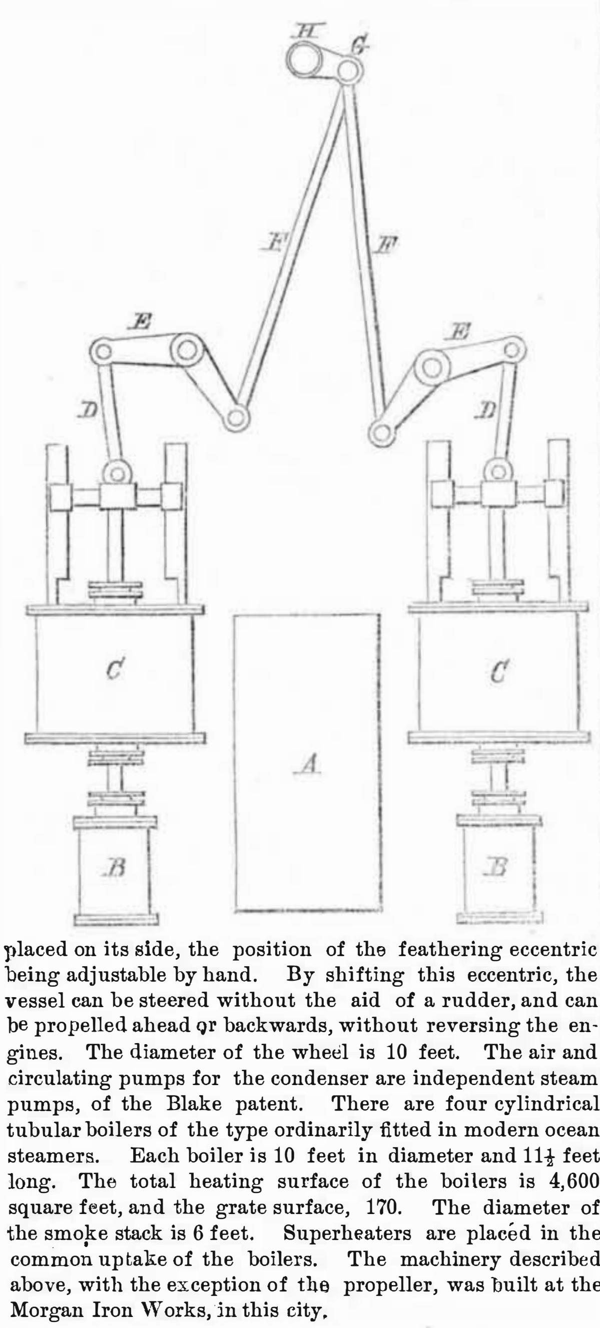
written with the expectation that they will be interpreted by teachers, our remarks may not come amiss to those who are obliged to study without assistance from an instructor.

We shall be happy at all times to aid the young student in his difficulties, and hope that those who are in need of assistance will apply to us freely. We shall, from time to time, give the solution of simple problems, illustrating the value and use of a right understanding of mathematics and mechanical principles.

ENGINES OF ADMIRAL PORTER'S TORPEDO BOAT.

In a recent number of the SCIENTIFIC AMERICAN, we gave an illustration of this vessel, and we now present a sketch, showing the general arrangement of the engines, which are quite novel in design. The engines are of the compound variety, with four cylinders, the condenser, A, being placed between them. There are two high pressure cylinders, B, diameter 20 inches, stroke 30 inches, and two low pressure cylinders, C, with a diameter of 38 inches and a stroke of 30 inches. The low pressure cylinders are jacketed. Short connecting rods, D, from the crossheads are attached to two bell crank levers, E, which have a throw of 27 inches. The crank connecting rods, F, are attached to the other ends of these bell crank levers, and to a common pin in the driving crank, G, which latter crank has a throw of 15 inches. The valves (not shown in the sketch) are on top of the cylinders, and are operated by eccentrics working on an intermediate shaft which is actuated by levers from the crossheads. No links are fitted to the valve gear of these engines, as the revolution always takes place in one direction, whether the ship is going ahead or backward. It will be observed that the propeller shaft, H, is vertical, the wheel employed being what is known as the Fowler patent. This can be described as a Manley feathering paddle wheel



placed on its side, the position of the feathering eccentric being adjustable by hand. By shifting this eccentric, the vessel can be steered without the aid of a rudder, and can be propelled ahead or backwards, without reversing the engines. The diameter of the wheel is 10 feet. The air and circulating pumps for the condenser are independent steam pumps, of the Blake patent. There are four cylindrical tubular boilers of the type ordinarily fitted in modern ocean steamers. Each boiler is 10 feet in diameter and 11½ feet long. The total heating surface of the boilers is 4,600 square feet, and the grate surface, 170. The diameter of the smoke stack is 6 feet. Superheaters are placed in the common uptake of the boilers. The machinery described above, with the exception of the propeller, was built at the Morgan Iron Works, in this city.

THE SUN'S DISTANCE AND HOW IT IS MEASURED.

One of the simplest problems in applied trigonometry is to find the hight of an inaccessible object. The solution involves the measurement of a baseline and the angles formed on it by two lines connecting its extremities with the object whose elevation is to be found. For example, suppose the object to be a balloon. If at the same moment two persons, in line with the balloon and a considerable distance apart, make a note of its angle of elevation, the angles thus obtained, with the distance between the observers, are all the data required for calculating the hight of the balloon above the earth. In like manner, if two observers, say, one at Washington and the other at Lima, or one at Paris and the other at the Cape of Good Hope, observe the position of the moon's center at the same moment, they will have two angles of a triangle, which, with the included side—the distance between the observers,—will enable them to determine the length of the remaining sides of the triangle, that is, the distance between either station and the moon. In this case, the triangle is extremely long and narrow, the longer base line mentioned giving an angle at the moon of only about a degree and a half.

It is obvious that an object much farther off than the moon would give, with any base line obtainable on the earth, an angle too small for direct measurement. In the case of sun, for instance, the distance is so great that the nicest observation fails to show any measurable difference in his position, whether he is viewed from one or another part of the earth's surface. The determination of his distance must therefore be by other means than by direct triangulation.

Several ingenious attempts were made by ancient astronomers to solve this problem of the sun's distance indirectly, but the limits of error by their method were so wide that the results obtained by them had no value even as approximations. Indeed it was not until Kepler discovered the proportions of the solar system that it became possible to attack the problem with any hope of success. As soon, however, as Kepler's third law made all the distances of all the system calculable as soon as one was exactly known, it was clear that, if the distance from the earth to one of the nearer planets, say Mars or Venus, could be found, then a simple proportion would give the distance of the sun.

Mars was the first planet to be studied for this purpose. Venus approaches nearer to the earth; but as her orbit lies within that of the earth, her position during her periods of conjunction is unfavorable for observation, save at remote intervals when she happens to be exactly in line with the the sun's disk, that is, during her transits. Of these more hereafter. Since Mars, when nearest the earth, is still too far away to be reached by direct triangulation—that is, so far that two lines connecting the extremities of the longest base line to be had on the earth with the planet's center would be so nearly parallel that the angle of their convergence could not be directly measured—it is obviously necessary to devise some other means of discovering the value of that important angle. Omitting all but the fundamental elements of the problem, the plan adopted may be roughly illustrated as follows: Hold a small object, say a pencil, steadily at arm's length and note the spot on the wall which the pencil point covers when looked at with the right eye, the left being closed. Now close the right eye and look at the pencil point with the left eye. Its position is shifted to the right, more or less according to the distance of the pencil from the eye and from the wall. The amount of this shifting, in angular measurement, may be called the pencil's parallax.

Suppose that, instead of being held between the eye and a wall, the pencil is placed before the moon at such a distance from the face that, when looked at with the right eye, its point covers the left horn of the moon, and, when seen with the left eye, the right horn. We may now imagine two similar triangles: one having for its base the distance between the eyes, and for its sides two lines proceeding from the eyes and meeting at the pencil point, the other formed by the prolongation of the same lines to the opposite sides of the moon's disk. The measure of the vertical angle of the triangle standing on the moon's diameter is the portion of the great circle of the heavens covered by the moon, that is about half a degree. The vertical angle of the triangle having for its base the distance between the eyes is the same; hence the remaining sides of the triangle—that is, the distance of the pencil from either eye—can be determined by a simple process of calculation.

Precisely the same principles are involved in the determination of the distance of a heavenly body like Mars, the displacement of the planet, as seen from two distant observatories, being measured with reference to some star lying as nearly as possible in the same direction. (Since the distance of a star is so extremely great that its position is not appreciably altered by any difference in points of view possible on the surface of the earth—in other words, since the star has no parallax—it answers perfectly as a fixed point of comparison.) As soon as the distance of the planet has been calculated, the distance of the sun can be determined by an application of Kepler's third law. Kepler made the calculation on the basis of Tycho Brahe's observations of Mars; but owing to the rudeness of those observations, he could only say that the sun's parallax could not be greater than one sixtieth of a degree (1′) which would make his distance not *less* than thirteen and a half million miles.

Subsequent observations of greater exactness enabled Cassini to calculate that the sun's parallax could not exceed ten seconds of arc (10″) and he was confident that it was not greater than 9·5″, corresponding with a distance not less than 85,500,000 miles. The establishment of more widely separated points of observation, and the immense improvement made of late years in the construction of astronomical instruments, have enabled modern observers to make great improvements on these figures, which will be noticed directly. In the meantime, however, the transits of Venus in 1761 and 1769 furnished data for another and entirely different set of calculations.

The importance of the transits of Venus hinges on the fact that at such times the planet appears as a black spot on the sun's disk, so that her position can be observed with great exactness. The conditions which serve to complicate the problem are too numerous and complex to be taken into account here. The apparent position of the planet on the sun's face at any given moment of her transit necessarily depends on the position of the observer. The amount of such displacement is the essential term for calculating the distance of the planet, and from that the distance of the sun.

The observations made during the transit of 1761 were interpreted as giving a solar parallax of 8·65″, corresponding to a mean distance of about 94,500,000 miles. More elaborate preparations were made for the observation of the transit of 1769; but the conditions were less favorable, the observers were unprepared to meet a grave difficulty which arose, and the results were exceedingly discordant. Some made the sun's distance nearly 109,000,000 miles, others less than 88,000,000. About fifty years ago, Encke re-examined the observations made on both transits and, combining results, deduced the distance 95,174,000 miles—an estimate which was accepted as the best that could be hoped for until the transit of 1874 should furnish data for a new determination. It could not hold its ground, however, in the light of modern science.

From a study of the perturbations of the moon depending on the position of the sun, Laplace had deduced a solar parallax closely corresponding with that subsequently obtained by Encke from the transits of Venus. But in 1854 Hausen applied the same method to a larger number of more exact observations, and obtained 91,650,000 miles for the sun's distance.

By another method, depending on the apparent motions of the sun, Leverrier calculated a solar distance of 91,330,000 miles. Mr. Stone, of Cambridge, Eng., discovered a numerical error in Leverrier's work, and, on correcting it, made the sun's distance 91,739,000 miles. By the same method, our own Professor Newcomb obtains 92,500,000 miles. Foucault, by an experimental study of light, obtained results which would make the sun's distance 91,400,000 miles. Applying improved methods to the study of Mars, several astronomers, including Newcomb, Stone, and Winnecke, obtained, between 1860 and 1864, slightly varying figures approximating 92,000,000. It was clear that Encke's estimate was too great. Thereupon the observations of 1769 were subjected to another scrutiny with results so clearly confirming the later and smaller estimates that the distance, 92,000,000 miles—with a margin of possible error of 500,000 miles—was provisionally adopted. The finer instrumental and other appliances, which will be brought to bear on the transits of 1874 and 1882, will no doubt establish an exacter estimate, which it may take centuries to improve upon.

SCIENTIFIC AND PRACTICAL INFORMATION.

NEW ROUTE FROM NEW YORK TO LONDON.

A quicker route from New York to London is suggested, to wit: By rail to Shippegan, on the Gulf of St. Lawrence, thence across the Gulf by steamer to St. George's Harbor, Newfoundland, thence by rail to St. John's, thence by steamer to Valencia, Ireland, thence by rail to St. George's Channel and by steamer to England. The time of this route can be reduced to seven days three hours, the longest water steaming being 4 days, to wit, St. John's to Valencia, 1,600 miles. At the present time, from 10 to 12 days is occupied by the fastest steamers in sailing from New York to Liverpool.

POISONOUS COBALT COMPOUNDS.

According to some experiments of Siegen, the compounds of cobalt are to be reckoned among poisons. This savant experimented with the nitrate and chloride of cobalt, and found that one sixth of a grain of either substance would kill a frog in half an hour, and five grains killed a strong rabbit weighing over 3 lbs. in three hours. The poison seems to act directly upon the muscles of the heart. A frog was poisoned whose heart had been previously exposed, and its contractions became from 50 to 25 per cent less frequent; and after five minutes it stopped, and mechanical scratching failed to produce any farther contractions. With rabbits 1·66 grains produced a strong dyspnœa, and the pulse fell from 178 to 128 per minute.

POWER OF EXPLOSIVES.

Some experiments have been made recently in a German iron mine at Hamm, to ascertain the relative efficiency of powder and some of the nitro-glycerin compounds for blasting purposes. The following were the results obtained:

Ordinary saltpeter gunpowder, 1 unit of force; extra best powder, with excess of saltpeter and cherry tree charcoal, made by L. Ritter at Hamm, 3 units; dualin, obtained from Herr Dittmar, lieutenant of artillery, Charlottenburg, 5 units; lithofracteur, from Krebs & Co., Deutz, 5 units; colonia powder (a sort of powder saturated with 30 to 35 per cent nitro-glycerin) 5 to 6 units; dynamite, 6 to 7 units. It will be seen that dynamite far exceeds the others in power, and its use is displacing theirs in German mines.

THE TRANSATLANTIC CABLE AND PLANET NO. 131.

An example of the free transmission of telegraphic dispatches relating to astronomical discoveries was presented on the occasion of the last new planet (No. 131), discovered at Washington on May 26 and observed at Marseilles on May 27 of the present year. The news was received by Atlantic cable and telegraphed from Paris to Marseilles in the following cabalistic terms: "Planet, sixteen, fourteen, south, twenty-one, eighteen, movement, right, west, eleventh." This, being interpreted, means: "A planet has been discovered, of which the right ascension is 16 h. 14 m., and the declination, southerly, 21° 18′: its movement is directly toward the west, and it is of about the eleventh magnitude."

It is an odd coincidence that the first planet discovered in America (during the year 1854) was No. 31, so that this last new comer, No. 131, also first noted in this country, is the hundredth found since.

TO REMOVE PAINT.—Chloroform will remove paint from a garment or elsewhere, when benzol or bisulphide of carbon fails.