possible, one can determine which blade or blades of the propeller, if any, is producing more vibration than the others. As the velocity of the wake, and hence the slip of the wheel, is greatest near the surface, and as the thrust of the propeller increases with the slip, consequently each blade of the propeller experiences a greater resistance near the top, and a less resistance near the bottom of its revolution; hence, as each blade passes through the top position, it produces a vibration upon the ship which is recorded by the machine. Being mainly a transverse vibration, it is most noticeable on the transverse curve, which shows as many vibrations per revolution of the engine as the propeller has blades. If, now, one blade be a trifle larger or of slightly greater pitch than the others, it produces a greater vibration, and, knowing the position of the engine (as explained above) at the instant this blade passes through its position of maximum resistance, it is a simple matter to identify that blade.

The critical number of revolutions of the engine can also be determined with this machine. Vessels having quick-running engines, such as torpedo boats, experience an excessive vibration as the number of revolutions of the engine approaches a certain amount, decreasing as this point is passed but reappearing at each multiple of the original. This number of revolutions is known as the critical number, and is the point at which the number of revolutions of the engine coincides with the natural period of the ship's hull.

With this machine the forces of the engine producing vibration can be studied; and knowing the instantaneous position and direction of motion of each part of the engine, those parts producing vibration can be identified, and means adopted for their suppression. The effect of the various systems of balancing can also be studied and compared.

An ingenious beacon is located at Arnish Rock, Stornoway Bay, in the Hebrides, Scotland. It is a cone of cast-iron plates, surmounted by an arrangement of prisms and a mirror which reflect the light from the lighthouse on Lewis Island, 500 feet distant across the channel.

MORNING AND EVENING STARS FOR 1907.

BY FREDERIC R. HONEY, TRINITY COLLEGE.

The purpose of this article is the same as that of my contribution on this subject for 1906, viz., to assist the non-professional student in identifying the planets which rise before and which set after the sun, for any day of the year.

The orbits of Mercury, Venus, the earth, and Mars are plotted; those of Jupiter, Saturn, Uranus, and Neptune extending beyond the limits of the page.

Mercury's revolution round the sun is performed in very nearly 88 days; and since Venus revolves in her orbit in 224 days and a fraction, a common divisor of 88 and 224, i.e., 8 days, has been selected as a convenient interval of time.

Mercury is represented in eleven positions 8 days apart during each revolution, and Venus is shown in twenty-eight positions at the corresponding dates.

After an interval of exactly 88 days, Mercury gains on his first position only a very small fraction of a degree (= 5⅓ minutes) and in four times 88, or 352 days, during which Mercury makes four revolutions, he advances on his first position about 1-3 deg. (= 22 minutes). By assuming a mean position, this very small error is diminished and is not noticeable in a plot of these dimensions. The positions of the planet are therefore made identical, and four dates are attached to each. Intermediate positions at intervals of four days are also shown.

Mercury's position on January 6 is again reached on April 4, July 1, and September 27. Similarly, his position on January 14 corresponds with that of April 12, July 9, and October 5. By this arrangement the planet's positions are indicated for 44 different dates.

Since the period of Venus's revolution is 224.7 days, after the exact interval of 224 days she falls a little behind her first position of January 6, and during the remainder of the year is represented by an open circle with the new date attached. She reaches on August 18 very nearly the same position as that occupied on January 6; and the same statement applies to each of the subsequent dates.

The positions of the earth and Mars are shown at intervals of eight days from January 6 to December 24. Jupiter's distance from the sun is more than five times that of the earth; it is therefore impracticable to plot his orbit on the same scale, and since his period is less than twelve years, he revolves at an average of about 30 degrees a year. His positions in the heavens are indicated by the arrows for January 6, April 4, July 1, September 27, and December 24. His apparent motion is so slow that the reader will have little difficulty in approximately determining the intermediate position for any assigned date.

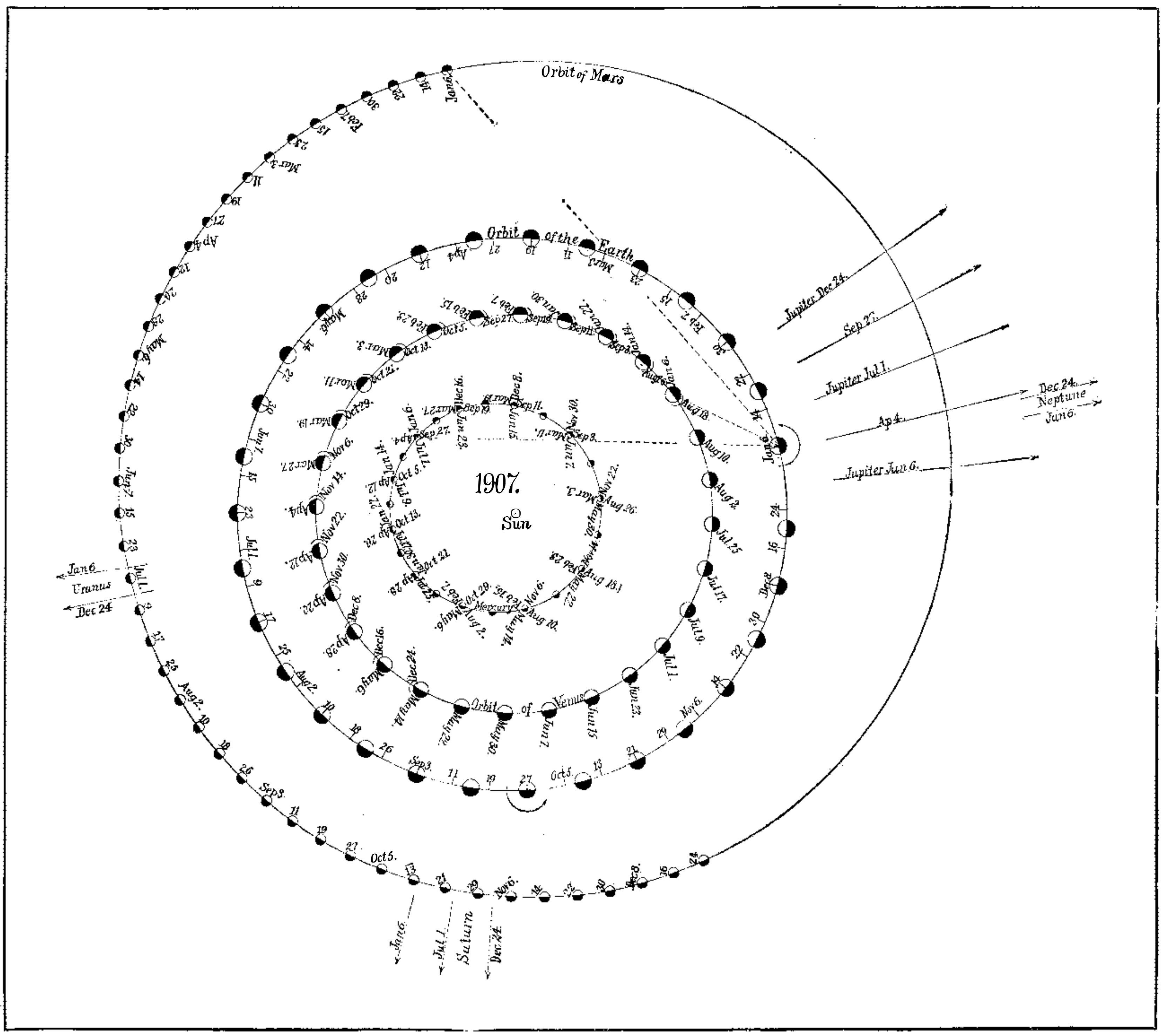
The statements also apply to Saturn, whose distance from the sun is about nine and a half times that of the earth. His positions are indicated by the arrows for January 6, July 1, and December 24. His period is nearly 29½ years.

The apparent motions of Uranus and Neptune are so slow that it is only necessary to indicate the dates at the beginning and at the end of the year. The former is over nineteen times the distance from the sun to the earth, and his period is 84 years; while Neptune is thirty times the distance between the earth and the sun, and his period of revolution is nearly 165 years.

If the reader will note that the earth rotates on its axis in the direction of the arrow (see September 27) he will see that at sunrise the observer is emerging from the shadow area, and that at sunset he is entering it. Before sunrise any planet which in the plot is on the right of the sun will evidently rise before him, and is morning star; and after sunset any planet which is on the left of the sun will set after him, and is therefore an evening star.

In order to ascertain which planets are morning and evening stars, this page should be turned until the earth at the assigned date is between the reader and the sun, so that the date attached to the earth may be read without turning the head. For example, if this page is turned about one-quarter of the way around, until the earth in the plot on January 6 is between the observer and the sun, it will be seen that Mercury, Venus, and Mars are on the right hand of the sun, i.e., they are morning stars at this date.

While it is true that Mercury is approaching aphelion



MORNING AND EVENING STARS FOR 1907.

his apparent distance from the sun is very much diminished, on account of the relative positions of the planet and the earth, and he is also in the neighborhood of his maximum distance from the earth. He reaches superior conjunction on February 2; his apparent diameter is therefore approaching its minimum.

On January 6 Venus is very near the earth. Her apparent diameter is about five-eighths of her maximum size, which is more than six times larger in diameter than she appears at superior conjunction, when she is separated from the earth by a distance equal to the sum of the orbit radii of the planets. A large part of her surface is in shadow, but her visible illuminated surface reflects a great deal of light.

At this date a large part of Mars's illuminated surface is visible, but on account of his great distance from the earth, his apparent diameter is not more than about one-half as large again as the minimum.

As between sunset and sunrise the observer is somewhere within the shadow area, the reader will easily conclude from an inspection of the plot that on January 6 Jupiter and Neptune will be visible during the hours of darkness.

Saturn being on the left of the sun will set after him, and is therefore evening star. The apparent distance from the sun will diminish as the earth revolves in its orbit.

If the reader will place a straightedge through the centers of the earth and sun, Uranus will appear a short distance on the right, and is therefore morning star. As the earth revolves in its orbit the apparent distance between the sun and Uranus will evidently increase.

In order to become familiar with the method of using the plot, the reader is recommended to give his attention to one planet, and note the change of its position relative to the sun and earth. Following the rule here given, he can easily determine whether it is morning or evening star, and also when conjunctions occur.

At superior conjunction, Mercury and Venus change from morning to evening star; while at inferior conjunction, the change is made from evening to morning star. After five conjunctions, alternately superior and inferior, of which three will be superior and two inferior, Mercury will reach the last conjunction this year on November 14, when a transit across the sun's disk will occur. After this date Mercury will be morning star for the rest of the year.

Mercury passes aphelion on January 14, April 12, July 9, and October 5. For several days before and after April 12 he will be seen very advantageously as morning star. Also before and after June 23 and October 21 he will be distinctly visible as evening star, when he is approaching and receding from aphelion. These positions are selected as illustrations, because at these dates he is not far from his maximum distance from the sun. The perihelion passages are on February 27, May 26, August 22, and November 18. The transit will occur four days before the planet reaches perihelion.

Venus will be morning star until September 14, when she will reach superior conjunction. She will then be evening star for the rest of the year.

The positions of Mars relative to the sun and earth before and after opposition, which occurs on July 6, have been explained in the SCIENTIFIC AMERICAN in a previous article (November 24, 1906), and with the aid of the plot the reader will have little difficulty in realizing the situation in the heavens of Jupiter, Saturn, Uranus, and Neptune at any assigned date.

Lead in Ice Cream.

Baldoni (Riforma Med.) finds considerable amounts of lead in ice cream, fruit ices, etc., as sold in Rome. He attributes many of the disturbances of digestion occurring during the summer when ice cream, fruit ices, sorbets, etc., are consumed in larger quantities to the lead contained in these articles. The linings of the receptacles in which ice cream is made often consist of an alloy of tin and lead. The ingredients of ice cream dissolve this, but in addition to this, in turning the mass in the freezer a certain amount of the lining of the vessel is rubbed into the cream. This was proved conclusively by the writer, who found that particles of tin and copper were precipitated at the bottom of glass vessels in which he melted ice cream. On filtering the liquid these articles also were found on the filter. He destroyed the organic portions of the cream by means of fuming nitric acid and by electrolysis, and recovered the lead.

Price of Illuminating Gas in England.

Consul F. W. Mahin reports that the price of illuminating gas in Widnes, Lancashire, England, is now 32 cents to small consumers, but will be reduced to 30 cents on July 1. Large consumers will pay from 22 to 26 cents. This is claimed to be the cheapest gas in the world. The town has about 30,000 population. The price of gas is remarkably low everywhere in Great Britain, whether under public or private control, the general range of price being 40 and 70 cents.

Correspondence.

Large Powder Chambers a Cure for Erosion.

To the Editor of the SCIENTIFIC AMERICAN:

Supplementing my former letter and your editorial comments thereon, appearing in your issue of the 19th instant, I desire to direct attention to further and most important lessons taught by the firing records made by both the Gen. Crozier wire wound, and the Brown wire 6-inch guns, recently tested by the United States government at Sandy Hook.

Most surprising results were revealed in regard to high velocities with low maximum pressure.

The first round from the Gen. Crozier gun, with 33 pounds of powder (100-pound shot) gave a muzzle velocity of 1,604 feet per second, with a pressure of 8,600 pounds per square inch.

The second round (100-pound shot) with 49 pounds of smokeless powder, gave a muzzle velocity of 2,161 feet per second, with a pressure of only 15,470 pounds, which was most astonishing in comparison with the results obtained with the old brown prismatic powder, when a pressure of about 37,000 pounds per square inch was required to secure about 2,000 feet per second velocity.

To establish more fully the fact that these remarkable results were due to the large powder chamber, we quote the government record of the first two shots fired from the Brown wire 6-inch gun, which also had a powder chamber of about the same size as that of the Crozier gun: The first round with 33 pounds of powder (100-pound shot) gave a muzzle velocity of 1,913 feet per second, with a pressure of 12,275 pounds per square inch. The second round from the Brown gun, with 49 pounds of powder (100-pound shot) gave a muzzle velocity of 2,484 feet per second, with a pressure of only 20,866 pounds per square inch.

Thus we have the records of both the Crozier and the Brown guns, both having large powder chambers, to establish conclusively the fact that such guns are capable of giving comparatively high muzzle velocities with low maximum pressures.

Indeed, the official records show that these guns did give muzzle velocities as great as can be obtained from the best service guns of the same caliber now in use, with very much lower maximum pressures.

The importance of these facts is, that when fired with service velocities of 2,600 or 2,700 feet per second the pressures would be so extremely low—at least 10,000 pounds less than the service gun—that the life of these guns will be many times longer than that of any guns of the same caliber having the present service powder chamber.

A 40-caliber 12-inch gun with a powder chamber of 25,000 cubic inches, which would be about the same proportion as the chambers in the Crozier and Brown guns, and with 480 pounds nitrocellulose powder, properly granulated, would easily give an 800-pound shot a muzzle velocity of 2,600 feet per second, and with a pressure of not more than 26,000 pounds per square inch. With that low pressure, a 12-inch gun could fire three or four times as many shots, without being very much eroded, as the 12-inch guns now in use can stand without serious erosion. These require a pressure of about 37,000 pounds per square inch to give the same velocity that 26,000 pounds pressure would give in a 12-inch gun with the larger chamber.

It is stated in the last annual report of the chief of ordnance of the United States army, that the life of their 12-inch guns was limited to 60 shots.

In event of great emergency a large-chambered 12-inch gun could be fired with 600 pounds of powder, which would give an 800-pound shot a velocity of 3,200 feet per second and a pressure not exceeding 45,000 pounds per square inch, being the service pressure of the above-mentioned 6-inch wire guns.

The adoption of the large-chambered 12-inch gun is feasible, and the weight of the gun need not be increased, nor its cost, if it were wire wound, and wound its entire length, on the plans of the Crozier 10-inch wire-wound gun, or the 6-inch Brown wire gun.

This large-chambered 12-inch gun would have many advantages over the proposed 14-inch guns which were recently recommended by the Ordnance Department to replace the 12-inch guns now in service.

1. In the first place, its cost, including carriage (the present disappearing carriage for 12-inch guns could be used), would be very much less than the 14-inch gun with correspondingly larger carriage.

2. The life of this 12-inch gun with the large chamber would be as long as the more expensive 14-inch gun, when fired, to obtain the same energy.

3. Such a 12-inch gun could be fired more rapidly, the ammunition being so much lighter, and when emergency charges were necessary, it would have fully 50 per cent greater striking energy.

Pressures increase rapidly with the increased density of loading without a corresponding increase of velocity, as illustrated by the following figures, quoted from the official government firing sheet of the 6-inch Brown wire gun, viz.:

33 pounds of powder gave 1,913 feet velocity with 12,274 pounds pressure.

49 pounds of powder gave 2,484 feet velocity with 20,866 pounds pressure.

61 pounds of powder gave 3,000 feet velocity with 30,000 pounds pressure.

75 pounds of powder gave 3,514 feet velocity with 50,000 pounds pressure.

84 pounds of powder gave 3,723 feet velocity with 66,000 pounds pressure.

If the powder chamber in this 6-inch Brown gun had been even still larger, so that the density of loading had not exceeded 0.6 of its capacity, the maximum pressures would have been much lower than they were, and the muzzle velocities would still have remained about the same, and naturally the life of the gun would have been prolonged.

In order to get high velocities from small or ordinary chambered guns, the density of loading is necessarily very high, thus resulting in high pressures and short life to the gun. JOHN H. BROWN.

New York, January 30, 1907.

Aeronautical Notes.

Members of the Aero Club of America will go to Washington, D. C., and make a balloon ascension at that city on Washington's Birthday. They expect to interest a sufficient number of people to form an affiliated club in the capital city.

The announcement has just been made that a wealthy American gentleman has given the Aero Club a prize running up into the thousands for the first flight in this country of a motor-driven aeroplane. The amount of the prize and the conditions under which it will be contested for have not as yet been announced. Altogether, the prizes offered in Europe and America now aggregate over $200,000, which should be sufficient inducement for inventors having a perfected machine to make some public demonstrations. The Wright brothers, of Dayton, Ohio, were in New York recently, and they stated that they were building two new machines, one of which would be capable of carrying two people, while the other is intended for long distance flights. No doubt these gentlemen intend to compete for the prizes that have been offered.

The Aero Club of America announces that, owing to the generosity of certain citizens of St. Louis, it will be enabled to offer a number of supplementary prizes to the contestants in the Bennett International Aeronautic Cup Race, to be held in that city on October 19. These prizes are in addition to the International Aeronautic Cup and the $2,500 offered to the winner. They include $1,000 for the contestant making the second greatest distance; $750 to the third; $500 to the fourth, and $250 to the fifth. These prizes will be given in cash or plate, at the option of the winner. It is probable that the Aero Club will offer a separate cup to the aeronaut who remains in the air the greatest length of time, while the German-born citizens of St. Louis have promised a special cup to the representative of Germany who makes the best record in the race. Foreign entries closed Feb. 1. American competitors must make their entries 60 days before the race. The American team will be chosen by a committee from among about a half dozen entries. Three balloons, or other type of flying machine will represent each country, and it is expected that representatives of England, France, Germany, Italy, and Spain will take part in the second contest.

By a decision of the Secretary of the Treasury under date of January 16, 1907, it has been decided that airships and balloons may be imported into this country under bond for the purpose of competing in the race. Free entry under bond by non-residents of the United States will be limited to balloons for the purpose of racing or taking part in specific contests, but not for display at shows of any kind. A consular invoice to cover such balloons must be obtained before departure from the United States consul at the city where the goods are shipped. On this consular invoice there must be affixed a declaration of intention by the oath of the owner, or his agent, to the effect that these balloons are shipped into the United States for the purpose of taking part in the Gordon-Bennett International Aeronautic Cup Race. This consular invoice and certificate must be presented at the time of entry into the United States. The Aero Club of America has appointed Messrs. Niebrugge & Day, 121 Pearl Street, New York, to act for the contestants in this contest. It is suggested that balloons should arrive at the port of New York at least two weeks before the date of contest in order that they may reach St. Louis in ample time. It is also suggested that Messrs. Niebrugge & Day be given notice at least a week in advance of the shipment, with name of steamship. These gentlemen will make arrangements with some surety company to issue bonds to cover the customs dues. The balloons must be exported from the United States within six months from the date of entry.