THE SITUATION AT SANTIAGO DE CUBA.

With Admiral Cervera's fleet in the land-locked harbor of Santiago and Commodore Schley's battleships guarding the narrow entrance, the naval campaign in the West Indies has lost all the complexity which has characterized it during the past few weeks—or ever since the Spanish cruisers turned up unexpectedly at Martinique. From the time when Cervera sailed, supposedly with full bunkers, from Curacoa to the day when he was definitely located at Santiago, the movements of our fleets have been directed to the location and destruction of his ships. It was naturally expected that he would make for Cienfuegos, where he would be in close touch by rail with Havana and could ship the supplies of war material which he was reputed to have on board, to General Blanco. At the same time it was realized that he might attempt to make Havana, either by running through the Windward Passage and proceeding along the northern coast of Cuba or by doubling Cape San Antonio and attempting to run in from the east. In order to intercept the fleet or shut it up in Cienfuegos, Admiral Sampson divided his ships, sending Commodore Schley around the western end of the island, while he himself went to the Windward Passage.

Contrary to expectations, Cervera made for the nearest Cuban port, Santiago. Why he should have done so is a question that is puzzling in the extreme. The stores of coal at that point are not large, it has no connection by rail with Havana, and the fact that the eastern half of the island is practically controlled by the insurgents will render it difficult for him to communicate with General Blanco, and absolutely impossible for him to send him any supplies of war material, supposing that he has them on board. It is not unlikely, however, that some of the ships are greatly in need of repairs. The Spaniards are notoriously bad engineers, and after a cruise of many weeks, engines and boilers probably called for attention that could only be given in the shelter of a home port.

Santiago de Cuba is situated on the south coast of the island, about one hundred miles from its extreme eastern point. The harbor is an ideal refuge, the approach being unusually narrow and tortuous and lying between lofty hills which on both sides are surmounted by fortifications, upon which, according to the latest information, strong batteries of modern Krupp guns have been mounted.

The entrance channel, three miles in length, is not only tortuous but it is said that its available width has been narrowed down to about one hundred feet by sinking obstructions on either side of it.

The captain of a ship which sailed from Santiago on May 13, reports that the channel has been carefully mined, a statement which is incidentally confirmed by the fact that a large quantity of high explosives and submarine mining material was shipped to Santiago last January and unloaded at the government wharf.

The accompanying map shows the great natural strength of the harbor, resulting from its difficult entrance and the excellent conditions for defense. To the right of the entrance is the inevitable Morro Castle, old fashioned, as all such Cuban forts are, and incapable of resisting the modern rifles carried by our ships. Two batteries and a fort also command the entrance from the eastern shore, while on the western shore, at the immediate entrance, is another battery. The fact that the channel is narrow, winding, and sown with torpedoes, coupled with the short range, plunging fire to which a fleet attempting to force a passage would be exposed, would render the task of entering the harbor extremely perilous. An attempt to countermine the channel would probably be disastrous, as the small boats which undertook it could be swept at close range by a murderous fire from the guns of the forts—even the obsolete smoothbores would be effective for this work, using grape and shell.

In spite of its natural strength, however, there is little doubt that Commodore Schley's fleet, provided the draught of his ships would allow it, would be equal to the task of countermining the channel, running by the forts and successfully engaging the fleet in the harbor; but the victory would be dearly won both in ships and men, for it is too much to hope that Cervera and Santiago are as poorly prepared as were Montojo and Manila in the Philippines.

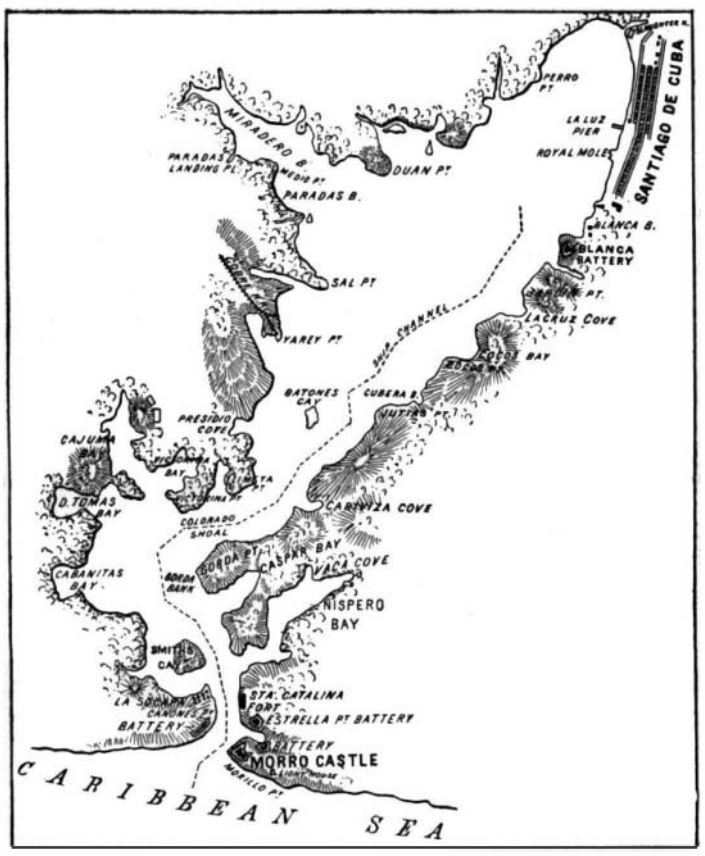
With Cervera actually shut up in Santiago we have gained a strategic point of great importance, which could only be surpassed by the complete destruction, or better yet the capture, of every vessel in the fleet. The capture of the fleet would mean the addition to our navy of four fine ships of just the very type in which we are deficient, to say nothing of two of the largest and swiftest torpedo boat destroyers in existence. There are two ways in which the capture of the fleet intact might be effected. We might keep a fleet of overwhelming superiority off the harbor entrance until the close of the war, or we might make a combined assault by sea and land on the forts at the entrance and, after they had been captured, close the narrow channel by sinking stone-laden vessels or barges in the channel. The Spanish fleet would thus be effectually trapped in the upper bay, and would be ours at the close of the war.

The second plan is the better, judged from any point of view. The blockade of the harbor would necessitate our keeping idle a fleet superior to Cervera's, and our navy would be proportionately weakened for operations elsewhere. On the other hand, if we landed troops on each side of the entrance and made a simultaneous assault by sea and land, we could undoubtedly silence and capture the forts and effectually seal up the harbor. Our small boats could then remove the mines, and the hulks could be towed into the channel and sunk in positions where any attempt on the part of the enemy to remove them would be subjected to a concentrated fire from the forts, now in our possession. With the entrance in our hands and the channel effectually closed, there would be no necessity to keep a blockading fleet off the harbor, and the whole of Sampson's fleet would be available for the reduction of Havana and San Juan or the destruction of the Cadiz fleet, should it venture across the Atlantic.

It has been suggested that the Spanish admiral would destroy his ships rather than allow them to fall into the hands of the enemy; but we doubt very much if the Spanish government, in view of the indemnity demand which is sure to follow the close of the war, would voluntarily reduce its assets by from fifteen to twenty million dollars in the destruction of the fine ships which compose Cervera's squadron. But even if the ships should be destroyed, the Spaniards would merely be doing a work which, if we attempt it outright, will probably cost us many lives and serious damage to the vessels of our squadron.

Now that the "Oregon" has successfully completed her remarkable 14,000-mile journey from the Pacific station, we have gathered in Cuban waters a great fleet of over seventy vessels, undoubtedly the most powerful aggregation of American warships ever drawn together upon the high seas. It includes all of our battleships, four of the monitors, the two armored cruisers, a whole fleet of protected cruisers, most of the gunboats, the torpedo flotilla, the converted yachts, a fleet of colliers, a hospital ship, water supply vessels, dispatch boats, converted tugs and all the etcetera in the way of craft that goes to make up a great fleet engaged in the blockade of an enemy's ports.

A representative squadron of these ships is shown in the accompanying full-page engraving, which represents Admiral Sampson's squadron, reinforced by two or three cruisers, after its return from the bombardment of San Juan. The point of view is such that the eye is able to take in every gun on the battleships; and it must be admitted that the term "bristling with guns," which was so frequently used in describing the old wooden three-deckers of a bygone day, is applicable to the heavily armed battleships of our navy. This effect is particularly noticeable in the "Iowa," the largest vessel in our navy, and it will be noticed that she is capable of concentrating an extremely powerful fire either ahead or astern or on either broadside. She is a later ship than the "Indiana," and shows her superiority to good advantage in the illustration. She is provided with a forecastle or spar deck, which has the effect of increasing her freeboard by some 7 or 8 feet. Her forward pair of heavy guns is carried above this deck at a height of over 26 feet above the water, and hence they have a fine command. The 12-inch guns, being at the same level as the 8-inch guns, which are carried in four turrets amidships, the blast of the 8-inch does not interfere with the big weapons when the former are fired dead ahead or dead astern. The "New York" is another favorite ship in the navy, and on account of her roominess and superior quarters, she has done more duty as a flagship than probably any other ship in the navy. The "Indiana," a veritable bulldog of war, is a sister ship to the "Massachusetts" and the "Oregon." Her 13-inch guns are more powerful than the 12-inch weapons of the "Iowa," but sitting so much lower in the water, she does not carry them so well nor keep them so dry in bad weather as the latter ship. The "Terror," "Amphitrite" and "Puritan" are responsible for the slow speed made by Sampson's fleet on its cruise to San Juan; but their 10 and 12-inch guns enabled them to redeem themselves when they came tardily upon the scene of battle. The "Detroit," "Marblehead" and "Montgomery," with their splendid batteries of ten 5-inch rapid-firers, are very effective ships of their class. They have already made themselves heard in the war and will doubtless be frequently heard from again before it is over. The "Porter" and "Dupont" are our fastest torpedo boats, with a respective speed of 28·6 and 28·5 knots, and the "Foote" is credited with 24·5 knots per hour. The "Mayflower," formerly Mr. Goelet's yacht of that name, is a gunboat of 1,475 tons and over 18 knots speed, and in the far distance is seen the "St. Paul," whose speed of 21 knots and great coal capacity render her capable of scouting far from the fleet and bringing early tidings of the movement of the enemy. The total displacement of this fleet is about 69,000 tons, and it includes the following armament of heavy guns: Four 13-inch, eight 12-inch, eight 10-inch, twenty-two 8-inch, four 6-inch, thirty-two 5-inch and twenty-six 4-inch, in addition to which there is an innumerable battery of 6-pounders, 1-pounders and machine guns.



THE HARBOR OF SANTIAGO DE CUBA.

Robert Fulton's Torpedoes.

Before he turned his attention to navigation by steam, Robert Fulton invented a marine torpedo which he endeavored to dispose of to the United States government. Succeeding in interesting James Madison, then Secretary of State, in the matter, he obtained a small appropriation from the government for the purpose of conducting some public experiments. In the summer of 1806 he invited the high dignitaries and a number of prominent citizens of New York to Governor's Island to see the torpedoes and machinery with which his experiments were to be made. While he was lecturing on his blank torpedoes, which were large, empty copper cylinders, his numerous auditors crowded around him. After a while he turned to a copper case of the same description, which was placed under the gateway of old Castle William, and to which was attached a clockwork lock.

Drawing out a peg, Fulton set the clock in motion, and then he said in solemn tones to his attentive audience: "Gentlemen, this is a charged torpedo, with which, precisely in its present state, I mean to blow up a vessel; it contains one hundred and seventy pounds of gunpowder, and if I were to suffer the clockwork to run fifteen minutes, I have no doubt that it would blow this fortification to atoms."

The circle of humanity which had closed around the inventor began to spread out and grow thinner, and before five of the fifteen minutes had passed there were but two or three persons remaining under the gateway. Some, indeed, lost no time in getting at the greatest possible distance from the torpedo, and they did not again appear on the ground until they were assured that the engine of destruction was safely lodged in the magazine, whence it had been taken. The local historian of that period remarks:

"The conduct of Mr. Fulton's auditors was not very extraordinary or unnatural; but his own composure indicated the confidence with which he handled these terrible instruments of destruction and the reliance he had on the accuracy of the performance of his machinery. The apprehensions of his friends surprised and amused him, and he took occasion to remark how true it was that fear frequently arose from ignorance."

IN a report presented recently to the Central Railway Club, appointed to inquire into the question of standardizing steel coil springs, used for freight cars, the following was recommended, says The Mechanical Engineer, as the chemical composition: Carbon, 1·00 per cent; manganese, 0·25 per cent; phosphorus, not above 0·05; silicon, not above 0·10; sulphur, 0·03.

Havana Tobacco in Florida.

The almost total suspension of industries in Cuba has ruined one of the most important tobacco centers of the world, and Havana cigars will soon become a misnomer if something is not done shortly to revive business in that unfortunate island. Nearly every tobacco plantation in the famous Vuelta Abajo district is in ruins to-day, and, as little more than a tenth of the normal crop was obtained from that district in 1897, the world's supply of choice Havana tobacco is very small. It is estimated that it will take from ten to twenty years for the Vuelta Abajo district to recover its normal condition again, and probably it may never reach its former flourishing lead in the tobacco world. The plants, and consequently the seeds of the particular brand that made this district famous, have all been destroyed, and it will require years of careful cultivation to establish new plants equal to the old.

Meanwhile, Florida and other States of this country have profited by Cuba's war, and the tobacco industry has been transferred to American soil. For several years now tobacco growers have been gradually withdrawing from Cuba, and establishing themselves in different parts of Florida, anticipating the final destruction of all plantations and property in Cuba. They brought with them the seed of the tobacco plants raised for ages in the Vuelta Abajo, and, where the conditions proved favorable, plants nearly equal to those raised around Havana have been established. The soil of many parts of Florida is identical to that around Havana, and the moisture needed is supplied by spraying or irrigation.

Secretary Wilson, of the Agricultural Department, has directed special attention to the study of the new tobacco plantations in Florida, and experts of the department do not hesitate to say that they believe Florida can produce as good tobacco as any ever raised in Cuba. In fact, such good results have already been accomplished. Of the millions of Havana cigars sold in the United States to-day, over 50 per cent are made of tobacco raised in Florida. One peculiarity of the industry in this country is that the plants show a tendency to degenerate, and in order to keep up the quality of the best grades, it is necessary to secure seeds from outside sources. Heretofore the Florida growers have imported their seed annually from Cuba, and it is feared that, if that source of supply is cut off in the future, the present high quality of Florida tobacco cannot long be maintained. But with Vuelta Abajo as a great seed farm, the Florida planters never had any reason to expect any deterioration in their goods.

The Cuban cigar makers and tobacco curers have followed in the footsteps of their industry, and Florida to-day employs on her tobacco plantations and in her cigar factories more expert Cuban workers than in all Cuba. Finding their industry ruined at home, they emigrated to Florida, and at Key West and Tampa they throng the streets, and contribute their knowledge toward the building up of the finest tobacco plantations and factories in the world. Florida is not yet by any means near the head of our tobacco producing States; but the quality of her tobacco promises to lead in the long run. In short, every effort is being made to place her in such a strong position that no amount of rivalry will ever ruin her rapidly increasing industry. When Cuba finally rises out of the ashes of her sorrow, she will find a strong competitor in Florida in the tobacco markets of the world.

There are nearly forty varieties of tobacco known to growers, but of these only a few are worthy of cultivation. That raised in the district around Havana is considered the best, but the soil, climate and method of curing the leaves affect the quality to a greater or less extent. Connecticut, Massachusetts, New York and Pennsylvania raise what is called Havana tobacco, that is, tobacco plants that have been grown from imported Havana seed, but this is not by any means similar to the fine tobacco that the Cubans roll into cigars in the Key West and Havana factories. Similarly, Sumatra tobacco is grown in a dozen different States in this country, and the leaves make pretty good wrappers, but the pure Sumatra is still largely imported from the island that gives it the name. The mysterious influence which climate and soil has upon the tobacco plants is beyond the comprehension of botanists and practical growers. All that can be done is to find soil and climate as similar as possible to those found in the plant's native country, and then try to supply artificially certain other conditions.

One of these conditions is more rainfall and a moister climate. Irrigation supplies in Florida all the water the plants need around their roots, and now artificial spraying is being experimented with to see if it will supply the leaves with an imitation rain. During the rainy season in Cuba the tobacco plants are drenched most of the time. This may have a direct bearing on the quality of the tobacco plants. Another question calling for solution is that of curing. The leaves in curing go through a process of fermentation, and as this is caused by the activity of certain bacteria, it is possible to control it if the right kind of bacteria could be employed. One theory is that the flavor of the tobacco leaves is largely due to the bacteria, and that each species produces a quality peculiarly its own. This is only another way of saying that the climate effects the curing of the tobacco, for the species of bacteria that would thrive in the Cuban climate might not be able to exist in Connecticut. However, experts from the Department of Agriculture are investigating the subject, and if it can be proved that the peculiar flavor of the Havana tobacco is partly due to bacterial fermentation, efforts may be made to introduce the particular species found in the Vuelta Abajo district in Florida. The little organisms might be artificially cultivated and good results be obtained from them.

In respect to tobacco culture, the United States stands foremost of all countries of the world, and statistics compiled up to the beginning of the present year show that we supply about one-quarter of the 1,000,000 tons annually produced. Last year our exports of tobacco amounted to 281,174,422 pounds of leaf tobacco, 5,000,000 pounds of plug, 900,000,000 cigarettes and nearly 2,000,000 cigars. These exports went to all parts of the world. The Dutch are the leading consumers of tobacco in proportion to population, with Belgium second and Turkey a close third, with the United States fourth on the list. The Germans consume about 75,000 tons of tobacco a year; France, 40,000; and Great Britain, only 25,000 tons.

All sorts and grades of tobacco are raised in this country, and, as the world demands all sorts and conditions of the weed, we can supply the trade in all particulars. England, for instance, wants a strong, navy plug tobacco, and Virginia produces an article well suited to the taste. A strong, heavy, but better flavored smoking tobacco is in demand by such countries as Algiers, Morocco and Tunis, and considerable of our exports eventually go there to be made up into cheap cigars. Spain and France require a mild and well flavored article for their cigars and cigarettes, and our merchants are not slow to cater to their needs.

The tobacco district of the United States is a variable one. Years ago it was supposed that the weed could be raised successfully only in the Southern States; but gradually one State after another has taken up its culture, until more or less is raised in every State of the Union. In fact, some of our Northern and Eastern States, which were formerly considered unsuitable for tobacco growing, lead some of the old tobacco States in the quantity, if not in the quality, of tobacco raised annually. Kentucky headed the list in 1897, with North Carolina second and the other States in the following order—Virginia, Tennessee, Ohio, Maryland, Pennsylvania and Wisconsin. Connecticut and New York stand tenth and fourteenth respectively on the list.

Nearly all of the tobacco raised in Cuba was either made up in cigars at home or shipped direct to the United States, and in recent years American capital controlled most of the trade on the island. Tobacco buyers from this country went down to Cuba before the harvesting season, and often bought the crop before it was picked. These buyers represented an army of experts who could distinguish one grade from another with little difficulty. They tested the leaf by the smell, by the ashes and by smoking it. A slight variation in leaves obtained from the same plantation would condemn the whole crop in the eyes of the buyer. Tobacco that would not hold its fire when rolled up as a cigar would also come under the rule of condemnation, but tobacco that would burn three or four minutes without going out would pass for extra good cigar material. G. E. W.

The Current Supplement.

The current SUPPLEMENT, No. 1170, contains a number of articles of more than general interest. "The Fortifications of Manila" is the title of an illustrated article which will prove of great interest in view of the recent reduction of these fortifications by Commodore Dewey. "Kites: Their Theory and Practice," by Capt. Baden-Powell, is a practical article on the manufacture and methods of flying kites both singly and in tandem. This will prove very useful to our readers, who frequently ask for a practical article on this subject. "An Electrical Bureau" is the subject of an address before the International Association of Commissioners and Inspectors of Buildings. It advocates an efficient electrical bureau to supervise new and old installations of wire, motors, etc. "The History of the Stone Arch," by Prof. M. A. Howe, is the beginning of an important paper illustrated by 12 half tone engravings showing famous stone arches. "Five Early Astronomers" gives an interesting biographical account of Copernicus, Tycho Brahe, Kepler, Huyghens and Galileo Galilei. "American Competition with France in Agricultural Products" gives important economic information. "The Governmental Department of Science" is advocated by Prof. J. H. Gore.

TO BLACKEN ZINC SURFACES.—According to the Decor. Gaz. the zinc article is dipped in a weak solution of copper sulphate; it is then dried by moderate heating, rubbed off well with a dry cloth rag, and finally wiped with a flannel rag upon which a few drops of olive oil have been poured.

Prof. Dewar Liquefies Hydrogen.

Prof. Dewar has recently liquefied hydrogen, which is an unprecedented feat. This invention was announced by cable to The New York Sun on May 11, and now fuller accounts of his experiments have been published. There is already controversy as to where the credit belongs for first bringing this element into control. The Polish scientist Olszewski forestalled the discovery a year or two ago by accurately determining the critical temperature and boiling point of hydrogen, but he did not succeed in reducing the gas to a liquid form in a really practical way, so that it could be examined and its properties tested. This has been done for the first time by Prof. Dewar, and most interesting are the disclosures which are certain to result from experiments made at the extremely low temperature of —205 degrees Centigrade. Prof. Dewar has explained his latest researches at a meeting of the Royal Society, and his discoveries were received with extraordinary interest. Two or three years ago Prof. Dewar showed how a jet of hydrogen could be used to cool bodies below the temperature that could be reached by the use of liquid air, but all attempts to collect the liquid in vacuum experiments failed.

The type of apparatus used in these experiments worked well, and it was therefore resolved to construct a much larger liquid air plant, and to combine with it circuits and arrangements for the liquefaction of hydrogen. A start was made with hydrogen cooled to —205° Centigrade, and under a pressure of 180 atmospheres, escaping continuously from the nozzle of a coil of pipe at the rate of about 10 or 15 cubic feet per minute, in a vacuum vessel, double silvered and of special construction, all surrounded with a space kept below —200° Centigrade. Liquid hydrogen began to drop from this vacuum vessel into another, doubly isolated by being surrounded with a third vacuum vessel. In about five minutes 20 cubic centimeters of liquid hydrogen were collected, when the hydrogen jet froze up from the solidification of air in the pipes. The yield of liquid was about one per cent of the gas. Five gallons were produced in an hour. Hydrogen in the liquid condition is clear and colorless, showing no absorption spectrum, the meniscus being as well defined as in the case of liquid air.

The liquid must, in Prof. Dewar's opinion, have a high refractive index and dispersion, and the density must be in excess of the theoretical density—0·18 to 0·12—which we deduce respectively from the atomic volume of organic compounds and the limited density found by Amagat for hydrogen gas under infinite compression. Prof. Dewar's old experiments on the density of hydrogen in palladium gave a value of 0·62 for the combined body. Not having arrangements at hand to determine the boiling point, he made two experiments to prove the excessively low temperature of the boiling fluid. In the first place, if a long piece of glass tubing, sealed at one end and open to the air at the other, is cooled by immersing the closed end in liquid hydrogen, the tube immediately fills with solid air where it is cooled. The second experiment was made with a tube containing helium—a rare gas which has hitherto resisted all attempts to effect its liquefaction.

Two years ago, arguing by analogy of the molecular weights of fluorine and oxygen, Prof. Dewar suggested that the volatility of hydrogen and helium would probably be found close together. A specimen of helium which had been extracted from Bath gas was sealed in a bulb with a narrow tube attached, and was placed in liquid hydrogen, when a distinct liquid was seen to condense. From this result it would appear that there cannot be any great difference in the boiling points of helium and hydrogen. All known gases have now been condensed into liquids which can be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels. With hydrogen as a cooling agent we shall get within 20° or 30° of the zero of absolute temperature. No one can predict the properties of matter under zero of temperature. Faraday liquefied chlorine in the year 1823. Sixty years later Wroblewski and Olszewski produced liquid air, and now, after fifteen years' interval, the remaining gases, hydrogen and helium, appear as static liquids.

The Whitehead Torpedo.

The Whitehead torpedo, of which we may hear frequently in the next few weeks, is 16 feet 5 inches long, 17·7 inches greatest diameter, and weighs, ready for service, 1,160 lb., says Engineering News. It carries 220 lb. of wet guncotton at a speed of about 28 knots per hour, and at that speed it has a range of about 850 yards. This torpedo is built of steel and is propelled by two two-bladed screws, revolving in opposite directions on the same axis, to neutralize the rolling tendency of the torpedo. The screws are operated by a three-cylinder engine driven by air compressed to 1,350 lb. per square inch; and an intricate apparatus, called the Obry gear, is used to automatically keep the torpedo pointed straight during the run. The Obry gear is essentially a gyroscope controlling the valves of the steering engine, which operates two rigidly connected vertical rudders.