importation of that fabric from Scotland, where it was manufactured by the laborious method already described.

The three machines, represented in our engraving on the side of the enclosure opposite to the great loom, are, first, the bag loom, in the foreground; second, a ten-quarter cot ton loom; and third, a heavy jute carpet loom—three admirable exemplifications of the wonderful capabilities of the invention.

THE BAG LOOM

weaves four seamless bags with one mechanism. There are four shuttles connected by rods in the single raceway; and they are caused to travel so that each, in passing to one side or the other, fills the place formerly occupied by its neighbor. The bottom of the bag is closed in the loom, so that, as the bags are woven, it is merely necessary to cut them apart. The weaver is, besides, enabled to examine both sides of her work, and thus the holes and defects in the under sides of the bags, which in some other looms cannot be examined, are avoided, and a perfect fabric produced. The machine travels at the rate of about 120 picks per minute, and in construction it is mechanically beautiful. That it must eventually supersede other methods of bag weaving seems to us merely a question of time.

THE CARPET LOOM,

in the distance, has a large cop in its shuttle to make heavy jute striped carpet. Its running is the perfection of ease. It makes 110 picks per minute, or about 100 yards of carpeting per day.

THE TEN QUARTER COTTON LOOM

is exhibited at the Exposition weaving unbleached sheeting for the well known New York Mills, of Utica, N. Y. The fabric produced is pronounced by competent judges to be unexcelled in point of fineness and level. One girl can attend three machines with ease. The speed is about 94 picks per minute. In this loom are embodied some most ingenious new mechanical devices, in the shape of compound let off motion, variable dwell crank, thin place protector, etc. It is a piece of mechanism well worthy of study in its every part, and its value may be estimated from the fact that the type which it represents has been adopted by the leading mills of the country, those above named and the Wamsutta Mills, of New Bedford, Mass., and many others.

We leave for the last the description of a machine which, were all we have already alluded to blotted out of existence, would still be sufficient to ensure for its inventor a world-wide fame. We refer to

THE CORSET LOOM,

represented in the center of the illustration. It is a marvelous combination of the positive motion and power loom with the Jaqcuard apparatus, an embodiment of the three greatest inventions ever made in the weaver's art. Four webs of corset are woven at once, in perfect form, all precisely similar and yet possessing every gore, every gusset, every welt formerly laboriously put in by hand work. Five corsets per day was the extent of the labor of the German weaver; this wonderful invention makes eighty-four in infinitely superior manner in the same period of time. The Jacquard cards govern the quantity of warp to be kept in action, so that, when for instance the parts which fit about the protruding portions of the body are to be made, only a certain portion of the warp is kept in play, and through this only the weft passes. As the shuttle then does not pass through the whole warp, but over a portion of it, it would necessarily seem that a slack loop of weft, corresponding to that portion in length, would be left. This is provided for by a let-off device in the shuttle, so that the thread, passing to and fro (after leaving the bobbin) several times between extended leaf springs, is always held taut, and thus only the exact amount required for the pick is allowed to escape.

This machine lies at the foundation of a great industry which has already achieved a fair footing.

THE POSITIVE ADVANTAGES OF THE POSITIVE LOOM.

Thus far we have indicated the immense value of the Lyall loom principally negatively, by showing wherein older devices have failed; it remains now to sum up, in brief terms the advantages which the invention secures, and these are: First, the abolition of the picking sticks; second, a positive motion to the shuttle from any point in its course; third, the unlimited width of the fabric which may be woven; fourth, the unlimited variety of fabrics which may be produced, from the finest silk to the heaviest carpet, from jute oil cloth foundation to exquisite woven embroideries; fifth, the almost total absence of wear, through the small motion of the reed which thus wears but little on the warps, through the small opening of the heddles which thus offer less strain on the same, through the absence of friction of the shuttle on the yarns, and the non-subjection of the weft to sudden pulls on starting; and sixth, the extremely small amount of power required to operate the looms. We saw the huge 8 yard machine, driven by a 3½ inch belt, and easily worked by hand power exerted on the gearing. We were told that it required but half a horse power for its operation. We saw, furthermore, that, as the great engine at the Exhibition slackened and stopped at noon, the looms continued weaving until their momentum gradually succumbed

We can add no better conclusion than by repeating the opinion we expressed regarding the invention shortly after its first appearance: "It is to the loom what the link motion is to locomotive engineering, or the compass to navigation. It substitutes certainty for uncertainty, and thus lays the foundations for future development in the textile arts hitherto unattainable. Radical in its character, it may be compared to the invention which placed the eye of the sewing machine needle at the point; and like that invention, it will in its proper field be likely to produce results impossible at present to estimate at their true value." Bold predictions, many pronounced these when we uttered them; but that they are fulfilled even in greater measure than we anticipated, the whole weaving industry of the country will bear us witness. That there has been no corresponding advance in weaving since the application of power to the loom may confidently be asserted; that within late years no invention in any field has exceeded this in importance and value to humanity is likewise truth. It will pass to posterity as one of the great triumphs of American inventive genius, as the peer of the grand accomplishments of Watt and of Arkwright, of Whitney and of Jacquard.

Correspondence.

The Weight of a Body in a Hollow Sphere.

To the Editor of the Scientific American:

Your correspondent, whose communication appears on page 84, seems surprised to find that the "body in a hollow sphere doctrine" is endorsed by Professor Young He will probably, upon inquiry, find that not only Professor Young, but every professor of standing in the scientific world endorses it, and none have ever repudiated it. It was first demonstrated by Sir Isaac Newton, and mathematical demonstrations are not easily set aside.

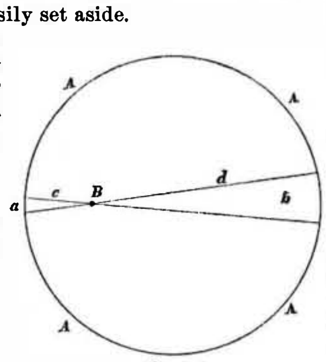

Fig. 1

Let A represent the hollow sphere, and B the body placed within, say half way between the center and one side. Then let a represent a certain portion of the mass of the shell, which of course attracts B in that direction, and let b be the mass which is opposite to a, and attracts it in the other direction. Let c represent the distance of a, and d the distance of b. Now the attraction is inversely as the square of the distance; consequently the relative forces are as $\frac{a}{c^2}$ on the left, and $\frac{b}{d^2}$ on the right. But the force is also directly as the mass; and b, being farther off, is a greater area, and hence a greater mass (included within the angle), than a, and is just as much greater as the square of the distance, d, is greater than the square of the distance, c. That is, the mass, b, is to the mass, a, as d^2 is to c^2. Hence $b = \frac{a \times d^2}{c^2}$. Now in the expression of the force on the right, $\frac{b}{d^2}$, we will substitute for b its value $\frac{a\,d^2}{c^2}$; and we have: $\frac{a \times d^2}{c^2} \div d^2$ or $\frac{\frac{ad^2}{c^2}}{d^2}$. Now, cancelling d^2, which appears both as multiplier and divisor, we have $\frac{a}{c^2}$, just the same as on the left. It ought to be obvious to any one that the body, B, is attracted equally in both directions, and hence will be at rest as far as the portion of the mass, a, and all the mass exactly opposite, b, are concerned: also that the same will apply to every point of the sphere and to every position of the body, B. Hence "a body placed within a homogeneous hollow sphere of uniform thickness will, so far as the attraction of said sphere is concerned, remain at rest in any position."

Between this proposition and the other, given by Olmsted, that "a body lowered toward the center of the earth would lose in weight in proportion to its distance downward,' there is no discrepancy whatever. Of course it is understood that he means this upon the supposition that the earth is homogeneous, leaving out of consideration the difference of density at different depths.

Let us take the case presented by your correspondent. A body upon the surface of the earth, at A, weighs, say, 24 lbs. If lowered to P, half way to the center, C, it passes $\frac{7}{8}$ of the "mass," that is, it reaches a new circumference, P E F G, inside of which there remains but $\frac{1}{8}$ of the whole mass. Thus the whole $\frac{7}{8}$ outside of this line, farther from the center than the body at P, being neutral according to this theorem, P is still attracted toward C by the mass within, which is $\frac{1}{8}$ of the whole.

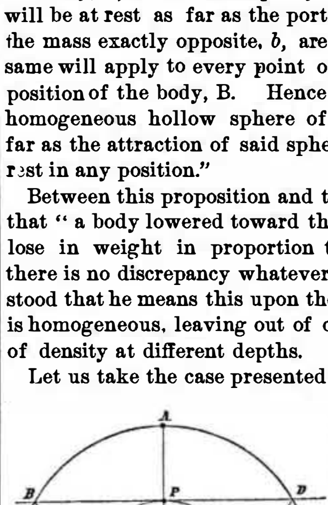

Fig. 2

But it does not follow, according to the "queer theorem," that it would weigh but $\frac{1}{8}$ as much as at A. Your correspondent has quite overlooked two considerations: 1. Masses attract each other with a force in inverse proportion to the square of the distance. 2. The distance from P to C being but one half from A to C, the attraction of the interior $\frac{1}{8}$ for the body at P is four times as great as that of the same $\frac{1}{8}$ when the body was at A twice as far from C.

Hence, the mass being $\frac{1}{8}$ as much, and the square of the distance four times less: $4 \times \frac{1}{8} = \frac{1}{2}$, and this is the amount of attraction at P.

One half of 24 is 12; so that, according to this "absurd theorem," the body weighing 24 lbs. at A will weigh 12 lbs. at P, half way down, just as your correspondent believes it would, in fact; and the old proposition does not "fall to the ground," but agrees exactly with the other.

Davenport, Iowa. W. H. PRATT.

Weight On and In the Earth.

To the Editor of the Scientific American.

With your permission I will show Mr. Whitman the error into which he falls in attempting to disprove the mathematically demonstrated "body in a hollow sphere doctrine." A careful study of his own diagram will prove that the external shell cannot exert any influence on the inclosed body. I will demonstrate it in the following simple manner: Let E, Fig. 1, be the shell of uniform density, C the center, B the body, and A D a diameter passing through C and B. Suppose the distance, A B = three times B D; it is plain that the body cannot depart from the line, A D, because we have equal masses at equal distances from the body on all sides of the line. It is also plain that it cannot approach A or D, being equally attracted in both directions. This last assertion I must prove: Imagine four lines passing through the center of B, and touching D at the four corners of a surface one inch square. If these lines are produced to A, they will touch A at the four corners of a surface three inches square. Produce these four lines through both sides of the shell; and the parts of the shell within the lines will be two masses, the one at A being nine times as great as the one at D. Now supposing the mass, A, to be divided into nine masses, each as great as the mass, D, each one of these small masses at A exerts $\frac{1}{9}$ of the attraction on B that D exerts, because placed at 3 times the distance. The nine small masses at A then exactly counteract the attraction of the mass, D.

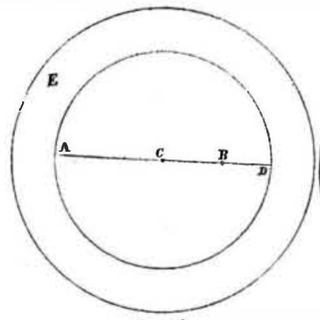

Fig. 1

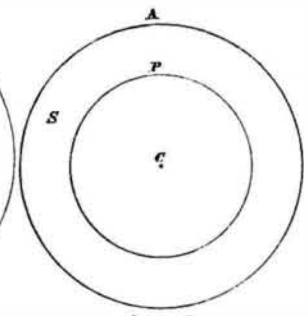

Fig. 2

I will now show why a body which weighs 24 lbs. at the surface of the earth will weigh 12 lbs. when lowered half way to the center: At A, Fig. 2, the body weighs 24 lbs.; remove the shell, S, and still keep the body at A, and it will weigh but 3 lbs., because attracted by a body $\frac{1}{8}$ the size of the earth. Now place the body at P on the surface of the small sphere, and it will weigh four times 3 lbs., being at one half the distance from C, as when at A. Attraction does not vary in inverse proportion to the distance from the attracting body, but in inverse proportion to the square of the distance. JAMES M. PALIN.

Savannah, Ga.

Locomotives for Steep Grades.

Messrs. Copeland & Bacon, of this city, have constructed, under the supervision of Mr. Henry C. Walters, and from his designs, a locomotive for use on inclined railroads, and we have had the pleasure of observing its workings on an inclined track. The engine is worked by means of a strong wire rope which runs from one end of the track to the other, making several turns around two large drums on the engine, one above the other, the upper drum being connected with the steam power by means of a huge cog wheel. Six of these locomotives are to be built by Messrs. Copeland & Bacon for use on a couple of mountain roads—one near Salt Lake and the other near San Francisco. They are four miles long and very much curved, and do a freight and passenger business, connecting two other railroads with each other. The locomotive works finely, and can be stopped anywhere on the steep plane.—*Bridgeport Standard.*

A New Odontograph.

Professor S. W. Robinson, of the Illinois Industrial University, has devised a new and very simple odontograph for describing accurately and quickly, all kinds of gear teeth, such as epicycloidal in every form, involute, etc., without the aid of any other instrument. The device is a ready made scribe templet of flat brass, graduated and finished alike on both sides. By means of tables given once for all, it is properly set for the face or flank of a tooth; and by means of countersunk holes, it may be mounted by wood screws on a radius rod and swung round to position for each tooth of the wheel. The device may be examined at the Centennial Exposition in Machinery Hall, at B 10, column 77, and its theory will be found fully explained in No. 24 (just out) of the Science Series, published by D. Van Nostrand, 23 Murray street, N. Y.

Falling Hair.

A correspondent of the *Medical and Surgical Reporter* asks: "What will prevent the falling of hair? I have used, for the past ten years, in my own case, and prescribed frequently for others, the following with complete satisfaction: Glycerin and tincture capsicum, each 2 ozs., oil of bergamot, 1 drachm; mix and perfume to suit. This is to be the only dressing for the hair. Wash the head occasionally with soft water and fine soap.