which is 100 feet in width by 215 feet in height, and has an over-reach of 66 feet. The traveler is served by four electric hoists, and it can handle the heaviest sections, which weigh as high as 105 tons. The material for the bridge is placed in a storage yard near the end of the structure, which is 750 feet in length and is served by two 70-foot electric cranes.

A Few Facts About the International Exposition, Milan, Italy.

In order appropriately to celebrate the completion of the Simplon tunnel—one of the greatest triumphs of engineering—an international exposition under royal patronage will be held in Milan from May to November, 1906. It will be the largest European exposition ever held outside of Paris. Practically all of the European countries will participate officially, as well as several of the Asiatic nations.

In the transportation section, retrospective exhibits will show the historical development of the various methods of travel.

The dominant feature will be motion. All products, as far as possible, must be shown in connection with the processes, thus filling the halls with live exhibits.

Arrangements will be made for field tests and competitive trials in all classes where it is expedient.

An especial feature will be the automobile display, to which an entire pavilion will be devoted. This "show" will terminate in mid-summer, so that machines exhibited may be sold for early delivery.

The great success that attended the Turin exhibition of decorations has prompted the Milan authorities to set aside a special pavilion for decorative arts. They are very desirous to see the United States well represented in the section.

One large building will contain all forms of welfare work, grouped under the several heads: Mutual assistance and insurance, co-operation, savings institutions and popular credit, protection of labor and insurance against enforced idleness.

Milan is the center of the most productive section of Italy. Its population is one and a half millions, while Lombardy, no part of which is more than three hours distant, has nearly five million inhabitants.

Genoa, the port of entry, is less than one hundred miles distant. The cost, therefore, of transporting exhibits from the United States will be comparatively cheap.

Owing to the fact that a large proportion of the labor is employed in the shops and factories, there is available only a small number of food-producing workmen. This makes it imperative that supplies be secured from abroad. The authorities of the exposition recognizing this condition will inaugurate about June 15 a special food show. It will be well for the American producers of food stuffs to profit by the opportunity to display their products.

A Balloon Race.

The long-distance balloon race which started October 15 from the gardens of the Tuileries has resulted so far as known as follows:

Boulanger in the balloon "Eden" landed on October 16 at 1:40 o'clock at Annaberg, Germany, a distance of 810 kilometers from Paris. David in the balloon "Cambronne" landed at Platting on the Austrian frontier, 780 kilometers, at 7 o'clock A. M. Maison in the balloon "Concorde" landed at Neustadtsalle, Bavaria, at midnight, 610 kilometers.

Erik Tollander de Balsch, in the balloon "Finland," landed at midnight at Metz, 282 kilometers. Bachelard, in the balloon "Phoebe," landed at 10:30 P. M. in a tempest at Engreux, 290 kilometers. Le Blanc, in the "Albatross," landed at 1 o'clock A. M., October 16, at Densborn, Germany, in a snowstorm, 340 kilometers. Oultremont, in the balloon "Belgique," landed at 9:15 P. M., October 15, in a violent tempest, at Kirin, Oldenburg, 398 kilometers. Von Willer, in the balloon "Centaure," landed at 3 o'clock P. M., October 15, in a tempest at Darmstadt, 480 kilometers.

Gasnier, in the "Eole," arrived at 9 o'clock A. M., October 16, at Rulles, Luxembourg; Blanchet, in the "Archimède," at 9 o'clock at Beaufort, Luxembourg; Duprat, in the "Belle Hèléne," on the Belgian frontier, in a terrific snowstorm; Balzon, in the "Académie Aeronautique," at 7:20 A. M., October 16, near Vouziers; Jacques Faure, in the "Kabylie," at 10:30 A. M., October 16, at Kirchdorf, Hungary.

An Economy Test for American Automobiles.

On October 30 the New York Motor Club will start a six-day economy test. Runs will be made to Philadelphia, Albany, and Southampton, L. I. Strict account will be kept of all fuel and oil used and repairs made, and the results will show the cost of transportation per passenger per mile as compared with the railroad fares. No allowance will be made for repairs to tires, which will also figure in the general expenses. It is expected that some twenty cars will participate in the test, and that much interesting and valuable data will be obtained.

MEASURING THE DISTANCE OF A STAR.

BY PROF. EDGAR L. LARKIN.

No conception whatever can be had of the magnitude of the visible universe until the distances of the stars are known. None of the millions of human beings that have lived and died knew the distance of even one star from the earth until within the last seventy years. To all who lived before the advent of modern astronomy, the stars were points in a rigid firmament, only a short distance "above" the earth. They were made to give light to the earth's inhabitants, a belief incredible to relate, still lingering in the minds of some. Before A. D. 1542, ignorance was at its lowest depth. But in that auspicious year Copernicus gave his book to the world teaching that the earth revolves around the sun. Of course the people raised strenuous opposition. This was expected. But unrest and perplexity filled at least one of the ablest minds in Europe, that of Tycho. From the days of Aristotle and Ptolemy, the theory that the sun revolves around the earth dominated men's minds. Not one law could be discovered so long as it was believed that the earth is the center of the universe and at rest. Copernicus upset this doctrine, and made the sun the center of planetary motion. The great Tycho Brahe actually rejected this basic truth of nature. His mathematical powers must have told him that Copernicus was right in asserting that the earth moves around the sun. But when he saw that if this is true, the entire orbit traversed by the earth around the sun, that mighty ellipse, shrinks and subsides into nothingness, his mind was simply submerged by the immensity of the idea, and all it led to. For twenty years he toiled in an observatory making measurements with every accuracy possible without telescopic aid. And he failed to detect the slightest displacement of any star throughout the year. For it is certain that if the earth moves around the sun, the stars in position at right angles to the plane of the orbit must shift to and fro at intervals of six months corresponding with the displacement of the earth from side to side of its majestic pathway. So he taught that the earth is at rest. He could not force himself to admit that the diameter of the orbit of the earth as seen from any star is next to nothing, and that the earth is next to next to nothing, and man an infinitesimal so minute that no combination of figures is able to tell how small he is. Tycho could measure four minutes of arc with some approach to accuracy; still he could not detect the slightest displacement of a star. He at once knew that the stars were not less than one thousand times farther away than the sun. Saturn at that time was the known limit of the solar system, and if the hypothesis of Copernicus were true, the stars must be at least one hundred times more distant. This vast space again overwhelmed his mind. He argued that Nature would not so waste space. But Copernicus advanced arguments that Tycho could not overthrow, so Tycho compromised. He made the five planets revolve around the sun, and the sun around the earth, immovable in the center of the universe. At that epoch, it is probable that if Tycho had an instrument capable of measuring one second of arc and had he tested it on any star, the Copernican system would have been crushed. For he would have discovered that the stars do not shift even one second in six months. For with an annual shifting of one second of arc the star in question would have been known by Tycho to be 206,265 times more distant than the sun. Medieval minds would have collapsed and an indefinable fear would have settled down on mankind, when thinking of its littleness.

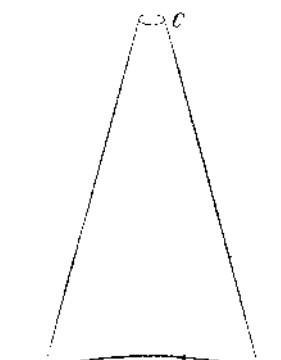
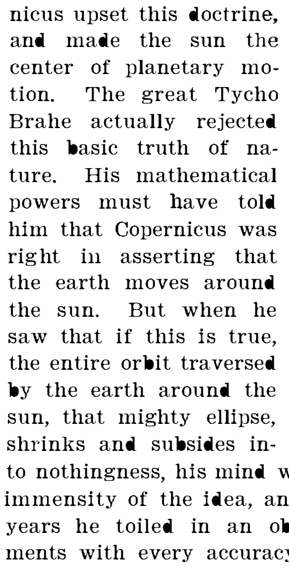


FIG. 1.—*S* is the sun. *A* is the earth's place on its orbit to-day; and *B* its position six months later. The arrows on the orbit of the earth show the direction of its motion. *C* is a very minute orbit apparently traversed by a star once each year. It took 230 years from the date of invention of the telescope to detect and measure it.



Bessel's Method of Finding the Distance of a Star.

FIG. 2.—Showing the sun *S*, in the center of the earth's orbit, and places of the earth at intervals of six months, at *A* and *B*. *C* is a star whose distance is sought. *D* and *E* are two stars, presumably so much more distant than *C*, that they cannot show displacement as the earth moves from *A* to *B*. The angles *E*, *D* and *C*, and the lengths of the lines *E D*, *C D* and *E C*, are often measured with precision. In this way Bessel found the shifting and thereby the distance of 61 Cygni. The reader will understand that all the angles in Fig. 2 are immensely exaggerated. All the early astronomers thought that two lines drawn to a star from opposite sides of the earth's orbit were parallel as are the two lines *F* and *G*. And more than two centuries in incessant toil were consumed in finding that they are not exactly parallel. For the line *A B*, 186,000,000 miles in length, is next to nothing.

Matters moved on apace. Tycho died, and the Copernican doctrine spread. Then came Galileo with his little telescope, and pointed it full on the distant stars in A. D. 1610. This aroused Europe, and the exciting search began. Astronomers now armed with instruments that magnified were able to detect far less displacements of stars than could be detected by Tycho. And they began to watch. Thus they noted the position of a star, its direction in space and its distance from other nearby stars and recorded these determinations. In six months they repeated the process with great care. They were dumbfounded. Although the earth had moved from its first place, by the diameter of its mighty orbit, no trace of motion, however minute, could be detected in the stars, even in a telescope that magnified two hundred times. A number of great astronomers tried their hands from 1542 to 1650, a period of 108 years, with total failure as a result. Bradley and Molyneaux detected a motion of stars; but in a direction opposite to any caused by the motion of the earth. This was the aberration of light. Other astronomers after elaborate trials with the most nearly perfect instruments that could be made, failed utterly.

About 1650 the micrometer was invented. This is an instrument to be attached to the eye-end of a telescope. It contains fixed and movable spider's threads, and it can measure excessively small angles and intervals. It was crude at first, but during the succeeding two centuries, the most accomplished mechanics applied their skill in making it as perfect as anything wrought by human hands. At present it is able to measure the diameter of a spider line. The object of making it of such extreme accuracy is to be able to measure the diameter of the earth's orbit as seen from the stars. For next to nothing is the diameter seen from stellar distances.

Passing the labors of the Herschels and the Struves and many other eminent astronomers, who made use of every conceivable method of finding the distance of a star, we descend rapidly to Bessel and Henderson, two illustrious observers, who finally succeeded, and reaped the reward of two centuries of labors surpassing those of Hercules. Bessel, at last, in 1840, found the distance of the star 61 Cygni. He used a different kind of telescope, the heliometer with a divided object glass. He employed the method known as triangulation. He selected two stars adjacent to 61 Cygni and measured a network of triangles, whose sides were the distances from star to star and from each star to 61 Cygni. He repeatedly measured these angles from October, 1837, to March, 1840, and had the extreme good fortune to see 61 Cygni move. And the direction of motion was as it should be, if caused by the annual circuit of the earth. He found that if we go to 61 Cygni, turn and look this way with a powerful telescope and micrometer, the distance of the earth from the sun would measure 0.3483 second of arc. The arc of any circle in length equal to the radius contains 206,265 seconds, which divided by 0.3483 equals 590,000. That is, the star is at the colossal distance of 590,000 times that of the sun. To reduce this to miles, multiply by 93 million. The result is so enormous that the ablest mathematicians never try to begin to think about it. Light, known to move with the unthinkable speed of 186,000 miles during one second of time, requires nine years to traverse the abyss. Before this work of Bessel, Henderson, in the observatory at the Cape of Good Hope, made extended observations on the bright star Alpha Centauri, not visible in the United States. His instruments were not nearly so accurate as those of Bessel; yet he detected a displacement of the star. Maclear in 1839-40 made more accurate measurements, and later observers with far better instruments have finally deduced a parallax of 0.75 second of arc. Parallax means the angle subtended by the radius of the earth's orbit as seen from a star. Now 206,265 divided by 0.75 equals 275,020, the number of times that Alpha Centauri is more distant than the sun. This is 25 trillion miles; and that star is our nearest neighbor, so far as is known. Light requires 4.3572 years to reach us from the nearest neighbor our sun has. But there are so many stars whose distances are so much greater than these two, that the 25 trillion miles is used merely as a yard-stick to measure them. Of late, these minute displacements of stars are measured on photographic plates after long exposure to the stars. Great attention is paid to parallax determinations, for without them we must forever remain ignorant of even approximate dimensions of the sidereal structure. Some astronomers think that so great precision is now had, that parallaxes of 0.1 second of arc are obtained. And perhaps fifty stars are measured with this degree of accuracy. A star with one-tenth of a second parallax is 2,062,650 times more remote than the sun. These are "near-by stars," for there are millions of stars so distant that no instrument, however accurate, can ever hope to secure a parallax. It is time now to put in the term "next to nothing" again for all things terrestrial. That is, the thickness of a spider thread would obscure the entire orbit of the earth in its mighty sweep around the sun, as seen from the distant stars. And all agree that a spider line is next to nothing, so the astronomer Tycho rejected the true order of Nature simply because of its mind-crushing magnitude and splendor. He had not the fortitude to admit the infinitesimal dimensions of the earth and man. All kinds of estimates have been made as to the probable radius of that part of the universe visible in the greatest telescope. Opinions vary between the limits of 4,000 to 15,000 light years. That is, with a radius of 15,000, the diameter would be so immense that light would require 30,000 years to traverse it. The opinion of the writer is for the 30,000 yet no positive proof is possible. This opinion is based on photometric grounds. The word millions has for long been used in telling the number of the stars. But billions now appears to be more appropriate. Each one is a hot sun, and each may be attended in many cases by inhabited worlds.

The Best Cat Story Yet.

BY DR. JOHN NICOL.

Without attempting to decide as between heredity, imitation, or reasoning, or what part each or all or any of them played in enabling the cat to perform the feat of which I am about to tell; merely premising that I can vouch for its truth, as can many others who had frequently seen it done.

The cat belonged to my brother-in-law, the owner of Hazeldell farm, near Ulster, Pa., and that it might go out and in at its own sweet will, the usual cat-hole was cut in the door between the kitchen and the woodshed. Besides the cat referred to, which may be called the house cat, there were several others who remained mostly in one or other of the barns and were not encouraged to enter the house, although shortly before the time of which I am about to speak they began to come in more than the mistress cared for.

To prevent this, a swing door was placed on the outside over the cat-hole. It was simply a piece of board a little larger than the hole, and fastened by leather hinges at the top, so that by pushing her head against it from the inside the cat could get out, but could not by such pushing get in again.

For a time the cat did not appear to understand the new arrangement, but "meoued" persistently each time she wanted to go out, till some one taking her in his hands and pushing her head against the door showed her what to do, and *she did it herself ever afterward.*

This went on for some time, always getting out herself, but always calling loudly whenever she wanted to get in, till the letting of her in began to be considered a trouble, and she was often allowed to call in vain. Just how long this continued I do not know, but it did cease, and the cessation of one trouble threatened to bring about another. The cat was found in the house when those whose duty it was to put her out and not let her in again asserted that they had been true to their trust. This was "by some believed and some misdoubted," and, like other trifles, was likely to bring trouble in the household, when those that blamed the cat were found to be more correct than the cat blamers generally are; *the cat had discovered a method of opening the door for herself.*

The accused member of the family, strong in the justice of her cause, determined to watch, and this is what she saw: The cat, on coming to the door, lay down on her back, and with both her front paws raised the hinged board considerably above the level, and then, with what I cannot find a better expression for than a wriggle, rapidly turned on her belly and drew her body inside.

I may add that this was seen not once but perhaps hundreds of times, as it got to be one of the show things at the farm, the cat not being in the least shy, but always ready to perform the feat in the presence of visitors.

While heredity can have had nothing to do with this operation, I may take the opportunity of recording another in which heredity alone was the active agent. It is well known that Manx cats have no tails, only slight stumps, and that the offspring of such in other parts of the world, in the first generation at least, are in the same abnormal condition. While living in Scotland some thirty years ago we had a Manx kitten given to us, which, although born there, was tailless. The door of our breakfast room was spring-shutting, something like most of the screen doors in this country, but opening only toward the inside. Before the kitten was full grown he had learned to let himself in by pushing from the outside, but never learned, although we often tried to teach him, to pull it open from the inside. It was not, however, the opening of the door from the outside to which I wish to call attention—any cat could have easily learned to do that; but the fact that invariably, after he had so pushed it and got his body partially in, he made a rapid turn or whirl to prevent the tail that was not there (but heredity impressed on him the fact that it ought to have been) from being caught between the closing door and its frame. This he did dozens of times every day so long as we had him, and was always willing to show off before our visitors, as he never seemed to recognize the fact that he had not a tail like his neighbors.

Correspondence.

The New Process of Resuscitation Proves to Be Old.

To the Editor of the Scientific American:

I notice in the Scientific American for October 7, 1905, an article entitled "A Novel Process of Reanimation."

It might be interesting to you to know that there is in the Proceedings of the American Association for the Advancement of Science a record of an address by Dr. Alexander Graham Bell, presenting over twenty years ago an idea substantially the same as that of Dr. Gradenwitz. I beg to quote an abstract taken from the thirty-first meeting of the above-named society, held at Montreal, Canada, August 1, 1882:

"I propose to surround the waist of the unconscious patient by a rigid jacket or drum somewhat larger in diameter than his body. The apparatus can be rendered practically airtight by a rubber band around the thorax, and another around the loins. Upon exhausting the air inside the drum, a partial vacuum is produced around the abdomen. Under such circumstances, the pressure of the atmosphere forces air through the mouth and nose into the thorax, causing the depression of the diaphragm and consequent expansion of the abdomen. The alternate rarefaction and condensation of the air confined around the abdomen thus cause alternate inspiration and expiration."

Charles R. Cox.

Volta Bureau, Washington, D. C., October 15, 1905.

Old Things Forgotten in These Progressive Days.

To the Editor of the Scientific American:

It is surprising to an oldish man how many things of daily use the present generation seems to have forgotten.

Here are some instances.

1. To tell the points of the compass by a watch.—Point the hour-hand at the sun. Then south is half-way between the hour-hand and the figure twelve of the dial.

2. To measure an angle by a watch.—Lay two straight-edged pieces of paper on the angle, crossing at the apex. Holding them by where they overlap, lay them on the face of the watch with the apex at the center. Read the angle by the minutes of the dial, each minute being six degrees of arc. It is easy to measure within two or three degrees in this way.

3. To start a tight screw.—Press the screwdriver firmly in place with one hand, but do not turn it. Then take hold of it sideways with flat-jawed pliers as close to the head of the screw as possible, and turn it with them. A hand vise is better than pliers. Leave just enough of the tip of the screwdriver outside the vise to fill the slot of the screw, but no more. This reduces the danger of breaking or bending a badly-tempered screwdriver to a minimum.

4. To put a pin through starched linen, rub the pin with paraffine. To push a collar button through a starched buttonhole, rub paraffine on the back of the buttonhole.

Jacob Bromfield.

Boston, September 23, 1905.

The Reasoning Power of Animals.

To the Editor of the Scientific American:

I read your valuable paper weekly with much interest and profit. The several articles that have appeared recently therein on the subject, "Do Animals Reason?" have deeply interested me; and the facts stated so strongly appeal to my love for justice for animals that many abuse and underrate, as well as my love for them, that I desire to repeat a single instance, one of many, showing the rapid reasoning and quick action by one, and the intelligent confidence displayed by another animal in my presence—a dog and a horse.

I was the possessor of a bright, active Irish setter dog, "Laddie," who accompanied me on my many drives through the country. My dog and horse were inseparable friends, and when we were out driving "Laddie" assumed to take charge of both the horse and myself; several times helping us out of what might have resulted in serious difficulties, at one time catching and holding the horse, when frightened and running away, until I could reach her. But the instance I desire to relate occurred two years ago last spring. I was driving through a rough and hilly section of the country, where the road was frequently crossed by brooks, which at that season of the year, at times, assumed large proportions, flooding both roads and bridges. I approached one of these streams, over which was a bridge about twelve feet long and somewhat raised above the road on the farther side from me. The water was up to the bridge, and beyond the bridge was a pond of water some five or six rods in width, dark and muddy and several feet deep in places. A little way from the point of crossing were some large rocks standing close together, over which the dog could cross without taking to the water, and he started to cross in that manner. When I drove onto the bridge, my horse stopped and refused to take to the water, which stood level with the bridge; my dog stood on one of the large rocks watching my progress, and when the horse stopped and refused to go on, the dog with human intelligence and reasoning instantly leaped from the rock onto the bridge, ran up in front of the horse, looked into her face, gave a sharp bark of encouragement, and then turned and deliberately walked off from the bridge into the water, all of the time looking over his shoulder at the horse, saying, "Come on," as plainly as his intelligent face could express those words. Then without any urging on my part the horse at once followed the dog into the water and across the flooded strip of road to the dry land, at times up to her belly in the flood, the dog swimming over the center of the road just in front of her.

The intelligence displayed by both animals struck me very forcibly at the time. The dog saw the difficulty, and with the quickness of human reasoning he saw the way to overcome it, and he acted on the instant. The horse had unlimited confidence in the dog, gained from their former experiences together, and she was ready to follow where he would lead without any hesitancy. Returning some hours later over the same road, the dog, always in advance, stopped a moment, just long enough to see if the horse would make the passage of the water all right, and when he saw that she raised no objection to crossing, he took to the rocks and crossed without wetting his feet.

I have often thought of this incident; the quick, active reasoning of the dog, the quick action taken by him, and the understanding of the dog's purpose and confidence in him displayed by the horse.

D. R. P. Parker.

Hermon, N. Y., October 10, 1905.

THE SECOND ANNUAL AUTOMOBILE RACE FOR THE VANDERBILT CUP.

As stated in our last issue, the second annual race for the Vanderbilt cup resulted in the triumph of two French, one American, and one Italian car. It was the first time an American machine ever was placed in an international race, and for this due credit should be given to the designer and driver of the 120-horse-power Locomobile which finished third. One of our illustrations shows this car as it crossed the line at the finish, while for descriptions of the machine and the changes recently made upon it, we refer our readers to the issues of May 27 and October 7. The day before the race this machine developed a cracked cylinder, which necessitated the replacement of one of the pairs of cylinders. Mechanics worked until 5 A. M. October 14 putting on the new cylinders and a new crank case, as this also was broken. In view of the fact that the machine had never been run with these new parts until it went to the starting line, its performance was remarkable. Its fastest time, 27:40, was made on the fifth round, and corresponds to a speed of 61.38 miles per hour. The average speed for the whole race was 56.90 miles per hour. No tire trouble was experienced, though several stops were made for gasoline, water, and oil, and to wash oil out of the clutch with gasoline.

What was undoubtedly the most consistent performance was that made by Heath, who drove the same 90-horse-power Panhard car with which he won the race last year. The only change in this machine is the substitution of a honeycomb radiator for the framed radiating coils employed a year ago. The engine is a 170 x 170 millimeter (6.692 x 6.692 inch) four-cylinder, vertical motor with steel cylinders and corrugated copper water jackets. It is fitted with a Krebs automatic carbureter and Eiseman high-tension magneto ignition. A four-speed transmission is used. This car also had no tire trouble, and its flat-tread Michelin tires appeared to be in first-class condition at the end of the race. Heath steadily rose from fourteenth position at the start to second place at the end of the fourth round, which position he held to the end. His average speed for the entire distance was 60.72 miles an hour.

The winner of the race, Hemery, drove an 80-horse-power Darracq racer of light construction and mounted on wire wheels. A companion car driven by Wagner burst a tire in front of the grand stand at the end of its second round and gave out during the fourth round from the loss of the gear box cover and the seizing of bearings in the transmission. Hemery, however, had better luck. He succeeded in covering all but the fourth round in less than 28:35. His fastest time—68.42 miles an hour—was made on the fifth round, which was covered in 24:49. At this point in the race he was sixth. The next round saw him jump to third place, which he held until the eighth round, in which he passed Heath and wrested first place from Lancia. His total time for the 283 miles was 4 hours,