MEETING OF THE NATIONAL ACADEMY OF SCIENCES.

BY WILLIAM H. HALE, PH.D.

The autumn meeting of the National Academy of Sciences was held at Columbia University, New York, beginning November 14. Prof. Wolcott Gibbs, president, in the chair.

In welcoming the Academy, President Seth Low, of Columbia, remarked that the preceding meeting at New York had been held five years ago in the old Columbia buildings on Forty-ninth Street, on which occasion the first award of the Barnard prize for scientific research was made. At the present meeting on the new site of Columbia, the second award is to be made.

Prof. Gibbs, replying, said that he came back to Columbia as an alumnus of fifty-eight years' standing.

The principal business of the fall meeting is the preparation of the annual report to Congress. Several papers were also read, some highly technical, others of sufficient general interest to justify an abstract.

Among the latter was an account by Prof. Ogden N. Rood, of Columbia, of his observations on color vision by means of his apparatus called the flicker photometer. The subject of color blindness has been much studied on account of the importance of rigid tests of vision of railroad men and others who have to distinguish colored signals. Prof. Rood finds, however, that even among persons of normal color vision different degrees of sensitiveness to different colors exist, so that no two persons have the same sensitiveness.

Prof. Edward C. Pickering sent a report of recent results of the Henry Draper memorial, read by Dr. Barker, giving a detailed account of discoveries by photography at Harvard and at the Arequipa Observatory in South America. Several new double stars have been discovered of two classes, those in which both components are luminous and those in which one is dark, the latter class being variable, because of the occasional interposition of the dark component.

Several of the double stars have periods of rotation less than two days. one being even less than thirty hours. In one of the second group the transition from minimum to maximum brightness occurs in two hours.

Dr. R. S. Woodward, of Columbia, has long been investigating the physics of the earth's atmosphere. He read a paper in which he stated that the atmosphere extends at the equator 26,000 miles beyond the earth, and at the poles 17,0C0 miles, thus taking a position intermediate between those who hold that it has no limit and those who place the limit within one or two hundred miles of the earth's surface. He also maintains that the old estimate of the weight of the atmosphere as equal to that of a shell of mercury 30 inches thick all round the earth is incorrect, and assigns as a maximum limit to the mass of the atmosphere $\frac{1}{1200}$ that of the earth and a minimum limit $\frac{1}{100000000}$—a very wide range.

In discussing the paper, Prof. Cleveland Abbé stated that old estimates of height of the atmosphere based on decrease of temperature of 1° C. for each 100 meters of elevation must be abandoned. The actual decrease is only 0·6° per 100 meters.

Dr. George F. Barker, who has recently returned from England, where he heard the lecture of Prof. Dewar, and saw his experiments with liquid hydrogen, gave an extremely interesting account of it, and exhibited a few of Prof. Dewar's vacuum tubes, prepared by liquid hydrogen, "which," said he, "Prof. Dewar was kind enough to give me, or I might rather say, I was audacious enough to steal."

Hydrogen is a limpid fluid, clear as water, but only of $\frac{1}{14}$ as much specific gravity, so that cork sinks in it as lead in water. It is intensely cold, having four times the frigorific potency of liquid air. The absolute temperature of it is only 21° above absolute zero, against 82° for liquid air. Air freezes and sinks in it.

Prof. Dewar dipped a brass cylinder into it, and then withdrew it, and showed upon the screen how the intensely cold cylinder liquefied the air of the room, which dripped from the cylinder.

Cotton dipped into the liquid hydrogen and then placed in a magnetic field shows magnetic affinities; but this is due to the liquefaction of oxygen from the atmosphere, as hydrogen is not itself magnetic.

Prof. Dewar's attempt to exhibit liquid hydrogen a year ago failed, for the very curious reason that the hydrogen contained about one-half of one per cent of air, which froze in the valves and clogged them so as to impede the action of the apparatus.

The vacua produced by liquid hydrogen are more perfect than by any other means, the pressure certainly not exceeding one-millionth that of the atmosphere. They are made by freezing out the gas contained in the vacuum tube. Prof. Barker exhibited samples prepared in tubes filled with several different gases. So perfect were the vacua that the electric spark would not pass through, and even the phosphorescence which characterizes high vacua was very faint.

When a vacuum is prepared from the air, everything less volatile than hydrogen is frozen out. This includes all the formerly recognized constituents of the air, and also the newly discovered argon; leaving only hydrogen, helium and neon. It is probable that hydrogen in minute quantity is always present in the air. This process will detect a gas which is present only in quantity of one twelfth of one per cent. One of the tubes shown contained helium and hydrogen. A tube containing neon was included in the collection. Neon gives a spectrum of remarkable brilliancy, but the hall was not dark enough to exhibit the spectrum.

The other substances at one time supposed to be new constituents of the atmosphere, namely, metargon, xenon and krypton, are found to be either imaginary or one of them is a hydrocarbon.

Prof. E. W. Morley sent in a memoir of the late William A. Rogers as a physicist. Morley and Rogers were collaborators in the accurate determination of atomic weight of certain elements and in other physical researches.

Prof. Henry P. Bowditch gave a report of the conference at Wiesbaden for the purpose of organizing an international union of scientific societies, from which he has recently returned, the conference having been held in October.

Other papers were read on "The Time of Perception as a Measure of Difference in Intensity;" and on "Relations of Time and Space in Vision," by Prof. J. M. Cattell; (by invitation) "A Direct Proof of the Effect on the Eulerian Cycle of an Inequality in the Equatorial Moments of Inertia of the Earth," by Prof. R. S. Woodward; "The Definition of Continuity;" "Topical Geometry in General," and "The Map Coloring Problem," by Prof. Charles S. Pierce; and on "The Electro-Chemical Equivalents of Copper and Silver," by Prof. Theodore W. Richards, a new member of the Academy.

President Gibbs appointed a committee of five to award the Barnard medal to the man who, within the last five years, has made that discovery in physics or astronomy or in the application of science which shall be adjudged most valuable to the human race. The report and award will be made at the annual meeting at Washington next April. The previous award five years ago was to Lord Rayleigh for the discovery of argon, on which occasion an equal amount was raised and given to Prof. Ramsey for his share in the investigation.

A DISCUSSION OF THE SUPERIMPOSED TURRET FOR WARSHIPS.

It sometimes simplifies the discussion of a difficult and complicated question, particularly if it has to do with mechanical construction, if we reduce it to what we might call its simplest terms. While the question of the use of the superimposed or double-deck turret involves many considerations of structural economy of weights and parts, we think that the primary object may be set down as being the desire to obtain the greatest possible range of fire for the guns. Assuming that this is the case, let us suppose the case of a battleship whose whole armament consisted of two heavy guns carried within a turret which was placed amidships on the center line of the vessel, with the smokestack carried up through a cylindrical casing at the vertical axis of the turret, and let us suppose that apart from the turret and smokestack there was absolutely no other projection showing above the deck. In this case, and in this case alone, the ship's battery would have an absolutely unobstructed, all-round fire. Such a ship, if we remember rightly, was made the subject of a patent some ten or twelve years ago by one of the ex-chief constructors of the British navy.

A vessel of this kind, however, does not lend itself to the requirements of the modern battleship, in which it is desirable to have many guns of varying caliber, placed in gun positions as widely separated as the structural possibilities of the battleship will permit. As soon, however, as we commence to place the guns in separate turrets or casemates, we begin to sacrifice the arc of fire through which they can be trained, until some of the guns, such, for instance, as those which are placed in the broadside batteries, are limited to an arc of fire of 90 degrees. The distribution of the battery, the determination of the positions which give the greatest range for the largest number of guns, has been one of the most difficult problems in naval designing.

When the plans for the "Kentucky" and "Kearsarge" were under consideration, it was proposed by Lieut. Joseph Strauss, of the United States navy, to place one of the 8-inch turrets with its pair of guns upon the roof of each 13-inch turret and thereby secure in two 8-inch turrets the same concentration of fire ahead or abeam that was possible from four 8-inch turrets as installed on the "Oregon" type of battleship. The proposal met at first, but not latterly, with some opposition from a few officers of the line, and was received with more energetic opposition from the construction department. The first objection urged is that the system violates one of the first principles of battleship design, which is that the main armament should be as widely distributed as possible, so as to localize the injury resulting from a well-placed shot.

A structural objection urged against the system is that it concentrates a great amount of weight at one point and renders the problem of construction more complicated, besides aggravating the moment of inertia of the ship in a head sea, and subjecting the ship to special risks in docking. The "Kentucky" and "Kearsarge," however, have proved to be excellent sea boats.

Another objection is the tactical difficulty that the 8-inch and 13-inch guns, being mounted in the same turret, will at all times be trained upon one and the same part of a ship, whereas it would be desirable at close range to train the heavier guns upon the belt or barbettes and the lighter guns on the casemates or less heavily protected portions.

As against these objections it is urged by Lieut. Strauss that the risk of disablement, at least for the 8 inch guns, is greatly lessened by the fact that in place of the thinly armored barbette, the unprotected base and the light ammunition tube of the old system, these guns have now the splendid protection offered by having the massive turret and barbette armor of the big guns beneath them —a point which is certainly well made and goes far to offset the other objections above named. As regards the concentration of weight, it is pointed out that in consequence of the reduced thickness of modern armor, due to its superior quality, the entire weight of one double turret on the "Kearsarge" is only 947 tons as against 987 tons in the single turret 13-inch emplacement of the "Oregon."

The complexity of the ammunition supply, it is claimed, is avoided by having the ammunition hoist of the two 8-inch guns lead in a closed chute from the breech of the guns down through the 13 inch turret, passing between the guns to a separate handling room, which lies immediately below the 13-inch gun turret, and by having the ammunition for the 13-inch guns carried up from a handling room which is situated immediately below the handling room of the 8-inch turret. As to the tactical difficulty, it is urged that at the ordinary fighting ranges a warship presents so small a target that it would be impossible to select any particular part of the vessel for attack. Moreover, as the 8-inch guns of the "Kearsarge" can be fired two or three times while the 13-inch guns are being loaded, there will be, it is claimed, at close ranges, abundant time to use them on lighter parts of the vessel.

It is further to be remembered that by getting rid of the two complete turrets, their handling rooms, etc., there is a saving of 320 tons of weight, and that, as the barbette armor, training engines, etc., of the 13 inch guns now do double duty, there is a further saving of 140 tons, making a total economy of weight of 460 tons as compared with the use of separate turrets on the "Oregon." This is an enormously valuable feature which must commend itself strongly to the members of the construction department.

A further advantage is that the chief battery is reduced to two thoroughly protected positions, and that the absence of interference of one gun with another would enable a commander in going into battle to lay his ship in any desired position without considering the question of blast interference. Lastly, it is urged that the vulnerable target is smaller; although we think it is questionable whether this can fairly be mentioned as an advantage, since the target, when it is hit, will involve a wider range of destruction than would be possible in a single hit on either of the two separate turrets.

In conclusion, we would add that there is one feature which militates somewhat against the system and ought to receive mention in this connection. We refer to the fact that the firing of any one gun of the four is liable to be disconcerting to those who are sighting the other three. In two or four-gun turrets the guns are placed at a certain distance from the vertical axis, and the recoil at the instant of firing any one gun exerts a powerful turning moment about that axis, tending to swing the turret slightly to the right or left. It must be admitted that this is true of all turrets in which more than one gun is emplaced, but we think this interference with sighting may be somewhat aggravated in the case of a four-gun turret of the "Kearsarge" type.

The above consideration of this subject leads us to urge again that the government should make at the earliest practical opportunity a complete firing test of the main armament of the "Kearsarge," and we think that no time should be lost in taking her to sea for this special purpose. Unquestionably, Lieut. Strauss makes out a strong case in favor of the new system, but at the same time the objections are too numerous, and, if valid, too serious to be passed over lightly. There may be, moreover, unsuspected weaknesses in the system which could only be d tected in the course of a long-sustained and severe trial.

In view of the fact that the Board of Construction has recommended the double turret for our latest battleships (although this action is not final) we trust that the Secretary of the Navy will see to it that the gunnery trials of the "Kearsarge" are pushed forward with all possible dispatch.