Commander William S. Sims, who has been mainly responsible for the recent remarkable development of the marksmanship of the United States navy. The report is published in its entirety in the current issue of the Supplement for the benefit of those of our readers who wish for a more complete statement of the arguments in favor of the high-speed, all-big-gun, uniform-caliber, battleship than it is possible to give in the present article.

The report is based upon recently acquired information regarding the events of the battle of the Sea of Japan, which Lieutenant-Commander Sims considers to be absolutely reliable. We may summarize his deductions by saying that he favors the "Dreadnought" type of battleship in respect of its size, of its high speed, and of its use of large guns of uniform caliber. Furthermore, he proves that not only is a battleship of this type more efficient per unit of displacement, but that it costs considerably less per unit of fighting power and is considerably more economical to maintain.

In proving the superiority of the 12-inch gun, Lieutenant-Commander Sims states that experience has shown that the percentage of hits per round is greater with large than with small guns. The danger zone, or the space within which a ship will be hit, is, at 6,000 yards range, 100 per cent greater for the 12-inch than for the 6-inch gun. The latest reports of Japanese fire in the battle of the Sea of Japan state that 19.6 hits per cent of rounds fired were made by the 12-inch guns, and that this was twice as great as the percentage obtained with the smaller guns. The Japanese fired 50 pounds of small-caliber projectiles for every pound that reached the enemy; but they fired only 5 pounds of 12-inch shell, for every pound that got home. Add to this the fact the 12-inch shell has a bursting charge of 38 pounds as against a bursting charge of 4 pounds for the 6-inch shell, and the superiority of the 12-inch gun is strongly established. Another powerful argument in favor of using only one caliber of gun is the modern system of fire control, with which such accurate shooting has been obtained in our own and the British navy. Accuracy of gun fire has come to be regarded as the most vital element of all in the fighting efficiency of a warship. At the longer ranges it is necessary to have an observing party for each caliber of gun, whose duty it is to check the accuracy of the sighting bar by observing the splash of the projectiles. If the ship carries two or more calibers of gun, there must be a duplication both of the observation party and of the fire-controlling apparatus. A most important point brought out by this report is that "interference," of which we have heard so much recently, is not a question of the influence of the flash of the guns so much as of the disturbance of the atmosphere, or "the refraction of the lines of sight by heated gases." Before a gun, adjacent to another gun which has just been fired, is discharged, it becomes necessary to wait until the hot gases of the first discharge have cleared away, and hence, the frequent firing of a numerous battery of small, rapid-fire guns seriously interferes, by the heating of the atmosphere, with the fire of the more important large-caliber guns. This is especially true of the after pair of 12-inch guns, across whose line of sight the heated gases will pass as the ship moves forward. Hence, there is bound to be a decided advantage in mounting a smaller number of high-powered guns of uniform caliber; since the ultimate object of warship design is accuracy of fire, or the getting home of a maximum number of hits of maximum destructive effect within a given time.

Another important advantage of the "Dreadnought" type of ship established by Lieutenant-Commander Sims is the fact that in the case of two fleets of equal total displacement, in one of which that total is made up of ten 20,000-ton battleships, and in the other of twenty 10,000-ton battleships, the advantage of concentration of broadside fire would lie altogether with the fleet of "Dreadnoughts." For the fleet of ten big ten-gun ships, which would be strung out in a comparatively short line of battle, would be able to offer a broadside of thirty-eight 12-inch guns per mile, as compared with a broadside of only twenty-one 12-inch guns per mile, offered by the longer line of ships of the mixed-battery type, carrying only four 12-inch guns apiece. The effect of this would be that the portion of the four 12-inch gun, old-type battleship line, which was immediately opposite the fleet of ten 12-inch gun, modern battleships, would be enormously overmatched, at a range of 6,000 yards, by the superior number of 12-inch guns opposing it, and its higher speed would enable the big-ship fleet to maintain that range indefinitely.

Compared on the basis of comparative cost, the all-big-gun, one-caliber battleship costs less than the four-big-gun, multiple-caliber, smaller ship, when both are compared on the same unit basis. Thus, although the big battleship can concentrate 80 per cent more guns within a given length of line of battle, the first cost is only 50 per cent greater per unit of concentration, while, measured on the same basis, the size of the crew required to fight the big ships is about 50 per cent less. Another important economy is secured in respect of the annual cost of maintenance; for the cost of maintaining ten 20,000-ton ships would be less by about $10,000,000 per annum than that of maintaining twenty 10,000-ton ships mounting the same total number of 12-inch guns.

Upon no question affecting modern tactics do the results of the battle of the Sea of Japan speak with greater emphasis than that of the value of high speed; for it now appears that the Japanese ships had an advantage of speed of between 6 and 7 miles an hour, the Russian fleet maneuvering at about 9 knots, and the Japanese at between 15 and 16 knots. This enabled Admiral Togo to place himself at that range (about 6,000 yards) at which he found that he could inflict a maximum amount of damage on the enemy, while yet keeping outside the extreme range at which the Russians were able to do any effective shooting.

## COMPARATIVE TEST OF ALCOHOL, KEROSENE AND GASOLINE AS AUTOMOBILE FUELS.

The first practical demonstration of the use of denatured alcohol as a fuel for automobile use was made last week by a Maxwell touring car, which was run from New York city to Boston on 40¾ gallons of the new tax-free alcohol. In order to make a direct comparison, two identical cars, the motors of which were run on kerosene and gasoline respectively, accompanied the alcohol-driven machine. The test was made under the supervision of the Automobile Editor of this journal and representatives of the Automobile Club of America and the American Automobile Association. It yielded considerable interesting data as to the consumption of gasoline, kerosene, and alcohol in an ordinary two-cylinder, opposed-type engine when used to drive a car at an average speed of about 15 miles an hour over roads covered with snow of from 4 to 10 inches depth.

The start was made from New York at 9:10 A. M., January 28, and the cars reached Boston together at 1:15 P. M. January 30. The trip was thus made comfortably in two and one half days, despite the fact that the weather was rather cold and the ground was covered with about a foot of snow.

As is well known, the Maxwell engine is of the double-opposed-cylinder type, having a bore and stroke of 5 inches and a compression of about 60 pounds. It drives the live rear axle through the usual 3-speed sliding gear transmission, propeller shaft, and bevel gears. Individual spark coils with vibrators, fed by six cells of dry battery, supply the high-tension ignition current. All valves are mechanically operated; the cooling water is circulated without a pump on the thermo-siphon principle; and the entire engine and gear box form a unit, suspended at three points. On account of the low compression, it was not expected to show much efficiency with denatured alcohol as a fuel, for this substance requires a compression three or four times as great as does gasoline, in order to equal or surpass it in thermal efficiency. Used in an engine with the proper compression and having a long stroke, a thermal efficiency of 31 per cent has been obtained as against 20 to 23 per cent with gasoline. The main object of the test was to demonstrate that a modern gasoline car can be run successfully on alcohol or kerosene if necessary, and to bring out the relative cost of operating it on either of the three fuels. In order to start the engines, when cold, it was found necessary to prime with gasoline. The one that was run on kerosene was provided for this purpose with a special pipe extending from the dashboard to the inlet pipe, and at first it was necessary to run it a couple of minutes in this way, until it had become warm. In the case of alcohol, by squirting a little gasoline into the hot-air jacket around the cylinder, to which is connected the air inlet pipe of the carbureter, the engine could be readily started and would continue to run on alcohol. The power developed by the engine, when running on the new fuel, seemed fully equal to that developed when it was run on gasoline, and the pulling qualities of the engine when its speed diminished under load were remarkable, being the nearest approach to a steam engine that we have thus far observed. Despite the fact that it was the most heavily loaded (weighing 2,750 pounds, as against 2,520 and 2,270 of the kerosene and gasoline cars), the alcohol machine opened the way through the snow and kept well ahead of the other cars. There seemed to be nothing lacking in power and speed. The kerosene car, too, showed good power and speed, especially the first day. Later on the heavy carbon deposit which undoubtedly formed in the cylinders owing to incomplete combustion, caused the engine of this car to knock badly under a load, apparently from pre-ignition. The spark plugs on this car were provided with spark gaps, as a result of which they operated with little or no trouble. That the kerosene was not vaporized properly but was burned in excess in the raw state could readily be seen from the heavy, ill-smelling smoke that was emitted. Because of the lubricating qualities of the kerosene, the driver was able to run his car half of the distance without the use of lubricating oil in the cylinders. On account of its low cost and other desirable features, kerosene would no doubt come into wide use, especially for commercial work, if some form of carbureter were introduced that would thoroughly gasify the liquid. Even with a greatly increased consumption, on account of its low cost, it was the cheapest of the three fuels used. The car running on this fuel averaged 7.4 miles per gallon, as against 6.13 of the alcohol car and 10.1 of that run on gasoline.

The total fuel consumption of the three cars—gasoline, kerosene, and alcohol—for the 250-mile journey was 24¾, 33¾, and 40¾ gallons respectively. At the prevailing prices of these three fuels, viz., 20, 13, and 37 cents per gallon, the total fuel expense of each car was $4.95, $4.39, and $15.07. This would make the cost per car mile $0.019, $0.0175, and $0.0603 in the order named, and the cost per ton-mile $0.0169, $0.0139, and $0.04.48. From the latter figures it is seen that at the present time the use of denatured alcohol as fuel in an ordinary gasoline automobile engine fitted with the regular carbureter costs nearly two and one-half times as much as the use of gasoline, and over three times as much as the use of kerosene. In order to be on a par with gasoline at 20 cents a gallon, alcohol must be purchasable at 22 cents a gallon and must be used in a specially constructed engine giving 10 per cent more thermal efficiency than does the gasoline engine. Already, one month after the new alcohol law has gone into effect, the denatured spirit made by the addition of 10 parts (by weight) of wood alcohol and ½ part of benzine to every 100 parts of 90 per cent grain (ethyl) alcohol, can be purchased through dealers in this city for $0.36 a gallon in 5-barrel lots. A decided, increased demand has already occurred for the spirit for use in the varnish and similar industries, and when once it begins to come into use as a motor fuel, with the largely increased demand that will then occur, the price will no doubt drop to approximately the same figure as that at which gasoline can be purchased to-day. Because it lacks the dangerous and ill-smelling qualities of gasoline, wealthy automobilists may yet prefer it to this fuel even though the expense be greater.

A description of some of the foreign carbureters which have been designed for alcohol motors, as well as much information regarding the theory and practice of this type of engine, will be found in the new book "Industrial Alcohol," which we will publish during the present month.

## THE CURRENT SUPPLEMENT.

The current Supplement, No. 1623, opens with an article by William Mayner on the Rudolf Virchow Hospital, which is, perhaps, the finest institution of its kind in Europe. Something of the size of the institution may be gathered from the fact that it numbers fifty-seven buildings. Following the publication of the plans and specifications for constructing a 100-mile wireless telegraph set in Scientific American Supplement No. 1605, and the location and erection of a suitable station for housing and operating this installation, printed in Scientific American Supplement No. 1622, Mr. A. Frederick Collins, in the current Supplement, describes how the set may be installed in the station to the best advantage, and finally, how the instruments may be properly adjusted and tested. An historical account of the eolipile, an ancient steam generator, is given by Mr. S. J. Berard. The epoch-making paper on the art of cutting metals read by Mr. Frederick W. Taylor before the American Society of Mechanical Engineers contains no more important chapter than that on the "Chatter of the Tool." This chapter will be found published in the current Supplement. The English correspondent of the Scientific American writes on a novel engineering achievement in burying a river to a depth of 120 feet. Mr. W. H. Dugdale writes instructively on some early vicissitudes in engineering. Some practical hints for concrete constructors are given. The third installment on new incandescent electric lamps is published. The well-known aeronaut Carl E. Myers writes on the progress in airships and on forms of gas bags. A very good article is that on the tactical value of the "Dreadnought" type of battleship, the arguments being based upon the results of the battle of the Sea of Japan.

## TELEPHONE STATISTICS.

Figures of the amount of business connected with telephones made public to-day, indicate that there were 5,071,500,000 exchange telephone talks and 133,600,000 long-distance or toll communications in the year 1906 in this country. On December 31 there were 7,107,835 instruments in use, 1,436,236 miles of toll wire, 2,385,742 miles of underground wire, 11,373 miles of submarine wire, and an aggregate of 6,080,282 miles of wire devoted to telephone service. The stations number 2,715,367, the total circuits 1,407,900, and the employees 90,000. These figures show a growth in six years of 171 per cent in number of employees, of 239 per cent in the number of stations, and of 349 per cent in the total number of miles of wire.