## THE NAVIES OF THE WORLD. I. GREAT BRITAIN.

The present article on the British navy is the first of a series on the navies of the world which will appear during the next few months in the columns of the ScI-ENTIFIC AMERICAN. The great popularity enjoyed by the SPECIAL NAVY EDITION and the large number of requests that have reached this office for a series of illustrated papers on the leading navies of Europe make it evident that the newly awakened interest in naval matters will render such a series particularly acceptable at this interesting and critical period of the world's history.

The British navy is selected for first consideration, as holding the same predominant position in the East-

Of the two chapters devoted to this navy, the first will deal with the battleships and armored cruisers, the second with the protected cruisers, gunboats, and torpedo craft.

Including all the new vessels that will be laid down in the private and government yards by the close of the year, the official lists show that the fighting ships of the British navy of all classes, from battleships to torpedo boats, make a grand total of 625 vessels. This total is made up as follows: Armored vessels, comprising battleships, coast defense vessels, and armored cruisers, 103; unarmored vessels, including protected cruisers, unprotected cruisers, and gunboats, 226; destroyers, 106; torpedo boats, 190.

The above estimate, it must be remembered, includes all vessels that appear on the official lists of the navy. Some of them are necessarily old ships whose slow speed and out-of-date armament would greatly restrict the sphere of their usefulness. While they are by no means obsolete and could render good service on the innermost lines of defense, or at the remote and less important stations of the empire, they cannot justly be included in an estimate of the modern British navy. By way of eliminating these older vessels, we will apply a scale of speeds, omitting all ships in the repective classes which fall below the speed limit. This test is a more representative one than might at first sight be supposed; for with the gradual introduction of superior armor, guns, and construction, there has always been a proportionate increase in the speed of war vessels.

Omitting, then, all battleships that fall below about 14 knots speed, coast defense vessels below 10 knots, armored cruisers below 17 knots, protected cruisers below 15 knots, and gunboats below 12 knots, we get the following results: Armored vessels, 96: including 54 battleships, 25 coast defense vessels, and 17 armored cruisers. Unarmored vessels, 194; including 97 protected cruisers of from 14,000 to 2,000 tons and 97 small cruisers and gunboats of 2,000 tons and less. Adding these totals to those of the destroyers

giant. The cruisers' guns would burst a storm of harmless shells against the battleship's belts and turrets. while the 12-inch shells of the latter would pierce the cruisers from side to side. Their light gun shields and casemates, moreover, would prove to be little better than shell traps, serving, as did the thin turret shields of the "Oquendo," at Santiago, merely to burst the heavy shells as they passed through and insure the death of the whole gun detachment which was sheltered (?) behind it.

Although the brunt of the battle will fall upon the line-of-battle ships, the cruisers and torpedo boats that accompany the opposing fleets would probably assist

in dealing the decisive strokes when the ships of one or other side had been badly crippled. After a battleship's ern as our own navy does in the Western Hemisphere. unarmored ends had been blown away, her engines or ships and around the bases of the turrets, while above

these 34 ships, we would mention their size, seaworthiness, and speed, and in these respects they are peculiarly suited to the needs of a nation whose possessions are found in every quarter of the globe. The average size is over 14,000 tons, they all, with two exceptions, have a clear freeboard of from 20 to 25 feet, with a main deck extending unbroken from stem to stern, and the average speed is 18 knots,

Commencing with the oldest of these ships, we have the "Nile" and "Trafalgar," completed in 1890; sister ships of 11,940 tons, 163/4 knots, and 1,200 tons coal capacity. They are notable for their heavy armor, the belt being from 16 to 20 inches, the bulkheads from 18 to 14 inches, and the turrets 18 inches in thickness. The 16 to 20-inch armor is carried up to the main deck amid-



"Magnificent" Class-14,900 Tons. Also "Formidable" Class, with continuous waterline belt and two additional 6-inch guns on main deck.



this is an armored redoubt of inch armor. The main battery onsists of four 67-ton 131/2-inch uns, the secondary battery of ght 4.7-inch rapid-firers. The efensive qualities of these ships re excellent; the defects are the w freeboard (about 13 feet, or ie same as our ships of the Oregon" type) and the very ght secondary battery.

The next group of ships to be uilt was the 8 large vessels of ne "Royal Sovereign" class, of hich the "Resolution," Plate 3, one. They were completed etween the years 1892 and 1895, nd were designed by Sir Wilam White, the chief naval conructor, who has designed all the ter ships of the British navy, icluding those of the Naval lefense Act of 1889. He insted that a warship must be eaworthy, commodious, comortable for the crew, carry her uns high above the water, and ave good speed and large coalarrying capacity, in addition to eing heavily armed and armord. To embody all these feaires involved a large ship, and ence the new vessels had a dislacement of 14,150 tons. They arry 1,800 tons of coal, are of 7.5 to 18.0 knots speed, and are rotected with compound armor s follows: Belt, 18 inches; gun ositions, 17 inches; bulkheads, 3 inches; and deck, 3 inches. 'he armament consists of four 3½-inch breech-loaders, ten 6ich rapid-firers, and 38 smaller apid-fire and machine guns The other ships of this class are

he "Empress of India," the Hood," which differed from the thers in having her guns caried in turrets, the freeboard eing reduced to 14 feet, the Ramillies," "Repulse," "Reso-ation" (see Plate 3), "Revenge," nd "Royal Oak."

At the same time two smaller utfaster battleships were built, he "Barfleur" and "Centuion," whose particulars are as ollows: Displacement, 10,500 ons; coal, 1,240 tons; speed, 181/2 :nots ; armor, 12-inch compound elt and bulkheads. 9 inches on un positions, and 2½-inch deck. The armament is light for ships of this size, consisting of four 10nch breech-loading guns, ten 4'7nch rapid-firers, and twenty-

and torpedo boats gives a grand total of 586 efficient and up-todate vessels.

While there is, of course, great strength in numbers, the real

of 54 seagoing battleships. These constitute the main line of defense, and if this line should ever be penetrated and its ships dispersed or sunk, all the other 500 vessels could not save the vast British empire from dismemberment or the "tight little isle" itself from invasion. It is a sound axiom in naval warfare, the naval warfare of steel armor and high-powered guns, that no vessel can fight outside of her class with any reasonable hope of success-not, at least, where the opposing ships are handled by crews of equal efficiency. Battleship must be opposed by battleship, cruiser by cruiser, torpedo boat by torpedo boat destroyer. A fleet of unarmored cruisers could no more lie in the line of battle against a fleet of armored battleships or are soon to be so.

"Canopus" Class-12,950 Tons.

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fighting power of the British navy lies in its fleet steering gear crippled, or her heavy guns dismount- and embodied such modern improvements as wireed, the armored cruisers and the more powerful of wound guns and Harveyized steel. These are known as the "Majestic" class, after the first of them which the protected cruisers might be trusted to close in was completed. 'The others are the "Jupiter," and finish her-and this duty they would undoubtedly "Magnificent," "Mars," "Cæsar," "Prince George," perform. But this always presupposes that the bulldog has had its teeth drawn, and such work can only "Hannibal" (see Plate 2), "Illustrious," and "Vicbe done by the battleship.

torious." As compared with the "Royal Sovereign" class, the "Majest'cs" have 750 tons more displacement, The 54 battleships may be subdivided most advantageously according to their age, according as they were carry about the same amount of coal, and have the built in the present or the preceding decade or at an same speed. The higher quality of the steel used in their armor (Harvey steel) permits the thickness to be even earlier date. Under this distribution we get 34 battleships 10 years old or less; 11 battleships over 10 reduced, and hence a larger area of the ship can be covered. Thus in the "Royal Sovereign" class the main and less than 20 years old; and 9 battleships that are belt extends vertically only as high as the flat protecover 20 years old and have been refitted and rearmed tive deck; while in the "Majestics" the 9-inch belt is

with any hope of success than a pygmy could fight a If asked to name the most characteristic features of carried up to the gundeck (see diagram). Moreover, the

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ine smaller guns.

The next building programme included nine more huge vessels that were similar to the "Royal Sovereign" class but were larger

# Scientific American.



3.-First-class Battleship "Resolution." "Royal Sovereign" Olass of Eight Ships. Displacement, 14,150 tons. Speed, 175 to 18 knots. Bunker Capacity, 1,800 tons. Armor: Belt, 18 inches; barbettes, 17 inches; casemates, 6 inches; deck, flat, 8 inches. Armament, four 13½-inch, ten 6-inch rapki. Arers, thirty-six smaller guns. Torpedo Tubes, 7 (two submerged). Complement, 730. Date, 1852 to 1895.



5.-First-class Turret Battleship "Hood." One of this Type. Displacement, 14,150 tons. Speed, 175 knots. Bunker Capacity, 1.800 tons. Armor: Belt, 18 inches; turrets, 17 inches; casemates, 6 inches; deck, flat. 13 inches. Armament, four 13½-inch, ten 6-inch rapid-firers. thirty-six smaller guns. Torpedo Tubes, 7 (two submerged). Complement, 730. Nate, 1802 Date, 1893.



-Forward Pair of 13½-inch, 67-ton Guns of the "Resolution," Mounted in Barbette. 4.

Height of guns above sea, 27 feet. Note: In the "Resolution" class the large guns are mounted in the open. In the "Majestic," "Canopus," and "Formidable" classes they are protected at the breech by hoods of 6-inch steet.



6.-First-class Battleship "Barfleur." Also "Centurion."



8.-Forward 10-inch Guns of the "Renown." The six ships of the "Canopus ' class (1834 knots) carry four 12-inch guns and twelve 6-inch rapid-firers.



7.—First-class Battleship "Renown." Also six of "Canopus" Class, improved "Renowns" of 12,950 tons and 1834 knots. Displacement, 12,350 tors. Speed, 18 knots. Coal, 1,800 tons. Armor, 8-inch belt, 10-inch barbettes. Armament, four 10-inch, ten 6-inch rapid-firers, fourteen 3-inch rapid-firers, twenty-one small guns. Tor-pedo Tubes, 5 (two submerged). Complement, 674. Date, 1896.

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10.-Armored Cruiser "Australia." Seven of this Class.

Displacement, 8400 tons. Speed, 16'7 knots. Bunker Capacity, 1,130 tons. Armor: Belt, 10 inches; barbettes, 436 inches; deck, 2 inches fat, 4 inches slopes. Armament, four 92-inch, ten 6-Inch rapid-firers, twenty-four smaller guns. Torpedo Tubes, 6. Complement, 544. Date, 1888.

From Photographs by Symonds & Co., Portsmouth, England,

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waterline is further protected by sloping the sides of the protective deck, these slopes being 4 inches in thickness. The belt, the slopes, and the coal protection present a resistance equal to 18 or 19 inches of Harveyized steel. The main battery is protected by 14 inches and the secondary battery by 6 inches of Harvey steel. The armament is also more powerful, consisting of four 12-inch wire-wound guns, twelve 6-inch wirewound rapid-firers in casemates protected by splinter bulkheads, eighteen 3-inch rapid firers and twelve 3 pounders, besides eight machine guns.

tic" the main battery is carried "en barbette," that is to say, the guns fire over the walls of a fixed barbette, and have no turret armor to protect them. This system has been permanently adopted in the British navy on account of the greater height at which the guns can be carried, and the greater ease of manipulation, owing to the fact that only the guns, and not the turrets and guns, have to be trained. In the "Royal Sovereign" the gun crew are entirely exposed, but in the "Magnificent" and all later ships, a sloping shield, 6 inches in thickness (equal to about 9 inches vertical), protects the breech and the gun-crew.

The next vessel, the "Renown" (1896), showed a tendency to return to smaller displacement, and obtain higher speed at the expense of the armament, the latter being absurdly light for a ship of her size. The particulars are as follows : Displacement, 12.350 tons; speed, 18 knots; armor belt, 8 to 6 inches; gun positions, 10 inches; armament, four 10-inch, ten 6 inch rapid-firers, fourteen 3-inch, and twenty-one smaller guns.

Following the "Renown" come the six vessels of the "Canopus" class (Plate 7), which are a great improvement over the former ship. Although they are only ticulars of each type are given below the illustrations tates are those that are obtained by reduction, and 600 tons larger, they have a much higher speed, a of the respective ships and call for no special remark. that the tenuity seems to increase with the number of larger coal supply, and carry 12-inch in place of 10inch guns, besides two extra 6-inch rapid-firers. The particulars are: Displacement, 12,950 tons; speed, 1834 addition to the protective deck. In both the "War- or sulphide of sodium as a reducing agent. The first knots; coal supply, 1,850 tons; belt armor, 6 inches, associated with 3-inch sloping deck; gun positions, 12 inches. Armament, four 12-inch, twelve 6-inch rapid- "Warspite," and the sisters to the "Australia" are the ble of giving with metals, and the best known of which firing, and eighteen smaller guns. These ships will be "Aurora," "Galatea," "Immortalité," "Narcissus," are the two double hyposulphites of sodium and silver, completed this and next year. The other ships of the "Orlando," and "Undaunted." The date of these that are so important in photography. But M. Girard "Canopus" class are the "Albion," "Glory," "Goliath," "Ocean," and "Vengeance."

The next programme, which is now under construction, called for three sister ships, the "Formidable," "Implacable," and "Irresistible," which are to be even larger than the "Majestic" class and of at least half a The first four of these are of the following dimensions, knot greater speed, steaming 18 knots under natural draught. The armament is to be increased over that of the "Majestic" by the addition of two 6-inch rapid- | flat, 3 inches on slopes; gun positions, 6 inches, firers, while the side armor will be carried out to the stem and stern.

Under the supplementary vote this year for the increase of the navy, three other 15,000-ton ships, simithese ships will be armored with Krupp steel, and knots speed, and great steaming radius. the weight so saved in armor will be put into speed, armament, or ammunition supply. The three latest ships are to be of 1834 knots speed.

Passing now to theeleven battleships over ten and less than twenty years old, we notice first what areknown as the "Admiral" class, completed between 1886 and 1889. There are six of these : The "Benbow," "Collingwood," "Howe," "Rodney," "Anson," and "Camperdown." The smallest is the "Collingwood," of 9,500 tons, and the other five are of 10,600 tons displacement, while the record of any previous year. Invention is certainly that M. Girard has not as yet thoroughly elucispeed of all six is about 16% knots per hour. The main not on the decline, and the man with an idea and a dated. armament of the "Collingwood" consists of four 12inch guns (not wire-wound); that of the "Benbow" of two 16¼-inch 110-ton guns ; and that of the other four ships, of four 131/2-inch 67-ton guns. The freeboard of the ships is low (about 13 feet), and the main battery is carried "en barbette." The armor is of the com- came along added recruits to the army that never halts of the manipulations will not fail to contribute toward pound type, 18 inches in the belt, 16 inches in the bulk- in the march of progress. The following table marks the success of this new industry-the photochromy of head, from 12 to 14 inches in the barbettes. The the line of increase for each decade since 1840: secondary battery of six 6-inch rapid-fire guns is carried amidships, without any protection. The coal capacity is 1,200 tons. The good features of these are their heavy main battery, the heavy armor of belt and barbettes, the good speed, and large coal capacity. The weak points are the low freeboard, rendering the ships not very seaworthy; the feeble secondary battery, and the lack of armor protection to the latter and to the bases of the barbettes, which are not covered by the armor belt. Another and more serviceable ship is the "Sanspareil," 1889, sister ship to the ill-fated "Victoria." She is of 10,470 tons and 17.2 knots, with belt and turret armor 16 to 18 inch, compound. She carries as main armament two 110 ton guns in a forward turret and one 10-inch rifle aft. In broadside are twelve 6-inch rapid-firers, supplemented by twenty smaller guns.

Considerably older than these are the turret ships thing is its property. It pares a potato and shells peas, "Conqueror" and "Hero" (1882) of 6,200 tons, 15.3 knots speed, and 650 tons coal supply. They carry two 12inch guns forward in a turret of 12-inch armor and on the upper deck have four 6-inch slow-firers.

The third class includes nine battleships built more than twenty years ago. They have an average displacement of 8,872 tons and an average speed of 14.1 knots. The largest is the "Dreadnaught," of 10,820 tons and 13.7 knots, the smallest the "Rupert," of 5,440 tons and 14 knots speed. Some of them, such as the "Mon- as in peace it is equally potential and irrepressible. It In both the "Royal Sovereign" and the "Majes-|arch," "Alexandra," and "Sultan," have been re-en-plans arms of precision and propels explosives under gined, reboilered, and partially rearmed with modern the waters and above them, conceives and fashions a guns. It is proposed to rearm and refit the others.

> big "Inflexible," of 11,880 tons, 24 inch armor, 12.8 knots | life be spared. speed, and armament of four 16-inch 80-ton guns, to the "Orion." of 4.870 tons. 12 knots speed. 8 to 12-inch armor, and main armament of four 12-inch muzzleloading rifles. Among these are included the old broadside line-of-battle ships of the seventies, such as the "Agincourt," 10,600 tons and 12 knots, the "Nelson" and "Northampton," of 7.610 tons and 13½ knots, and it possible to obtain exactly analogous colors to those others of a similar class. They are fine, high freeboard ships, and afford good gun platforms. They have protective decks, from 51/2 to 12-inch side and citadel armor, and, if rearmed, would prove to be highly serviceable for coast defense. There is a strong movement afoot to floats, although sometimes of greater density. The carry out this rearmament, and it will probably be metallic object, previously very carefully cleaned, havdone.

> Great Britain has only of late years taken up again the construction of that invaluable type of ship, half battleship, half cruiser-the armored cruiser. At present she has nine; two of the "Warspite" class (Plate 9) colored. and seven of the "Australia" class (Plate 10). The par-The distinction between the armored and the pro- the intermediate reactions. These facts led him to tected cruiser is that the former carries side armor in select hyposulphite of sodium, sulphureted hydrogen, spite" and the "Australia" the belt is 10 inches in of these substances gave him the best results, because thickness. The sister ship to the "Imperieuse" is the of the numerous double hyposulphites that it is capaships is from 1886 to 1889.

Realizing the immense importance of the type and prompted, no doubt, by the example of the French government, England has commenced the construction of eight large armored cruisers of the "Cressy" class. etc.: Displacement, 12,000 tons; speed, 21 knots; coal supply, 800 tons; belt, 6 inches; deck, 2 inches on is heated, the double salt is decomposed at about 70 or all of Krupp steel. Armament, two 9.2-inch rifles, twelve 6-inch rapid-firers, and seventeen smaller guns. The other ships of the class will be the "Aboukir," "Hague," and the "Sutlej." The designs for the kept as near as possible to its free surface. It is then lar to the "Formidable," were ordered. All six of other four call for ships of 14,000 tons displacement, 23 observed to become covered successively with the vari-

> the British navy, with illustrations and descriptions of object has assumed the tint desired, it is removed from the unarmored ships, such as protected cruisers, gun- the bath. The color is due to the interferences of inciboats, and torpedo craft.

# Patents.

applications for patents during the year 1897 outran interference and absorption colors. This is a point model is in stronger evidence than ever. In no time in the history of the Patent Office has there been any sign of a marked relapse in inventive ingenuity—here and there perhaps a parenthesis, as in times of panic photochromic bath, the immense variety of colors that and trade stagnation; but as a rule each year as it may be obtained with this bath alone, and the facility

r the ten years beginning 1840 the average is						1,186.9
••		••	1850		<sup>-</sup> <sup>**</sup>	3,884.2
64 C	64.	••	1860	**	"	11,724.5
			1870		"	20,259.5

and girds the planet with telegraph cables. The commonest and cheapest form of tool does not escape its improving hand, and it is equally as available in utilizing the epoch-making discoveries of science. It creates new industries, as in the case of the bicycle, the telephone, electric appliances, linotype machines, etc. As it has been doing it will continue to do, keeping pace with discovery and declaring nothing as unimprovable that man has devised or constructed. In war murderous pellet of lead, and gives the surgeon a The twenty-five coast defense vessels range from the Roentgen ray by which the bullet can be located and

### The Photography of Colors and Photochromy of Metals.

Very recently, M. Joseph Girard, preparator of chemistry at the Faculty of Sciences of Paris, has found obtained by Edmond Becquerel, without the intervention of the electric current, as used by Becquerel.

The body to be deposited is obtained in the state of very tenuous precipitate in a liquid in which it ing been immersed in the liquid, attracts the precipitate through capillary phenomena and causes it to deposit in a layer of which the thickness increases with the duration of immersion of the object to be

M. Girard remarked that the most tenuous precipidid not wish to use silver salts on account of their high price and their great sensitiveness to light. He prefers to them copper or lead salts.

When a solution of sulphate of copper or acetate of lead is mixed with one of hyposulphite of sodium, there forms a double hyposulphite of sodium and copper or lead, both of which are soluble salts. When the liquid 80 degrees into a sulphide, which precipitates in extremely fine particles. It is at this moment that the object to be colored (which may be of copper, tin, nickel, zinc, etc.) must be immersed in the bath and ous colors of the spectrum in their usual order-red, In another issue we shall conclude the description of orange, yellow, green, blue, indigo, violet. After the dent light with the light which, after traversing the thin layer of deposited sulphide, has been reflected upon the metallic plate in order to traverse the layer of sulphide again. However, as the latter is slightly The Keystone has this to say about patents: The colored, it seems as if there were here a mixture of

> The best results have been obtained by employing a mixture of sulphate of copper and acetate of lead. The low price of the products used for forming the metals.

But M. Girard's researches have, aside from an industrial scope, an interesting scientific one. There is a widespread prejudice that consists in believing that the blue violet and ultra-violet radiations of the spee trum are alone capable of causing chemical reactions, and from this comes the very improper name of chemical rays that is often given this region of the solar spectrum. Now, red, orange, and green radiations are capable of giving rise to chemical reactions that, Ingenuity is not exclusive. It isolates nothing. It although different from those produced by blue and

Other ships are the "Colossus" and "Edinburgh," of 9,420 tons and 14.2 knots, armed with four 12-inch rifles quitous character of inventive genius. It ranges from tive plate by the method employed in the photochromy a shawl pin to a monster crane, and from a mouse trap of metals, M. Girard has been able to obtain a photoin turrets, five 6-inch slow-firers and twenty smaller or a lemon squeezer to a tubular boiler, an electric graph of the solar spectrum in colors. So, we shall guns. They carry compound armor 16 to 18 inches motor, or a superb locomotive. It represents the de- not be astonished if his researches end before long in a thick. They are of the central citadel type like our own mocracy of genius, in which nothing is too small to be new solution of the very interesting problem of the "Texas," and, with their coal supply of 970 tons, are important or too great to be unapproachable. Every- photography of colors.-La Revue Technique. fairly serviceable ships.

Fo

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From the character and number of the patents granted in 1897, it is evident that the fertile mind of the inventor is fructifying in every field of endeavor.

covers every imaginable form of device, and has its violet rays, are none the less interesting. M. Girard improving hand on every type of tool, machine, imple- has, in particular, found in his researches that the ment, or apparatus helpful to industry or contributory metallic sulphides, especially copper sulphide (Cu<sub>2</sub>S) to the comfort and convenience of human kind. In and silver sulphide  $(Ag_2S)$ , are very sensitive to red every annual report of the Commissioner of Patents radiations. This property will not fail to be utilized we have a list of devices that are as diversified as was for the preparation of isochromatic photographic the population of Noah's Ark, and in the literature of plates, which will prove very useful for the photoingenuity nothing more clearly demonstrates the ubi- graphy of colors. Moreover, upon preparing a sensi-



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1.—After pair of 12-inch guns on the Battleship "Collingwood," showing method of mounting in barbette. "Admiral" class: Number in class, 5. Four of the "Admirals" carry each four 13½-inch guns, and one, the "Benbow," two 16¼-inch guns.

![](_page_3_Picture_7.jpeg)

From photographs by Symonds & Co., Portsmouth, Englan d.

From photographs by Symonds & Co., Portsmouth, Englan d.
2.—First-class Battleship "Hannibal." "Majestic" class of nine sbips. (Also six ships of "Formidable" class, improved "Majestics" of 15,000 tons and 18% knots.)
Displacement, 14.900 tons. Speed, 17:5 to 18 knots.
Hunker capacity, 1,850 tons. Armor: Belt, 9 inches by 18 feet deep; barbettes, 14 inches; casemates. 6 inches; deck, 2½ inches flat, 4 inches slopes. Armainent: Four 12-inch wire guns; twelve 6-inch rapid-fire; sitteen 3-inch rapid-fire; siteen 3-inch rapid-fire; siteen

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