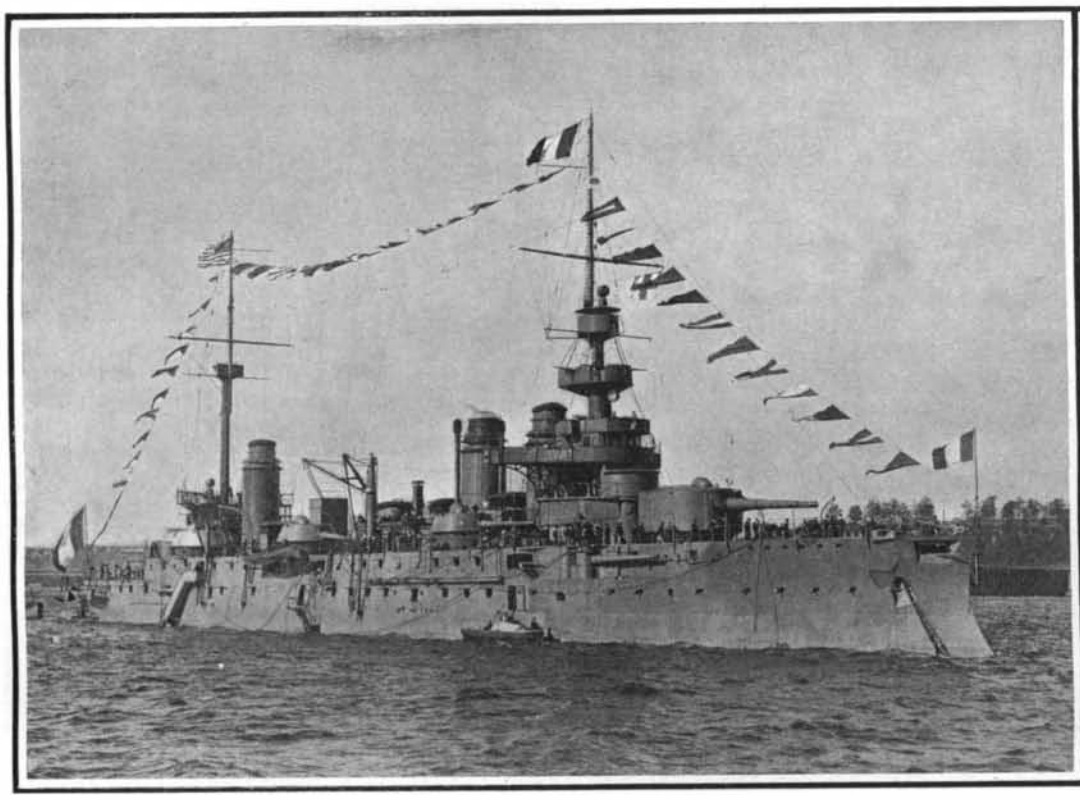
tons of coal, kindling lighters, 50 pounds of waste, 200 gallons of oil for lighting, the storage for oil, and the building of a coal house. For the first year's equipment for oil pots, including 800 pots for ten acres, and fuel at 5 cents a gallon, the cost is estimated at $494.25, and for the second year $153.75.

Now that the question of raising the temperature even 10 or 15 deg. over a large area has been settled beyond doubt, the next problem facing the fruit growers is that of regulating the temperature and economy of fuel and labor. For example, there is no need of raising the temperature 10 deg. when raising it 2 deg. will put the blossoms out of danger. Some are planning to meet this problem by having a large number of small pots and only light enough of them to keep the temperature above the danger point. Others have devised pots with a system of drafts, so that the heat may be increased or decreased as is necessary.

The fruit ranches of the Grand Valley are very extensive. One, for example, contains 243 acres, and is valued at a quarter of a million dollars. Its crops include peaches, apples, pears, plums, cherries, and soft-shell almonds. An army of people is required to pick the fruit. By another season it is expected electric lines will be running out to the orchards all over the valley, and refrigerator cars will be carried right to the orchards.

THE VISITING WARSHIPS—A COMPARISON.

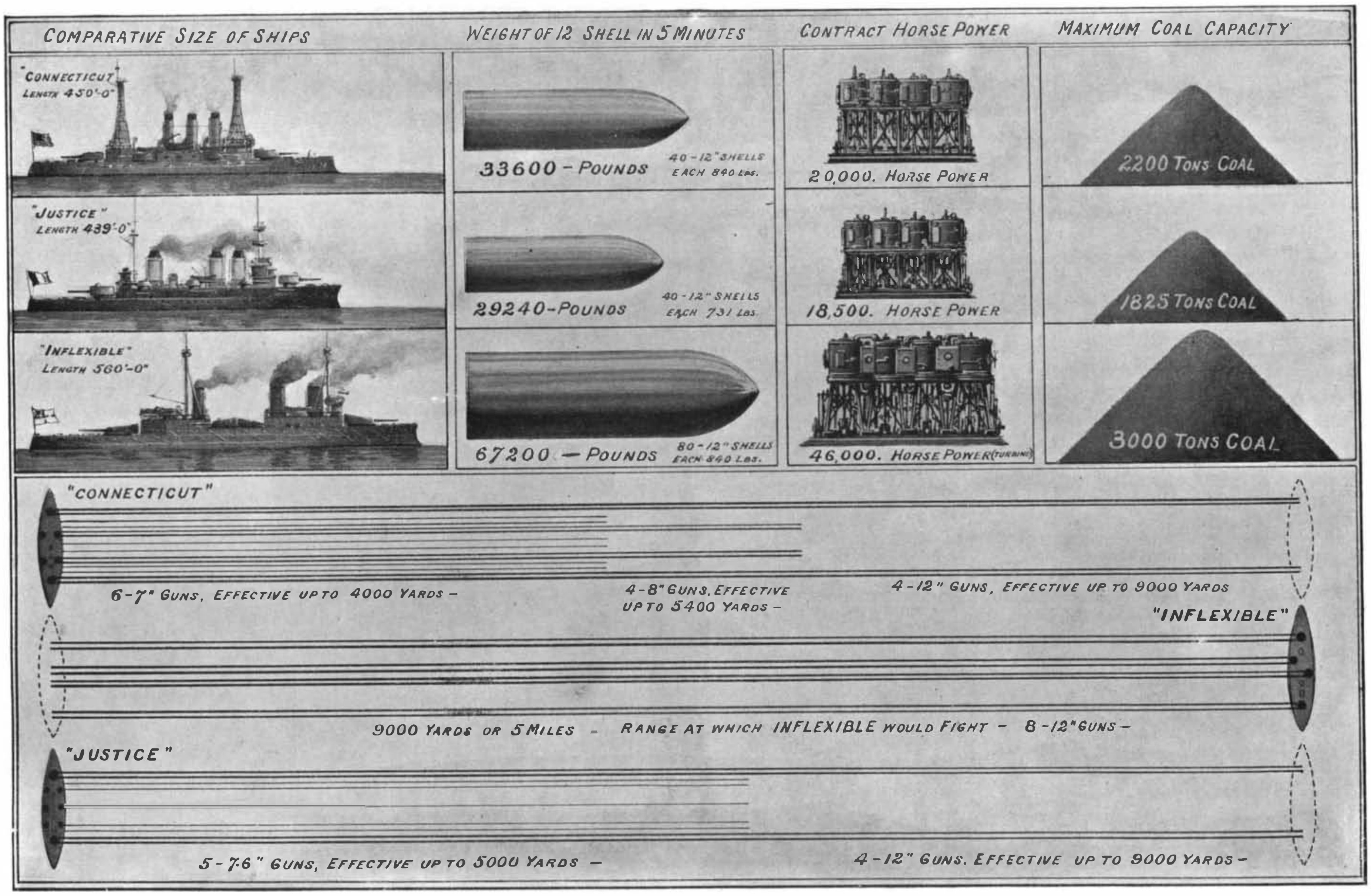
Because of incompetence in its management the naval parade, which should have been one of the most attractive features of the Hudson-Fulton Celebration, came very near being a complete failure, and it was only redeemed by the fact that its line of travel lay parallel with the finest assemblage of warships that was ever gathered in the waters of the Western Hemisphere. The very devil of mischance seemed to have been abroad on the morning of September 25th, and he became busy at the very outset, when the "Half Moon," in a laudable endeavor to show herself under sail, had no sooner spread her canvas, than she plumped squarely into the "Clermont," and came very near ending the career of that little craft there and then. The two great errors which made the parade a failure were, first, the anchoring of the "Half Moon" and the "Clermont" off 110th Street, instead of sending them under tow around the whole line from 42nd to 205th Street; and secondly, the failure to dispatch the commercial steamers, tugboats, yachts, etc., two or three abreast and with reasonably short intervals between them. As it was, a vast part of the visitors both ashore and afloat, all, in fact, who were above 110th Street, never caught a glimpse of the two vessels, the "Half Moon" and the "Clermont," in whose honor the parade was being held. Instead, for them, the procession consisted of a lot of detached and widely separated passenger steamboats, big and little, which



Displacement, 11,900 tons. **Speed,** 19.4 knots. **Guns:** Four 12-inch; ten 7.6-inch.

French Flagship, "Justice."

The "Half Moon" under sail in the Lower Bay, New York.



In an engagement with the "Connecticut" and "Justice" the "Inflexible" would try to fight outside the armor-piercing range of their secondary batteries. These batteries, however, would cut her unprotected parts to pieces.

THE VISITING WARSHIPS—A COMPARISON.

steamed leisurely around the fleet—vessels with which the majority of the spectators were already perfectly familiar, from the "Hendrick (*sic*) Hudson" down to our venerable friends the "Iron Steamboats."

It was the noble line of warships, nine miles in length, however, that saved the day. At the head of the line, above Spuyten Duyvil, was the turbine-driven 26-knot scout cruiser "Salem." Astern of her were the armored cruiser, "New York," the flagship of Admiral Sampson during the Spanish war and now fresh from a one million dollar overhaul, in which she has been brought as far up to date as a ship of her age can be. Then there was the "North Carolina," a handsome modern armored cruiser of the pre-"Dreadnought" period. Below these in majestic array came the sixteen battleships which made the memorable voyage around the world. Astern of these was the "Dreadnought" cruiser "Inflexible," the largest and most up-to-date warship in the fleet, with her three armored cruiser consorts, the "Drake," "Duke of Edinburgh," and "Duke of Argyll." Following these were the quaint wooden training ship "Portsmouth" and the Dutch protected cruiser "Utrecht," which was anchored in the position of honor opposite the water gate at 110th Street, where the official reception of the "Half Moon" and "Clermont" took place. Then came the four armored cruisers "Victoria Luise," "Hertha," "Dresden," and "Bremen," representing Germany. Astern of these followed what in some respects was the most imposing of the foreign display, namely, the first-class battleships "Justice," "Verité," and "Liberté," flying the flag of France. Astern of these were the protected cruisers "Etna" and "Etruria" of Italy; the training ship "Presidente Sarmiento" of the Argentine Republic; the gunboat "Morales" of Mexico; the U. S. gunboat "Newport," with the President's yacht "Mayflower" forming the last ship of the line.

THE "CONNECTICUT," "JUSTICE," AND "INFLEXIBLE" —A COMPARISON.

Of the many navies represented at the Celebration, there were three which contained fighting ships of sufficient powers of offense and defense to be placed in the first line of battle, namely, the French, British, and our own. It is impossible within the limits of the present paper to discuss in detail the various units which made up this nine-mile line of warships, with which most of which the readers of the Scientific American have already been made familiar. We will therefore take the three flagships, the battleship "Connecticut" of the United States navy, the battleship "Justice" of the French navy, and the "Dreadnought" cruiser "Inflexible" of the British navy, and compare their fighting power under those conditions of long-range fighting under which, we are told, modern battleship engagements will be fought.

The theory upon which the latest battleships of our own and modern navies are being designed, and according to which the crews are now being instructed in target and battle practice, is based upon the belief that future engagements will be fought at extremely long ranges, probably of five miles and over. Now, the most accurate gun, and the one that can inflict greatest punishment at long ranges, is the big gun, and the bigger the gun the more accurate and deadly the fire. It is in this fact that we find the explanation of the modern "Dreadnought," which is armed entirely in its main battery with the 12-inch gun, the exception being the German navy, which makes use of an 11-inch piece. Now, the determination of the range at which a battle shall be fought lies with the ship which possesses the greatest speed; for, if the enemy should attempt to close in, the faster ship is always able to draw away. On the other hand, if the enemy should wish to increase the range or draw out of the fight altogether, the faster vessel can still maintain the range, and place herself on whatever

COMPARISON OF "CONNECTICUT," "JUSTICE," AND "INFLEXIBLE."

	"Connecticut."	"Justice."	"Inflexible."
Navy type	United States Battleship.	France Battleship.	Great Britain Cruiser-Battleship.
Length.......	450 feet.	439 feet.	567 feet.
Beam........	76¾ feet.	79½ feet.	78½ feet.
Draft.	26¾ feet.	28 feet.	28 feet.
Displacement.	16,[illegible]0 tons.	14,900 tons.	17,250 tons.
Horse-power..	20,000	18.550	50,000
Trial speed.	18.8 knots.	19 4 knots.	28 knots.
Coal supply...	2,200 tons.	1,825 tons.	3,000 tons and 700 tons oil.
Main Battery	Four 12-inch.	Four 12-inch.	Eight 12-inch.
Secondary battery..	Eight 8-inch. Twelve 7-inch.	Ten 7.6-inch.	....
12-inch gun protection...	12 to 10-inch.	12½ to 11-inch	10-inch.
Secondary battery protection	7 to 6-inch.	5½-inch.	....
Belt armor....	11 to 4-inch.	11 to 7-inch.	7 to 4-inch.

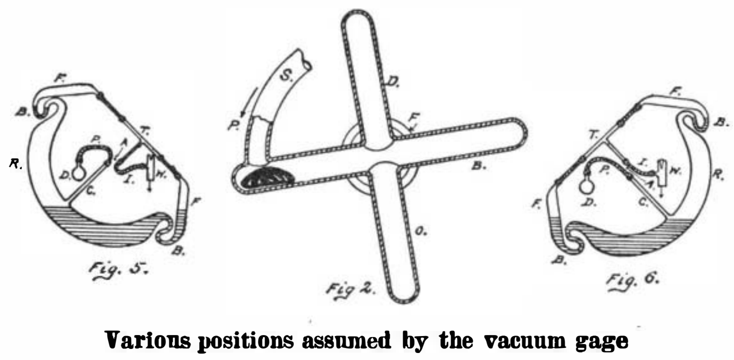
(*Continued on page 271.*)

A NOVEL AIR PUMP AND VACUUM GAGE.

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The most indispensable auxiliary of the physicist intent upon investigating those mysterious radiations the study of which is becoming more and more important is doubtless the air pump. For that reason many scientists and engineers have endeavored to improve the existing types of air pumps and have designed novel systems. One of the most interesting is that invented by Dr. Von Reden, of Franzburg, near Hanover.

This is a mercury pump, the design of which will be most easily understood by reference to Figs. 5 and 6. The pump consists of a tube filled one-half with mercury, as indicated by the shaded portions. This tube is provided at its two ends with S-shaped tubes



Various positions assumed by the vacuum gage

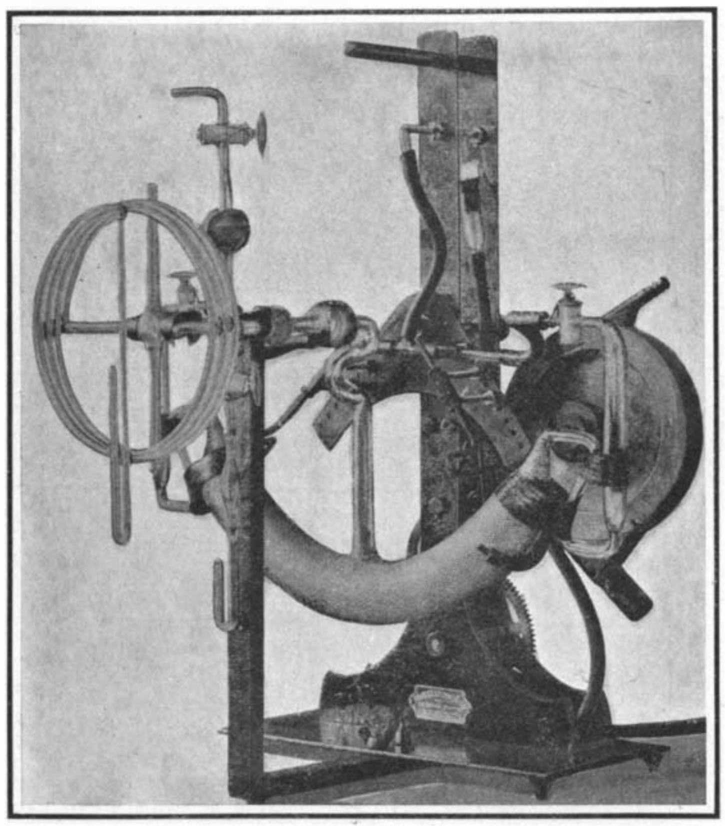
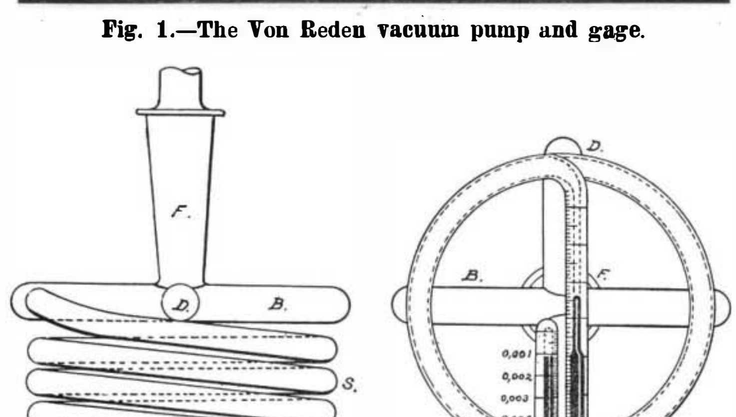


Fig. 1.—The Von Reden vacuum pump and gage.



Spiral glass tube attached to two cross tubes.

A NOVEL AIR PUMP AND VACUUM GAGE.

B, and at its middle with a straight tube *C*. The S-shaped tubes are connected on both sides to widened portions *F*, connected by rubber tubing with a T-shaped tube and thence by tube *I* with a water supply *W*. The straight tube *C* and the bulb *D* to be exhausted are connected by a rubber tube *P*. The entire apparatus turns round a pivot *A*.

After having produced a preliminary vacuum (of about 20 millimeters of mercury) in the bulb *D*, and the apparatus, by means of the water pump *W*, the apparatus is oscillated from the position represented in Fig. 5 to that of Fig. 6 and back. The mercury remaining in the S-shaped tubes *B* acts as a pressure valve, and prevents the air in the enlarged portions *F* from returning to the tubes *R*. On the other hand, the air entering from the bulbs *D* in both positions through *C* is driven by the mercury toward the widened portions of the apparatus through the right-hand and the left-hand S-shaped tubes respectively, in order to be eventually discharged by the water pump. The connecting tube *P*, which, owing to its porosity, would not be very efficient, is advantageously replaced by a connection consisting of ground-glass joints in the shape of perforated glass balls, fitting tightly in the carefully polished hemispherical cap, as shown in a halftone illustration, Fig. 1. In order to connect the ball with the cap, metallic springs may be employed.

Fig. 1 represents to the right a turbine belted to a pulley, which oscillates the tube by means of gearing and a crank mechanism. The glass ball joints lead to the spiral vacuum gage and the joint provides a connection with the bulb to be exhausted. A short-arm manometer is mounted below the bulb.

The pump above described can exhaust within three minutes a bulb of about 500 cubic centimeters capacity (a preliminary vacuum having been previously obtained by means of a water pump) to 1/100 of a millimeter of mercury; in four minutes, to 1/1000; in five minutes, to 1/10,000; and in thirteen minutes, to 1/100,000 millimeter of mercury, the lower handle being turned at the speed of six revolutions per minute. All the air should be expelled from the two vacua *F*, in order to obtain the vacuum last named. This is effected when the pump has been given its maximum inclination by means of the mercury, which on entering the apparatus throws back any residual air through the cocks *H* and *H'*, closed rapidly after the tube *R* has been kept oscillating for seven minutes. The pump is stopped only for a very short time.

The vacuum gage represented in Figs. 2, 3, and 4 consists of a spiral glass tube attached to two cross tubes (Fig. 2). The left-hand tube *B* incloses a small amount of mercury, and the cross tubes *B*, *D*, *O* are mounted on a standard ground-glass joint, the conical angle of which is accurately given.

By turning the spiral round on the axis of the joint *G* in the direction of the arrow *P* (Fig. 2) the small amount of mercury represented at the left of Fig. 2 is made to enter the spiral, there compressing the exhausted air, until after a number of revolutions it enters the U-shaped tube *E* of Fig. 4, in order there to occupy the position marked. The left-hand arm of the U-tube is so graduated that the divisions 0.001, 0.002, etc., to 0.006, limit 1/1000, 2/1000, etc., to 6/1000 of the total capacity of the U-shaped tube and of the spiral in the upper portion of the capillary tube. The right arm of the U-shaped tube is graduated to millimeters. In the present case, the exhausted air of the spiral is compressed as far as the division 0.001; that is, to 1/1000 of its previous volume; in the right arm of the tube, the mercury takes up a position 16 millimeters higher. As, however, the atmospheric pressure in the bulb to be exhausted is 1/1000 of the pressure read on the gage, its value has accurately been 16/1000 millimeter.

The spiral gage will indicate vacua up to 1/10,000 millimeter. The only distinctive feature of the one used in measuring a vacuum of 1/100,000 millimeter is its being provided with a longer spiral and thinner U-shaped tube.

According to a consular report dealing with the trade of Chinkiang, it is proposed to build a railway from Kuachou, at the mouth of the Grand Canal, to Tsingkiangp'u and Hsüchoufou, and thence joining the Peking-Hankow line *via* K'aifêngfu. This line has been surveyed, and the money is being asked for among Chinese merchants. The enterprise, the report states, is to be purely a "people's undertaking." The Chinkiang-Hsüchoufou-K'aifêngfu portion is to be laid first, as the canal provides a temporary transport for goods from Tsingkiangp'u southward, and therefore this portion is not so pressing. The line is to be finished in four or five years. If the Tientsin-Pukow line gets into working order first, a great deal of the trade of Chinkiang must go to Nanking, and may never be recovered. But although the future prosperity of this port would seem to depend upon the new line in question being ahead of the Tientsin-Pukow line, the wealthy merchants of Chinkiang and Yangchow and other places seem still reluctant to subscribe the necessary capital, nor will they consent to a foreign loan, however favorable in terms. It was hoped that this being a "people's line"—the Tientsin-Pukow line being official—would commend itself to the merchant class, but the reason for want of support is to be sought in the want of confidence when large sums are to be placed in the hands of a few "managers."

once more over the top sprocket drum and pulley where it meets the picture film traveling from the upper spool, and the operation is repeated.

The grave disadvantage of the revolving disk is that the screens therewith have to be, as it were, standardized; that is to say, must be such that they are equally applicable to any picture that may be used in projection irrespective of the densities of the color filters used in photographing. This often destroys or depreciates the true color effects and values. On the other hand, with the band it is possible to secure the same relative color screens that were used in taking the picture, so that the latter is virtually projected through the same color filters as were employed for photographing.

With the band, moreover, a new film can be far more easily fed into the machine. In this apparatus the gateway is of special design. The picture film has a short length of lead indicating successively red, green, blue, in the order in which the exposures are made. All that is necessary to do is to open the gateway, superimpose the one color filter of the endless band upon its corresponding indication upon the lead, and then all is ready for projection. The apparatus has been demonstrated in London and Paris, and the possibilities of the Friese-Greene system, owing to its simplicity and economy combined with truthfulness of color value and density, have attracted considerable attention.

THE VISITING WARSHIPS—A COMPARISON.

(*Continued from page 262.*)

point of bearing is most advantageous for her batteries and least advantageous for those of the enemy.

Now, from what we have said above, it will be evident that when an all-big-gun ship meets one that carries a mixed armament of big guns and guns of medium caliber, she will endeavor to place herself at sufficient distance from the enemy to be outside of the armor-piercing range of its medium-caliber guns and within the armor-piercing range of her own big guns. She can only do this, however, by possessing a reasonable superiority of speed, and the greater her excess of speed the more completely will she be master of the position.

Applying these facts to the "Connecticut," "Justice," and "Inflexible," we can see at once how completely the all-big-gun, high-speed, fighting ship of to-day outclasses the big and medium gun, moderate-speed battleship of the pre-"Dreadnought" period. The big-gun ship is *vitally* vulnerable only by the penetration of her waterline or of the barbettes and turrets in which the 12-inch guns are mounted. The greater part of the personnel of the pre-"Dreadnought" battleship, on the other hand, is stationed at the numerous guns of the secondary battery, where they are protected by comparatively light armor; and even at the fighting range of five miles they would be exposed to complete destruction by the high-explosive, 12-inch shells.

GUN POWER.—Comparing the three ships on the basis of gun power, we find that the "Connecticut" carries four 12-inch 45-caliber guns, eight 8-inch 45-caliber guns, and twelve 7-inch 50-caliber guns; the "Justice" mounts four 12-inch 50-caliber guns and ten 7.6-inch 45-caliber pieces; while the British "Inflexible" mounts eight 12-inch 45-caliber guns, but no secondary armament. Now, at a fighting range of five miles, the 12-inch gun of the "Connecticut," firing an 850-pound shell at 2,700 feet per second velocity, can penetrate 8 inches of Krupp armor; the 12-inch gun of the "Justice," firing a 731-pound shell with a muzzle velocity of 3,000 feet per second, can penetrate 7 inches of Krupp armor; and the 12-inch gun of the "Inflexible," firing an 850-pound shell at 2,900 feet per second, at the same range can penetrate 9 inches. Now, since the belt armor of the "Connecticut" varies from 11 inches amidship to 4 inches at the ends, and that of the "Justice" varies from 11 inches to 5½ inches at the ends, it follows that the vitals of both these ships would be quite secure against the attack of the "Inflexible" at this range; although it would be possible for her to penetrate both ships at each end of the waterline. Since the 12-inch guns of both the "Connecticut" and the "Justice" are protected by from 10 to 12½ inches of steel, they should be practically safe against penetration. On the other hand, the "Inflexible" would not fare so well, since her belt protection varies from 7 inches amidships to 4 inches at the ends, and she would be theoretically penetrable by the guns of both her opponents at five miles range. Her 12-inch guns, however, with a turret and barbette protection of 10 inches armor, would be secure against penetration.

It should be borne in mind, however, that these figures of penetration are worked out for impact *at right angles to the armor*. At these distant ranges the projectiles would be falling at an angle of several degrees, and therefore the resisting power of the armor on all three ships would be considerably higher than that mentioned above.

The secondary armament, both of the "Connecticut" and the "Justice," could riddle the unarmored, but could not penetrate the armored portions of the "Inflexible," whereas the turrets and casements in which this secondary armament is mounted could be completely destroyed by the "Inflexible's" guns. Thus, for the 8-inch of the "Connecticut" to penetrate the 7-inch belt of the "Inflexible," they would have to be within 5,400 yards of that ship, and the 7-inch battery would have to be within 4,000 yards; while the 7.6-inch gun of the "Justice" would have to be within 5,000 yards to effect penetration at normal impact. On the other hand, the 6-inch and 7-inch armor which protects the secondary battery of the "Connecticut," and the 5½-inch and 4-inch armor on the turrets and bases of the secondary battery of the French ship, would be at the mercy of the "Inflexible's" 12-inch guns.

In this supposititious engagement to show the advantages of the "Dreadnought" type of battleship over the type with the mixed armament, the "Inflexible" with an advantage of 6 to 8 knots of trial speed (it will be understood, of course, that an engagement would never be fought at these maximum speeds) would elect to place herself at the maximum effective range for her own guns, which, if the weather were clear, would probably be not less than five miles. Her higher speed would give her the same advantage which the "weather gage," or windward position, gave to the old fighting frigates in the days of sail power and the smoothbore. Her probable plan of attack would be to assume a position somewhat ahead of the leading ship and then concentrate the whole of her eight guns upon that vessel, in the endeavor to cripple each ship in detail; and it is an interesting question whether this concentration of fire on each ship in turn, coupled with the vulnerability of the armored positions of the secondary batteries, and the great exposure of the crews of those batteries, would not go far to offset the lighter armor protection of the "Inflexible." By taking skillful advantage of her superior speed, and if the gunnery on all three ships were equal, it is conceivable that she might win the fight. Should she be getting the worst of it, on the other hand, her higher speed would leave her free to draw out of the conflict, whenever her commander saw fit. From what we have said, however, it is evident that ship for ship she would be more than a match for either vessel alone, and in a duel she would probably close in to 6,000 or 7,000 yards, and try to overwhelm the enemy quickly with her 12-inch guns.