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.	16,000 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.

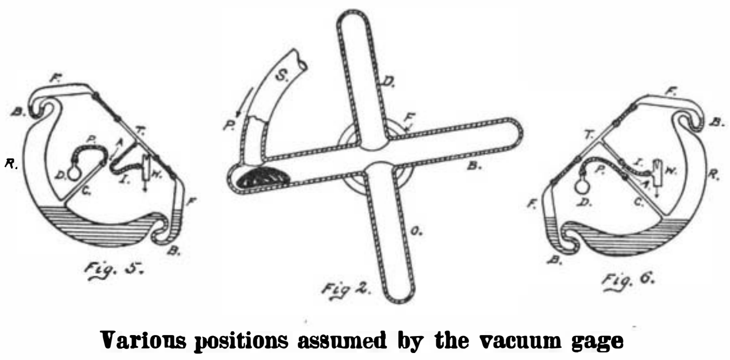
(*Continued on page 271.*)

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

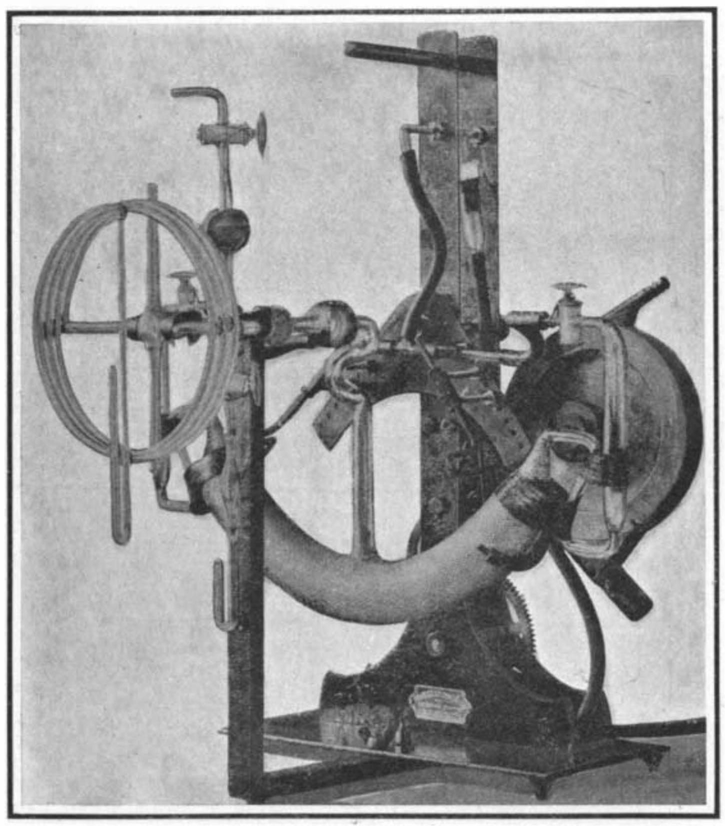
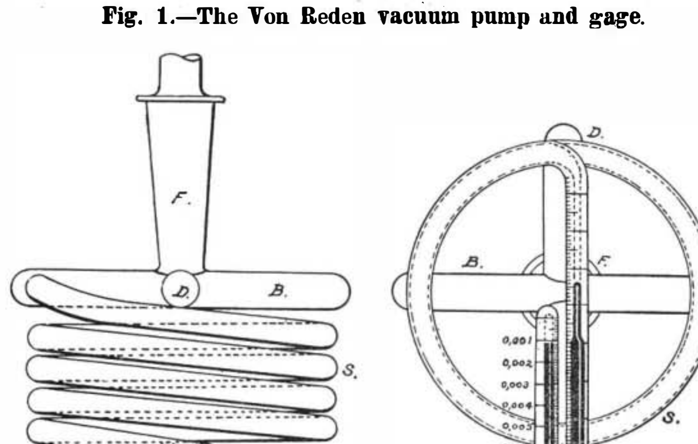


Fig. 1.—The Von Reden vacuum pump and gage.



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."