and her mate are of 1,237 tons more displacement than the Indiana, and yet, as at present designed, the horse power is to be only ten thousand, which is the amount that was indicated by the Massachusetts during her recent trial. The estimated speed corresponding to the ten thousand horse power of the Kearsarge is fifteen knots. It would be a wise policy to make the fifteen and a half to sixteen knot speed of the Indiana type the lowest allowable rate of speed for the battleships of the new navy. When a fleet goes into action, its speed will be limited to the speed of the slowest ship, and a wise policy would suggest that the new battleships should be as least as fast, if not a little faster than, their predecessors, even if this should involve the addition of another thousand horse power to their boiler capacity.

The Massachusetts and her sister ships are designed specially for coast defense, as distinct from the Iowa, which is a seagoing battleship. They sit low in the water, their freeboard being about 12 feet, and consequently they will form a more difficult target to hit than the lofty ships of some foreign navies which have a freeboard of over 20 feet.

Their sphere of action will lie off the coasts and in the harbors and roadsteads, although it should be understood that, if called to do so, they could make the transatlantic trip with ease. As they will operate within easy reach of the home ports, they do not require to carry a large supply of coal and ammunition. The weight which is ordinarily devoted to these in the seagoing ship has been devoted in the Massachusetts to guns and armor, with the result that she could deliver heavier blows and stand more hammering than any other battleship afloat.

Protection.—The "vitals," that is the engines, boilers, and magazines, are protected by a continuous vertical wall of 18 inch armor at the water line, 7½ feet high, which is roofed in by a flat steel deck 2¾ inches thick. At each end of this armored wall a circular barbette of 17 inch armor is built up to a height of 15 feet above the water line. Within this revolves a turret of 15 inch steel, in which is placed a pair of 13 inch guns. It will thus be seen that from the water line up to the guns there is a continuous wall of steel 17 and 18 inches thick to protect the turret machinery, the powder and shell, and the gun crew.

The eight 8 inch guns, which are carried at the great height of 26 feet above the water line, are similarly protected. A stout ammunition tube of 5 inch steel protects the ammunition in its passage from below the armored deck to the base of the barbettes. The barbettes are protected by 8 inches and the turrets above them with 6 inches of steel. The 6 inch guns are protected by 6 inches of steel, and shells are prevented from entering and bursting below them by a belt of 5 inch steel, which rises above the 18 inch belt armor. A conning tower situated at the base of the military mast, and protected with 10 inches of steel, will shelter the commander when he takes the ship into action.

Now, when it is remembered that the 18 inch armor is barely penetrable by the heaviest artillery under ideal conditions at the proving ground, and that the

VANITY FAIR AT OLYMPIA—SCREENING THE LADY.

6 and 8 inch armor is equally proof against the shells of the heavier class of rapid firing guns, it is safe to say that the Massachusetts could carry her guns unharmed through a long protracted naval fight.

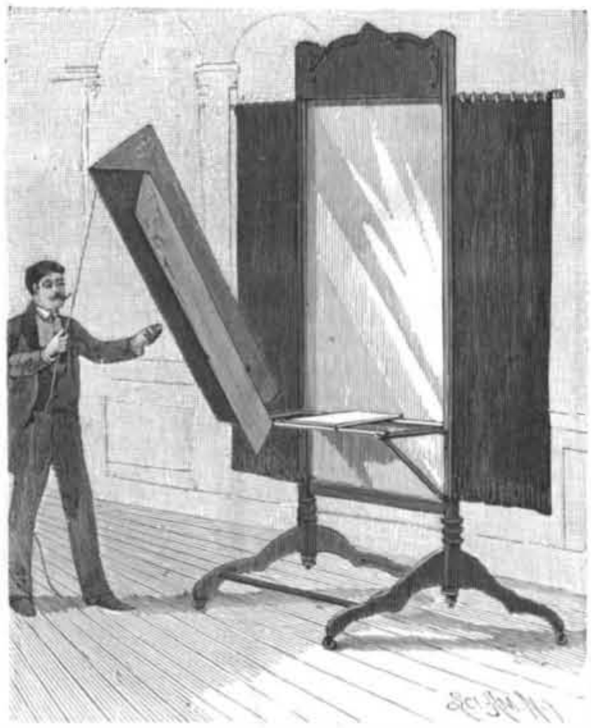
Armament.—The great offensive power of the Massachusetts is shown in the accompanying table.

No.	Caliber Inches.	Weight of shot Pounds.	Muzzle velocity Feet.	Muzzle energy Tons.	Muzzle penetration of iron Inches.
4	13	1,100	2,100	36,627	34·6
8	8	250	2,150	8,011	21·6
4	6	100	2,150	3,204	15·6
20	6-pounder rapid firing guns.				
6	1-pounder " "				
6	Torpedo tubes.				

It is the battery of 8 inch guns which gives this type of vessel its superior power of attack as compared with other ships; and in a naval duel it would probably decide the issue in its favor.

THE ILLUSION VANITY FAIR AT THE OLYMPIA.

We illustrate a very clever illusion which has recently mystified thousands of people who patronize



VANITY FAIR AT OLYMPIA—THE LADY HAS VANISHED.

the Olympia in this city. It presents the disappearance of a lady, apparently through a solid looking glass. The method used is remarkably ingenious.

A large pier glass in an ornamental frame is wheeled upon the stage. The glass reaches down within about two feet of the floor, so that every one can see under it. The only peculiarities which a skilled observer would be apt to notice are a wide panel extending across the top of the frame and a bar crossing the glass some four feet from the floor. The first is ostensibly for artistic effect—it really is essential to the illusion. The horizontal piece purports to be used in connection with a pair of brackets to support a glass shelf on which the lady stands—it also is essential to the illusion.

Brackets are attached to the frame, one on each side, at the level of the transverse piece, and a couple of curtains are carried by curtain poles or rods extending outward from the sides of the frame. Across the ends of the brackets a rod or bar is placed and a plate of glass rests as a shelf with one end on the rod and the other on the horizontal piece, thus impressing upon the audience the utility of the crosspiece. Its real function is not revealed.

A lady steps upon the shelf, using a step ladder to reach it. She at once turns to the glass and begins inspecting her reflection. The exhibitor turns her with her face to the audience and she agains turns back. This gives some byplay, and it also leaves her with her back to the audience, which is desirable for the performance of the deception. A screen is now placed around her. The screen is so narrow that a considerable portion of the mirror shows on each side of it. All is quiet for a moment, and then the screen is taken down and the lady has disappeared. The mystification is completed by the removal of the portable mirror, it being thus made evident that the performer is not hidden behind it.

Two of our cuts illustrate the performance as seen by the audience, the third explains the illusion. The mirror is really in two sections, the apparently innocent crossbar concealing the top of the lower one. The large upper section is placed just back of the lower piece, so that its lower end slides down behind it. This upper section moves up and down in the frame like a window sash, and to make this possible without the audience discerning it the wide panel across the top of the frame is provided. When the glass is pushed up, its upper portion goes back of the panel, so that its upper edge is concealed.

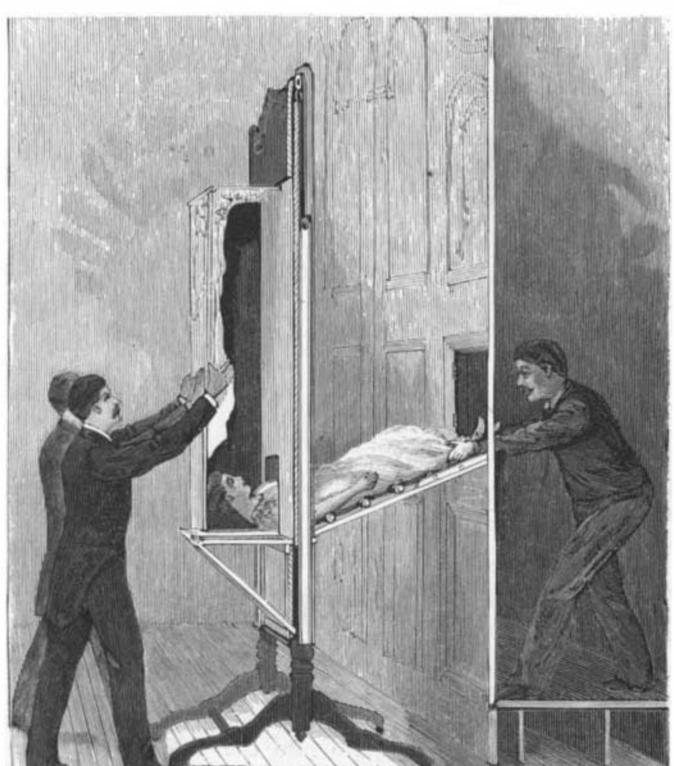
Out of the lower portion of the same mirror a piece is cut, leaving an opening large enough to admit of the passage of the person of the lady, The third cut, with this description, explains everything. The mirror as brought out on the stage has its large upper section in its lowest position. The notched portion lies behind the lower section, so that the notch is completely hidden from the audience. When the glass shelf is put in place, the performer steps upon it and is screened from view. The counterpoised glass is raised like a window sash, exposing the notch. The screen is just wide enough to conceal the notch, the fact that a margin of the mirror shows on each side of the screen still further masking the deception. From the scene piece back of the mirror an inclined platform is projected to the opening in the mirror. Through the opening the lady creeps and by the assistant is drawn away behind the scene; next the platform is removed, the glass is pushed down again, and, the screen being removed, there is no lady to be seen. The fact that some of the mirror was visible during the entire operation greatly increases the mystery. The lady passes through the notch feet foremost, and her position, facing the mirror, makes this the easier.

Lippman's Interference Color Photography.

In a lecture before the Royal Institution, of London, on April 17, M. Lippman, as reported in Photography, stated that the essentials of his interference method of photography in colors required an emulsion almost transparent, with no visible grain, the film to be in contact during exposure with a mirror, for which a sheet of platinum could be used, but mercury was better. The rapidity of light was stated to be 186,000 miles per second, but by means of the mirror it was induced to stand still and have its portrait taken. The formation of the stagnant waves was shown by a very pretty experiment with an India rubber tube suspended from the ceiling; and the explanation that at the nodal points there was no movement of light, and consequently no reduction of silver, led up to the explanation of the deposition of the silver in strata, of which there were about five hundred in the thickness of an ordinary sheet of note paper.

The reproduction of color by these negatives was explained from the analogy of the phonograph, which was able to set up vibrations similar to those which had caused the impression on the cylinder.

MIMICRY IN PLANTS.—While, in animals, color is greatly influenced by the need of protection from their numerous enemies, plants rarely need to be concealed, and obtain protection by their hardness, their spines, their hairy covering, or their poisonous secretions. There seem to exist, however, a few cases of true protective coloring, the most remarkable being that of the stone mesembryanthemum of the Cape of Good Hope, which in form and color closely resembles the stones among which it grows: and Dr. Burchell, who first discovered it, believes that the juicy little plant



VANITY FAIR AT OLYMPIA—THE DISAPPEARANCE EXPLAINED.

thus generally escapes the notice of the cattle and wild herbivorous animals. Mr. J. P. M. Weale has also noticed that many plants growing in the stony Karoo have their tuberous roots above the soil, and these so perfectly resemble the stones among which they grow that, when not in leaf, it is almost impossible to distinguish them.

Recommendations in Regard to High Pressure Gas Cylinders.

Some time ago, after an unexplainable explosion of a gas cylinder at a suburban railway station near London, the Secretary of State appointed a committee to investigate and obtain scientific advice. The committee gave the matter careful consideration and ascertained that, of nineteen cases of explosions in different parts of the world, four were due to carelessness, one from mixed gas or vapor due to improper compressing arrangements, four to bad cylinders, three to bad cylinders or to excessive pressure due to overcharging, one due to ignition from oil, and one for which no cause can be assigned. Five were caused by explosions of pressure gages or reducing valves attached to cylinders. The report says further, which we find in the Magic Lantern Journal and Photographic Enlarger, that the committee offers the following recommendations:

A.—CYLINDERS OF COMPRESSED GAS (OXYGEN, HYDROGEN, OR COAL GAS).

(a) Lap-welded Wrought Iron.—Greatest working pressure, 120 atmospheres, or 1,000 pounds per square inch.

Stress due to working pressure not to exceed 6½ tons per square inch.

Proof pressure in hydraulic test, after annealing, 224 atmospheres, or 3,360 pounds per square inch.

Permanent stretch in hydraulic test not to exceed 10 per cent of the elastic stretch.

One cylinder in fifty to be subjected to a statical bending test, and to stand crushing nearly flat between two rounded knife edges without cracking.

(b) Lap-welded or Seamless Steel.—Greatest working pressure, 120 atmospheres, or 1,800 pounds per square inch.

Stress due to working pressure not to exceed 7½ tons per square inch in lap-welded or 8 tons per square inch in seamless cylinders.

Carbon in steel not to exceed 0·25 per cent, or iron to be less than 99 per cent.

Tenacity of steel not to be less than 26 or more than 33 tons per square inch. Ultimate elongation not less than 1·2 inches in 8 inches. Test bar to be cut from finished annealed cylinder.

Proof pressure in hydraulic test, after annealing, 224 atmospheres, or 3,360 pounds per square inch.

Permanent stretch shown by water jacket not to exceed 10 per cent of elastic stretch.

One cylinder in fifty to be subjected to a statical bending test, and to stand crushing nearly flat between rounded knife edges without cracking.

Regulations Applicable to all Cylinders.—Cylinders to be marked with a rotation number, a manufacturer's or owner's mark, an annealing mark with date, a test mark with date. The marks to be permanent and easily visible.

Testing to be repeated at least every two years, and annealing at least every four years.

A record to be kept of all tests.

Cylinders which fail in testing to be destroyed or rendered useless.

Hydrogen and coal gas cylinders to have left-handed threads for attaching connections, and to be painted red.

The compressing apparatus to have two pressure gages and an automatic arrangement for preventing overcharging. The compressing apparatus for oxygen to be wholly distinct and unconnected with the compressing apparatus for hydrogen and coal gas.

Cylinders not to be refilled until they have been emptied.

If cylinders are sent out unpacked, the valve fittings should be protected by a steel cap.

A minimum weight to be fixed for each size of cylinder in accordance with its required thickness. Cylinders of less weight to be rejected.

B.—The committee suggests that factories where gas is compressed be inspected regularly, something on the plan of boiler and elevator inspection in the United States.

Such an inspection should be directed to all matters referred to in this report as important in securing safety. The inspector should act on a scheme of instructions, which could be modified from time to time as experience showed that modification was permissible or ne essary. The inspector should have the right to examine the specifications to which cylinders were manufactured, to inquire into the precautions taken to secure proper thickness and complete annealing, to examine the records of tests, and occasionally to order tests of cylinders for his own information. He should, acting in accordance with instructions, order the reannealing or retesting of cylinders. He should have the right to test the pressure gages, weighing apparatus, and other appliances, and to require alterations to be made if they were unsatisfactory. He should occasionally examine cylinders to see that they were not overfilled.

When an inspector was satisfied that the arrangements at any factory were adequate and that the precautions laid down were being taken, he should report to that effect, and a certificate should be issued stating that the factory had been inspected and that the arrangements had been found satisfactory.

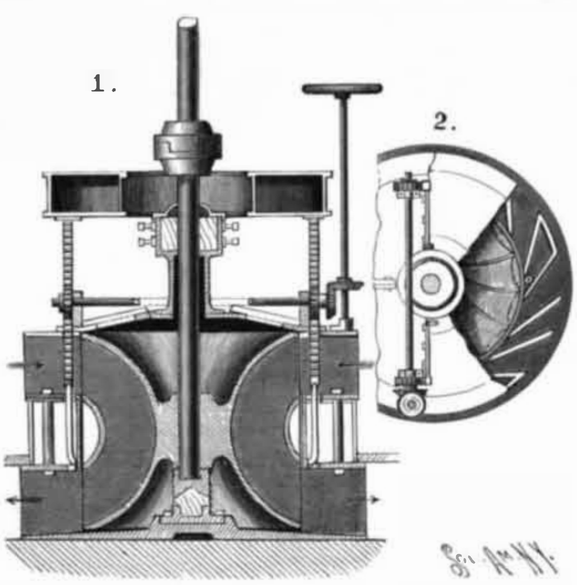
Factories holding such a certificate should be authorized to test and mark cylinders, and to place on them a special form of test mark.

C.—After such inspection and tests, the committee think that the railway companies might, without risk, withdraw the regulation as to packing cylinders, in the case of firms holding a certificate of inspection.

The high pressure system is adopted to some extent in the United States as regards other gases than oxygen and hydrogen. Explosions here of moderate pressure cylinders are very rare indeed, and we believe the express companies are not specially exacting in the transportation of such cylinders, because of their general reputation for safety.

A TURBINE WATER WHEEL.

The illustration represents a turbine water wheel of which the gates are balanced, so that they may be opened or shut with but little exertion, and made to close either the inlets or the outlets of the buckets. The improvement has been patented by Adam W. Haag, of Fleetwood, Pa. Fig. 1 represents a vertical section through the wheel and Fig. 2 is a plan view, with a portion of the top of the wheel casing broken away, showing the buckets. A central, inwardly curved belt surrounds the bucket section of the wheel, providing an inlet and outlet for each bucket, as indicated by the arrows. A series of tangential partitions is arranged in the wheel casing to form inlet buckets, and an annular gate which surrounds the wheel is secured to the lower ends of two racks, which move vertically in the casing, and whose upper ends are secured to the under face of a float. The float is preferably made of metal, and has a central opening through which the wheel shaft is carried, and is also connected by tubular rods with the space below the



HAAG'S TURBINE WATER WHEEL.

penstock, the rods serving as guides for and to deliver water from the float. Attached to the upper section of the wheel casing is a cover, in bearings on which is journaled a transverse shaft carrying pinions meshing with the racks to which the gate is secured, and the transverse shaft has at one end a bevel gear meshing with a similar gear on a vertical shaft at whose upper end is a hand wheel. The float is designed to be of suitable capacity to perfectly balance the annular gate and the connected operative mechanism. When the wheel is in operation the gate is located, as shown in Fig. 1, at the division between the outlet and the inlet, but by turning the hand wheel, the gate may be moved upward to close the inlets of the buckets, or it may be carried downward below the bottom of the penstock, to close the outlet—an arrangement designed to be especially advantageous if any obstruction should enter the inlets.

Salted Petroleum.

The Revue Industrielle, quoting from the Practische Maschinen Constructeur, describes the following process of rendering petroleum uninflammable:

If to 250 gallons of petroleum there be added 550 pounds of common salt, and the mixture be heated to 100° C., there will be collected about 60 gallons of volatile and easily inflammable hydrocarbons that are commonly called benzines. The remaining petroleum is no longer inflammable below 100° C., and, as it contains chloride of calcium, bromide of magnesium and sulphate of magnesia, its illuminating power is increased. To these 190 gallons of petroleum that have undergone distillation there are added 375 gallons of crude petroleum, and the mixture is heated for one hour at 100° C., and then allowed to cool to 40°. Then the 60 gallons of benzine that were previously separated are added, and the whole is again heated up to about 85°. The fuel thus obtained will be uninflammable below 75° C.

Notice to Our Readers.

In order to obtain the opinion of the readers of the SCIENTIFIC AMERICAN as to what invention *introduced within the last fifty years* has conferred the greatest benefit upon mankind, we publish the accompanying card, which please cut out and return to the editor. Those who preserve the paper for binding and do not desire to deface their files, or who read this notice at a library, will please answer by postal card. It is desired to get as full a vote as possible. The result of the vote will be published in the *Special 50th Anniversary Number of the* SCIENTIFIC AMERICAN *on July* 25.

Editor of the SCIENTIFIC AMERICAN.

Dear Sir:

I consider that....................

....

invented by..................................

has conferred the greatest benefit upon mankind.

Name..

Address ....

Why Sand Floats on Water.

In a recent number of the American Geologist Mr. Frederic W. Simonds gives some interesting observations on sand floating on water. It is quite well known that small, dry particles of substances of greater specific gravity than water will float upon it, by reason of capillary action. The surface tension of the water enabling the water to form a depression somewhat larger than the particle, this has the same result as if the specific gravity of the particle had been decreased. The phenomenon observed by Mr. Simonds at Llano River is interesting, as the granite sand was larger and heavier than the dust which had usually been observed heretofore. He tried various kinds of sand and found that they all floated, with one exception. Mr. Simonds says:

"The morning after my arrival, the river was found to be rising, and, as I stood on the bank, at the point where we secured our water supply, I noticed a considerable froth and what appeared to me at the time scum passing down the stream. I spoke of the condition of the river to my companion, Mr. Laurence D. Brooks, of Austin, who remarked that what seemed to be scum was really sand. I thereupon went down to the water's edge, and, dipping up some of the floating material, was astonished to find that the patches were composed of sand, mainly of quartz. At this time—half-past nine or ten—the water supported a large number of patches, which varied in area from less than a square inch up to several square inches, all swept along by the current. . . .

"A week later, when the river was well down and the sandy stretches of its bed had become quite dry on their surface, I gathered sand by handfuls, and sent it floating down the stream in such quantities that the sand rafts actually cast shadows on the bottom as they passed.

"When shaded, it will be seen that the floating sand grains cause a depression of the water's surface, which indeed is quite as apparent in the case of isolated grains as in that of patches. I recall one instance where the depression, of very short duration, possibly but a few seconds, was so great as to be positively startling. As I was sprinkling some sand upon the river, for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed like a funnel for say half an inch, before the cause of this unexpected phenomenon broke through the surface and sank to the bottom.

"It appears from these and other observations that the weight of the sand grains actually depresses the surface of the water; yet the elastic reaction of that surface is sufficiently great to prevent them from sinking, especially when the resistance offered by their angularity is taken into consideration. In the launching of grains the more rounded would tend to roll over in the water and thus become wet, in consequence of which they would sink, while those of an irregular shape would overcome the tendency to roll and remain partially dry, thus fulfilling a condition necessary for floating."

EXPERIMENTS have been carried on in Germany by Drs. Hall, Riegel, Notbe, and others with the view of ascertaining how the bacteria of the soil may be rendered useful. Herr Notbe has succeeded in cultivating these bacteria on a large scale, and he is convinced that the sowing of the bacteria necessary for the assimilation of nitrogen and the successful cultivation of leguminous plants will make soils more productive which need them, and will do so in a cheaper and more convenient way than the method of inoculating suitable earth, devised some years ago.