nut until the chain is taut. As the sawing progresses, the handwheel is turned so as to screw the nut outwardly in order to force the sprocket-wheel toward the outer end of the bar. When the nut reaches the end of the threaded portion of the bar, a segment of the chain is removed ; and the nut is returned to its initial position.

IMPROVEMENTS IN ROTARY ENGINES.

The many failures which have attended the efforts to produce a successful rotary engine and the fact that the direct acting crank and rod reciprocating engine remains in full possession of the field have led many people into the erroneous belief that there is something inherently wrong in the principle of the rotary engine—that, like perpetual motion or the supposed self-multiplying powers of liquid air, its theory is based upon a misconception or absolute ignorance of natural physical laws. As a matter of fact, however, the objects aimed at in the rotary engine are perfectly legitimate, and the principles upon which inventors have been working ever since Ramelli, in 1588, designed his rotary pump, of which the rotary engine is actually a reversal, are perfectly sound.

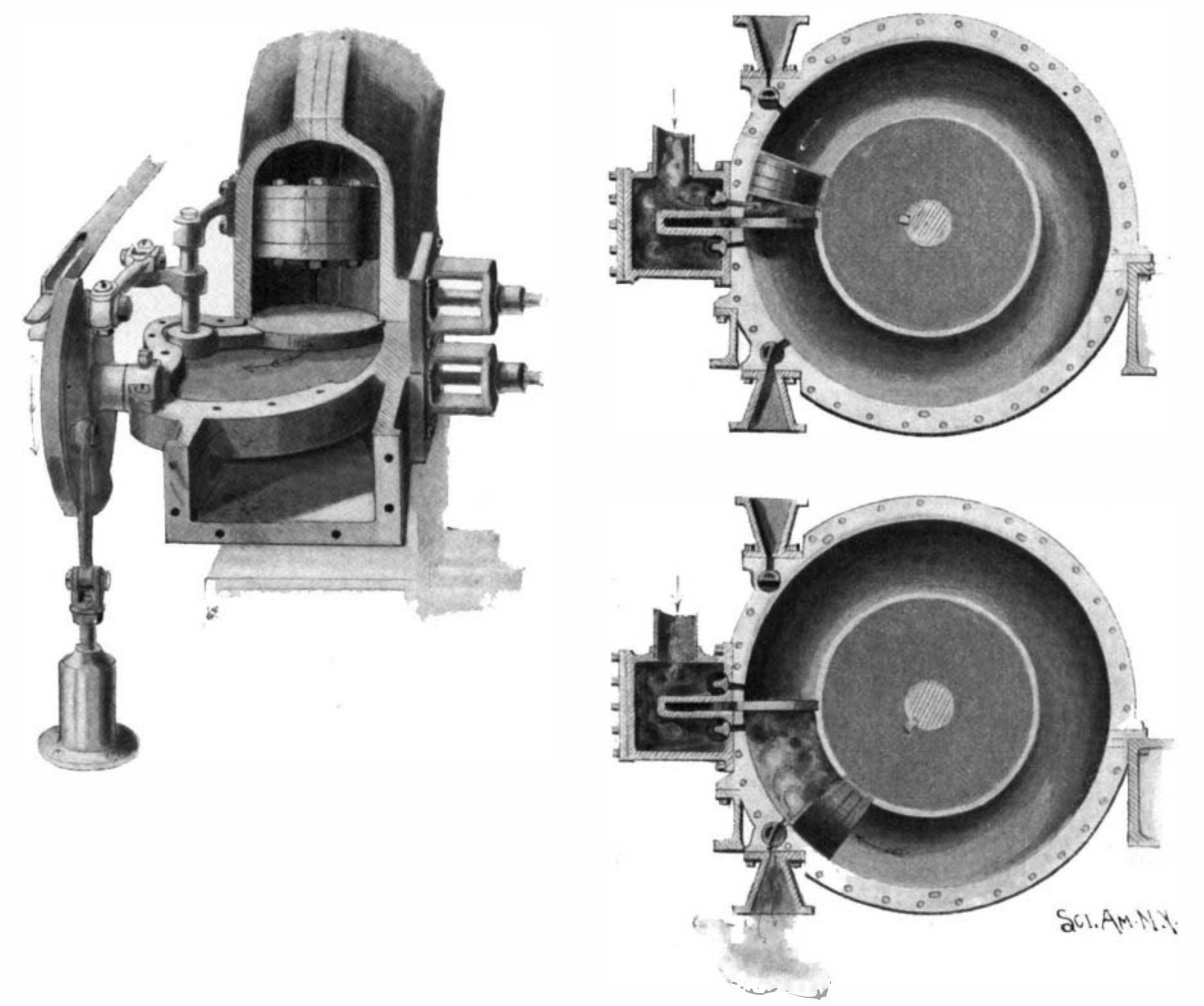
The stumbling blocks which have brought rotary engine builders to grief have been entirely of a mechanical or structural nature.

Undoubtedly the feature that has proved most attractive in the rotary engine is the fact that the pressure on the piston is at all points of the stroke applied tangentially to the circle described by the crank, and so avoids the "dead centers" of the reciprocating engine. The turning moment of any given amount of pressure at the crank pin upon the crank shaft is the product of this pressure by the vertical distance between the direction in which it is exerted and the axis of the crank shaft. In a reciprocating engine this vertical distance varies from zero on the dead centers to a maximum just before the half stroke, when the crank and connecting rod are at right angles. Consequently, a constant and even turning moment can only be secured in the reciprocating engine by connecting two cylinders to a common shaft and placing the cranks at ninety degrees. The piston pressure of a rotary engine, on the contrary, is always exerted tangentially to the circle described by the crank, and, consequently, its turning moment is at a maximum throughout the whole revolution.

There is, moreover, a loss of power in the reciprocating engine due to the change of direction of pressure at the cross-head, a certain component of the piston pressure being exerted against the guide bars. This loss is greatest when the crank is near the half stroke and the turning moment is largest. Another alluring feature of the rotary engine is the fact that the heavier reciprocating parts of the standard type of engine are dispensed with, and it is not necessary to provide the customary massive flywheel or heavy counterbalance weights. Lastly, there is the attractive feature of the economy of space that is realized by doing away with piston rods, cross-heads, guides, and connecting rods, and the economy in material and labor which is consequently realized in manufacture.

Now, the above well-known theoretical and practical advantages of the rotary engine cannot be disputed and they have served to attract an amount of mechanical thought and skill which has resulted in some extremely ingenious designs by such men as Cochrane, Napier, Fletcher and later inventors. While it is true that hitherto no rotary steam engine, except those of the turbine type, has been so successful as to establish itself in competition with the standard reciprocating engine, the rotary principle has been applied with marked success to various types of blowers, ventilators and pumps of which Roots' blower is the most notable example.

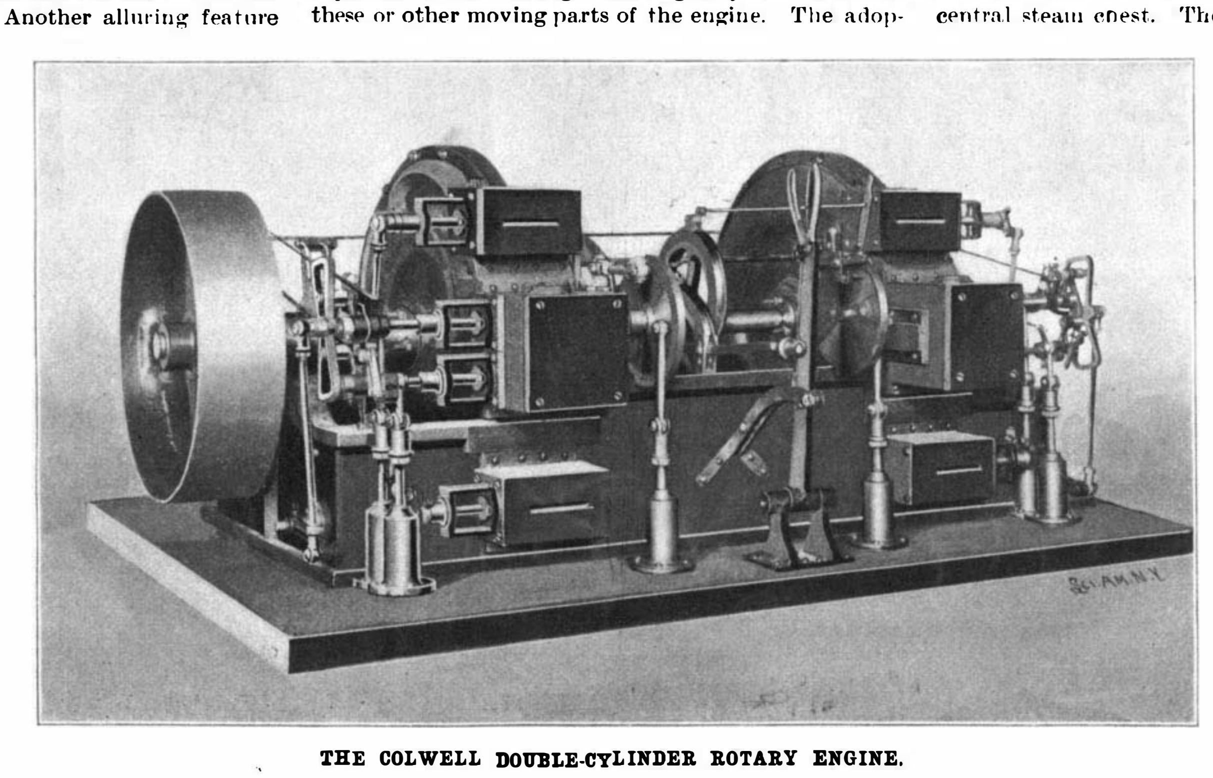
Chief among the difficulties which have hitherto stood in the way of the production of the successful rotary engine have been those of providing a satisfactory form of valve gear, steam ports, etc., for the admission and control of the steam and a suitable sliding abutment to support the reaction of the steam within the cylinder. The accompanying engravings of a two-cylinder rotary engine, which have been prepared from drawings furnished by Mr. T. M. Colwell, 704 Atwood Building, Chicago, Illinois, show an intelligent attempt on the part of the designer to overcome these difficulties, and it will be noticed that both in the details and general plan of the engine, there is a departure from previous types. In the first place the engine is in duplicate and consists of two annular cylinders, mounted upon a common shaft, each cylinder having its own independent valves and abutment gear, the only parts common to the two being the eccentrics, link motion and reversing mechanism. The annular cylinders are true circles in cross section, the pistons being segments of a true circular ring, with the faces radial to the center of the main shaft. They are packed with split piston rings, and it is stated that no difficulty has been experienced in securing steam-tight joints either in these or other moving parts of the engine. The adoption of the annular form of cylinder conduces to cheapness and accuracy of manufacture, and indeed in these respects it is perhaps the best form into which the rotary engine can be cast.



ABUTMENT AND VALVE GEAR—COLWELL ROTARY ENGINE.

The vital feature of the engine is the abutment mechanism, shown in the accompanying detail drawings. A rotary engine to be efficient must be so constructed that the piston shall be under pressure substantially throughout its entire stroke, and it must be capable of expanding the steam to the extent that is attained in engines of the reciprocating type. To secure these results the steam must be admitted with a minimum amount of clearance between an abutment and a movable piston, and the supply must be capable of being cut off at any desired point of the revolution. Also it is evident that for the best results the arc of the circle through which the steam pressure is operative on the piston must be the greatest possible. This requires that the abutment be allowed to remain in place until the piston is about to complete the entire circle of movement, then very rapidly withdrawn to let the piston pass, and as rapidly re-inserted behind the piston so that the steam may be again admitted before the piston has had time to travel any appreciable distance without pressure.

Now, the difficulty has been to remove and insert the abutment with sufficient rapidity without destructive hammering or bruising of the mechanism. In some engines the abutment has been moved slowly, with a consequent increase in what might be called the "dead" space in the cylinder, and to compensate for this the circle of the piston space has been inconveniently enlarged. In the present case the dilemma has been avoided by reducing the weight of the abutment, to allow the use of a "swinging" mechanism that is exceedingly rapid in its movement. Intimately associated with the problem of the swinging abutment is that of the position and action of the steam ports, and the whole problem is met by using the regular Corliss valves and gear and placing the admission ports in close proximity to the abutment. There are separate valves for the admission and exhaust, and these are provided in duplicate (as shown in the illustration), so that by throwing over a single reversing lever both engines may be reversed. This is rendered possible by using double links for working the valve stems, so that one pair of eccentrics does duty for the whole eight valves. The arrangement is clearly shown in the general view of the engine, where the lower and upper steam chests contain the forward and reverse exhaust valves, while the forward and reverse admission valves and the recess which receives the abutment during its withdrawal are contained in the larger central steam chest. The operation of the valves and abutment is shown clearly in the detail views. In the upper view the piston has swept by the abutment which has just been swung back into place, and the inlet valve is admitting steam, the exhaust valve being at the same time open. In the lower view the steam has been cut off and the piston is about to sweep by the exhaust port. The abutment will be withdrawn only just in time to clear the front face of the piston as it passes forward in its path. When the engine is reversed, the lower admission valve and the upper exhaust valve are utilized. The right hand drawing shows the mechanism for swinging the abutment, which is made exceptionally light and is pivoted on a vertical shaft which is at-



THE COLWELL DOUBLE-CYLINDER ROTARY ENGINE.

tached by a rocker arm and connecting rod to an oscillating disk, as shown. The disk is oscillated by a horizontal shaft which is attached to a rocker arm actuated by the valve gear link motion. As this arm reciprocates it engages a pin on the disk and draws it forward, thereby swiftly removing the abutment from the steam space. The instant the abutment is clear of the cylinder, the horizontal arm is tripped and the disk under the influence of the dash-pot, which is shown below the disk, flies back to its normal position and swings the abutment into place within the cylinder. The arrangement and action of the valves and abutment indicate a careful study of the idiosyncrasies of the rotary engine, and in the matter of clearances at the abutment the design appears to be well up to the limit of possibilities of an engine of this particular type.

Repairing Vessels at Cavité.

Naval Constructor Hobson has some pertinent comment to make on the question of dry-docking facilities required by the government at Cavité, which he embodies in a report submitted to the Navy Department recently, on the question of the wrecked vessels raised in Manila Bay, which are now being repaired at Hong-Kong under his direction. Mr. Hobson contends that economy demands that the United States establish its own dock and repair station, and shows that large sums would be saved which are now paid private firms at Hong-Kong for overhauling American warships.

His report is an argument in favor of the maintenance in the Philippines of an important navy yard and dry dock, where the largest and most powerful vessels of war may be overhauled and attended to. The report states that in compliance with the bureau's direction the three vessels under reconstruction, the "Isla de Cuba," "Isla de Luzon," and "Don Juan de Austrias," are about 80 per cent completed. The value of the vessels when completed, exclusive of armament, will be about as follows: "Isla de Cuba," $215,000; "Isla de Luzon," $215,000; "Don Juan de Austrias," $180,000. Total, $610,000. Raising and refitting have cost about $304,000, making a net gain to the government on the three vessels of $306,000. The credit for this result is given to Naval Constructor Capps, who made the contracts. Thus the large engine parts were scarcely injured at all. This feature has an important bearing upon the wrecks still in Manila Bay which he is to examine with divers when the vessels now in hand are completed. The longer period that they have been immersed may not have seriously injured the principal parts, and there may be similar advantage to the government in further salvage, particularly as to the "Don Antonio de Ulloa" and the "Velasco," sister ships to the "Don Juan de Austrias," which, from all accounts, suffered less damage than those that have been raised.

Mr. Hobson adds: "There would be great advantage to the government in the establishment in the Philippines of a yard thoroughly equipped with docks and plant capable of doing all the work of docking and repairing of the navy. The British government is undertaking such an establishment here, though at great cost, involving the making and reclaiming of a large part of the land required. This would necessitate the employment of Chinese labor. This labor is not only unlimited, but it is equal to practically all the requirements of modern industry. Chinese do all the work inside and out for all the departments of the shipyard, white supervision being required only to show what is wanted. The Chinese have a remarkable natural aptitude. Their industrial capacity is simply marvelous. To the extent of my observations and inquiries, there is no place in modern industry which they cannot fill."

In his speech introducing the naval works bill in the Commons, Mr. Austin Chamberlain, in order to show the necessity for increased dock accommodation, stated that whereas, in the year ending March 31, 1889, the tonnage of the vessels built and building for the royal navy was 864,000 tons, on March 31 of this year it was 1,800,000 tons; more than double that of ten years ago. The longest battleship then was 345 feet long and the largest cruiser 400 feet. Now battleships of 400 feet in length are being built, and there are cruisers 500 feet long in commission.

The British government have in contemplation the immediate construction of five first-class docks for naval purposes solely. One of these new docks will be built at Chatham, and will be of sufficient dimensions to accommodate the largest ship afloat in the British navy. Another dock is to be built at Hong-Kong. This last named dock will be 750 feet in length and of dimensions to accommodate the ships of the "Majestic" class. At Bermuda another fine dock will be added to the one already at that important point. At Malta two docks will be laid down, and the latest improvements will be embodied in these docks, as also in the two to be built at Cape Town, Africa. These five docks are to be of stone and built in the most thorough manner and will cost an aggregate of $5,000,000.—Army and Navy Journal.

Correspondence.

Can Insects Count?

To the Editor of the SCIENTIFIC AMERICAN:

That insects have some idea of numbers is claimed by Lieut.-Colonel Delauney in La Nature, Paris, July, on the base of a single observation made upon what seems to have been a small bug allied to Corisa, in New Caledonia. It was noted that this species was gyrating upon a leaf, first in one direction, then in the other, beginning with six turns and coming down in order to one. This was done once only, and no other specimens were observed. That the insect could count from six to one is thus considered proved upon what seems to one who has observed insects remarkably slim evidence.

The gyrating habit is a common one in insects and especially among some of the smaller moths or Tineids, who rarely come to rest after alighting without first turning several times in one or both directions in succession. Sometimes, without apparent cause, they will begin a dance that lasts for some time, almost exactly as described by Colonel Delauney, save that I have never noted the regular decrease in the number of turns. I cannot in the least believe that the insects have any real idea of number connected with these turnings; but I am nevertheless convinced that some insects do count up to considerably more than six.

An interesting illustration came under my notice in July, while collecting on the New Jersey side of the Delaware, at the Water Gap. At the foot of the cliff, along the line of the railroad, all the old sumach canes were used by the little wasp Odynerus ornatus for breeding purposes, and from three to six brood chambers were found in the canes. The cells were stored with the larvæ of the locust leaf beetle, Odontata suturalis, then about full grown, and as a matter of curiosity I counted those in the cells of one stalk, finding ten in each store. To ascertain whether this was uniform I cut all that I could find at that spot and invariably ten larvæ were contained in a completed cell. The little wasp begins by putting in one larva and then lays an egg upon or at the side of it. Nine additional larvæ are then brought in, one at a time, for the larva is almost as large as the wasp, and then the cell is capped. Now this insect can not only count up to ten, but it can carry the idea of numbers for some appreciable time. After three or four larvæ have been placed in the cell the bottom one is lost to view and counting from above becomes an impossibility. The insect must, therefore, keep tab on its trips so as to neither over nor understock its cell. It is not a question of length of cell and simply filling a given space, for the diameter of the stalks varied, and as the diameter became greater the length of the cells became less.

It is worth noting that the habits of this little wasp have not been recorded, heretofore; but I have no doubt its allies with similar habits will be found to have the number sense equally well developed.

JOHN B. SMITH, Sc.D.

Rutgers College, New Brunswick, N. J.,
August 25, 1899.

Wood Seasoning by Electricity.

In a recent issue of a European trade journal, there is a description of a new process of seasoning wood and timber by electricity, known as the Nodon-Bretoneau process, which must be a commercial success, for it is claimed that the company's shares are now at a premium of nearly 600 per cent, says E. Theophilus Liefeld, United States consul at Freiburg. The effect of the electrical treatment seems to be to expel the sap and replace it by insoluble matter which will not putrefy, and to increase the tenacity of the wood and its resistance to vertical compression.

This is said to be the first industrial application of the principle of electric osmose, viz., if the electrodes in an electrolytic solution are separated by a porous partition and a current passes, the volume of the liquid in contact with the positive pole diminishes, while that in contact with the negative pole increases.

The process is about as follows:

The positive pole of a dynamo is connected with a lead grating, upon which the wood to be treated is placed. A solution, which is kept at the uniform temperature of 100° F. by means of a steam pipe underneath the grating, is poured into the vat so as to almost cover the log of wood treated. At a public demonstration, the solution used contained 10 per cent of borax, 5 per cent of resin, and three-fourths of 1 per cent of carbonate of soda, the borax being used on account of its antiseptic properties and the carbonate of soda to help dissolve the resin. A porous tray, the bottom of which consists of two sheets of canvas with a sheet of felt between, is placed over the log, and a sheet of lead connected with the negative pole of the dynamo is placed above this.

When the current is turned on, the solution is drawn from the bottom and the sap driven out, and its place taken by the borax and resin. The time required for a 10-inch log is about seven or eight hours, and then the wood is slowly dried, which takes in the open air in summer several weeks or even months. It was stated that a unit of electrical energy was required for every six cubic feet of timber treated.

Commercial Education in Russia.

Commercial education is continually receiving more attention and encouragement in Russia. Not only the government, but also commercial institutions, large firms, and even private individuals, are opening new commercial educational establishments, varying from the engineering college (polytechnic) opened by the government at Warsaw last year, where young men who wish to become civil, mechanical, chemical, or electrical engineers, architects, or surveyors, can obtain a thorough theoretical and practical technical education, to the simple evening artisans' class, designed to give apprentices a certain amount of theoretical knowledge of their trade to supplement the practical knowledge gained at their work. Consul-General Murray says that between these two extremes come commercial schools, where boys can get a thorough commercial education as clerks or commercial men, and artisan schools, where the sons of workingmen can get a preliminary education at certain trades, such as carpentering, locksmiths, etc. It thus only remains for the parents, and the boy himself, to decide what line he will take, and how much time can be given to his education, for which facilities are at hand from the time he first goes to school until he has finished at the engineering college at 22 or 23. The two branches of commercial education which appear to be the most neglected, as compared with Germany, are shorthand, it being extremely difficult to get a clerk who can take down a letter in shorthand, and then print it off on the typewriter, so common an accomplishment elsewhere, and the careful special training of commercial travelers, which is carried to such a pitch of perfection in Germany, has little attention paid to it in Russia.—Journal of the Society of Arts.

Igniting a Jet of Hydrogen.

C. G. Hopkins describes a method by which a jet of recently generated hydrogen can be ignited with absolute safety and without loss of time. As soon as the action begins, collect the escaping gas in a test-tube, and, when the latter is thought to be full of pure gas, remove it two or three feet from the generator and ignite the hydrogen in it; then immediately attempt to light the jet of hydrogen with the hydrogen flame contained in the test-tube. If the gas is explosive, it will explode in the test-tube and leave no flame. If, on the other hand, a flame remains in the test-tube with which the jet can be ignited, it is certain that the gas in the generator is no longer explosive. By adopting the precaution, therefore, of never lighting the hydrogen jet except with the hydrogen flame obtained as described above, absolute safety can be insured. Attempts may be made to ignite the jet by this method as often as thought proper, and if the hydrogen is properly generated, the gas will be ignited in less than a minute.—Journ. Am. Chem. Society.

Extinguishment of Fires in Mines.

An account of the application of liquefied carbonic acid gas to extinguish underground fires was given by Mr. George Spencer at the recent meeting of the Institution of Mining Engineers, says Nature. At a colliery with which Mr. Spencer was connected a fire occurred in a heading, as the result of a fall of roof and sides on steam-pipes. The heading was built off with as little delay as possible, but notwithstanding all efforts to shut out the air, sufficient reached the seat of fire to keep it burning slowly. It was therefore decided to apply carbon dioxide, and for this purpose six cylinders of liquefied gas were successfully used. It is not claimed that the method described can be successfully applied to all fires, but there are undoubtedly many cases which might be so treated. In case of fire on shipboard, the use of carbon dioxide would no doubt prove invaluable, as it could be quickly applied, and would not cause the same damage to cargoes as water.

"City of Rome" Strikes an Iceberg.

The recent collision of the "City of Rome" with an iceberg brings forcibly to mind one of the many dangers to which transatlantic navigation is exposed. The vessel at the time was in latitude 48 30 N. and longitude 48·44 W. The weather was foggy and a rain had just ceased falling when an iceberg was sighted near at hand, and the ship was slowed down to quarter speed. Shortly after this a massive berg loomed up over the bow of the liner, and before the engines could be reversed she struck, and her bow lifted several feet, the vessel finally sliding back into the water again.

Fortunately she sustained no damage beneath the waterline, the only marks of the encounter being her crushed figurehead and a bent bobstay.

THE United States torpedo boat "Talbot" is being fitted with machinery for the use of liquid fuel and the work is being done at the Norfolk navy yard.