posed only along his polygonal contour; the interior of his polygon—his own interior—is to be reached only through this contour, for there is no "above" and no "below" within his cognizance. To convince him that a third dimension of "upward" and "downward" exists, touching and leading from even the interior of his polygon—his own internal parts—would be a hopeless task. Even if he accepts the arguments from analogy as to the properties of such a dimension, he would rebel at the idea of looking within himself to find it. Yet, even there, at right angles to the two dimensions which he knows, it is to be found—as well as everywhere else in his space. And, similarly, within himself, quite as much as anywhere else, must man look if he is to find the fourth dimension.

Were one to explain to this flat-man that a three-dimensional being, approaching from the direction of that unknown third dimension, could reach within his most securely locked barn and remove its contents without opening a door or breaking a wall—or could touch the very heart of the flat-man himself without piercing his skin—the flat-man might still be none the nearer to an appreciation of the third dimension. Equally impossible is it for man to understand from what direction a four-dimensional robber must come to steal the treasures from the soundest vault without opening or breaking it—or by what way of approach the four-dimensional physician would reach to touch the inmost spot of the human heart without piercing the skin of the body or the wall of the heart; yet the route of such a robber and of such a physician lies along the fourth dimension. By that route must come the four-dimensional being who is to remove the contents of the egg without puncturing the shell or drink the liquor from the bottle without drawing the cork. Such four-dimensional creatures, inhabiting a space containing the three-dimensional space where man lives, would constitute the most perfect of ghosts for man's world; and the absence of such ghosts argues against the existence of a four-dimensional space so situated and so inhabited.

Algebra demands that geometry picture all its problems; and since an algebraic problem may contain four or five or more unknown quantities quite as well as any lesser number, algebra demands a four-dimensional, five-dimensional, or higher space for its use quite as imperatively as the spaces of lower dimensions. Perhaps certain phenomena of molecular physics or the mechanical principles of the electric current may find a complete explanation only with the use of the fourth dimension. Perhaps the fourth dimension escapes man's discovery only because the measurements in its direction are always very minute in comparison with the measurements in the three other dimensions. Thus far, however, the space of four dimensions—and all spaces of more dimensions—may be only "the fictitious geometric representation of an algebraic identity."

A NEW SCOTCH ELEVATING FERRY.

BY WILLIAM CARLIN.

The front-page illustration shows the construction of the new elevating vehicular ferry steamer "Finnieston No. 1," recently constructed at Port Glasgow for the Trustees of the Clyde Navigation under the direction of G. H. Baxter, Esq., mechanical engineer. The vessel was launched with machinery aboard and steam up, the illustration being a photograph taken immediately after the launching. The leading dimensions are, length 104 feet, beam 45 feet, and molded depth 12½ feet.

It may be stated that the elevating platform which carries the vehicles has a range of 17 feet and is carried on eight double-threaded buttress screws of forged steel. The screws are hung on collar bearings in cast-steel brackets, which are supported by the framing legs. The platform is built up of H girders connected with massive built steel girders on either side of vessel. The supporting screws are fitted with worm wheels at their lower ends, and mesh with forged steel worms.

A triple-expansion, three-crank engine raises or lowers the main platform. An automatic gear is fitted to this engine, so that the platform may not be raised or lowered beyond its intended travel. A brass gage in the engine room also indicates the position of the platform in feet and inches.

The lower or main deck is of steel plating, and has no projections above 10 inches. As a result, the platform may drop to its lowest level.

Vertical three-crank, triple-expansion engines are used for propulsion, each engine driving two propellers, one forward and one aft, with two thrust blocks fitted on each line of shafting. The engines are controlled from the house on the top of the framing by balanced rods, which actuate the steam valves on the direct-acting steam and hydraulic reversing engines. There are no rudders, the vessel being maneuvered entirely by the propelling machinery. Two reversing handles are situated in the wheel house, one on each side of the man at the wheel.

Correspondence.

THE EGYPTIAN STEAM CULTIVATOR.

To the Editor of the SCIENTIFIC AMERICAN:

In March last I noted a short article in your paper speaking of a steam cultivator by Boghos Pacha Nubar, a farmer in upper Egypt. The description and purpose of this cultivator are both identical with a machine that I was interested in some ten years or more ago, together with a number of others here, a company to promote which was formed, but failed to produce a thoroughly commercial machine. By that I mean that although several machines were built, with from two to six rotary disks or tools, as we call them, owing to lack of capital we were not able to put out a machine that would work day in and day out without a break of some kind. This we know was only a question of capital and experiments.

I write you so as to correct any impression that may exist as to the originality of the machine you speak of; for I may add this principle was patented here in Canada more than twenty years ago, and should you desire to know more of it, the information could be secured. H. J. ROSS.

Montreal, Canada.

THE PROPOSED MONTREAL DRYDOCK.

To the Editor of the SCIENTIFIC AMERICAN:

I read in the press of a proposal to have a floating drydock in Montreal, and the following suggestion flashed into my mind as being most suitable for local reasons: Instead of a floating dock, why not excavate a dock, near the exit of the Lachine Canal, in two sections, one the real drydock with the floor just above the level of high water at Montreal, the other in continuation with floor at level of present harbor bottom level.

Vessels could then run into the lower section, gates be closed, and water run in from the canal through sluices, which would raise the level some 50 feet, or as required; pass the boat into the inner section, close sluices and open outflow, letting the water run out, thus saving pumping, time, and expense.

At the beginning of navigation, perhaps some pumping might be required during the freshets.

This, in my opinion, would be the easiest, cheapest, and most permanent way to build a drydock at Montreal. VICTOR F. CONNOR, L.R.C.P.I.

Great Village, N. S.

THE NUMBER OF OUR ANCESTORS.

To the Editor of the SCIENTIFIC AMERICAN:

May I suggest that Mr. McCullough has not solved the problem put by Mr. Venning?

No one will deny that, shall we say, John Brown had a father and a mother, that his parents each had a father and a mother, and so on, for (all?) previous generations. It would appear, then, to follow that x generations back, John Brown had 2^x ancestors! This is what Mr. Venning says *appears* to be the fact. He does not say it *is* the fact; indeed, he asks for an explanation of the difficulty he is placed in, in not being able to reconcile this apparent fact with common sense.

Would any of your readers explain where the error creeps in? John Brown we know had 2 parents; we know he had 2^2 grandparents; we know he had 2^3 great-parents. Why then is it not true that for the xth generation back he had 2^x ancestors?

Bristol, England. F. C. CONSTABLE, M.A.

SIGNALING TO MARS.

To the Editor of the SCIENTIFIC AMERICAN:

The possibility of signaling to Mars is merely a question of elementary mathematics. That it should have excited such widespread interest and discussion can have astonished no one more than the writer. That in spite of this widespread and in many cases correct exposition by the newspapers, there should still remain some who fail to grasp the elementary principles of the problem is my only excuse for what may seem to many of your readers a wasteful use of valuable space in your paper.

Reference is here made to two communications in your issue of June 26th. The first is by a gentleman connected with Adelphi College, Brooklyn. This criticism is that if the signals were sent when Mars was in opposition they could not be seen. The obvious answer would seem to be: "Then why send them when Mars is in opposition?" There are two positions of the earth in its orbit when it is invisible from Mars. One is when it is between Mars and the sun, and the other when it is on the opposite side of the sun. So it would hardly seem desirable to send signals to Mars under either of these circumstances. Signals could be sent in any other relative position of the two planets, as has been fully explained in several of the daily papers. This statement will also answer the criticism of the gentleman regarding the perfectly logical and correct suggestion of Prof. Wood, that a signal might also be sent by means of a dark area upon a white field.

The first mistake of the other writer is due to the fact that in the cases which he cites, and with which he is familiar, the angular size of the mirror is greater than the angular size of the sun. The object of the silvering of the mirror is to change the direction of the rays of light, but it really has nothing to do with the question in hand, and we may consider for convenience that the mirror has been removed during our experiments, and that the sunlight is simply shining through the hole in the frame. If now we are very near the mirror, so that we see the whole of the sun's disk through the aperture, a 2-inch mirror will transmit just as much light as one ten feet in diameter. If, however, we go to a distance of several miles, the large hole will clearly let through much more light than the small one.

The second mistake of this correspondent is to suppose that the signal would only be seen over a small portion of the surface of Mars. In point of fact, when Mars was distant one hundred millions of miles from the earth, the signal would be seen simultaneously over an area one million miles in diameter. No great accuracy would therefore be required in pointing the mirror, as he seems to suppose.

In closing, the writer would repeat that the proposition of signaling to Mars is merely a question of the most elementary mathematics. It is a problem which any astronomer can work out in ten minutes' time and which involves no uncertainty whatever. When Mars is at a distance of one hundred millions of miles from the earth, a beam of sunlight half a mile square would appear to its inhabitants of the same brightness as a fifth magnitude star. On account of the brightness of the earth, however, it would be quite invisible to eyes resembling our own, unless aided by a powerful telescope. Whether there are the equivalents of human eyes and telescopes upon Mars is another question entirely and has nothing whatever to do with the case.

WILLIAM H. PICKERING.

Harvard College Observatory.

Official Meteorological Summary, New York, N. Y., June, 1909.

Atmospheric pressure: Highest, 30.23; lowest, 29.69; mean, 29.97. Temperature: Highest, 92; date, 25th; lowest, 53; date, 19th; mean of warmest day, 82; date, 24th; coolest day, 56; date, 9th; mean of maximum for the month, 78; mean of minimum, 63; absolute mean, 70.5; normal, 69.1; excess compared with mean of 39 years, 1.4. Warmest mean temperature of June, 72 in 1888, 1892, 1899, 1906; coolest mean, 64 in 1881, 1903. Absolute maximum and minimum of June for 39 years, 97 and 45. Average daily excess since January 1st, 2.0. Precipitation: 3.17; greatest in 24 hours, 0.70; date, 4th and 5th; average of June for 39 years, 3.21. Accumulated deficiency since January 1st, 0.19. Greatest precipitation, 7.70, in 1877; least, 0.86, in 1894. Wind: Prevailing direction, southwest; total movement, 7.014 miles; average hourly velocity, 9.7; maximum velocity, 43 miles per hour. Weather: Clear days, 7; partly cloudy, 12; cloudy, 11; on which 0.01 inch or more of precipitation occurred, 12. Thunderstorms, 22nd, 25th, 27th, 28th.

The Current Supplement.

The opening article of the current SUPPLEMENT, No. 1750, discusses wild animals in captivity. A novel electric locomotive is described and illustrated. The astronomical clock at Lyons is an interesting article by Charles A. Brassler. The indestructibility of matter is treated by Prof. G. Zenghelis. Col. Sir Frederic L. Nathan's admirable paper on guncotton and its manufacture is concluded. W. C. Horsnaill writes illuminatingly on the subject of tidal power. The article should prove most helpful to inventors of tidal and wave motors. A *résumé* of F. W. Lanchester's discourse on aerial flight presented before the Royal Society of Arts is published. An apparatus is described for studying the friction of metals experimentally. An interesting article is that by C. Ainsworth Mitchell on the making of handwriting. Prof. John Joly, the distinguished geologist, contributes an article on radio-activity of deposits and the instability of the earth's crust.

The smelter production of lead in the United States in 1908, as given by C. E. Siebenthal, of the United States Geological Survey, under date of May 24th, was 408,523 tons of 2,000 pounds, against 442,015 tons in 1907, and 418,699 tons in 1906. The production of refined primary lead, which embraced all desilvered lead produced in the country, and the pig lead recovered from Mississippi Valley lead ores, was 396,433 tons, against 414,189 tons in 1907, and 404,669 tons in 1906. The antimonial lead produced was 13,629 tons, and the recovered or secondary lead 18,283 tons. In 1908 the lead smelted from domestic ores was 310,762 tons, and from foreign ores and foreign base bullion (almost wholly Mexican), 97,761 tons.