SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. XXXV.-No. 12.
[NEW SERIES.]

NEW YORK, SEPTEMBER 16, 1876.

[$3.20 per Annum.
[POSTAGE PREPAID.)

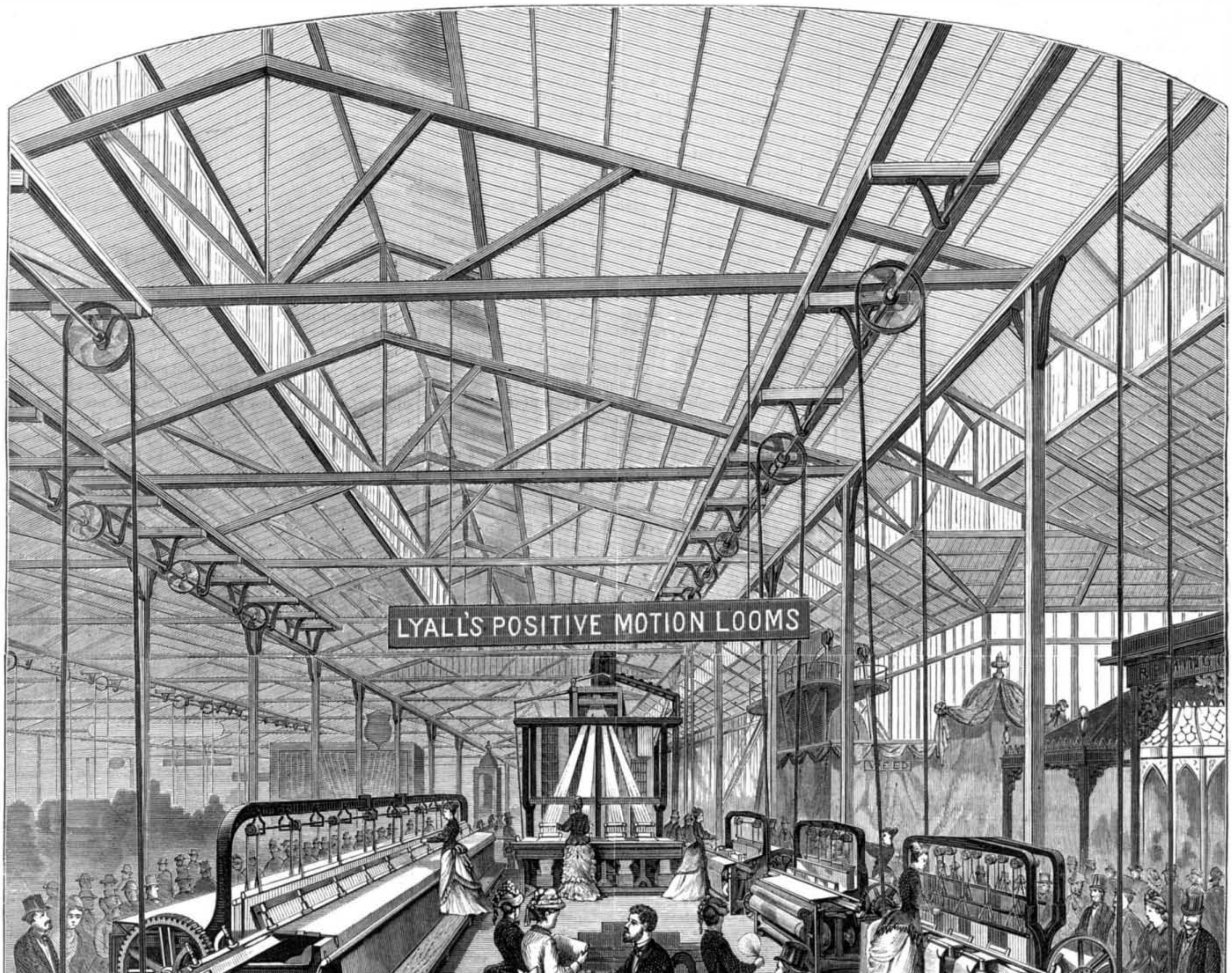
## THE GREAT TEXTILE INVENTION AT THE CENTENNIAL EXPOSITION—THE LYALL POSITIVE MOTION LOOM.

To trace back the complete history of the art of weaving would be to transcend that shadowy limit where begins the existence of the human race. The oriole and the weaver bird wove together twigs and rushes, to form their pendent nests, ages before the foot of man trod the earth; and from these, probably, the primeval savage learned to knit together fibers of plants and hair of animals into the rude prototype of the fabrics which have replaced the skins of beasts as human clothing. It is a marvelous fact, unparalleled elsewhere in the record of human progress, that, from the period when the loom was first devised—a period which we know to be earlier than the time of Jacob, for stone inscriptions of the era of that patriarch, in which weaving is referred to, have been deciphered—no great improvement or even modification in its mechanism was made until the year 1678, when De Gennes, a French naval officer, conceived the idea of a loom, driven by power other than that of the weaver himself. De Gennes started a current of invention, sluggish but onward in its tendency; and since his day, innumerable improvements in loom machinery have been made, keeping pace in large measure with advancement in other arts. But neither original invention nor the addition of improvements has uniformly affected all parts of the loom. We can point to marvels of ingenuity in the methods for producing intricate and curious tissues for guiding and regulating the motion, and even to a wonderful application of electricity in a device for superseding the Jacquard apparatus in its present form; but when we look for a means of producing apparently so simple a result as carrying the shuttle through the open warp, there has been no universally practicable improvement since John Kay, in 1740, invented the flying shuttle still in use in the great majority of looms.

### EARLY SHUTTLE MOTIONS.

That to substitute a positive, absolute, and uniform motion in the shuttle by means of an external appliance

*Continued on page* 180.




**LYALL'S GREAT TEXTILE EXHIBIT AT THE CENTENNIAL.**

*Continued from first page.*

moving exteriorly to the sheds of the warp, without absolute and positive connection between the shuttle and the motor, is a problem, requiring for solution something more than a mere modification of existing devices, has been apparently unrecognized. The first weaver pushed or threw the shuttle through the warp with his hands. Kay connected pickers or hammers at the end of the shuttle race with a cord along the front of the loom, and attached to the middle of the cord a handle or "picking peg;" and this the weaver jerked in one direction or the other, causing the pickers to strike the shuttle and drive it through from side to side. In the power loom, the pickers are operated by proper mechanism; but the principle on which they work remains precisely the same. The shuttle, in fact, becomes a mere projectile, entirely out of the control of the weaver during its passage across the warp. The disadvantages pertaining to this arrangement are so many and so great that the mere recapitulation of them is sufficient to excite the deepest surprise that, for a hundred and thirty years after the device was invented, during an age of progress more rapid than the world has ever before known, the skill and genius of mankind were baffled in every attempt toward reaching the radical change so obviously and imperatively demanded. And it is necessary to consider these disadvantages for a proper appreciation of the invention to which this article is devoted.

DISADVANTAGES OF THE FLY SHUTTLE.

The ordinary shuttle being a mere boat-shaped implement, it slides over the warp thread on its slightly convex bottom. It is obvious that, when hurled as it is with lightning rapidity, the friction on the thread must be excessive. This is in fact the case, and the result is frequent breakage of the warp and constant injury to the filaments of such delicate fabrics as silk, cambric, etc., so that a limit is speedily reached, in point of fineness of the goods made, beyond which the fly shuttle is practically useless. Similarly there is a limit in the width of the fabric, or, in other words, the distance the shuttle can be thrown. The wider the warp, the more difficult it is to pick, since, while it is harder to impel the shuttle, it is likewise harder to check its high momentum and reverse its motion. A still greater obstacle to the production of perfect fabrics is the variable nature of the force by which the shuttle is projected. A certain speed of the mechanism being just sufficient to make the throw, an increase in velocity may result in causing the shuttle to rebound, thus slackening the weft, or even leaving a bight in it. Again, if the speed be reduced only five per cent, the shuttle may fail to complete its journey. The least evil consequent is that some of the threads are tight, while others lie loose; and when the completed fabric is woven, the former take the strain, giving way first; and the material, as is commonly the case with poor and cheap silk, "cockles," and speedily becomes valueless. The greater evil is a "smash," which must occur where the shuttle either rebounds into the sheds or fails to pass through them. It then is struck by the lay, the delicate dents of the reed are bent or broken, and the threads of the warp in the vicinity are destroyed. Hours may be required to repair the damage; but even then, the loom overseer has no assurance but that, before the machine can make half a dozen strokes, the same accident may re-occur and necessitate the same outlay in time and expense. In making fine goods the bending of the dents is practically irreparable; and to continue weaving the piece with the reed injured, however slightly, is to produce a fabric with a slackly woven streak in it.

Again, the character of the selvedge of certain goods is one of the criterions by which the quality of the article is determined. To make a perfect selvedge, however, a very delicate adjustment is required to draw the thread of the weft firmly up against the exterior threads of the warp opposite the shuttle, after the latter, having completed its flight, comes to rest just prior to the beat of the lay. This adjustment is exceedingly difficult to attain; and where it fails, the quality of the goods is again injured.

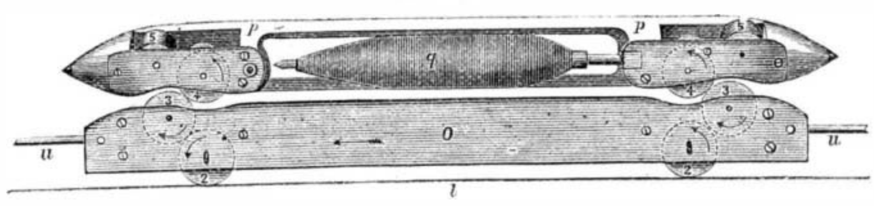
Lastly, the fly shuttle is a source of no inconsiderable danger. Guards have been devised for keeping it in place, and great ingenuity has been expended in the means for checking and reversing its motion. But it is obvious that the picker rarely strikes it so as to propel it in identically the same line, and that slight variations must constantly occur. From these and other causes, determining, perhaps, a failure of the safeguards, the shuttle has often been known to leave the loom and seriously to injure the operatives. It was only recently that we learned of a case where an unfortunate mill girl was struck in the eye and totally blinded, and there have been instances where the sharp pointed projectile has inflicted fatal wounds.

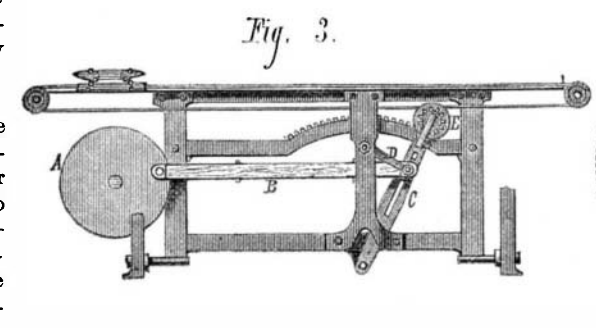
IMPROVEMENTS IN PICKING.

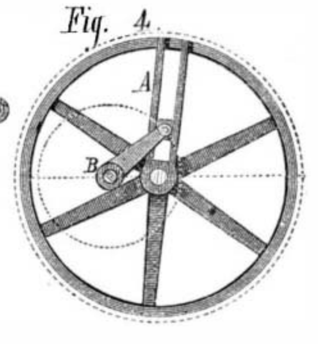
To remedy all these defects, there have been but few efforts. The air pump pick was an attempt to drive the shuttle by compressed air, forced into a cylinder, the two long piston rods of which gave motion to the drivers, which impelled the shuttle. This was a failure. Another and more successful device includes a long needle or arm, which carries the shuttle through the warp, then is withdrawn until the lay is beaten, and finally is returned to catch the shuttle and draw it back. This may be seen at the Centennial Exposition, applied to a carpet loom, for which class of machine it is best adapted. A double weft is thus laid in the warp. This is useful for ingrain carpets, but not available, for obvious reasons, for other fabrics. Another and somewhat similar plan includes two hook arms and no shuttle. One arm carries the bight of the weft into the warp for half the distance and delivers it to the other arm, which extends in similar manner from the opposite side. Still another ingenious inventor unsuccessfully attempted to draw the shuttle through by magnets moved above and below the sheds, but the shuttle persistently attached itself to the nearest lodestone, and refused to proceed further without destroying the warp threads in front of it. A device successful for short throws, not exceeding five inches or thereabouts, is a rack and pinion under the shuttle carrier. This is now employed in weaving ribbons and other narrow goods, and may be seen on the looms engaged in weaving bookmarks at the Centennial. One more invention is also worthy of notice here, though it failed, and is obviously of no practical value. It was positive, however, inasmuch as a cam traveled under movable needles, and these, rising through the warp in rear of the shuttle, surely but very slowly pushed the latter through.

The above will serve to convey to the reader some general idea of the difficulties existing in the loom, as well as of what others have done to remove them, at the period when Mr. James Lyall began the study which led to his remarkable invention.

Fig. 2.







## THE POSITIVE MOTION SHUTTLE.

THE POSITIVE MOTION SHUTTLE.

We now proceed to the explanation of that device, the essential features of which are represented in Fig. 2, where the shuttle is shown resting on its carriage, *o*. Motion is given to the carriage and through it to the shuttle by means of a stout band, *u*, which passes over grooved pulleys fixed to the ends of the lay and communicating with a single large pulley underneath the loom, to which, by special mechanism hereafter to be described, the proper movement is imparted. The wheels, 2, of the carriage are pivoted to the ends of short horizontal arms; the wheels, 3, are simply journaled in the carriage. The weight of the latter, therefore, rests on the pivots of wheels, 3; and as these rest on the tops of wheels, 2, it follows that they must receive a counter motion in the direction of the arrows marked on them, exactly equal to the motion of wheels, 2, which is likewise equal to the motion of the carriage along the raceway, *l*. Now suppose a sheet of parallel threads to be stretched above this carriage and beneath the shuttle, *p*. The only points where these threads will be in contact with carriage and shuttle are obviously between the wheels, 3, of the former, and wheels, 4, of the latter. If we move the carriage so that the wheels, 2, revolve to the left, wheels, 3, will rotate to the right; and supposing the shuttle removed, it is clear that, while the threads are successively raised as wheels, 3, pass under them, the rotation of said wheels precludes any lateral movement on their part. It is easy to see that the laying of the shuttle in place above the carriage will in no wise affect this result, because the wheels, 3, rotate the wheels, 4, at precisely the same speed; so that the successive threads, for the inappreciable instant of time during which they are between shuttle and carriage, sustain no disarrangement from their normal position beyond the very slight elevation, a small fraction of an inch, caused by wheels, 3. This clearly imposes no strain, while a moment's consideration of the mechanics of the device will show that friction on the threads is practically nothing, being applied at the mere line formed at the place of contact of two rolling bodies, and this never twice at the same points considered in horizontal succession from thread to thread, because the sheds are constantly alternating and constantly being moved bodily away as the weaving progresses. The wheels, 5, do not engage with the wheels, 4, but roll along the under surface of a beveled rail, holding the shuttle down to its work. The shuttle is dovetail in section, and, when in place with its carriage, can only be removed by drawing it out at the end of the lay.

THE LOOM MECHANISM.

The ingenuity and beauty of the device above described alone would be amply sufficient to secure prompt recognition of its surpassing value; but the inventor has grouped about this chief feature of his invention a wealth of novel movements and mechanical combinations, which are also well worthy of notice. Everything is positive; and when we state that cams are abolished and the crank everywhere substituted, we perhaps sum up all in the fewest words.

The two diagrams, Figs. 3 and 4, will serve to convey an idea of two of the most important devices out of several for effecting similar purposes. It is necessary in many cases to produce a dwell or period of rest, either in the shuttle or the lay. In the one case the shuttle stops sufficiently long at the end of its run to allow of the lay being beaten; in the other, the lay delays its beat sufficiently for the shuttle to make its journey. The dwell in the lay is necessary in making heavy goods. In all cases it is a great desideratum to have the motion of the shuttle swiftest midway in its course, and gentle at the ends; and one way in which this is accomplished is shown in Fig. 3, where A is a crank disk, from which motion is imparted by a connecting rod, B, to a sliding block in the slotted vibrating arm, C. D is a link attached to the sliding block and pivoted to the frame. Arm C, carries, as shown, the wheel, actuates the shuttle band, and is itself rotated by a rack and pinion device, clearly represented. When the crank disk starts from the position exhibited (the shuttle being at the end of the race), the sliding block is at the upper end of the slot in arm, C. Hence the arm, and consequently the shuttle, is given very slow motion. But as one end of the connecting rod is carried up the disk, its other end causes the sliding block to descend to the arm, the wheel on the outer extremity of which, therefore, constantly receives an accelerated motion, which is most rapid when the shuttle is midway in its course, and gradually in the same manner decreases until the pick is made. The shuttle is never returned until the lay is got home; so that on matter what the position of the shuttle is to the race when the loom is stopped, on starting again the first thing done is to draw it out of the way of the lay.

Dwell in the lay, an obvious necessity when the shuttle, in weaving wide fabrics, has to travel a very long distance, is obtained by the device shown in Fig. 4. A is a slotted pulley wheel, in the slot of which is a sliding block, to which is attached the crank of the shaft, B, which imparts motion to the lay. The crank wrist is eccentric to the pulley; and as the latter revolves, it moves radially in the slot. Consequently when nearest the center it imparts an extremely slow or no motion to the shaft, B, and a quick movement when it has traveled out toward the circumference.

THE EXHIBIT AT THE CENTENNIAL.

Without dwelling further upon the general features of the invention, we may pass to some of its practical applications as exhibited in the magnificent display made by Messrs J. & W. Lyall at the Centennial. The five great looms (taken from the factory in West 23d street, New York city) are located in a commanding position in Machinery Hall, and are represented in the superb engraving which occupies our initial page. These we shall consider briefly in their order, pointing out their several merits and capabilities. To the left of the enclosed space is seen the largest loom in the world, a physical embodiment of the fact, which the reader has doubtless, ere this, divined, that the width of fabric which can be woven by the Lyall loom is unlimited. Weaving wide fabrics, such as oilcloth foundations, by the hand loom hitherto has been a most arduous undertaking; three men were required, one at each end, to drive the shuttle with heavy hammers, a third to stand between them and aid them in beating the lay. It was labor of the severest sort, and those engaged in it became prematurely old. Contrast this with the colossal machine which scarcely requires the attention of the single young girl in front of it. Imagine a fabric woven 8 yards wide and 40 yards long in ten hours, 320 square yards of cloth in a single day. Ten such looms could make enough material to cover the enormous area of Machinery Hall in less than three weeks. The huge shuttle travels 31 feet at every throw, and its journey is completed 35 times in a minute. No need of a mechanical counter for the machine itself at the Exposition. It is only necessary to watch the involuntary motion of heads and eyes of those who stand in wonderment before the loom, as, like so many Chinese dolls, they gravely wag their craniums from side to side in time with the shuttle. The great loom is made in two yard sections, in other words, the lay is really beaten up in four places at once. This gives all the strength of fabric which would be imparted by four narrow looms placed side by side. The back beams are sections of 1 yard each, so that they can be made on an ordinary warping machine. In the loom they are united in one by male and female clutches. There is a dwell, of course, in the lay to accommodate the shuttle.

No one can witness the operation of this great apparatus, nor indeed of any of the others below described, without being impressed with the ease and grace with which the shuttle operates. There is no breaking of the yarn, no constant stopping for repairs, but perfect smoothness in every motion. We can readily believe the manufacturers' statement that the loom will weave shoddy almost too weak to stand its own weight, or filaments like cobwebs in their delicacy and fineness. Huge looms similar to that at the Centennial are now weaving all the oilcloth foundation that is made in the United States, and have stopped our 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 cotton 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 in vention, 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.

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.

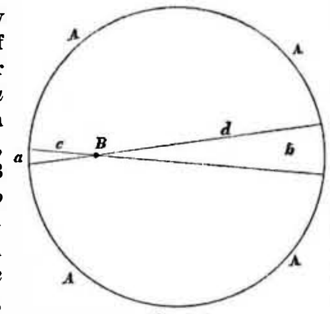


Fig. 1

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 ⅞ of the "mass," that is, it reaches a new circumference, P E F G, inside of which there remains but ⅛ of the whole mass. Thus the whole ⅞ 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 ⅛ of the whole.

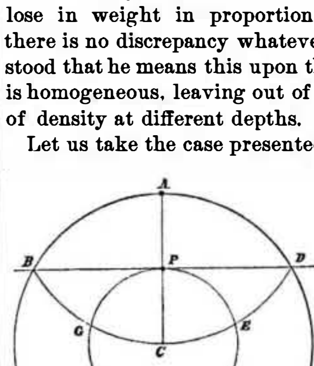


Fig. 2

But it does not follow, according to the "queer theorem," that it would weigh but ⅛ 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 ⅛ for the body at P is four times as great as that of the same ⅛ when the body was at A twice as far from C.

Hence, the mass being ⅛ 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.

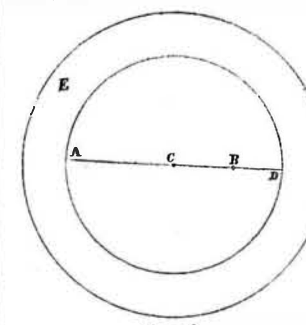


Fig. 1

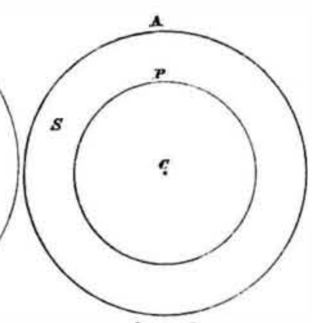


Fig. 2

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 ⅛ 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.