TEST OF THE NEW 16-INCH GUN

Not since the Armstrongs made their memorable test with the 16.25-inch gun, built by them for the British navy, has there been a trial of heavy ordnance to compare in spectacular interest with the test of the new United States army 16-inch gun, which was successfully carried out on Saturday, the 17th inst., at the Sandy Hook proving ground. We use the word spectacular advisedly; for, although the construction of modern ordnance is a matter of the coldest kind of calculation, and the gentlemen who design the guns have a wholesome horror of sensationalism, the achievements of these, the most potent engines of destruction known in modern life, will always in the public mind be estimated from the sensational standpoint.

From the accompanying table it will be seen that the great Armstrong gun is of slightly greater caliber; yet the reader must beware of making hasty deductions from this fact, and supposing that it is, therefore, a more powerful piece. Diameter of bore is but one of many elements that go to determine the energy of a gun. The strength of the gun steel, quality of powder, weight of projectile, muzzle velocity, each of them has its say in the matter of the ultimate power of the gun; and for these reasons the new army gun is a vastly more powerful weapon than its Armstrong prototype.

Comparing the two guns, then, we find that the new weapon is 6 feet longer over all, 19½ tons heavier; that its projectile is 600 pounds heavier; that because of the better quality of powder that has been developed during the intervening fifteen years since the Armstrong gun was built, the 16-inch gun requires only 640 as against 960 pounds of powder for a full charge, but that with this smaller charge the heavier projectile is propelled with a velocity greater by 219 feet per second, giving a muzzle energy greater by 33,610 foot tons. The direct test, however, of the relative efficiency of the two guns is the amount of energy developed per ton-weight of the gun itself, and this for the Armstrong gun of 1887 is 492 foot-tons, and for the United States 16-inch gun 677 foot-tons. As the 16-inch gun was designed several years ago, we give for purposes of comparison the data of a 12-inch modern high-velocity gun built by Krupp, with a velocity that brings the energy above that of the Armstrong gun of double the weight.

Type of gun.	Bore in inches	Total length in feet.	Weight in tons	Weight of projectile in pounds.	Weight of powder in pounds	Kind of powder.	Muzzle velocity in feet per second.	Muzzle energy in foot-tons.	Muzzle energy in foot-tons per ton weight of gun.
Armstrong..	16.25	43 5	110.5	1800	960	Slow burning cocoa.	2087	54,390	492
U. S Army.	16	49.7	130	2400	640	Nitro-Cellulose Smokel'ss	2306	88,000	677
Krupp	12	50	57.6	*771.6	334	Nitro-Cellulose Smokel'ss	*3330	59,280	1029

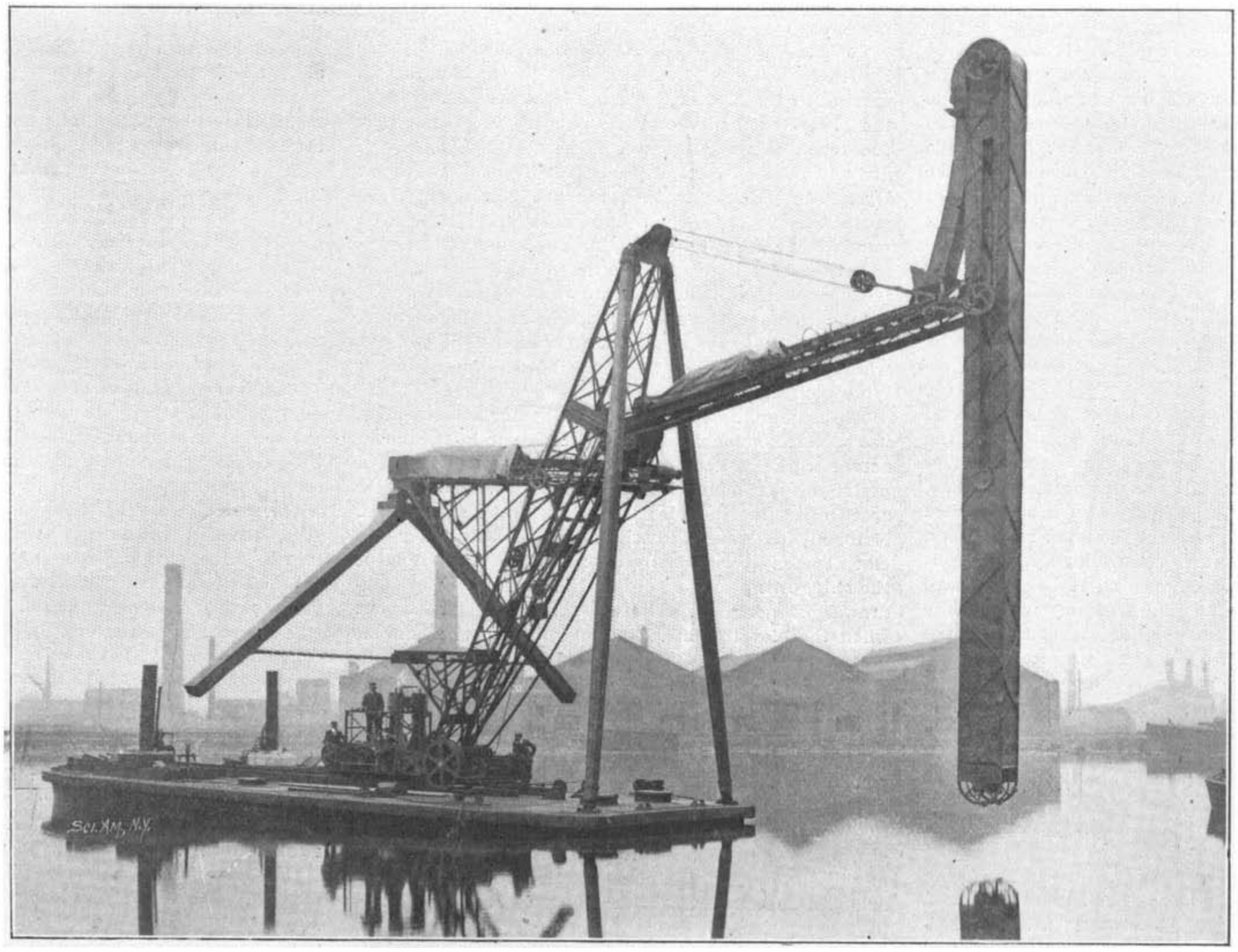
* In this comparison it must be remembered that the velocity falls off much more rapidly in the lighter shell; so that the "remaining velocities" will be proportionately greater in the 2400-pound projectile than in the case of the other two.

The test of Saturday served in every particular to establish the accuracy of the calculations on which the construction of the gun was based. Army gun construction has been eminently successful from the very first; and while the ordnance experts had no doubt as to the behavior of the gun under trial, there was, as Gen. Crozier, Chief of the Ordnance Bureau, stated before the gun was fired, a certain measure of uncertainty introduced, because of the very size of the gun and the unprecedentedly large charge of powder that was to be fired. Smokeless powder has shown at times in all countries a somewhat erratic action, and the General, with a characteristic candor, did not hesitate to state that chamber pressures might arise, when the gun was fired, greater than the piece could stand. Hence, at his suggestion, the guests retired to a distance commensurate with their sense of disastrous possibilities, even that war-worn veteran, Gen. Chaffee, not disdaining to take cover behind a neighboring heavy gun. In the process of loading, a 2,400-pound shell was brought up to the breech on a truck and rammed home by the united efforts of some twenty men on the rammer, fetching up in the lands with a "chug" that made even the 130-ton mass tremble. The powder was then loaded into the breech in six canvas bags, each carrying about 107 pounds, the last bag having in its center several pounds of fine-grained, quick-igniting powder, to make sure of the ignition of the charge. It should be mentioned here that a special bed of concrete 10 feet deep, 12 feet wide and 30 feet in length had been prepared for the reception of the gun, and the mount used in testing the 18-inch Gathmann gun, which lay alongside, was bolted to this platform, and proved equal to its heavy duty. Although calculation has been made as a mere matter of interest of the maximum range of the gun at an elevation of over 40 degrees, no attempt was made to throw a shell to the estimated distance of 21 miles. As a matter of fact, the elevation was only about 1½ degrees for the first two, and 4 or 5 degrees for the third round. From the spectacular point of view, the discharge must have been disappointing to those who were looking for sensations. The report lacked the sharpness and angry snap of an 8-inch or 10-inch piece, and the concussion was of the mildest. The rush of flame extended perhaps for 100 feet in front of the gun, and the smoke of the ignition charge of black powder mushroomed out and drifted lazily away to the westward. The shell struck a few thousand yards out to sea, throwing a vast column of spray heavenward and ricocheted, twice, sharply to the right before sinking below the waves. The first charge consisted of 550 pounds of powder, which gave a powder chamber pressure of 25,000 pounds to the square inch, and a muzzle velocity of 2,003 feet per second. The second charge of 640 pounds raised the chamber pressure to 38,000 pounds and the muzzle velocity to 2,306 feet per second. The third shot, because of the elevation of the gun, passed clear of the velocity screens and no velocity was taken. In his address before the firing of the gun, Gen. Crozier stated that the calculated pressure of the maximum charge was 38,000 pounds, and the maximum velocity 2,300 feet per second; so that, considering the unprecedentedly large charge of powder employed, the results were remarkably close to the estimate.

In connection with the firing of the 16-inch gun the party of visitors was treated to a display of high-angle firing from a 7-inch mortar. On account of the low muzzle velocity, it was possible for the eye to follow the mortar shell in its skyward flight, and it could be heard singing its weird note long after it became invisible. The shots fired from this gun rose to a height of two miles before dropping into the sea. Owing to the low temperature of the atmosphere, the course of the shell was marked by a fine streak of what looked like mist, caused by the condensation of the moisture in the air by the rapid passage of the shell. The second shot fired from the mortar was one of the new torpedo shells containing 120 pounds of the deadly high explosive maximite. Although on test this explosive has proved to be insensitive to shock, the guests were recommended to drop behind the bomb-proofs, since accidental detonation within the gun would have thrown the scattered fragments with high velocity in every direction. As it was, the shell dropped about two miles away, but owing to the failure of the delayed-action fuse, it did not detonate. We take this opportunity of acknowledging the courtesy of Maj. Rogers Birnie, Maj. Charles S. Smith, and Col. J. P. Farley, extended on many occasions during the construction of the gun and in the recent Sandy Hook tests.

A NEW DERRICK OR "GRASSHOPPER" ELEVATOR FOR UNLOADING GRAIN FROM VESSELS.

BY THE LONDON CORRESPONDENT OF THE SCIENTIFIC AMERICAN.



THE "GRASSHOPPER" ELEVATOR READY FOR USE.

The question of facilitating the transshipment of grain from the hold of a transatlantic freighter into lighters in the docks has resolved itself into one of the most important engineering problems of to-day, especially when the immensity of the traffic is recollected. There are several methods for the accomplishment of this work in existence, but in nearly every instance the initial cost of the plant, together with the heavy expense involved in its maintenance, militates against its widespread use.

An important development has been made by the introduction of the "grasshopper," or, as it is technically called, the derrick elevator now in use by the London Grain Elevator Company at the London docks. This machine, although it possesses a somewhat complex appearance, as may be gathered by reference to our illustrations, is in reality in its working arrangements simplicity itself. It has been specially designed for transshipping the corn from the holds of the largest types of American liners engaged in the grain trade, such as the "Minnehaha" and her sister ships of the Atlantic Transport Line, into lighters, for conveyance to other coasting vessels or warehouses. It is the joint invention of Mr. A. S. Williams, of the Atlantic Transport Steamship Company, Capt. W. K. Browne (manager) and Mr. A. H. Mitchell (engineer) of the latter company, and the experimental elevator of this type, which has been submitted to prolonged and exacting tests, was specially built by Messrs. Spencer & Co., Ltd., the well-known English granary engineers of Melksham (Wilts), to whose courtesy we are indebted for permission to reproduce the illustrations to this article.

This derrick elevator consists essentially of four parts, viz.: (1) the pontoon; (2) the traveling car, containing the engines of the various driving motions; (3) the structure supports, shear legs, lattice girders; and (4) the trunk which is lowered into the grain in the vessel's hold.

The pontoon is built of steel, and measures 75 feet in length by 24 feet beam and 8 feet draft. It is perfectly square at the bow, to enable it to be brought close up to a vessel's side and to remain there. The steel deck is specially constructed of braced steel girders, to afford a secure and rigid bed to the rails which

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"Grasshopper" Elevator in Housed Condition.

The Derrick in Operation, Discharging Grain Into a Lighter.

A NEW DERRICK OR "GRASSHOPPER" ELEVATOR FOR UNLOADING GRAIN FROM VESSELS.—[See page 75.]

are laid upon it, extending from bow to stern, and upon which travels the trolley actuating the elevator itself. The rails are laid at a 7-foot gage. In the stern are placed two boilers of the vertical type, one only being requisite to supply the steam for the engines, the second boiler being held in reserve. The coal bunkers are placed amidships. If necessary, the pontoon with its elevator can be made to travel from one point to another under its own steam, the pontoon being provided for this purpose with a small marine engine driving twin propellers. The remaining space in the hold contains a quantity of ballast to insure stability.

The car or trolley is a massive construction of steel girders about 17 feet in length by 9 feet wide, supported upon six pairs of steel wheels. It has a travel along the deck of approximately 36 feet and is propelled backward and forward by means of a pair of steel wire ropes, which are fastened at each end of the pontoon and to barrels on the trolley. These drums are driven by steel worm gearing and friction clutches. The engine, which is in the center of the trolley, is of the twin-cylinder vertical type, developing 30 horse power on the brake. Steam is supplied to the engine from the boiler placed in the stern of the pontoon, through special flexible piping, the connection being made to the center of a large revolving drum, which has special steam glands and stuffing boxes so arranged that as the trolley moves in either direction, the piping is automatically coiled or uncoiled on the drum, which is driven by spur gearing from the crank shaft of the engine. Upon trunnions near the forepart of the trolley the large lattice girder is carried, and running through these trunnions is the main shaft for driving the conveyor and elevator gearing. In front of this is the gearing for raising and lowering the main jib and also the gearing for lifting the elevator trunk to a vertical position. A foot plate is provided behind the engine, and all the various clutches and winding gears are worked by levers from here; and by means of an interlocking system the engineer in charge of the apparatus has complete control over each and every movement, and any possible combination of the various motions can be worked instantaneously and with perfect safety. The trolley is protected from the weather by a steel covering which has been removed for the purpose of our illustrations.

The structural supports consist of a lattice steel girder back leg, and two pitch pine shear legs in the bow, one on either side. The back leg is about 50 feet in height when raised, built up of steel angles and flats, and both this and the front shear legs are connected together at the top by a massive steel pin and collars. The back leg being hinged to the trolley and the front legs on the deck of the pontoon, all these parts have an easy action and can be raised to any angle, while it also allows perfect freedom of movement of the trolley backward and forward along the deck.

Our first illustration shows the elevator "housed" or closed up ready for transit to any desired destination.

About a third of the way from the top of the back leg is hinged the main jib, which fulfills the purpose of supporting the trunk of the elevator at its outer end. Along the upper surface of the jib travels an endless band, upon which the grain after its extraction from the hold is carried on its way to the lighter lying beside the pontoon. Upon the other side of the main girder, and just below the main jib, is a steel cantilever, projecting over the stern of the pontoon, and at its other end are two long shoots at a declined angle. Along the upper surface on this cantilever an endless conveying belt is fixed, terminating at the spouts through which the corn is discharged into lighters moored on either side of the pontoon. At the fork of these spouts valves are fitted, so that the flow of the grain can be regulated and discharged through either, or both, of the spouts, as may be desired.

The elevator trunk, which is lowered into the ship's hold, is built up of steel angles braced together and covered with steel sheeting. There are double chain wheels in the head of the trunk, with specially constructed steel chains, each of about 28 tons strength, to which are attached steel buckets. The latter are of a very ingenious design, being arranged upon the Spencer system. The feature of this equipment is that the buckets are fixed quite close together—not with a short interval between each, as is the general principle of such construction—and so built that the back of one bucket acts as the shoot for the grain in the next bucket. The advantage of this system is that when the buckets travel over the head, a steady, continuous flow of grain is obtained; the speed of the chains is moderate; and the vibration is reduced to a minimum. The grain as it is discharged out of the buckets at the head of the elevator trunk falls through a telescopic shoot connecting the latter with the traveling band conveyor supported by the main jib already described. The trunk has a vertical range of 18 feet, rising and falling in a vertical slot by means of wire ropes connected up to the winding gears on the trolley, the fulcrum being the crown of the back and front shear legs, as may be seen from our illustration. When at the maximum height the head of the elevator is 90 feet above the water level. The total length of the elevator trunk being 53 feet, this gives a clear height of about 40 feet between the water and the bottom end of the elevator, thus allowing it to be carried over the coamings of any ship even when lightened.

A very comprehensive idea of the range of action of the elevator in this connection may be gathered from the fact that in one test it was lifted over the bulwarks of a ship 30 feet 6 inches above the water, lowered into the hold to a depth of 43 feet, and set to work in seven minutes, the grain actually being discharged into lighters alongside within that time.

Our first illustration will show how compactly the vessel is housed when not in use. The trunk is lying flat upon the deck, and the delivering shoots are folded in, so as not to project over the sides of the pontoon. To raise the trunk, the wire ropes connecting the head of the trunk with the apex of the shear legs are hauled in, the trolley simultaneously moving toward the front of the pontoon, the result of such combined action being that the head of the trunk is lifted off the deck and is raised until the bottom end swings freely through the front shear legs. The position of the latter when the elevator is housed is at an angle of approximately 35 degrees to the deck, but when raised as in our second illustration, they are nearly vertical. As the machine is swung into working position, the other parts of the apparatus open out slowly, and the shoots extend outward, so that the open ends are well over the hold of the barge to be loaded with grain.

To bring the elevator into action, the main jib is hauled in, while at the same time the end of the jib moving in the slot in the side of the trunk travels to the lowest extremity of the slot, with the result that the trunk is raised to a considerable height in the air, and rests in vertical position in front of the shear legs. The pontoon is then brought bow against the grain vessel's side—its square nose gives it a good purchase against the ship's hull, to supply rigidity—and the trunk being above the deck is lowered, by letting down the main jib, into the hold of the vessel in the manner illustrated in the third photograph, where, by the way, the elevator is shown in use, the wheat being delivered from one spout into a lighter lying alongside the pontoon.

The maximum capacity of the elevator at present in use at the London Docks is 150 tons per hour, and in actual work an average of 136 tons per hour over a period of six hours has been attained. This latter speed of course includes trimming in the ship's hold. Naturally the rate of discharging decreases when the elevator has automatically descended to the bottom of the ship, owing to the hole that is caused by the withdrawal of grain immediately below the trunk; but when the elevator is descending through the bulk of grain, a speed of 150 tons per hour is easily maintained. Hand trimming is not sufficiently rapid to enable the machine to continue working at its maximum capacity, but Messrs. Spencer have devised an electric plow, which feeds the trunk adequately to enable the fullest delivery speed to be continued.

From our illustration of the derrick elevator in position ready for use it might be presumed that it is both weighty and topheavy, but such is not the case. Its total weight is only 30 tons, while it is so carefully balanced that even when the jib and trunk are lifted to their maximum height, the center of gravity is only 25 feet above the deck of the pontoon. Even when in the position shown in our second illustration, it may be moved from one point to another without any apprehension being entertained as to its safety. This careful balancing may be realized by comparing our first two photographs. In the "housed" position the pontoon is a little down at the stern, while when the elevator is raised, the pontoon is down at the bow to approximately the same extent. The derrick elevator, which was only constructed for experimental purposes, has proved so successful, and possesses so many advantages over the other systems at present used for unloading grain, that additional elevators of this type and of larger capacity are to be constructed immediately.

THE HEAVENS IN FEBRUARY.

BY HENRY NORRIS RUSSELL, PH D.

There are many nights at this season of the year which, though perhaps the most brilliantly clear that we ever have, are practically useless for most astronomical purposes. They are usually marked by a sudden fall in temperature and a high wind, and may always be distinguished at a glance by the conspicuous and violent twinkling of the stars. One look through a telescope on such a night shows what interferes with observations. The image of a bright star is enlarged into a blurred and unsteady mass, which cannot be brought to a sharp focus. With a larger object—the moon, for instance—the whole area is seen to be "boiling"—that is, trembling like a landscape seen across a broad stretch of hot ground on a summer day—and all but the coarsest details are invisible. In such weather few observations can be made with profit except those of comets and nebulæ, which have no sharp outlines, but, being faint, are best seen on clear nights.

The explanation of this "bad seeing" is easy to understand. Every one knows that atmospheric air refracts the light which passes through it just as all other transparent bodies do, though in a relatively small degree. The refractive power of air depends upon its density, which is never quite uniform through any considerable region of our atmosphere, and is farthest from being so on just such nights as we have described, when different layers of air, unequally cooled, are mixed together by the wind.

The rays of light, proceeding from any given star, which reach different parts of the object-glass of a telescope, having passed through portions of air of somewhat different density, will be refracted in slightly different directions. Consequently they cannot all be brought to one sharp focus; and, as the wind carries new streaks of denser or rarer air across the line of sight, the blurred image will dance about and change its form.

The twinkling of the stars, as viewed by the naked eye, is due to the same cause.

An interesting confirmation of this theory may be obtained by viewing a screen illuminated by the light of Sirius, in the way described in the last article of this series. When one's eyes are sufficiently accustomed to the darkness, it is easy to see—at least on a night when there is much twinkling—that the star's light is not uniform, but that the screen is crossed by vague flickering alternations of light and shade, which are usually in rapid motion. These are "shadows" of the regions of varying density in the air. They move fastest on windy nights, and on calm nights when the air is steady they almost disappear.

It should be remarked that it was predicted by Prof. Young that a screen illuminated by a twinkling star would show such a phenomenon, many years before the writer succeeded in observing it.

Similar flickerings can be observed in the light of a few other stars, but with great difficulty on account of their faintness. It is highly probable that the "shadow bands" seen just before and after total eclipses of the sun are phenomena of the same character.

Another observation of some interest, that can be made while studying starlight in this way, is the comparison of a red and a white star. Alpha and Beta Orionis are well suited for the purpose. It will be found that the illumination of the screen produced by Alpha Orionis is very much fainter than that due to Beta, although the former is now the brighter of the two to direct vision. The reason for this is that, in the case of very faint light, the eye is sensitive to the green part of the spectrum alone.

We need not linger long over the description of the constellations. At 9 P. M. on February 15 Sirius is almost due south. Above him are Procyon and Castor and Pollux, the last near the zenith. Canopus can be seen on the horizon below Sirius from points south of Washington.

Orion, Taurus, and Auriga lie to the west of the meridian, Eridanus and Pisces in the southwestern sky, and Perseus, Aries, and Andromeda in the west and northwest.

Leo is the only conspicuous group in the east, though most of Hydra and part of Virgo have risen. Ursa Major is high in the northeast, Cassiopeia on a level with the pole in the northwest, and Cepheus and Draco low in the north.

THE PLANETS.

Mercury is in conjunction with the sun on the 2d, and becomes a morning star, in which capacity he may be well seen toward the end of the month. On the 27th he is at his greatest elongation, and rises about an hour earlier than the sun.

Venus is evening star in Aquarius, and is becoming increasingly conspicuous. At the end of the month she sets almost two hours after sunset.

Mars is in Virgo, and is rapidly brightening as he approaches opposition. He rises at about 10 o'clock on the 15th.

Jupiter is in conjunction with the sun on the 19th, and is consequently invisible.

Saturn is morning star, having passed conjunction last month. He rises two hours before the sun on the 28th.

Uranus is also morning star, and rises about 4 A. M. on the 15th.

Neptune is evening star in Gemini.

THE MOON.

First quarter occurs at 5 A. M. on the 5th, full moon at 8 P. M. on the 11th, last quarter at 1 A. M. on the 19th, and new moon at 5 A. M. on the 27th. The moon is nearest us on the 10th, and most remote on the 22d. She is in conjunction with Neptune on the 8th, Mars on the 15th, Uranus on the 21st, Saturn and Mercury on the 24th, Jupiter on the 26th, and Venus on the morning of March 1. None of these conjunctions are close.

London, January 1, 1903.