallons per hour. A large reservoir in the center of the building collects the clean water; the filters are grouped two and two, in two rows of six each side, and are supplied with water through the mains, A, A, while the funnels serve to charge the filters with the filtering material. Three tanks, together with thirty-six filters, have been recently fitted up by Messrs. Arnold & Schirmer at a large bleaching establishment near Warsaw, where about 800,000 gallons of filtered water are used daily.

The filter itself, shown in section in Fig. 3, consists of a wrought-iron casing containing a number, here twelve, of perforated brags, C, which form the bottom of flat bell-shaped cast-iron vessels, D, the whole grouped one above the other inside the casing. The water to be filtered enters by the funnel, A, and through pipe, B, runs into the vessel, overflowing in the direction of the arrows, and after passing through the filtering material spread upon the perforated brags, C, rises till it overflows at the outlet. The filtering medium is chemically prepared cellulose or vegetable fiber, and is variously treated according to the purpose for which the filtered water is to be used, or, in other words, according to the degree of purity required in the filtered water. Its price varies accordingly; the best quality is charged at 75s. per cwt., and a filter capable of purifying 1,000 gallons of water per hour requires, for its first charge, about 3 lb. of filtering material. To charge the apparatus, the fiber is mixed with water to a thin paste and admitted through the funnel, when it deposits in an even layer over the perforated surfaces, C, and the filter is then quite ready for action. After about 1,200 gallons of water have been purified per square foot of filtering area, the latter requires cleaning or washing out; this is performed in a very simple manner by charging the filter with water in the usual manner, and at the same time slowly rotating the vertical spindle, A, which carries the scrapers, E, and by means of which the filtering material is suspended in the water, the latter washing out the impurities. As soon as the water runs clear again the rotary action is stopped, and the tap, H, on the bottom of the casing opened to allow the water to run off, and the filtering material to settle, when the filter is again ready for use. The quantity of water which may be filtered before it becomes necessary to clean the fiber depends, of course, largely on its state of impurity, and it is advisable to use as a guide the pressure required to force the water through the filter. This should not exceed from 3 ft. to 4 ft. of water pressure, and it is therefore best to place the funnel about that height above the overflow. At each cleaning a small quantity of filtering material is naturally washed away with the impurities; this amounts to about 10 per cent, which quantity should be replaced by admitting it with the water. For the purpose of washing out the filter it is not necessary to use filtered water, nor is water of any particular pressure required; it may be simply charged through the delivery pipe. If at any time it becomes desirable to entirely empty the filter of the filtering material, water is charged through the delivery pipe or into the open vessel, and the tap, I, at the bottom of the supply pipe, A, is opened, when the fiber will run out with the water. The apparatus can be recharged as described above, and for the complete operation of cleaning one filter, one man only is required for about ten minutes. This filter is recommended by the manufacturers for purifying water for all purposes, a small size measuring only 9 in. in diameter and 15 in. high inside, and carrying only about 1 oz. of filtering material, is specially manufactured as a portable filter for military purposes, capable of filtering over 80 gallons of water per hour; this is apparently a very handy form, and certainly a very valuable addition to the field equipment of an army. We understand that Messrs. Arnold & Schirmer are about to make arrangements for the manufacture of these filters in this country.



PIEFKE'S IMPROVED RAPID FILTER.

The Diamond Rattlesnake.

Of all the snake varieties of which we have yet any knowledge, the diamond rattlesnake, as it is called, seems to be the most deadly. It grows to a length of six feet or seven feet, and is somewhat thicker than a man's wrist. It is armed with the whitest and sharpest of fangs, nearly an inch in length, with cisterns of liquid poison at their base. A terror to man and beast, he turns aside from no one, although he will not go out of his way to attack any unless pressed by hunger. A description of his movements by a traveler who has encountered him states that he moves quietly along, his gleaming eyes seeming to emit a greenish light, and to shine with as much brilliancy as the jewels of a finished coquette. Nothing seems to escape his observation, and on the slightest movement near him he swings into his fighting attitude, raising his upper jaw and erecting his fangs, which in a state of repose lie closely packed in the soft muscles of his mouth. This snake is not so active as the famous copperhead of North America, nor so quick to strike, but one blow is almost always fatal. His fangs are so long that they penetrate deep into the muscles and veins of his victim, who has little time for more than a single good-by before closing his eyes forever. In one instance the fangs were found to be seven-eighths of an inch in length, and though not thicker than a common sewing needle, they were perforated with a hole through which the greenish-yellow liquid could be forced in considerable quantities, and each of the sacs contained about half a teaspoonful of the most terrible and deadly poison.

THE official returns give the value of the tobacco consumed in France in 1882 at 363,500,000 francs. Cigars show a total of 60,500,000 francs; cigarettes, 16,000,000; and chewing tobacco, 9,000,000. The heaviest amount, 278,000,000 francs, was for ordinary smoking tobacco.