LYALL'S POSITIVE MOTION LOOM.

In a former issue of this paper we gave the first published description of Mr. James Lyall's invention. We now take occasion to give our readers some idea of the growth of an industry then in its infancy, and to show how all we then predicted of it as one of the most remarkable products of inventive skill of our time has been realized.

We present illustrations of the exterior and interior of the machine shop where the looms are constructed, forming only a part of the premises owned and occupied by the firm, and where in all are employed from twelve to fifteen hundred employes. The number of looms built by them in the course of a year may be conjectured from the size of the works and the number of hands employed. It is a large and steadily growing interest, sprung from the inventive skill of one man. Another picture is given of a two-piece loom with hundred-inch reed spaces for weaving patterns, known as a Jacquard loom, and having Mr. Lyall's positive motion shuttle, thus bringing together two of the three inventions which we shall show to be all that there is of the loom to-day, in contrast to that of many centuries ago; also a four and a five piece loom. These very perfectly present to the eye the construction of the machine and arrangement of the works.

They are shipped to all parts North and South, South America, and Europe. China and Japan have them, in consequence of the report of an imperial commission sent here to inquire into their excellence. Indeed, wherever looms are used, they have been steadily supplanting those formerly in use for all kinds of weaving, whether of the coarsest fabrics or the most delicate silks, textiles of the fineness of spider webs, or screens of iron wire. Diplomas, medals, and decorations attest the high appreciation in which the invention has been held.

The reason for this pre-eminence will become clear upon a brief inspection of the loom itself in operation. It will afford those interested a pleasant hour to read the history of weaving from its rude beginning. Concluding with this description of the loom *as it is*, they will be impressed with the fact that Mr. Lyall's invention has made that radical change in the possibilities of weaving which the hot-air blast did in the manufacture of iron—simple enough in contrivance after it has been discovered, but so marked, so radical in character, that it amounts to the creation of a new art—a new art in the sense that it produces, in a new and better way, an article in all respects different from the old article, except in the fact that both are known as fabrics.

The art of weaving has made, considering its antiquity, singularly slow progress in its improvements. Beginning with the dawn of history and apparently simple as an art, there have been but four notable improvements in the loom to this day, of which this is the last, and, we are tempted to believe, the most noteworthy. Until 1735, when John Kay, of Bury, England, devised the "flying shuttle," and was driven out of the realm to die in poverty by the men who were benefited by his invention, the art and the loom remained substantially as they were from the earliest times.

His contrivance reduced the requisite amount of labor, to produce a given amount of work, fifty per cent. of what it had been up to his time. It was the first step taken in the direction of labor-saving in this art. In this line, Dr. Arkwright's "power loom," which was the mechanical application of power other than that of the weaver to driving the loom, naturally followed—a great invention and prominent among the four. Power, as applied to machinery, implies not only labor-saving, but admits of elaborate workmanship, together with other advantages not necessary to enumerate.

In 1801 Joseph Jacquard invented the machine which bears his name, for mechanically weaving irregular patterns and designs. Like that of Arkwright, it has not been materially improved upon, remaining substantially as it left his hand, and marked an era. Thus, after centuries of mere repetition and a most limited application of the weaver's art, we find a movement started, an innovation toward devices for saving labor, or, properly speaking, the production of greater quantities with the same amount of labor. And though opinions differ, it seems to us that the quality and variety as well as the quantity of the product must of necessity be superior when made by machinery instead of by hand.

John Kay and Joseph Jacquard were both mobbed. Arkwright and Lyall were fortunate in belonging to a more enlightened age, whose inventors are acknowledged as benefactors.

Improvement in any art, machine, or process, almost always shortly requires a corresponding advance in respect to something which had been neglected and left behind in the march, and which now imperatively requires to be brought up to the same standard of excellence.

So it was in this instance. It soon became apparent that passing the shuttle through the shed of warps by means of the "picking sticks" ("the flying shuttle") in a power loom was surrounded with many and great disadvantages; for reasons we will explain hereafter.

Indeed, the shuttle movement has always been considered the least perfect part of the machine, and especially was this true after the application of power. Since Arkwright, inventors have been at work trying to solve the problem, and innumerable attempts have been made to bring the shuttle movement up to a level with the mechanical efficiency of the rest of the parts, and until now without success. The "picking sticks" of Kay continued to hold their ground until this invention supplanted them.

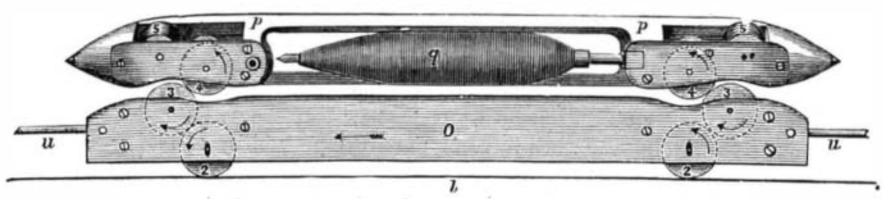


Fig. 1.—SHUTTLE AND CARRIAGE.

It was a simple contrivance, and in its day valuable. Briefly, instead of the shuttle being thrown through by one hand of the operative and caught in the other, it was projected through by a blow of the picking stick, and sent back again by a blow from the other one. Not here to dwell upon the disadvantages of this contrivance, the problem was how to pass the shuttle through the sheds of warp by an action always under control, by an actuation which should be uniform and constant, not intermittent. The difficulty was, that when to accomplish this the shuttle was permanently attached to the actuating parts of the machine, the sheds of warp, in changing position alternately from above and below, would weave this attachment along with the weft into the fabric.

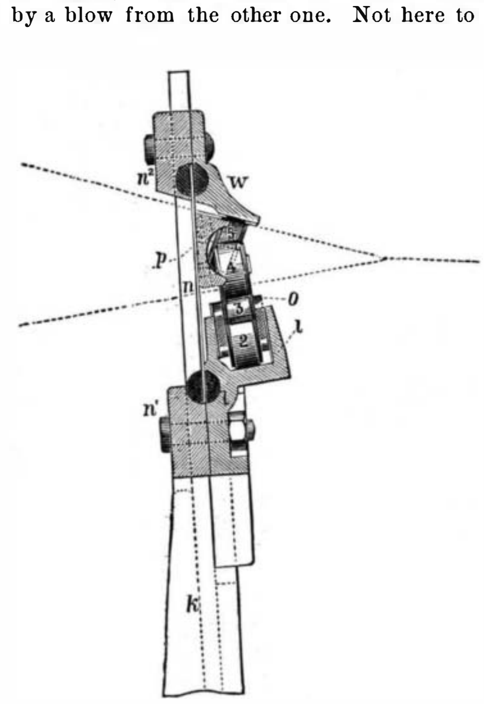


Fig. 2.—SECTION OF LAY, REED, AND RACEWAY.

It reminds one of the trials of the Chinese to make a barrel with two heads. They could easily make one with one head, but when it came to setting the other head they had to put a man inside to assist the workman on the outside, and so when the barrel was finished, there was a man inside it. It was many years before they could deliver a complete barrel without a man in.

Innumerable attempts have been made. One was known as the "compressed air" shuttle motion, which was designed to project the shuttle back and forth by the force of atmospheric elasticity; another was by means of quickly revolving rollers which caught the shuttle and expelled it from a sort of shuttle box; "clutch sticks" to pull it through, and magnets, have been tried, all without practical success. It seemed for years as though an insurmountable mechanical obstacle presented itself in the way of obtaining a positive motion, and so it remained until this invention.

It has been accomplished by means at once simple and reliable, admitting of no uncertainty of movement, and fills all the conditions required of it.

Fig. 1 is a side elevation of the shuttle and carriage. Fig. 2 is a section of lay, reed, and raceway, with an end view of shuttle and carriage. Referring to Fig. 1, the carriage, O, rests on the track, *l*, inside the raceway (not shown), the sides of which are even with the top of the carriage. Immediately over the top of both carriage and raceway, at right angles to them, is stretched the lower shed of warp, passing through the open space between the carriage and the shuttle, *pp*. The carriage propelled by the band, *uu*, in either direction, moves across under the shed of warps, while the shuttle resting on the carriage moves with it over the shed of warps. To prevent the shuttle jumping off its carriage, it is held down by the rollers, 5, 5, which play against a track above, W, shown in Fig. 2, passing along the under side of the upper shed of warps. This prevents it rising sufficiently to permit roller 4 to pass over roller 3, and escape from the carriage. The inclosed position of the rollers 4, 4, between rollers 3, 3, imparts the motion of the carriage to the shuttle, while the play allowed, amounting to something more than the thickness of a thread of warp, admits of the warp passing through where the rollers are in contact. The revolution of the rollers as indicated by the arrows, which motion is derived from the track, facilitates the passage of warp between them as the carriage moves forward. Friction is thus almost entirely removed.

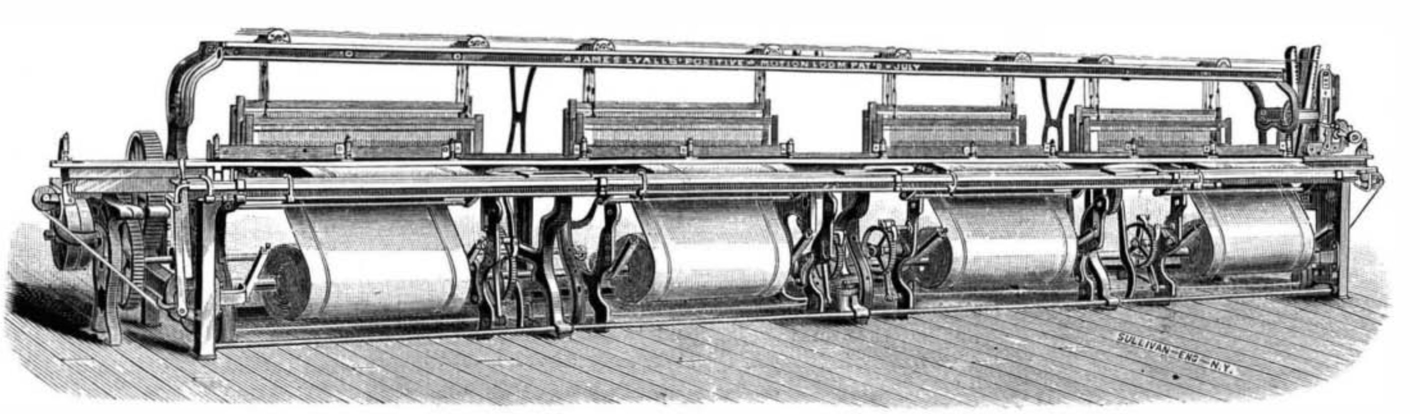
The mechanism may not be inaptly illustrated by the circus-rider standing on the back of his horse, and leaping over the ribbons as his horse runs. The horse represents the carriage, the ribbons the lower shed of warp, while the weight of the man really represents the upper rail keeping him down. The rider is the shuttle passing over the warp, while the horse, without absolute connection, carries him forward. The purchase which the shuttle gets from the carriage is the same, mathematically, which the man gets from the horse.

To enumerate some of the defects of the picking-staff shuttle will be equivalent to describing the merits of the Lyall machine, for it absolutely removes the objectionable features of the former, and has in fact supplanted it. The friction of the fly-shuttle on the warp is sufficient to materially injure the threads and cause them to break. This is also frequently the consequence of the uncertain and unguided direction of the "projectile," as it has properly been called, plunging into the warp and snapping the threads. The irregular indentation of the leather due to the constant hammering often gives a wrong inclination, causing the shuttle to be deflected from its mark, and it goes anywhere at random.

Its eccentric conduct can frequently not be accounted for or remedied for days, and the weavers say it has the devil in it. Sometimes the blow is not strong enough, and it stops short of the requisite distance; and, again, too strong, when it recoils from the opposite pick. This results in an irregular tension on the weft and a consequent defective selvage and irregularity in the texture. It must be borne in mind that every breakage costs time, which is money, and more money for repairs, as well as every defect or irregularity in the goods costs in the reduction of market price.

However useful in its day, it is now anomalous that the most essential movement of a machine should be almost entirely independent and out of control in its action, while the other parts go on with the reliability of mechanism. Consequently, if it stops midway in the loom, the other parts move on, and then comes a "smash" and consequent suspension of work and expense.

It is a wayward sort of thing, and we need enumerate its short-comings only so far as to say that it is irregular in its motion and violent in its action. Sudden and violent mechanical movements have always been abandoned in all classes of machinery so soon as a more regular and positive means has been discovered which would perform even an equivalent of duty.



THE LYALL POSITIVE MOTION FOUR WEB LOOM.

Let us now consider the positive merits of the positive motion loom. As a rule, substituting machine work for human skill secures a more perfect product. The machine does not tire nor lapse, and the fabric is more uniform than the best handcraft could make it. These advantages are all here secured. But the enormous strides they have made, and are still making, in improving the loom and its products, can only be properly comprehended by personally inspecting the works of the firm. No written description can more than suggest it. The saving of labor is apparent at a glance. One girl can now run ten looms, that is, two looms of five webs each, that is, the work of ten weavers, and on cloth of a width which formerly could not have been made on any loom in the world.

Indeed, the possible width is practically unlimited with a positive motion shuttle. The uniformity and steadiness of its action naturally produces uniformity and perfectness in the fabric.

It further admits of the use of a much larger "cop" of thread for the weft. And here, again, is a very great advantage. Every "stop," for the purpose of renewing the cop, involves a defect in the fabric, for it is impossible to start the machine with a new weft without, for one cause and another, the new thread being noticeable in the cloth.

Hence, the fewer the stops the fewer the defects in the cloth. This machine, carrying a cop six times as long as formerly was possible, calls for only one stop in six of what was formerly necessary. These two advantages, referring to quantity and quality, are alone sufficient to make the fame of any machine.

To understate it, the advantage secured is ten to one in quantity, and six to one in quality.

At the risk of repetition, we will conclude by briefly enumerating the advantages secured by it:

The striking feature of the loom is that the picking stick, heretofore of universal use, is entirely dispensed with. The shuttle being drawn through the warps, is, with all other parts of the machine, held, controlled and acted upon by a direct and continuous connection with the motive power; hence the liability of a "smash" is removed, and no injury can happen the reed. In case of the loom being stopped during the passage of the shuttle, or at any other time, each part is in place for starting again.

The advantages may be briefly enumerated:

1. The unlimited scope of the shuttle: it being drawn, instead of knocked, through the warps, enables the carrying of large quantities of weft any distance; which being kept at a uniform tension until it is beat gives a perfect selvage.

2. The friction of the shuttle on the yarn is perfectly overcome, therefore it does not wear the warps, nor break any threads, even in the finest fabrics of silk, wool, cotton or linen.

3. The weft is not subject to sudden pulls in starting, and may be of the most delicate texture, regardless of the width of the fabric.

4. The loom can easily be arranged to run a number of shuttles, weaving as many widths of cloth as there are shuttles, and with perfect selvage.

5. The width of the fabric may be extended indefinitely.

6. The loom runs with less power, much more quietly than others, and at any speed desirable.

7. The great desideratum is, that it dispenses with the necessity for the skilled labor heretofore required, enables the weaving of very wide goods at no greater cost per square yard than that of narrow, and on ordinary cotton and woolen fabrics gives a large gain.

The looms are now running in a number of the largest and most important mills in this country and giving great satisfaction, and for Jacquard irregular and heavy sleyed fabrics it is indispensable.

Their four-piece loom is arranged with head motion, for from 4 to 12 harnesses for weaving seamless bags, jeans, crash, toweling, ticking, duck, canvas, hose, etc. They build the above loom to weave from 2 to 5 webs in each loom up to 36 inches wide. Using the large cops or bobbins (which are 4 to 10 times larger than those used in other looms), a girl can run two looms 5 webs each, equal to 10 ordinary looms. It has positive take-up for a large roll of cloth 30 inches in diameter; wrought iron crank shaft, tension or friction let-off, geared for any number of picks per inch, and beam heads from 18 to 24 inches in diameter, and stop motion for each web; harness are also arranged to work from cams 2, 3 or 4 harnesses. These looms are used for sheetings, quilts and blankets, 2 webs in each loom, 80 to 100 inches wide, and are arranged for "Jacquard" when required. They also manufacture cop-winding, spool-winding and cop-compressing machines, of similar ingenuity and value.

Electrical Units.

The International Electrical Congress held in Paris decided to make use of the centimeter, gramme and second in all electrical measurements. They will retain the practical units, "ohm" for resistance, and "volt" for electromotive force. The *intensity* of a current produced by one volt, with a resistance of one ohm, will be called one "ampère;" and the quantity of electricity given by one ampère in one second will be called a "coulomb;" the term "farad" indicates the capacity of the condenser which, laden with a volt, holds one coulomb of electricity. The old term "weber," as unit of intensity of current, will not be used.

A LARGE STEEL CONTRACT.—The contract for supplying steel for the new bridge over the Frith of Forth, Scotland, calls for 45,000 tons. This is called one of the largest orders for steel for bridge building.

BREAK IN THE HUDSON RIVER TUNNEL.

An accident occurred at the New York end of the Hudson River Tunnel, Aug. 20, which may delay the work there for ten days or more.

Men were employed laying up the brick-work lining of a 15-foot section, the iron shell of which had been completed, when a plate of the temporary bulkhead gave way and allowed the compressed air to escape and the water to rush in. The temporary bulkhead was 65 feet from the west side of the caisson and 20 feet in advance of the fixed bulkhead carrying the air-lock. The men had ample time to take refuge in the air-lock, and no one was hurt.

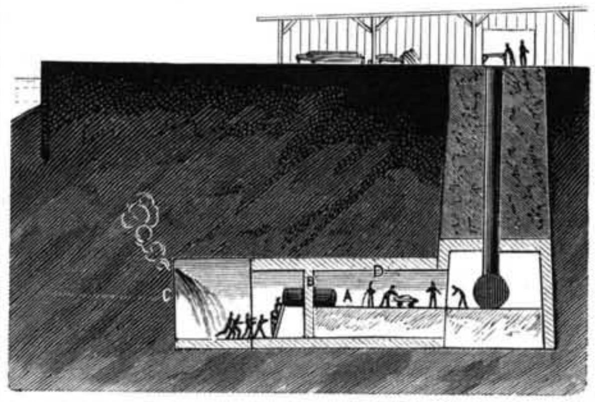


Fig. 1.—SECTION OF THE TUNNEL, CAISSON, ETC.

The process of working and the nature of the accident will be clearly understood from the illustrations herewith. Owing to the loose character of the soil on this side of the river, special precautions have been taken to protect the workmen against accident, and the value of these precautions has now been amply demonstrated.

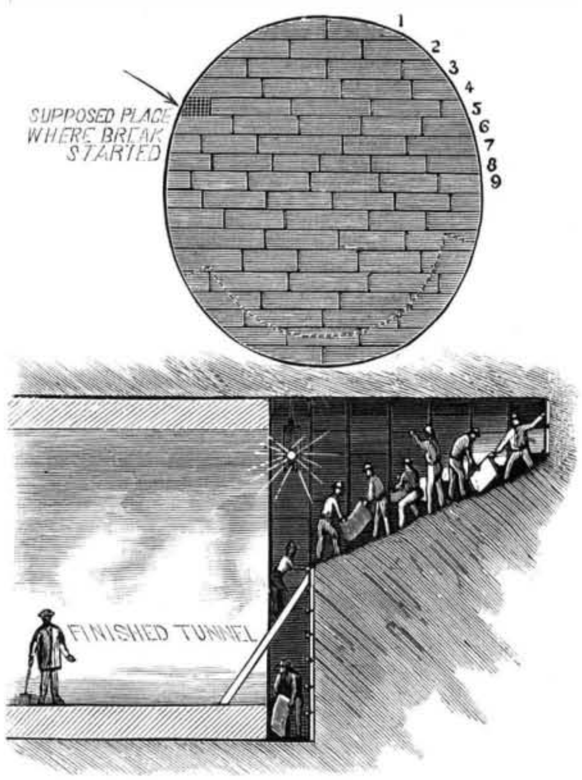


Fig. 2.—THE TEMPORARY BULKHEAD.—METHOD OF ADVANCING THE WORK.

Fig. 1 shows the situation of affairs in the tunnel at the moment of the accident: B is the fixed bulkhead; A the air-lock; C the temporary bulkhead; D the finished portion of the tunnel.

The novel feature is the temporary bulkhead, a plan of which is shown in Fig. 2, the dark spot indicating the plate supposed to have first given way. This bulkhead is built up of eighteen courses of boiler plates, bolted together, and is alternately taken down and reconstructed from the top as the iron shell of the tunnel is advanced, and the earth removed. The method of proceeding is shown in Fig. 2.

The tunnel is advanced in sections of fifteen feet. A new section is entered upon by removing one of the topmost pair of plates of the forward bulkhead. The earth before it is dug out, and one plate of the iron shell of the tunnel is inserted. Then the second plate of the bulkhead is removed and a second plate of the shell is put in. The second course of bulkhead plates is then taken out plate by plate, the earth excavated, and the construction of the shell continued, both at the sides and in front, until the forward progress of the shell at the top has reached a distance of fifteen feet. Then the first course of a new bulkhead is inserted. After that, as fast as the earth is removed, the iron shell and the forward bulkhead are constructed simultaneously, until both are complete, substantially protecting the workmen against large or sudden escapes of air and inrushes of water. As the work goes on in each section, the air-pressure is gradually reduced. The highest pressure is 26½ pounds.

The iron shell of a fifteen-foot section had been completed, with the temporary bulkhead in place, two days before the accident. The bricklayers had built up the brick lining or inclosing wall of the new section of the tunnel as far as shown by the dotted lines of Fig. 2, when a hissing sound warned them of escaping air. As the air-pressure lessened water came in, and the workmen fled to the air-lock leading to the completed portion of the tunnel, closed the door, and were safe. The manner of their escape is shown in Fig. 3. It is supposed that by some neglect the marked plate in the fifth course of bulkhead plates, as shown in the plan, had been imperfectly bolted, and the defect precipitated the accident. The flooded portion of the tunnel has since been entered from the air-lock by a diver, who found the bottom of the broken section covered with sand and stones. The iron shell of the section, in front and on top, had been broken in several places, leaving considerable gaps. These breaks have been stopped by a filling of sawdust, sandbags, and other material, and the work of pumping out is now going on. New plates will be substituted for the broken ones, and the work will then go on as before.

It may be added that the New Jersey end of the tunnel is being advanced from twenty to twenty-five feet a week.

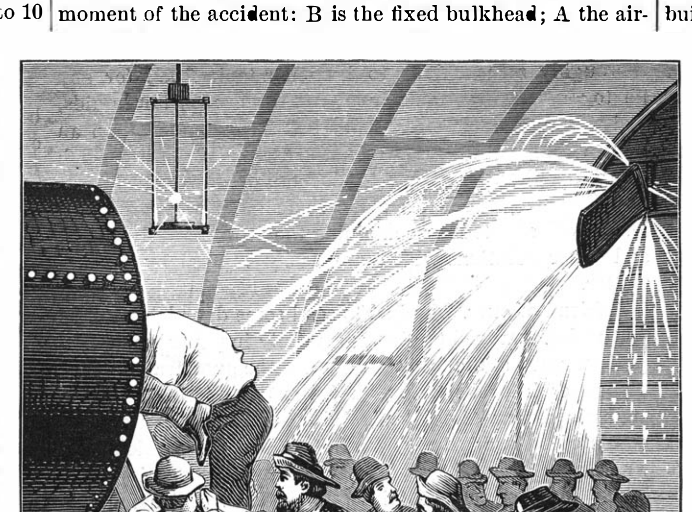


Fig. 3.—ESCAPE OF THE WORKMEN.

Earthquake in Mexico.

The severest earthquake felt in Mexico since 1864 was experienced July 19, at 2:35 P.M. The shock lasted two minutes and thirty seconds, making it one of the longest earthquakes on record. The *World's* correspondent at the City of Mexico says that the shock was felt at Cuernavaca, Iguala, Tlaxcala, Toluca, Puebla, Orizaba, Vera Cruz, Queretaro, Oaxaca, Cuautitlan, and Yautepec, so it is estimated that the shock extended over an area of 1,688 leagues.

In the capital it caused much mischief. The walls of several houses fell, a great many edifices were badly cracked, and the churches suffered greatly. In the Cathedral are several fissures in the principal vaults and a wide opening in the north wall near the entrance. The parochial church, El Sagrario, was very much cracked, as also those of San Fernando and San Salvador. In the National Palace and City Hall, and in the rooms occupied by the public archives, the walls are very badly cracked. The Mexican Railway Station also suffered. It is estimated that at least 80 per cent of the buildings in the city were more or less injured.

The water in the city fountains and that of Lake Texcoco overflowed in all directions. The earth opened in some places, and the ground sank in in others. The water pipes were broken and there was a great scarcity of water during the next forty-eight hours.

The monumental arches of the aqueduct of San Cosme and of the Salto del Agua suffered a great many fissures, from which the water flowed freely.

In Puebla nearly all the buildings were badly damaged. The inhabitants of Vera Cruz were fearfully alarmed; the shock was very strong there, and the sea roared furiously all the time. In the town of Yautepec the church and several houses fell. In Oaxaca it was accompanied by loud subterranean rumblings and caused much damage. The City of Huajuapam, in the State of Oaxaca, has nearly disappeared, as all the principal buildings, the churches, and the greater part of the private residences are in ruins; and in the thriving town of Huamantla, on the railway, very large rocks have fallen from that grand mountain, the "Malinche," causing great damage.

Fighting Field Fires with Steamers.

A threatening field fire which had been fought by a large part of the population of South Lewiston, Maine, without staying it, was subdued by a steam fire engine sent down from Lewiston. Three thousand feet of hose was used, water being taken from a brook. By saturating the mossy ground the fire was speedily stopped, though a large timbering had been burned over.