Vice Versa, if the cork is too small, cut off a transverse section from its lower end, make a deep vertical slit in the top of the cork, and wedge in the disk without trimming. The cork will now fit tightly in a bottle otherwise much too large, and may be properly trimmed. The thickness of the disk is proportionate to the difference between the diameters of the cork and mouth of the bottle.—W. Lawrence Stevenson, M.D.

THE NEW BEACHY HEAD LIGHTHOUSE.

The new lighthouse off Beachy Head, on the English Channel, is now completed. It has been erected by the Corporation of Trinity House, the body responsible for the lighting of English waterways. It has been built at a cost of $100,000, and represents the latest example of the sea-builder's skill, as the engineers who build these structures are called.

As the undertaking has already been described in the Scientific American of November 9, 1901, anything like a detailed reference to the new light is unnecessary. It is situated on the foreshore, some 550 feet from the toe of the great cliffs. At high tide the surrounding site is covered to a considerable depth, which naturally made the work difficult and progress slow, particularly during the winter months. Indeed, work was commenced on the site so far back as July, 1899. The foundation is laid to a depth of 10 feet in the hard chalk. As no blasting was allowed, the foundation had to be dug out by pick and ax. This work had often to be suspended for days at a time through rough weather. Fortunately, no serious accidents have occurred, considering the nature of the enterprise, one man having lost a toe while endeavoring to place a stone in position. Several tools were washed away, though the majority were eventually recovered.

At the base the structure has a diameter of 47 feet and is perfectly solid for a height of about 48 feet, with the exception of a space reserved for the storage of water. It is built of granite, which came from the Hard Stone Firms' quarries at De Lank, Cornwall. Altogether, some 3,660 tons of granite were used in its construction. The tower boasts of seventy-six courses. Up to the twenty-sixth course they have a depth of 4 feet 10 inches, many of the stones weighing 4½ to 5 tons. To the top of the masonry the new tower measures 123½ feet, while to the top of the lantern it has a total height of about 153 feet.

The lighthouse has eight rooms. They commence at course No. 26, termed the entrance-room. Then come the oil-room, crane-room, store-room, living-room, bedrooms and service-room. The lantern is equipped with a dioptric apparatus, giving flashes of about 83,000 candle power intensity every fifteen seconds. The illuminant is mineral oil converted into vapor passed through a Bunsen burner. The flashes are controlled by clockwork, which is wound by hand, the weight rising and falling in a tube in the center of the tower. The apparatus rotates in a mercury trough.

The new light is almost double the power of the one it displaces on the famous promontory above the shore. There were two reasons why the erection of a new lighthouse at this spot became necessary. In the first place, the old light, which stood 400 feet above the level of the sea, was frequently capped by fog, while the encroachments of the sea rendered it unsafe. There have been several large "falls" at Beachy Head during the last decade. It is estimated that in 1893 some 85,000 tons of earth and cliffs were dislodged, while a similar catastrophe in 1896 brought down a mass calculated to weigh 89,000 tons.

The English Pacific Cable.

The much-talked-of, much-obstructed and long-delayed Anglo-Pacific cable has at last been actually opened for the transmission of messages. Congratulations were exchanged on October 31 between Canada and Australia over the new line. The London Times in commenting editorially on this new enterprise states that its history is the history of every great undertaking, the history of patient effort by a few energetic and farseeing men fighting the obstacles of official dullness, public apathy and vested interests.

This new cable brings the Australasian colonies ten thousand miles nearer to Canada than they were before, and at the same time opens up possibilities of other substantial improvements in imperial communications. Across the Pacific, from Vancouver to Queensland, the cable touches only British territory; and now there is completed a telegraph girdle of the world which touches foreign territory only at Madeira and St. Vincent, in the Cape Verde Islands, both belonging to an old ally, Portugal. Thus the empire is bound together by what is all but an all-British line, giving an alternative means of communication free from the grave dangers which at critical moments would threaten connection with the colonies by the previously existing route. The new route will have a further great advantage in speed, since it has only three transmissions across the Pacific, all on British soil, in place of over a dozen belonging to various nationalities. Its tariff will be less than half that of the other route prior to reductions which are directly due to its competition. There is no reason to doubt that it will be fully employed, nor any reason to fear that it will do any harm to established companies. The reductions in their rates which nothing else would have induced them to make have been balanced by an increase of business, and further reductions would undoubtedly lead in the present conditions of the world to a yet greater increase of public patronage. The commercial use of the long-distance cables has been terribly hampered by almost prohibitive rates, and the social use of them can hardly be said to exist. There is indefinite expansion to be looked for in both directions, proportioned to the facilities that can be obtained at reasonable charges.

Having regard to the military and naval advantages obviously accruing from an alternative line of communication with distant portions of the empire, especially when that line is independent of all foreign territory, it is something of a satire upon British imperial professions that it has only now been secured through the colonies rather than through the home government. Even in the latest stages of the struggle for the Pacific cable, the haggling of the mother country about her share of responsibility for a possible deficit does not form a very inspiring chapter of history. It was only under considerable pressure from public opinion that England finally became responsible for five-eighteenths of the cost of the cable. To extend the benefit of an alternative and all-British route to India, where strategic considerations are surely important enough, it is still necessary to construct a line from the Cocos Islands to Ceylon. From the commercial point of view it is surely something of a scandal that, until the construction of the Pacific cable was assured, the rate between India and Great Britain was four shillings a word. It has been reduced to half a crown, but even that figure is much too high.

The Three Hundredth Anniversary of Otto von Guericke's Birth.

The 20th day of November, 1902, marked the three hundredth anniversary of the birth of Otto von Guericke, perhaps the most distinguished of the seventeenth century German experimental philosophers.

Guericke was the son of a Magdeburg councilor. When he was but fifteen years of age he matriculated at the University of Leipzig as a student of law. But the wars of the time put a summary end to his studies. Following his natural bent, he journeyed to Leyden and there studied physics and mathematics. During his student days (1620) Guericke's father died. Six years later, when he had hardly attained the age of twenty-four, Otto von Guericke was elected to a seat in the Council of the city of Magdeburg—such were his attainments even as a youth. Versed in engineering matters as he was, it was but natural that he was entrusted with the strengthening of the fortifications. The task thus allotted to him gave him much to do, especially at the time of the city's investment by Tilly. The terrible catastrophe which followed the storming of Magdeburg, May 10, 1631, almost cost the famous philosopher his life. Absolutely penniless, he managed to save himself with his young wife and his children. He was led into Tilly's camp and held a captive until the ransom which had been set upon his head had been paid. His reputation as a great scientist soon became known in the camp. After he had repaired a watch belonging to one of the imperial officers, his lot and that of his family became somewhat easier. The officer for whom he had acted as a watchmaker gave Guericke a ducat for his work. Long after, when he had attained a ripe age, Guericke used to recall this incident with pleasure. Finally, in January, 1632, the imperial army evacuated the city, and the inhabitants, among them Otto von Guericke, returned to their homes. At that time Guericke was perhaps the most respected and widely known personage of the town. He was overwhelmed with requests for assistance from the inhabitants, who had been compelled to impoverish themselves by quartering the imperial soldiers. In Guericke the inhabitants found an indefatigable friend. He saw to it that the new structures and fortifications that had been planned were carried out. We find him undertaking long and arduous journeys to Leipzig and Osnabrück, Münster and Regensburg, Prague and Vienna, for the purpose of interesting the great lords of those places in the welfare of the town of Magdeburg, to beg their protection and the withdrawal of the troops that had been quartered in the town for years. In order to win the protection of the Swedish General Torstenson, he made a most wonderful gilded celestial globe, which was turned by concealed clockwork. And this work of exquisite craftsmanship he presented to Torstenson, but without influencing the Swede the least in the city's favor. In recognition of his great services Magdeburg elected Guericke its Burgomaster in 1646. The city's condition having been considerably ameliorated and the inhabitants started on the road to prosperity, he could take up again the experiments which he had been compelled to abandon.

About this time Torricelli had proved that air was by no means incorporeal and imponderable, but that it exerted a pressure upon all bodies. It was a matter of great scientific importance to produce a vacuum, in order to prove its effect upon bodies therein contained. Guericke began by experimenting with a pump on water placed in a barrel, but found that when the water was drawn off, the air permeated the wood. He then took a globe of copper fitted with a pump and stopcock, and discovered that he could pump out air as well as water. Thus it was that Guericke became the inventor of the air pump (1650). This important discovery was publicly explained before the Emperor Ferdinand III. at the Imperial Diet which assembled at Ratisbon in 1651. At the same time Guericke illustrated in a simple but effective way the force of atmospheric pressure. Placing side by side two hollow hemispheres of copper, he exhausted the air from between them by means of a pump and stopcock, and it is recorded that thirty horses, some say twenty-four, were unable to pull the hemispheres asunder. Before the Elector of Mayence, Johann Philip, Guericke later repeated the experiments, employing hemispheres having a diameter of four feet. On this occasion twenty-four horses, twelve back to back, were unable to tear the globe apart. This experiment earned for Guericke an international reputation. Guericke further demonstrated with the aid of the air pump that in a vacuum all bodies fall equally fast, and that animals cannot exist therein. He also invented the air balance and the anemoscope, a species of weathercock, by means of which instrument he is said to have foretold the terrible storm of 1660. After the death of its inventor this precious apparatus was sold for 800 thalers.

Guericke was one of the first of the great experimental electricians. With his famous sulphur globes he discovered the property of electro-repulsion. He also made successful researches in astronomy, predicting the periodicity of the return of comets.

In 1681 he gave up his office of Burgomaster of the city of Magdeburg. Five years later, May 11, 1686, he died at Hamburg, at the house of his son. He was buried in the city to whose municipal prosperity he had contributed so much. In commemoration of these services, and in commemoration of his scientific achievements, the city of Magdeburg officially celebrated his three hundredth birthday.

Oil Fuel on the Pacific.

The American-Hawaiian Line, which operates a fleet of steamers between New York and San Francisco and Honolulu, is one of the first freight lines to adopt oil as a fuel. The fleet consists of the "American," "Hawaiian," "Oregonian" and "Californian," of 8,000 tons each; "Alaskan," "Texan" and "Arizonian," 11,000 tons each; and the "Nevadan" and "Nebraskan," 6,500 tons each. These last two steamers are designed exclusively for the San Francisco-Honolulu trade. The entire fleet is completed with the exception of the "Arizonian," which will be finished in about two months. The "Nevadan" and "Nebraskan" have already been fitted with tanks for carrying oil. The other steamers will be equipped with the apparatus as fast as possible.

The "Nevadan" was recently described in the columns of the Scientific American. She has made three round trips between San Francisco and Honolulu, using oil as fuel. The distance covered was 12,500 miles. In the last trip of the "Nevadan" to Honolulu, which was begun at San Francisco on October 9 and terminated on October 16, the Superintending Engineer of the line gave out the following statement:

"The results were better than were expected. The boilers and engines were worked to their full capacity. Not a burner was stopped throughout the trip. The steam was kept at 200 pounds with no variation of more than a pound or two. Ordinarily there was not the least sign of smoke from the stack. The boilers developed 2,500 horse power. Only 1.22 pounds of oil were used per indicated horse power. The consumption was 3,006 pounds, or nine and one-fourth barrels of oil, an hour. The time of the trip was seven days and three hours, and the average hourly speed was 12.3 knots. Running with coal, we would have made one knot less speed. The advantage of oil over coal, as indicated by our experience, is that 20 per cent more power can be obtained from the same boilers. Not only this, but the pressure is manipulated at the same point. There is a reduction in the cost for labor in the fireroom. We save twelve men. Instead of nine firemen we use three, and are obliged to have no coal passers, of whom we should require six if using coal.

"On the return trip the engineer was directed to run at a speed of ten knots an hour as an experiment. The steamer left Honolulu on October 27 and arrived in San Francisco on November 4. The speed was 10.54 knots an hour. The burners worked with the same success as on the outward trip. The amount of oil burned was 1,390 barrels, or 7.2 per hour. This was 191 barrels less than on the outward trip. The horse power developed was 1,834. The amount of oil burned per indicated horse power was 1.27 pounds. While the difference in the quantity of oil used was 191 barrels,

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THE BEACHY HEAD LIGHTHOUSE, RECENTLY COMPLETED.—[See page 358.]

it cost a day's time. Apparently it is more economical to use the maximum power of the boilers and engines. We have found that a pound of oil will evaporate from 14 to 15 pounds of water, while a pound of coal will evaporate only from 9 to 9¼ pounds."

Two-Cycle Automobile Engines.

BY E. W. ROBERTS.

Nothing except an unwarranted prejudice has prevented the two-cycle gasoline engine from as wide use for automobiles as for the motor boat. This prejudice may perhaps be accounted for by the fact that the earlier development of the gasoline automobile was in the hands of the French, with whom the two-cycle engine is practically unknown. Originally an English invention, the two-cycle engine having precompression in the crankcase has attained its fullest development in the hands of American manufacturers. To-day, probably ninety per cent of the small American-built motor boats employ two-cycle engines. The great demand for marine engines has been the most potent factor in preventing the makers of two-cycle engines from applying them to the automobile on a commercial scale. Where they have made such application, they have invariably found the two-cycle engine to give excellent service in the automobile. Such unsuccessful applications of this kind as have been made may invariably be traced to inexperience in two-cycle engine design. In the case of the marine-engine builders, the great demand for launch engines has prevented their further development of the automobile motor.

Fortunately, however, the adaptation of the two-cycle engine to vehicles was taken up by a firm building automobiles only, and hence its development on automobile lines has in this case proceeded without being handicapped by the demands of another branch of the business. Fighting the battle practically alone, the firm in question has so far overcome the popular prejudice that I do not believe there is an owner of one of their two-cycle automobiles who would care to change for one of the more complicated type.

Mechanically, the two-cycle engine bears the same relation to the four-cycle type that the oscillating steam engine bears to the slide-valve engine. If anything, the diversion is more marked in the case of the gas engine. In the two-cycle automobile engine there is not a valve or a moving part of any kind on the outside, all the functions of the valves being accomplished by the piston uncovering ports in the side of the cylinder at the proper time in the stroke. Even the igniter is operated directly from the piston without a cam, an eccentric, or a lever, outside of the cylinder. In fact, so simple is the engine, that once adjusted at the factory it will run for months without alteration. Such adjustments as are required at any time are no more than the tightening of the connecting-rod bearing or the igniter spring. As to flexibility, these engines have proven themselves fully equal to the four-cycle engine, and under throttle control without change of igniter lead they will run at speeds varying from 175 r. p. m. to nearly 2,000 r. p. m.

Given a two-cycle engine that will operate equally well in comparison with a four-cycle engine, its advantages are twofold. Having an impulse in each cylinder for each revolution of the crankshaft instead of every alternating revolution, as in the four-cycle engine, it will run much more steadily; so that for steady running a two-cylinder two-cycle engine is in every way equal to a four-cylinder four-cycle. Again, since it receives more frequent impulses, its power, weight for weight, is considerably greater than that of a four-cycle engine. The greater frequency of impulses also permits of the use of lighter flywheels on a two-cycle engine than on a four-cycle of the same size.

The unwarranted assumptions of some writers that the two-cycle engine will not keep up its turning moment with increase of speed is entirely disproven by tests that the writer has made. For instance, a 4-inch x 4-inch two-cylinder, two-cycle engine gave 4 horse power at 400 r. p. m. and 10 brake horse power at 1,000 r. p. m. In fact, the pull on the brake lever at the lower speed was but two or three ounces more than at the higher speed.

In a quite recent work on automobiles its author states that "while a four-cycle engine of a given horse power will run at as high a speed as 1,200 or 1,500 r. p. m., a two-cycle engine of the same power can make no more than 300 or 350 r. p. m." This statement is so far from the facts that it is truly nonsensical. In reality, there is absolutely no reason why a properly designed two-cycle engine should not run at as high a speed as a four-cycle. A carriage under the writer's observation has made mile after mile in a track test. on the second speed, with the engine above referred to running at 1,650 r. p. m., and doing it without a break, skip, or miss of any kind. In view of what experiments have been made, I am fully confident that this same engine can be operated without the slightest difficulty at 2,000 r.p.m. or more. In practice, where the same care is taken with the design of a two-cycle engine as with a four-cycle engine for the same service and the same speed, each will run with equal facility, and owing to the greater simplicity of the two-cycle engine, much less trouble will be experienced with disordered parts. The reader is particularly requested to note that the statements made in this article are not mere assumptions, but an account of what has been done.

In regard to service on the road, the two-cycle automobile has shown up equally well, if not better than the more complicated type, having come through both the 100-mile non-stop contests on Long Island with a clean record; while in the New York-Boston Endurance Run, two vehicles received first-class certificates, and one of them went through without any penalized stops. A two-cycle machine made a run from Detroit to Niagara Falls through Canada, returning on the American side, the whole trip covering over 1,000 miles of road, through sand, mud, clay, and some of the worst roads possible to imagine. At no time was there any trouble with the engine with the exception of the igniter wires getting loose; and, quoting from a letter written by the operator, he says: "During this trip I will say that we found no hills too steep, no mud nor sand too deep for our machine to climb or go through." It should also be added that this machine, although built for two passengers, carried three people and considerable luggage. It is notable that the owner's bill for repairs on this entire trip was only twenty cents. However, it must be said that he was extremely fortunate, as he had no more serious accident than a collision with a hidden stone, which broke two spring-bolts, the replacing of which was his only repair.

An Ocean Race of Warships.

The ships of the North Atlantic Squadron have recently engaged in a long-distance speed contest in the open sea. The naval regulations provide that new ships shall be speeded at their utmost at intervals. An opportunity presented itself a week ago, when the ships of the squadron were being assembled for the winter naval maneuvers. Under orders of the Navy Department, five of the ships lined up for a run from Hampton Roads on Saturday, November 15—the "Alabama," "Kearsarge," "Massachusetts," "Indiana," and the "Machias." This squadron included some of the oldest and newest battleships in the American navy. Thirty-five miles behind the vessels as they passed the Virginia capes followed the protected cruiser "Cincinnati." Speedier and lighter as she is, the 35 miles were for her a fair handicap. Almost from the time the starting gun was fired and the ships headed for Culebra, the "Alabama" forged ahead. So far as the battleships were concerned, it was a race between the "Alabama" and "Kearsarge," the products of two rival shipyards. The "Alabama's" superiority was soon demonstrated. In the first two hours she ran away from her rival, and four hours from the start, just before twilight, she left the "Kearsarge" hull down astern. The "Massachusetts" kept up surprisingly well, and proved a far stronger competitor to the "Alabama" than the newer "Kearsarge." But before night the older ship was also left behind.

At sunset on Monday, when all the battleships had long been distanced, the "Cincinnati" was sighted. She had made up her handicap and was fast catching up to the "Alabama." The two ships were pushed their utmost all day Monday and on Tuesday and Wednesday. When the Culebra Light was reached, the "Alabama" was under forced draft two miles astern of the cruiser. The "Kearsarge," "Massachusetts," "Indiana" and "Machias" were not in sight.

During the run the "Alabama" had steamed eight hours at full speed under natural draft, and had averaged 15.2 knots. Her average speed under forced draft for four hours was 16.65 knots. On her official trial trip the "Alabama" made 17.103 knots under forced draft. The "Kearsarge" during her builders' trial in September, 1899, was credited with 17.25 knots under forced draft; but her official average for four hours on her government trial was 16.816 knots. The "Cincinnati," which was built in the New York Navy Yard by the government and launched in 1894, made a record of 17.5 knots on her speed trial. In 1896 the "Massachusetts" made a run of 16.21 knots an hour. A year ago both the "Massachusetts" and "Alabama" were tried over the Barren Island course at Chesapeake Bay, with assisted draft instead of forced draft. Both ships recorded 15 and 16 knots an hour.

The use of oil lamps on yachts has always been a drawback and this has just been overcome on the pleasure schooner Thistle of Robert E. Tod by the introduction of acetylene. This gas is not generated on board, but on shore, and is brought on the vessel in tanks under pressure. These are stored in the bow of the craft, the tanks being removed as the pressure becomes low and replaced with freshly charged ones.

Science Notes.

B. Brauner has examined all the possible positions of the metals of rare earths in Mendelejeff's periodic system. He arrived at the conclusion that this group of elements may present some analogy with the group of asteroids in the solar system, forming, in the periodic system, a sort of link between cerium and the unknown element of the atomic weight 180. This interperiodical group is thus the continuation of the eighth line, terminating with the tungsten-platinum elements; gold is shown to be the first term of the ninth, and not of the eleventh line. The first element of the twelfth line is probably radium, followed by thorium and uranium.

A unique specimen of an Egyptian tool has been received by M. Albert Colson, of Paris, who gives an account of its fabrication and the character of the metal. The tool is a cold-chisel of the time of the Sheban dynasties, formed of a hard bronze blade whose present thickness is 0.12-inch and width 0.72-inch. The cutting bevel is made at an angle of 60 to 65 degrees. This hard alloy is inserted in an outer covering or sheath of soft and malleable bronze 0.6-inch thick, which covers it quite up to the cutting edge. This outer sheath has been either used as a mould for the central part or been added outwardly by hammering at a high temperature. In any case it is effective in giving the hard and brittle metal of the tool the elasticity necessary for receiving the shocks of the hammer. This artifice is analogous to that used at present in automobile construction for obtaining parts which are resistant alike to wear and to shocks; the pieces are made in soft steel and the parts exposed to friction are hardened by cementation. The non-cemented part preserves the elasticity of the piece, which if entirely hardened would be too brittle. In this case the soft steel is in the interior, while in the Egyptian tool the soft bronze is on the outside. The sheathing, unlike the central core, is of a laminated texture. The surface which separates the two alloys is marked by a black oxide, often stained with verdigris. The two alloys were separated and after cleaning were found to have different densities. The envelope, although more oxidized, gives $d=5.33$ and the core $d=5.18$. This anomaly showed that the former is richer in copper than the latter, as was proved by analysis. If a part of the tool is reduced by hydrogen near 500 deg. C. the envelope takes a red copper-color and the interior a buff-yellow. The following shows the composition of the bronzes which compose the two parts. After cleaning the alloys were first reduced by the blowpipe and found to lose in each case about 15 per cent of oxygen and 3 or 4 per cent of carbonic acid, sulphur, chlorine, etc. Then followed the analysis of the reduced metal:

	Envelope.	Central portion.
Oxygen	1.65	1.60
Chlorine and sulphur	0.80	traces
Iron	0.70	0.30
Lime and potassa	"	0.15
Tin	4.67	13.30
Copper	92.60	84.60

The hard bronze thus contains less copper and considerably more tin than the soft. The presence of chlorine and sulphur is due to the earth in which the tool had been buried. The lime and potash seem to come from the ashes of the fire which melted the alloy, for after reducing the powdered metal by hydrogen and treating with boiling water the solution sometimes turns red litmus to blue. The lime is thus in the free state and the potash in the form of carbonate.

The Current Supplement.

The current SUPPLEMENT, No. 1404, opens with the first installment of a most complete account of the Langley aerodrome—perhaps the only machine of its kind built on truly scientific principles, and actually tried. The article is very fully illustrated. Henry G. Kittredge continues his exhaustive discussion of the utilization of wastes and by-products in manufactures. Some notes on experimental researches on internal flow in centrifugal pumps and allied machines have been prepared by James Alex. Smith. The subject is one of considerable physical interest. "The Contact Process for the Manufacture of Sulphuric Acid" is the subject of an article which will doubtless be found of no little value to chemists. A new French process for sterilizing water is described and illustrated. Among the minor articles may be mentioned those on "Ferro-Concrete," "Oil Burning with Forced Draft," "The Phenix Accumulator," "Distribution of Light from the Nernst Lamp" and "Compensation for the Weakening of Permanent Magnets." Automobilists will read with profit an article on how to remove the inner tube of a double-tube automobile tire. The usual notes have also been published.

Ziegler's New Leader.

Ziegler has decided his next expedition to the North Pole will be headed by Anthony Fiala. The "America" is soon to be refitted, and the second expedition sent off as soon as possible.