

NAVIES OF THE WORLD.

III.—FRANCE.

In many respects the French navy is unique among the great navies of the world. There is no other in which the ships, as a whole, differ so markedly from those of other nations, or in which such a wide diversity of design is shown among the battleships and cruisers themselves. In any great naval review, such as has recently taken place at New York, Kiel, or Spithead, it is a matter of small difficulty, even for the layman, to pick out the vessels of the French republic. The long protruding ram, the sharp "tumble-home" of the sides, the towering upper works, and the enormous military masts, bristling with guns, are characteristic features more or less conspicuous in all the ships that fly the tricolor.

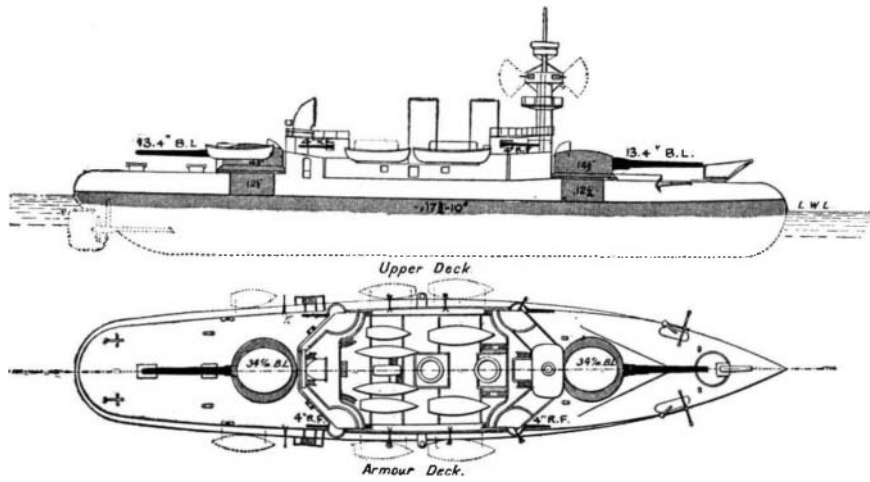
The French naval architects have always worked with a free hand. From the days of Napoleon III.,

sign, the French have had the good sense not to leave a single foot of the waterline unprotected by armor, and, with scarcely an exception, they have carried the topsides of their ships high above the waterline and given the guns an unsurpassed command.

It is true these qualities may have been pushed too far. While the waterline has been protected, a vast area of the ship's sides, extending from the top of the armor belt to the bottom of the barbettes, has been left unarmored and would be exposed to destruction even by the smallest rapid-firers of the enemy. It is also true that many of the French ships have proved to be top-heavy, the margin of stability being in some ships so slight that they dare not put the helm hard over at full speed for fear of capsizing. These are grave defects, the former of which is irremediable, while the latter has been remedied by removing military masts and cutting down the mass of upper works.

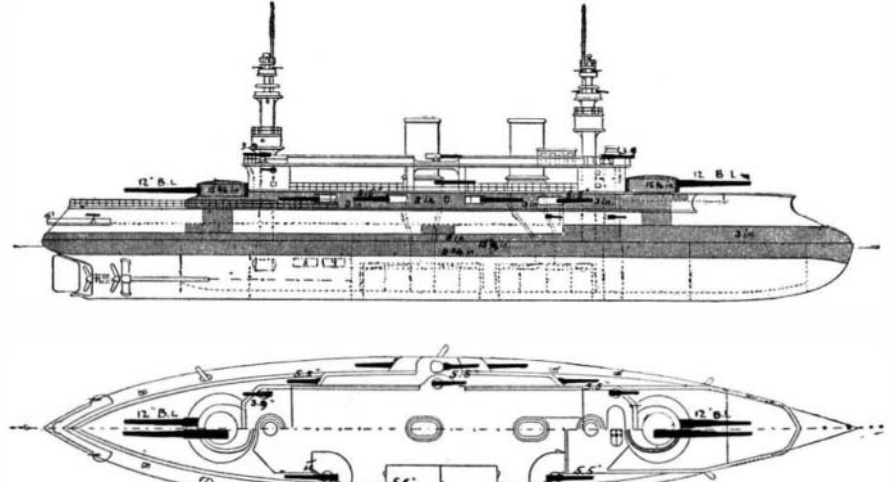
knots. Fifteen knots for the cruisers and 12 knots for the gunboats and small cruisers was adopted as a limit.

BATTLESHIPS.—Because of the diversity mentioned above, the ships of the French do not lend themselves so readily to classification as do those of the British navy. It is not possible to give a photograph and diagrams of one ship and say that she stands, in respect of guns, armor, and speed, for any other vessel of her class. The French have not built so strictly in classes, and where they have, successive administrations of the navy department have introduced numberless and very radical changes in the ships during their construction. Owing to this fact, the French fleets lose something of their tactical value, for it is of very great advantage to a fleet if, in its evolutions, all the ships have the same speed, turn through the same angle for the same degree of helm, and have a common point or points on

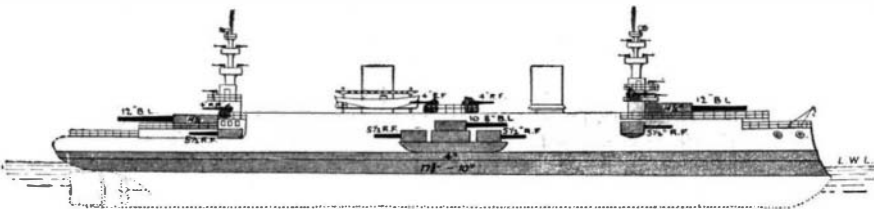


"Valmy" Class. Four Ships.

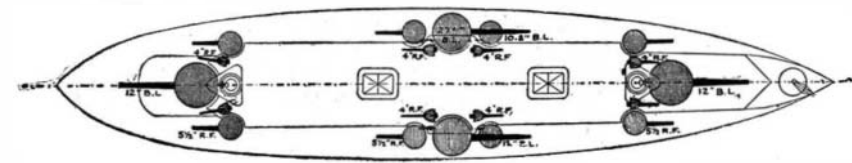
"Valmy" and "Tréhouart" have 13.4-inch guns in the turrets and four 3.9-inch guns. The "Bouvine" and "Jemmapes" have 12-inch guns in the turrets and eight 3.9-inch guns.



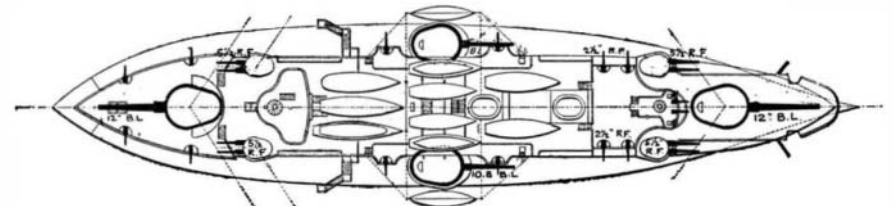
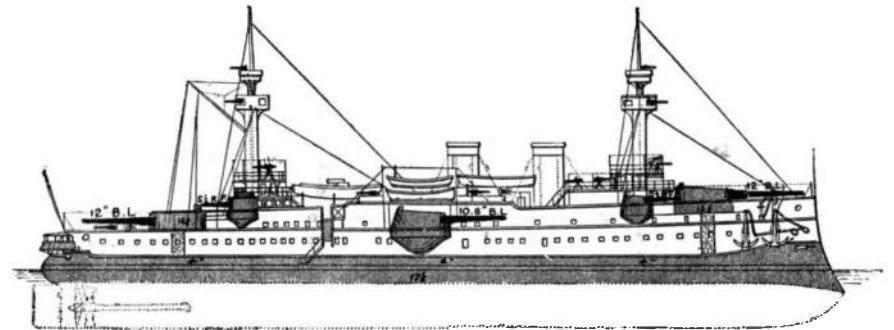
First-class Battleship "Charlemagne," 11,275 tons, 18 knots. Class of Three Ships. Also "Iéna" and "A 9," 12,052 tons, 18 knots.



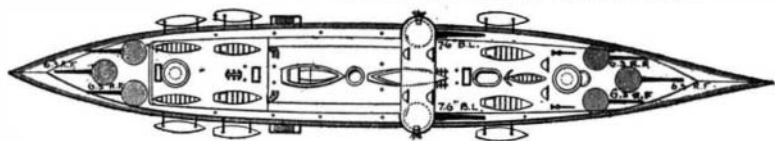
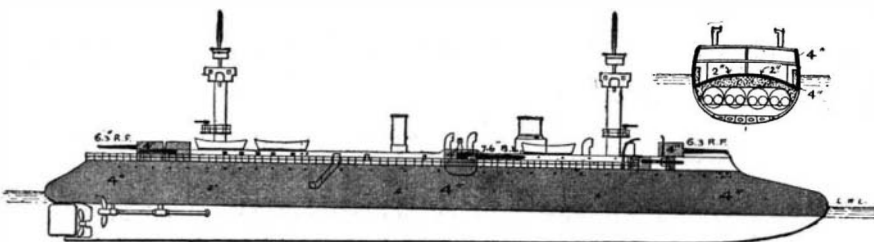
Note: To reduce weight the after Military Mast has been taken out and the bridges cut down.



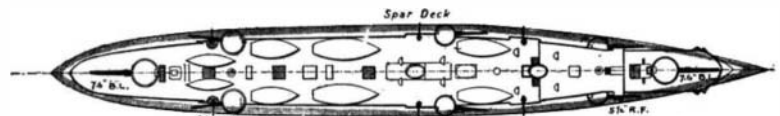
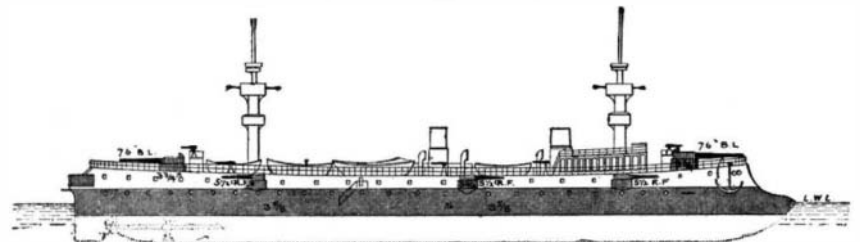
"Carnot" Class of Four Ships.



The "Jauréguiberry."



The "Dupuy de Lome."



The "Bruix" Class of Four Ships.

NAVIES OF THE WORLD—III. FRANCE.

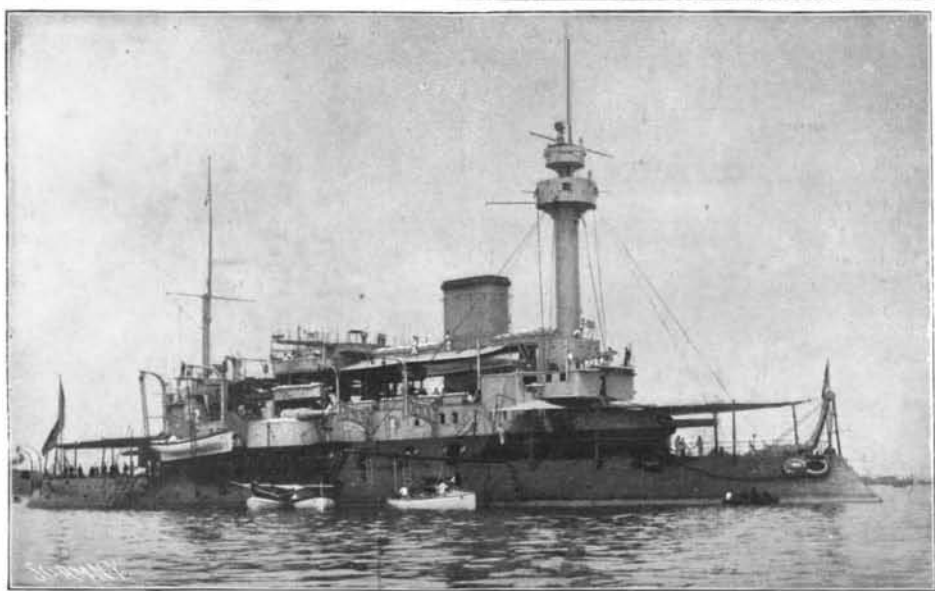
when "La Gloire" led the way in ironclad construction, they have been bold and original in their work, and many of the best features of modern construction are due to their initiative. Like all experimentalists, they have made many mistakes, as the French critics themselves have always been ready to admit; but there are certain excellent features of design to which, amid all the many fluctuations of style and type, they have tenaciously clung—features which the other nations are only now beginning to realize as absolutely essential in a first-class warship, whether she be battleship or cruiser. First among these we may mention a continuous belt of armor from stem to stern at the waterline and a high command for the guns. Modern developments in shell-fire have rendered necessary the first feature, and the second is becoming increasingly necessary for those sea-going qualities which are put down as of prime importance in modern ships. Now, with all their passion for novel and even fantastic de-

On the score of appearance we must confess to a partiality for the French vessels. While they may not have the clean, ship-shape look of the British vessels and our own, they do certainly convey an impression of formidable fighting qualities to a degree that is not found in the ships of any other navy. If an exception is to be made, it should be in favor of the battleships "Oregon," "Indiana," and "Massachusetts."

FIGHTING STRENGTH OF THE NAVY.—In our article, "The Comparative Strength of the World's Navies" (SCIENTIFIC AMERICAN, December 31, 1898), we showed that the effective fighting ships of the French navy numbered 144, made up as follows: Battleships 10 years old or less, 14; battleships from 10 to 20 years old, 9; battleships of between 20 and 25 years, some of which have been refitted, 12; coast defense vessels, 14; armored cruisers, 20; protected cruisers, 37; small cruisers and gunboats, 38. In this estimate no coast defense vessels were included whose speed is below about 10

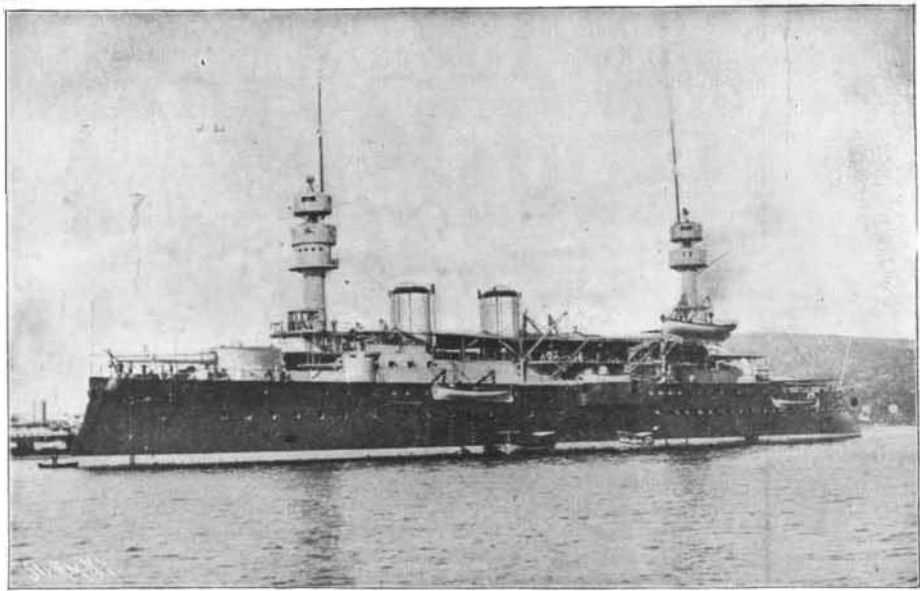
which they can concentrate their maximum weight of fire.

The most homogeneous and powerful squadron at present in commission is that composed of the four fine battleships of the "Charles Martel" type, a striking illustration of which is given on the front page. With these should be mentioned also the "Jauréguiberry." All of these ships have a speed of about 18 knots; all but the "Massena" have a complete waterline belt varying from about 10 to 17 inches in thickness; and they all carry their heavy guns after the French characteristic style in four separate heavily armored turrets, one forward, one aft, and one on either beam. They also have the excellent feature of carrying the eight heavy rapid-fire guns of the secondary battery in turrets of 4-inch armor, the "Jauréguiberry" having these guns in pairs on the spar deck in four turrets, two forward, two aft, and the four ships of the "Carnot" class carrying these guns singly



First-class Battleship "Hoche." * Class of Four Ships.

Displacement, 10,957 tons. Speed, 16 knots. Normal Coal Supply, 800 tons. Armor: Continuous belt, 18 inches; deck, 3 inches; gun positions, 16 inches. Armament, two 13.4-inch, two 10.8-inch, eight 5.5-inch rapid-fire, eight small rapid-firers, twelve machine guns. Torpedo Tubes, 5. Complement, 800. Date, 1884.



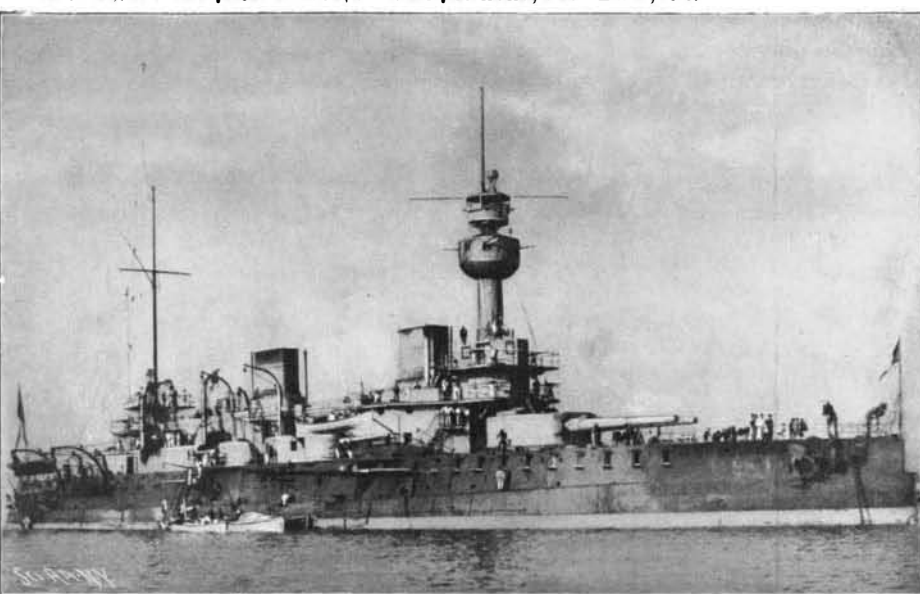
First-class Battleship "Jaureguiberry."

Displacement, 11,824 tons. Speed, 18 knots. Normal Coal Supply, 700 tons. Armor: Continuous belt, 17 to 4 inches; deck, 2.5 inches; gun positions, 14.5 inches. Armament, two 12-inch, two 10.8-inch, eight 5.5-inch rapid-fire, four 2.5-inch rapid-fire, twelve 1.8-inch, eight 1.4-inch rapid fire, and eight machine guns. Torpedo Tubes, 6. Complement, 625. Date, 1883.



Forward Pair of 13.4-inch Guns on the "Brennus."

Weight of Gun, 53 tons. Weight of Shell, 926 pounds. Muzzle Velocity, 2,655 feet. Muzzle Energy, 44,230 tons. Perforation of Iron at Muzzle, 42.5 inches.



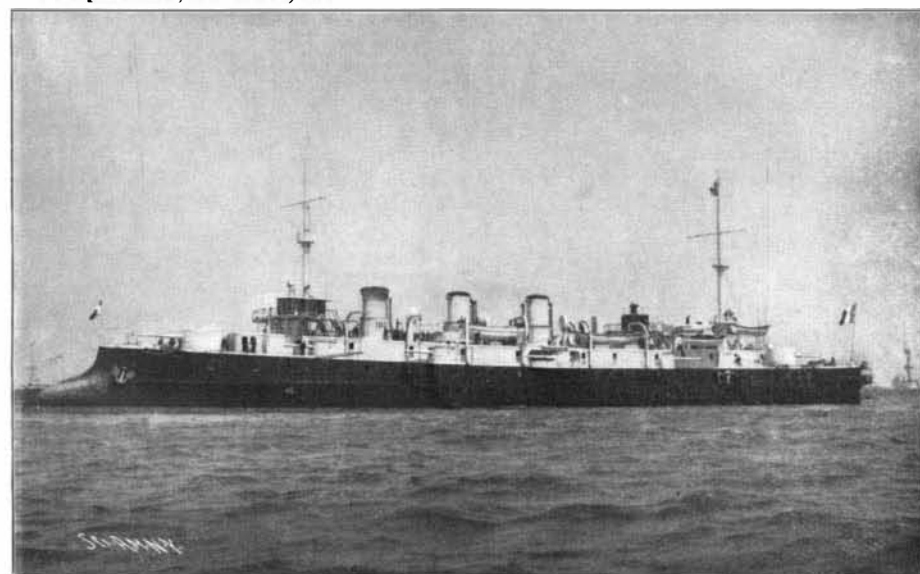
First-class Battleship "Brennus." * Class of Four Ships.

Displacement, 11,395 tons. Speed, 17.1 knots. Normal Coal Supply, 800 tons. Armor: Continuous belt, 15.5 inches; deck, 3.5 inches; gun positions, 15.5 inches. Armament, three 13.4-inch, ten 6.4-inch rapid-fire, four 2.5-inch, eight 1.8-inch rapid-fire, eight machine guns. Torpedo Tubes, 4. Complement, 686. Date, 1891.



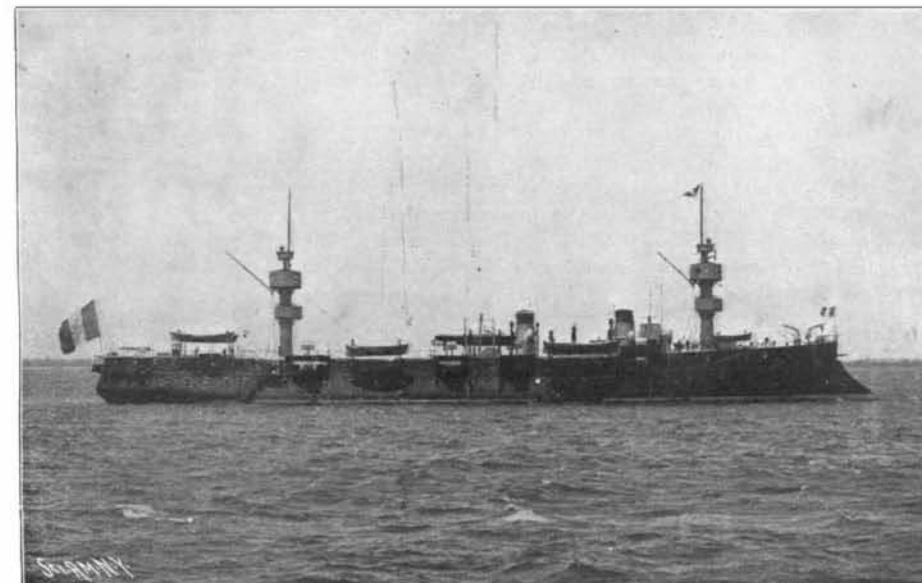
Armored Cruiser "Dupuy de Lome."

Displacement, 6,406 tons. Speed, 20 knots. Normal Coal Supply, 900 tons. Armor: Completely sheathed to upper deck with 4-inch armor; deck, 2 inches; gun positions, 4 inches. Armament, two 7.6-inch B. L. guns, six 6.4-inch rapid-fire, twelve 2.5-inch rapid-fire, six 1.8-inch rapid-fire, eight machine guns. Torpedo Tubes, 4. Complement, 515. Date, 1890.



Armored Cruiser "Pothuau."

Displacement, 5,360 tons. Speed, 19.2 knots. Normal Coal Supply, 538 tons. Armor: Complete belt 3.5 inches to 2 inches; deck, 3.5 inches; gun positions, 2.5 inches. Armament, two 7.6-inch B. L., ten 5.5-inch rapid-fire, sixteen 1.8-inch, eight 1.4-inch rapid fire. Torpedo Tubes, 5. Complement, 461. Date, 1895.



Protected Cruiser "Jean Bart." * Class of Six Ships.

Displacement, 4,109 tons. Speed, 19 knots. Normal Coal Supply, 940 tons. Armor: Deck 4 inches. Armament, four 8.4-inch rapid-fire, six 5.5-inch rapid-fire, fourteen 2.5-inch and 1.8-inch rapid fire, eight machine guns. Torpedo Tubes, 5. Complement, 332. Date, 1889.



Coast Defense Ship "Valmy." * Class of Four Ships.

Displacement, 6,592 tons. Speed, 16.7 knots. Normal Coal Supply, 300 tons. Armor: Belt, 1.5 inches; gun positions, 1.75 inches; deck, 4 inches. Armament, two 13.4-inch, four 3.3-inch rapid fire, four 1.8-inch rapid-fire, 10 machine guns. Torpedo Tubes, 2. Complement, 297. Date, 1892.

* There are considerable variations in the vessels of this class.

in eight turrets on the main deck. This disposition of the guns is made with a view to securing a heavy end-on fire, which in the case of the "Carnot" class (see deck plan) consists of one 12-inch gun, two 10.8-inch guns, four 5.5-inch, and four 3.9-inch rapid-firers.

It will be seen that this quadrilateral arrangement of the heavy guns in four turrets, as compared with their arrangement in two turrets, as in our "Oregon," gives a heavier concentration ahead or astern (three guns as against two), but a weaker fire on the beam (three guns as against four). It is doubtless the fact that most fighting will be carried on with the enemy abeam or on the quarter, that has led the French to abandon the quadrilateral arrangement in their latest ships of the "Charlemagne" and "Iéna" type.

The guns are of a modern and very powerful type. The 12-inch weapon, which weighs 46 tons, fires a 644-pound projectile with a muzzle energy and velocity of 30,750 foot-tons and 2,625 foot-seconds, the muzzle penetration being 37.3 inches of iron. The 10.8-inch gun, which weighs 35 tons, fires a 476-pound projectile with a muzzle velocity of 2,625 foot-seconds and a muzzle energy of 22,750 foot-tons, the penetration of iron being 33.7 inches, or equal to that of our 13-inch gun, which weighs, by the way, nearly twice as much as the smaller weapon. Though the 5.5-inch guns of the rapid-fire battery are rather light, according to modern ideas, which favor nothing less than 6-inch guns for this purpose, they are very formidable weapons. They fire a 66-pound projectile with a velocity of 2,625 foot-seconds and an energy of 3,100 foot-tons, the penetration being 17.7 inches of iron. This is a little more than our present 6-inch gun. At long ranges, however, owing to the rapid falling off of the velocity due to the lighter weight of the shell (66 pounds as against 100 pounds), the French gun is not so effective. In addition to the rapid-firers in turrets, the "Carnot" carries eight 4-inch rapid-fire guns on the superstructure and bridges, very efficient weapons, capable of penetrating 14.3 inches of iron at the muzzle. These guns are mounted behind 2.8-inch shields at a height of 35 and 40 feet above the sea.

The remarkable form of the hull of these ships above the water is due to what is known as the "tumble-home" of the sides, which curve sharply inward from the waterline and then with a reverse curve run vertically up to the spar deck. This is an exaggeration of a system adopted universally in the old wooden men-of-war. It has the advantage of reducing the width and weight of the upper decks, thereby adding to the ship's stability, and it allows the turrets to stand clear of the hull and gives the guns a more extended arc of fire fore and aft. In their latest ships the French show a disposition to adopt the vertical-sided form common in other navies.

Taken altogether, these ships with their water-tube boilers, high speed, ample protection, powerful and modern armament, and double armor decks, would probably prove to be the equal of any vessels afloat in fighting power. The name of the five are "Charles Martel," "Carnot," "Bouvet," "Massena," and "Jauréguiberry." An unusually handsome cut, showing the last-named ship on her trial trip, which was crowded out of the present article, will be shown in the SUPPLEMENT of next week.

In the later ships of the "Brennus" and "Charlemagne" types the French have adopted the two-turret plan for the big guns, and have placed the secondary battery in an armored citadel amidships, thereby for the first time in their history following the lead of the English. The "Brennus" (11,824 tons and 17.1 knots speed) carries two 13.4-inch guns in a turret forward and one 13.4-inch gun in a turret aft. She has a continuous belt of 15.3/4 inches maximum thickness, and above this is a 4.1/2-inch belt also reaching from stem to stern. The powerful secondary battery of ten 6.4-inch rapid-fire guns is carried on two decks in a central citadel of 4-inch armor, which extends from the top of the belt to the main deck. The 13.4-inch guns are the most powerful weapons carried in any navy at the present time. Their muzzle energy is 44,230 foot-tons and they can penetrate 42.5 inches of iron at the muzzle. The 6.4-inch gun is also of exceptional power. It fires a 99.2-pound shell with a velocity of 2,625 feet per second. The resulting energy is 4,730 foot-tons and penetration of iron, 20 inches at the muzzle.

In the "Charlemagne," "St. Louis," and "Gaulois," sister ships of 11,275 tons and 18 knots, now about completed, the French have returned to the 12-inch gun, the main armament consisting of four of these weapons, carried two forward and two aft in turrets. The secondary battery of ten 5.5-inch guns is carried in broadside behind a citadel of 3-inch steel, but the space between the gun deck and the armored deck is entirely unprotected and would be open to destruction by shell fire. In addition to the 5.5-inch these ships carry eight 3.9-inch rapid-fire guns. The most novel structural feature in these ships is the waterline protection. First there is a continuous belt 15.3/4 inches thick, 6 feet 7 inches in depth. Above this belt is another, 3 feet in depth and 3 inches thick. At the top of the main belt is an armored deck, 3.1/2 inches in thickness, and at the bottom of the belt, below the waterline, is a 1.1/2-inch

armored deck. The vitals of this ship should be absolutely proof against projectiles.

Except for the unarmored space between belt and citadel, these vessels are extremely formidable both for attack and defense, and the French are so well satisfied with the type that they are building two others, the "Iéna" and battleship "A 9," of slightly larger dimensions and more powerful armament. Their displacement will be 12,052 tons, speed 18 knots, and they will carry 6.4-inch in place of 5.5-inch guns in the secondary battery. Like the "Charlemagne" type, they will have triple screws and water-tube boilers.

The "Hoche," 10,997 tons, 16 knots, 18-inch belt, armed with two 13.4-inch, two 10.8-inch, and eight 5.5-inch rapid-fire guns, launched in 1886, is the only modern French battleship of low freeboard (see illustration). Her main battery is not of the modern type found in the "Carnot" and "Charlemagne," the guns being much shorter and of less power, and while she makes a good coast defense ship, she is not to be compared with the splendid vessels of later construction. Much trouble has been experienced in rectifying her bad points, the chief of which was the enormous superstructure amidships. By reducing this and removing her after military mast altogether the vessel has been rendered fairly stable, although she is still, on account of her heavy rolling, an unsatisfactory ship.

Of the older ships built over ten years ago, the "Magenta," "Marceau," and "Neptune," of 10,850 tons and 16.1/2 knots, are the best. They have a lofty freeboard and carry their four 13.4-inch guns (older pattern) at the level of the main deck, in four separate turrets. They have a powerful battery of fourteen 5.5-inch rapid-firers on the gun deck, mounted in broadside but unprotected. Their good points are high command for the main battery and good waterline protection. Their defects are the vast area of unprotected side between barbettes and belt and their instability. Inferior ships to these are the "Amiral Baudin," of about 11,911 tons and 15 knots, the "Formidable," 12,165 tons and 16 knots, and the "Amiral Duperré," 11,209 tons and 14.2 knots. All these have continuous belts 21.1/2 inches in thickness, whose resisting quality is about equal to 10 inches of Krupp steel, and 17.3/4 inches on the barbettes. The guns are mounted in barbettes high above the waterline and, as in all the French ships, there is no protection between barbette and belt other than an armored ammunition trunk. The armament consists of two 14.6-inch B. L. guns, eight 6.4-inch rapid-fire, and eight 5.5-inch guns, besides many smaller rapid-firers. The "Courbet" and "Devastation," launched in 1881 and 1879, are of 10,800 tons and 15 knots. Each carries four 10.8-inch, four 9.4-inch, and six 5.5-inch guns. The armor is 15 inches on the belt, 9.1/2 inches on the gun positions, and the deck is 2.1/2 inches in thickness.

In the list of old battleships of over twenty years, there are a dozen ships, four of which are of wood and the rest of iron. Their speed varies from 10.8 to 14.8 knots, and their average displacement is about 7,500 tons. Their guns are of an old model and therefore of limited power. In fighting qualities these ships are comparable to the old broadside battleships of the British navy, though the breech-loading French gun of this period is superior to the muzzle-loading British gun.

COAST DEFENSE VESSELS.—There are 14 coast defense vessels in the French navy, of which the "Valmy" and her class are the best representatives. If the United States must build ships of the strict coast defense class, it would be far better to expend the money on vessels of the "Valmy" class instead of putting afloat such archaic designs as our new monitors of the "Arkansas" type will be. The "Valmy" (see particulars beneath engraving) is a 6,592-ton vessel of over 16 knots speed and great power. This vessel and the "Tréhouart" carry two of the new powerful 13.4-inch guns, while the "Bouvines" and "Jemmappes" carry each two 12-inch guns. These weapons are sufficiently elevated to be fightable in a fairly heavy sea, and the speed of the ships coupled with their 17.3/4-inch armor would render them formidable antagonists for any battleship. Four other formidable coast defense ships are the "Caiman," "Indomptable," "Requin" and "Terrible," of about 7,500 tons and 15 knots, with 19.1/2-inch armor and carrying 16.5 and 13.4-inch guns in the main battery. A new coast defense ship of 8,948 tons and 17 knots, the "Henri IV.," is now building. She will be armed with two new type 10.8-inch breech-loading guns and seven 5.5-inch rapid-firers. The other coast defense ships are of less size, from 1,800 to 5,000 tons, and, though they are older, they are heavily armed and well protected.

ARMORED CRUISERS.—In the armored cruisers we find another class of vessels of which the French people may well be proud. On the first of January, 1898, there were twenty of these very effective ships either built or building. The best known of these is the "Dupuy de Lôme." She is remarkable as being the only warship in the world that is completely clothed with armor. From stem to stern and from below the waterline up to the main deck she is protected by 4 inches of steel. Equal protection is given to the guns, each of which is inclosed in a separate turret of

4-inch steel. These guns are so disposed as to secure a theoretical concentration of fire as follows: Two 7.6-inch breech-loaders and three 6.3-inch rapid-firers ahead or astern and one 7.6-inch breech-loader and four 6.3-inch rapid-firers on either beam. In the amount of armor carried this vessel shows the effect of the French experiments with shells loaded with high explosives. The 4-inch armor was supposed to insure the bursting of these shells outside of instead of within the vessel. In the four ships of the "Bruix" class the armor is not carried so high, but as the turrets rotate upon the main deck immediately above the side armor, the protection to the turning-gear and ammunition is fully as complete. The other ships of this class are the "Charner," "Chanzy," and "Latouche-Treville." The speed is about 18.5 knots. For further particulars, the reader is referred to the cut of the "Charner" on the front page.

The "Pothuau," a vessel of 5,360 tons and 19.2 knots, is an enlarged "Charner," her battery being increased over that of the "Charner" by the addition of four 5.5-inch guns.

There is no doubt that French influence and example are responsible for the present disposition to build armored instead of protected cruisers. At present they have ten of these fine ships under way, none of which is of less than 7,700 tons displacement and 21 knots speed. The particulars are given in the accompanying table:

	Displacement in Tons.	Speed.	Belt Armor.	Main Armament.
Jeanne d'Arc.....	11,270	23	6 in.	Two 7.6-in., eight 5.5-in. r. f., twelve 3.9-in.
Dupetit Thouars..	9,517	21	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
Gueydon.....	"	"	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
Montcalm.....	"	"	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
C 4.....	"	"	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
C 7.....	"	"	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
C 8.....	"	"	"	Two 7.6-in., eight 6.4-in. r. f., four 3.9-in.
Desaix.....	7,700	21	5 in.	Ten 6.4-in. rapid-fire.
Duplex.....	"	"	"	"
Kleber.....	"	"	"	"

PROTECTED CRUISERS.—The French navy includes 37 protected cruisers of a speed of 15 knots and over. The largest of these at present is the "Tage," 7,585 tons, 19 knots; though a larger ship, the "D'Entrecasteaux," 8,114 tons and 19 knots, was launched in 1896 and is nearing completion. Two commerce destroyers of the "Columbia" type are under construction. They will be known as the "Chateaufort" and the "Guichen." They are about 800 tons larger than the "Columbia," are somewhat faster, and are considerably stronger in armament, but they do not carry so much coal. The particulars are: Displacement, 8,277 tons; speed, 23 knots; horse power, 24,000; coal supply, normal, 1,460 tons; armament, two 6.4-inch, six 5.5-inch, ten 1.8-inch, all rapid-firing.

Of cruisers between 4,000 and 7,000 tons displacement the French navy possesses thirteen, of which the "Jean Bart" class (six ships) is the best representatives. This vessel was at New York during the Columbus celebration and will be familiar to our readers. Her particulars are given beneath the illustration of the vessel. There is nothing special in the design of these ships, and the speed is about a knot less than that of similar vessels in other navies. There is not much disposition on the part of the government to increase the numbers in this class, the requirements of the French service calling for battleships and armored cruisers and the larger type of protected cruisers rather than vessels of the "Bruix" class.

In the small cruiser and gunboat class France possesses 38 vessels of an average displacement of 988 tons and an average speed of 17.1 knots, the speed being higher than that of similar vessels in any navy but that of Italy. Among the small cruisers the "Lalande," 1,926 tons, 22 knots, is the best representative. Her speed is 22 knots and she carries six 5.5-inch guns as her main armament. Fourteen of these vessels are of over 1,000 tons displacement, with an average speed of about 18.5 knots; the others range from 400 to 900 tons in displacement and from 12 to 23 knots in speed.

Taken as a whole, the French navy, though less than half as large as the British navy in numbers and displacement, is, we think, fully equal to it in quality. It is true, many of the ships show grave defects; it is also true that they present many excellent qualities which are not to be found in the British ships. In the way of defects, the unarmored space between barbettes and belts in the French ships is fairly offset by the unarmored waterline at the ends of the British vessels, while we think the French plan of placing the rapid fire guns in armored turrets is preferable to the British plan of placing them in broadside armored casemates. In action the fragments of bursting shells that have passed into the ship will penetrate the thin rear walls of the armored casemates on the lee side of the ship, where the walls of the turrets would be proof against such fragments. In point of coal capacity, stability,

and seaworthiness the British ships are superior; but it must be remembered that the French battleships and armored cruisers would probably never operate at any distance from the Channel or the Mediterranean.

In point of personnel, if past history is a sure guide, the British fleet is superior, possessing at least equal skill and certainly more tenacity. The seamen are largely recruited from the hardy fishermen of the Britany and Normandy coasts, and to-day, as in the time of Nelson, they would doubtless exhibit the splendid qualities which were too often handicapped in the days of the frigate and three-decker by lack of dash and skill on the part of the captains and admirals of the navy.

THE KEELY MOTOR FRAUD.

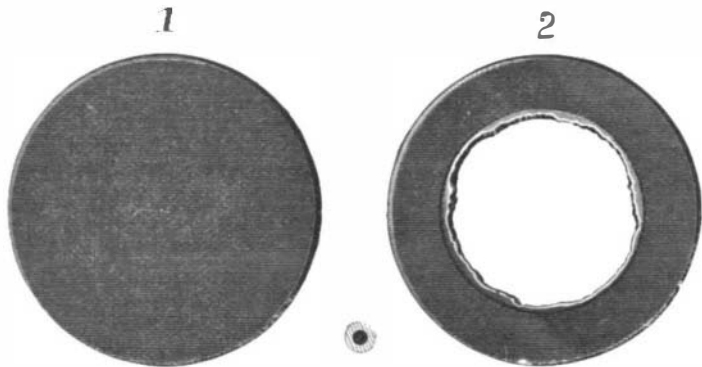
Ever since the death of John W. Keely, the fantastical collection of apparatus with which he puzzled the public, and incidentally diverted a golden stream into

tion to the Keely mania, and endeavored, we think, with considerable success, to check, if it could not wholly prevent, such obvious swindling of the public. We pointed out that all of the results obtained by Keely could be duplicated by using compressed air in suitable apparatus, and in 1884, in the case of the Keely gun, conducted experiments which proved that in this case, at least, we were correct.

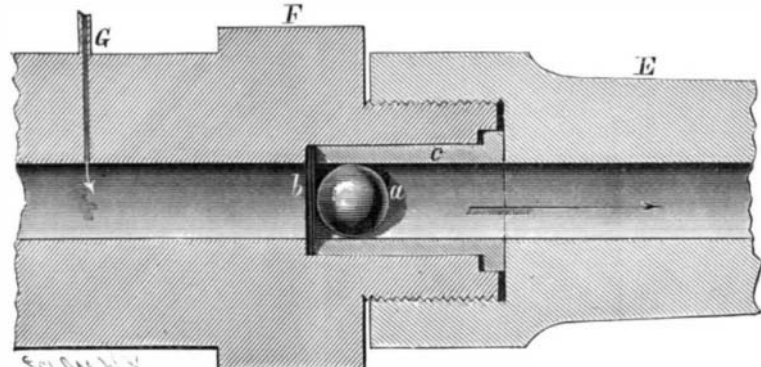
Keely had many different names for his newly discovered force, and just at the time of the famous gun experiments at Sandy Hook, he was pleased to call it "etheric vapor." Representatives of this journal were present on the occasion, and the accompanying illustrations were published in the SCIENTIFIC AMERICAN of October 11, 1884, in connection with an article exposing the trick by which the Keely Motor Company was able, in a single day, to send up its stock from nine cents on the dollar to fifteen cents, and swell its own bank account proportionately.

connected by a wire, *C* (so said Keely; the wire was actually another tube) to a second magazine, *B*. The supply from the small to the large magazine and from the large magazine to the gun was controlled by stop valves, as shown in the cut. These magazines, according to Mr. Keely, had been charged with "interatomic ether," which had been evolved by a "generator" set up in Mr. Keely's Philadelphia workshop.

In loading the gun the gas check was first placed in position and the muzzle screwed up tightly; then the ball was introduced at the muzzle and rammed home. Next the stop-cock was opened to admit the "etheric vapor" to the breech, and, after waiting a few seconds, the "vibrator," *H*, was struck with a wooden mallet, and the charge exploded, driving the bullet at a target 500 yards from the gun. Nineteen rounds were fired, and then a conical steel bullet was driven through 4 inches of pine plank placed a few feet from the gun. The noise of discharge closely resembled that caused by



GAS CHECKS BEFORE AND AFTER DISCHARGE OF GUN.



LONGITUDINAL SECTION AT BREECH OF GUN.

his private purse, has been as jealously guarded as ever it was in his lifetime. Recently the motor was removed, and the laboratory (Heaven save the mark!) in which for a quarter of a century he had conducted his so-called experiments was vacated. Whereupon Mr. Clarence B. Moore, whose mother had been the most generous of Keely's many victims, rented the premises, and calling to his assistance several gentlemen of high standing in the scientific world (some of whom, by the way, had been baffled witnesses of the Keely phenomena), proceeded to explore the premises in search of evidences of fraud.

The result proves not merely that the motor was a fraud, but that it was a fraud, as we pointed out fifteen years ago in the columns of this journal, of the very simplest and most transparent kind: in fact, the presumption is strong that this most colossal humbug of the century depended for its success upon that ever-fruitful theme of the bogus company promoter—compressed air. In the first place, hidden beneath the floor of the building was found a large and massive metal sphere, whose weight is given as three tons, and whose bursting strength under pressure is stated to be so many tons to the square inch. Apparently at one time connected with this was found, hidden in the brick wall, a quantity of small brass tubing, of just the size and strength

The "vaporic" gun used on that occasion (it was nothing more or less than an air-gun) had a spherical knob secured to the breech, from which projected a "vibrator" (!) *H*. The breech was $4\frac{1}{2}$ in. external diameter, the bore $1\frac{1}{8}$ in., and the total length was $3\frac{1}{2}$ feet. Just forward of the trunnion, at the point, *F*, the muzzle unscrewed, this construction being adopted to permit the placing of a gas check, *b*, in position. A sleeve, *c*, with a bore equal to that of the gun, was fitted in an annular recess in the forward part of the breech, *F*.

It will be seen that when the muzzle was screwed home, the sleeve was forced in until it held the gas check firmly in place. The latter consisted of three disks, having a common diameter of $1\frac{1}{8}$ inches. The two front disks were of common hard rubber, $\frac{1}{8}$ inch in thickness, while the third disk, which was placed next to the pressure chamber, was of soft rubber pack-

a common shotgun when loose powder having no ramming upon it is exploded. A small cloud of white vapor, which immediately disappeared, followed the discharge. The velocities of three consecutive shots were 482, 492, 523 feet per second. "The gun was then unscrewed," says the account of the proceedings, "the valve at the magazine was opened, and visitors were permitted to examine the 'interatomic ether' as it issued from the pipe. It had but a small trace of odor, no taste, and had no effect upon the lungs." Precisely; for there is not a question in the world but what the "interatomic ether" as it issued from the pipe was the common air at atmospheric pressure.

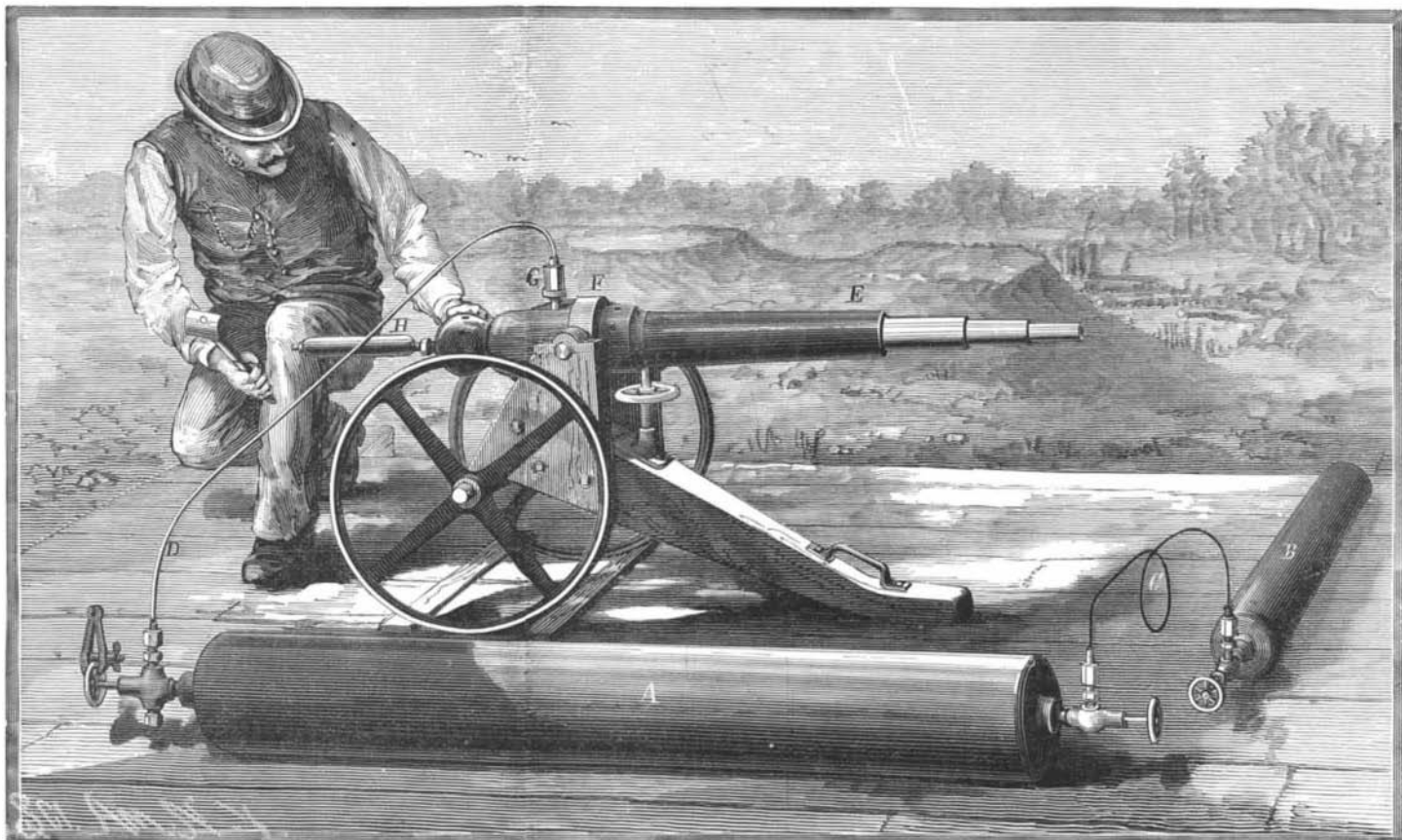
We declared at the time that the magazine, *A* and *B*, had been charged with compressed air at many thousand pounds pressure, and that when the stop-cock was opened, the air, owing to its high pressure, passed rapidly to the breech, behind the gas check, where it developed sufficient pressure to burst the check and expel the ball.

The tapping on the "resonator," *H*, had nothing whatever to do with the discharge, and was merely one of the charlatan "passes of the wand" by which this accomplished rogue bewildered his audience.

To prove the fact to his satisfaction, the representative of the SCIENTIFIC AMERICAN requested Keely to allow him to handle the wooden mallet (his purpose being to delay the tapping until after the discharge). It is needless to say that Keely refused.

Soon after Keely's gun experiments the editor of this journal conducted experiments in the same direction in New York, and an experimental gun was made of seamless drawn brass pipe of 1 inch bore and 2 feet in length, and set vertically under a skylight shaft several stories in height. A union joint was screwed to the bottom of the pipe, with a pipe connecting to a coil of about 100 feet of $1\frac{1}{4}$ inch pipe, placed beneath the gun.

A further connection was made with a hydraulic



TEST OF THE KEELY "VAPORIC" GUN AT SANDY HOOK, SEPTEMBER, 1884.

to match the strength of the steel reservoir, and corresponding to the tubing (see cut) used by Keely in his various public and private exhibitions. Underneath the upper floor of the house was found a false ceiling, well calculated to hide the necessary tubes for conveying the compressed air to the different air motors with which he produced his results; while a number of trap-doors were found scattered over the floor of this stage, from which, for a quarter of a century, this prince of humbugs played his part!

Many of our older readers will remember that from the very first this journal was emphatic in its opposi-

ing, $\frac{1}{8}$ of an inch thick. The disks are shown in full size in Figs. 1 and 2, the former figure representing the disk before discharge, and the latter after discharge. It will be noticed that the broken disk shows clearly the imprint made by the end of the sleeve. The bore of the gun was $1\frac{1}{8}$ inches, and a spherical lead bullet, *a*, was used. A copper tube, *D*, $\frac{1}{8}$ of an inch in external diameter and $\frac{1}{8}$ of an inch internal diameter, a full size cross section of which is shown between cuts 1 and 2, led the breech of the gun to the magazine, *A*, which was made of wrought iron and was $8\frac{1}{2}$ inches external diameter by $4\frac{1}{2}$ feet long. Another tube was

SCIENTIFIC AMERICAN

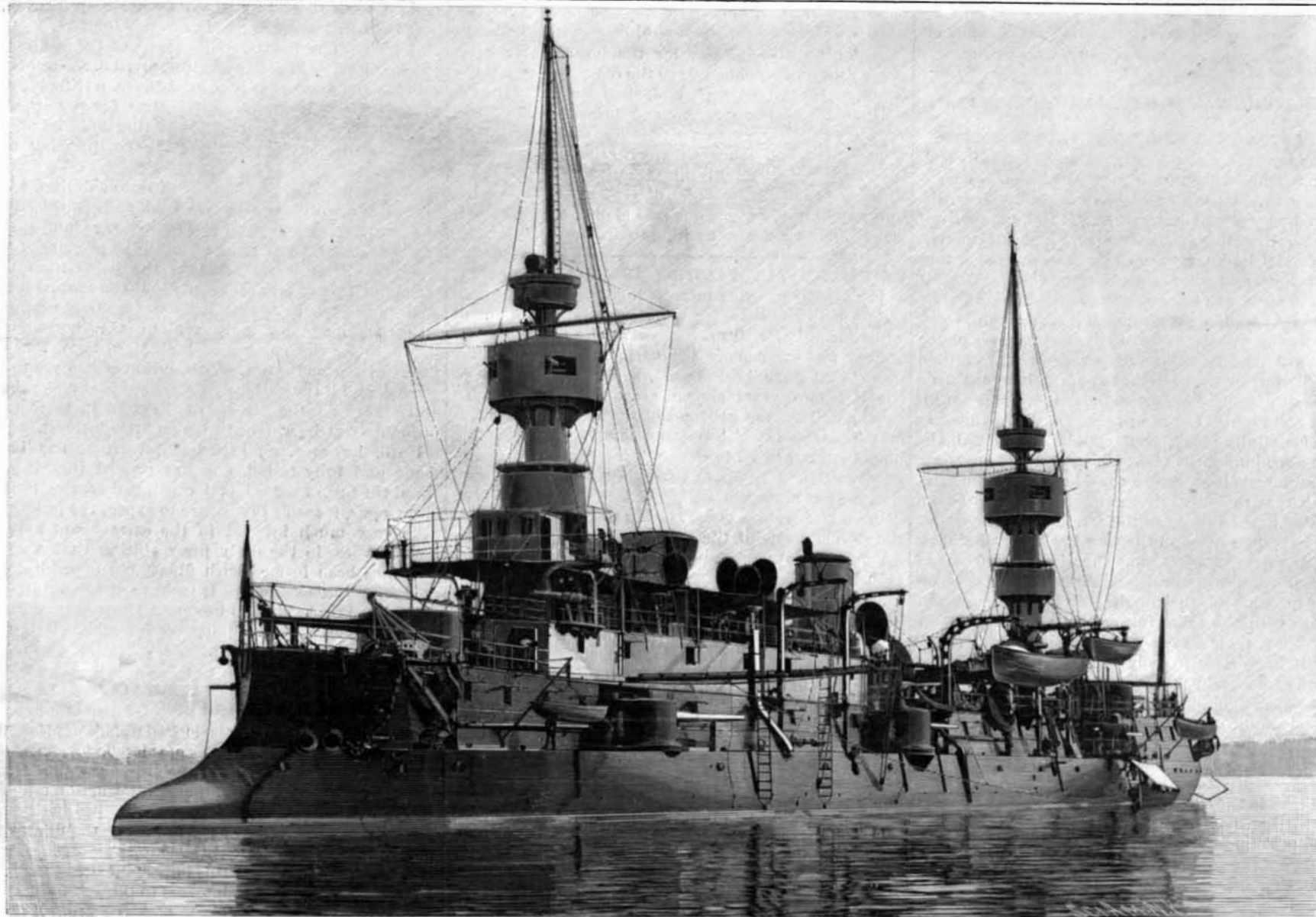
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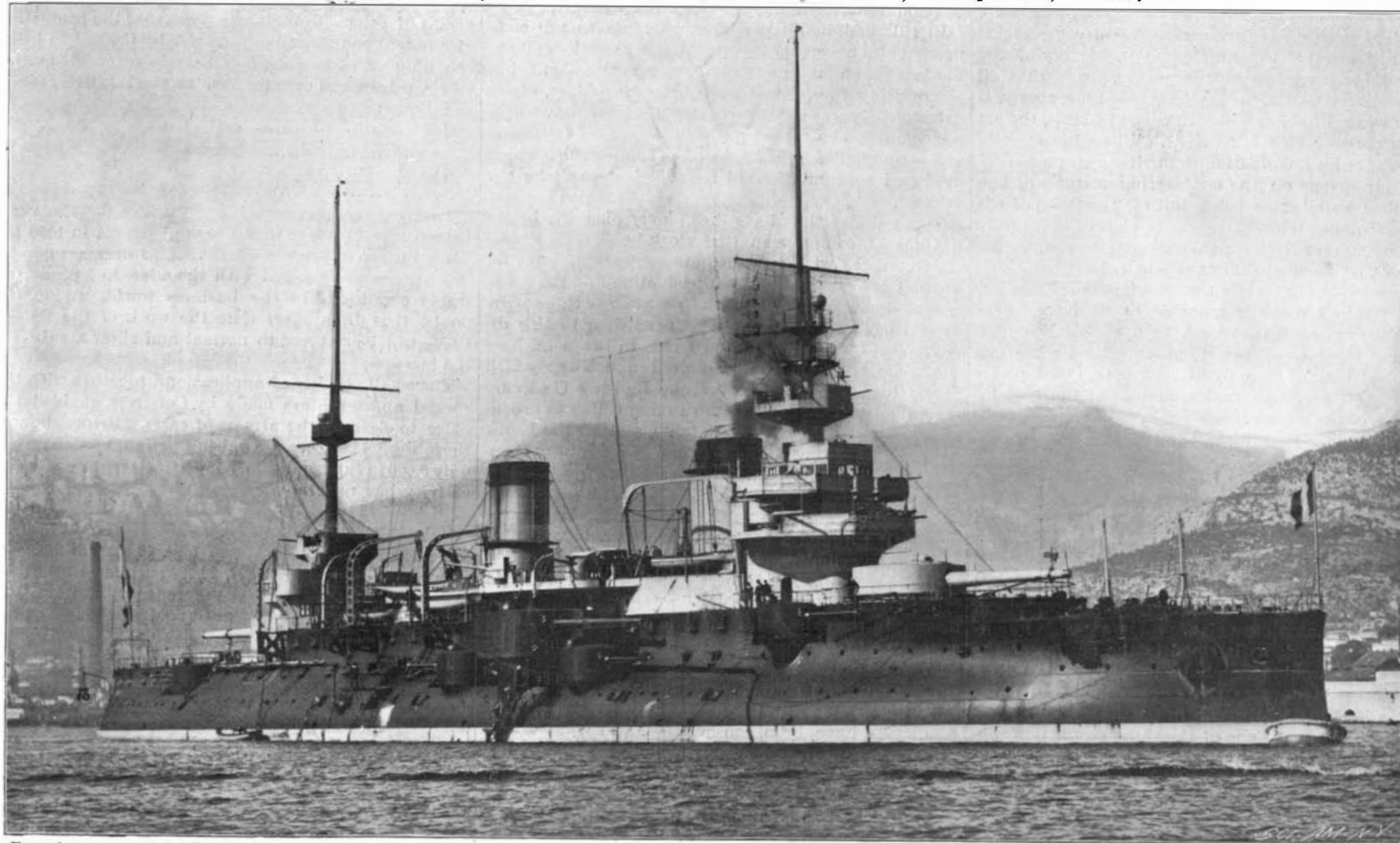
NEW YORK, JANUARY 28, 1899.

[\$3.00 A YEAR.
WEEKLY.]



Armored Cruiser "Charner." "Bruix" Class of Four Ships.

Displacement 4,792 tons. Speed, 18.2 knots. Normal Coal Supply, 413 tons. Armor: Continuous belt, 3¼ inches; deck, 2 inches; gun positions, 2 inches. Armament, two 7.6-inch B. L. guns, six 5.5-inch rapid-fire, four 2.5-inch rapid-fire, six 1.8-inch, six 1.4-inch rapid-fire. Torpedo Tubes, 5. Complement, 375. Date, 1893.



From photograph by Symonds & Co., Portsmouth, England. First-class Battleship "Bouvet." "Carnot" Class of Four Ships.

Displacement, 12,200 tons. Speed, 18 knots. Normal Coal Supply, 621 tons. Armor: Continuous belt, 15¾ to 8 inches; deck, 3¼ inches; gun positions, 14¼ inches. Armament, two 12-inch B. L. rifles, two 10 8-inch B. L. rifles, eight 5.5-inch rapid-fire, eight 3-inch rapid-fire, twelve 1.8-inch, and twenty 1.4-inch. Torpedo Tubes, 4. Complement, 631. Date, 1896.

NAVIES OF THE WORLD—III. FRANCE.—[See page 56.]