amplitude. When near one end of the path the length of the pendulum is increased, and when near the middle of the path the length is decreased. In the course of a few swings the amplitude can be very greatly increased. The process can also be reversed and the motion of the pendulum very quickly damped.

The increase in the energy of the pendulum as its amplitude increases comes from the work done in lifting the bob when near the middle of its path. This is because a given change in the length of the pendulum involves a greater vertical displacement when the pendulum is nearly vertical than when it is much inclined to the vertical.

ARTHUR TABER JONES

SMITH COLLEGE,

A QUICK METHOD OF ELIMINATING SEED-BORNE ORGANISMS OF GRAIN

THE seed-borne diseases of grain have proved difficult to definitely eliminate from the seed. In connection with studies of hot formaldehyde as a fungicide for potato diseases it was tried for wheat scab. It was soon apparent that holding the grain in a formaldehyde solution at 50° C. as for potato scab was ineffective in killing the fungus or destructive to the viability of the seed. In order to overcome these difficulties the grain was suspended just above the formaldehyde solution one part in 240 parts of water and the temperature was raised to 98 to 99° C. and the time of exposure shortened to twenty seconds. Under these conditions all fungi in or on the seed were killed and in the majority of cases the bacteria were also eliminated. This momentary treatment did not injure the germinating capacity of the seed. The fungus flora of wheat seeds were destroyed in twenty seconds while the germinating capacity of the grain was not injured in forty seconds and only slightly at fifty. It is believed this method can be made practical for the control of scab and other seed borne diseases of grain.

I. E. MELHUS,
L. L. RHODES

IOWA EXPERIMENT STATION,
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SCIENTIFIC BOOKS

The Grand Fleet, 1914–1916: Its Creation, Development and Work. By Admiral VISCOUNT JELLICOE of Scapa. New York, Geo. H. Doran Co. 1919.

One hardly expects a critical review of a book of this character except in military journals. Yet, this book is a plain, unvarnished narrative of the meeting in battle of the two great fleets of Great Britain and Germany. Jutland was the culmination of a struggle for supremacy on the seas and back of that for world domination. It was essentially a tryout of scientific methods of annihilation as developed and adopted by the two leading nations of the world. The book might well carry as a sub-title "Science in Naval Warfare up to 1916." And therefore brief comment upon the scientific methods of the opponents is not out of place here, for we all know *now* that professional military and naval men have to lean and lean heavily upon non-official scientific men.

The battle of Jutland as described in this book reminds one of a Homeric conflict, for just when some great captain had closed with his antagonist, the watching gods, disguised as mists, fogs and poor visibility intervened and separated the fighters. Much as we would like to compliment the British, the palm for preparation and scientific attainment must go to the Germans. The British had more ships and more guns; but the Germans had better range finders, better telescopic sights, better mine fields, better torpedoes, better submarines and more of them, better overhead observation facilities and a Zeppelin or two.

The Grand Fleet (British) appears to have made use of a single seaplane which flew very low, yet whose observations as Vice Admiral Beatty says, were "of distinct value."

The German battleships were of greater displacement than contemporary British ships and carried a greater weight of armor. Nine of the British dreadnaughts had protection to the main deck only, while all of the German dreadnaughts had side armor to the upper deck. The Germans had a delay action fuse which, combined with a highly efficient armor-piercing projectile, insured a bursting of the shell *inside* instead of outside the protecting armor. They also had decided advantages in under-water protection of their capital ships, and so when one of their ships was mined or torpedoed, it did not necessarily sink, while the British ships when thus hit, rarely survived. The Germans had star-shells, unknown at that time to the British. They could locate the British destroyers at night without revealing their own position. The German searchlights were more powerful and their control more effective. Lights and guns could be brought to bear upon a sighted vessel with a minimum of delay. They had also a better system of director firing of the secondary armaments.

How then did the Grand Fleet manage to do as well as it did? Probably because officers and men possessed enduring courage and that fine spirit of determination to take any odds and do their duty. We believe that our own Navy has much of the same spirit.

It is not to be supposed that the German High Command did not know of the inferior scientific equipment of the Grand Fleet. They were fully aware of the departmental methods and official inertia that can operate so effectively to bar progress and arrest development. Admiral Jellicoe places no blame for this failure to keep the Grand Fleet properly equipped, yet his manifest apprehension when relieved of command of the Fleet to accept promotion as First Lord of the Admiralty indicates the probable seat of the trouble.

In the book there are constant references to weather interference with naval operations. It is invariably offered as justification for change of course or failure to complete some projected movement. One wonders if it ever occurred to the High Lords of the Admiralty that a decisive conflict would take place some day between the fleets in the North Sea, and that the issue might hang upon the weather, as indeed it did? And was there a comprehensive study of the aerography of that ocean available? *There was not.* The highest meteorological authority in Great Britain informed the writer, that "the English left the study of the weather of the North Sea to the Germans."

In the memorandum issued to the fleet after the Jutland battle it is stated that "weather conditions of a highly unfavorable nature robbed the Fleet of that complete victory which was expected by all ranks . . ." and King George visiting the fleet on June 15, said to the captains, "Unfavorable weather conditions and approaching darkness prevented that complete result which you all expected; but you did all that was possible in the circumstances. . . ."

It is an open question whether the weather prevented a victory. Fog and mist may have helped the British, for certainly the punishment inflicted by the German battleships, when visibility permitted, was severe.

In connection with the weather conditions there is one interesting little sidelight on Lord Kitchener's death. A northeast gale prevailed at Scapa Flow, on June 5 when K.K. on his way to Archangel visited the Grand Fleet. It had been intended that the ship carrying him and his escort should depart up the eastern side of the Orkneys; but in conference, owing to the gale, it was decided that the *Hampshire* should take the west or lee side. By the time the ship was outside, the center of the storm had passed and the wind had backed to the northwest. So there was no lee on the west side of the Orkneys and when the accident occurred the sea was so high that no help could be rendered. In brief a faulty forecast of the weather sent England's great captain and those with him to their doom.

On p. 380 it is stated that "gunfire and under-water explosions were heard at intervals during the night and curiously enough the under-water explosions, four or five in number, were quite clearly recorded on a barograph in the *Malaya*, a ship well placed for the purpose as she was in the rear. There is little doubt that these records showed the explosion of our torpedoes against enemy ships." The natural question is, what kind of a barograph was it, and did any of the other barographs, assuming there were some, show similar records? Evidently there was no attempt at sound ranging.

The typographical work on the book is excellent except that the photographs, charts and diagrams are poorly lettered and not up to the rest of the book.

A. M.

SPECIAL ARTICLES

VARIATIONS IN THE ELECTRICAL POTENTIAL OF THE EARTH

AT a meeting of the Academy of Science of St. Louis, held on March 17, the writer presented diagrams representing variations in gravitational attraction between the masses of the Cavendish apparatus in the second story of the physics building at Washington University.

This apparatus is composed of a shield in which the smaller masses are suspended on a bi-filar suspension of silk fibers. The top, bottom and ends of this shield are of wood, covered within and without with tin-foil. The sides are of sheet metal, clamped to the wood frame by bars of wood and the joints sealed with wax. The wood clamps are covered by tin-foil. The whole is then surrounded by two end caps of metal which meet at the middle of the shield and are sealed together with tin-foil. The position of the suspended masses is determined by a telescope and scale in the usual manner. The mirror is observed through a narrow slit in the two metal screens which surround the suspended masses, and which is closed by a strip of glass sealed to the inner sheet of metal. The suspended masses are electrically charged by means of a wire armed with a pin which is thrust through a glass tube which is passed through a small opening in the end of the shield. When connected with the electrical machine in an adjoining room the air within the shield and the suspended masses were charged. This operation was made to come about gradually by having a gap armed with pins in the line leading to the machine. In some cases the suspended masses would swing into contact with the metal sheets forming the sides of the screen. It was arranged that they should be deflected towards the large masses. It was found that on withdrawing the glass tube and pin and closing the opening in the screen with tin-foil, the small masses could be liberated with an initial velocity approaching zero, by connecting the large masses and screen directly with the machine terminal, eliminating all gaps in the line. The impression thus created was that gravitational attraction was thus diminished until the torsional effect of the bi-filar suspension could detach the small masses from the screen, to which they were held by an electrical attraction.

After the suspended masses had come to rest in the center of the screen, which was usually on the following day, the large masses were directly connected with a large copper rod on the outer wall of the building, which served as lightning protection for the building. This rod was the ground connection for a steel tower on the roof of the building, which formerly was part of a system for wireless telegraphy. The top of this tower is 100 feet above the ground. This tower and the earth replaced the electrical machine, in the electrification of the large masses.

On clear days when there was practically no wind, the gravitational attraction of the large masses for the suspended masses has sometimes been diminished, until it has apparently become a repulsion. All artificial heat was cut off from the room, so that its temperature increased during the day not more than two or three degrees centigrade. The temperature of the air in contact with the large masses was under constant observation, the recording being made by means of a telescope. The temperature could be read accurately to tenths of a degree Centigrade, and hundredths of a degree could be estimated with fair precision.

When the masses were not in connection with the lightning rod, the rise in temperature during the day caused a very slow increase in the reading which determined the position of the suspended masses. This change was due to convection currents within the shield surrounding those masses.

These convection effects have been very carefully examined. They are distinctly appreciable when the temperature of the room