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The Canadian Patent Office Record and Mechanics' Magazine

Vol. II.—No. 1. APRIL, 1874. Price in Canada $1 50 per An
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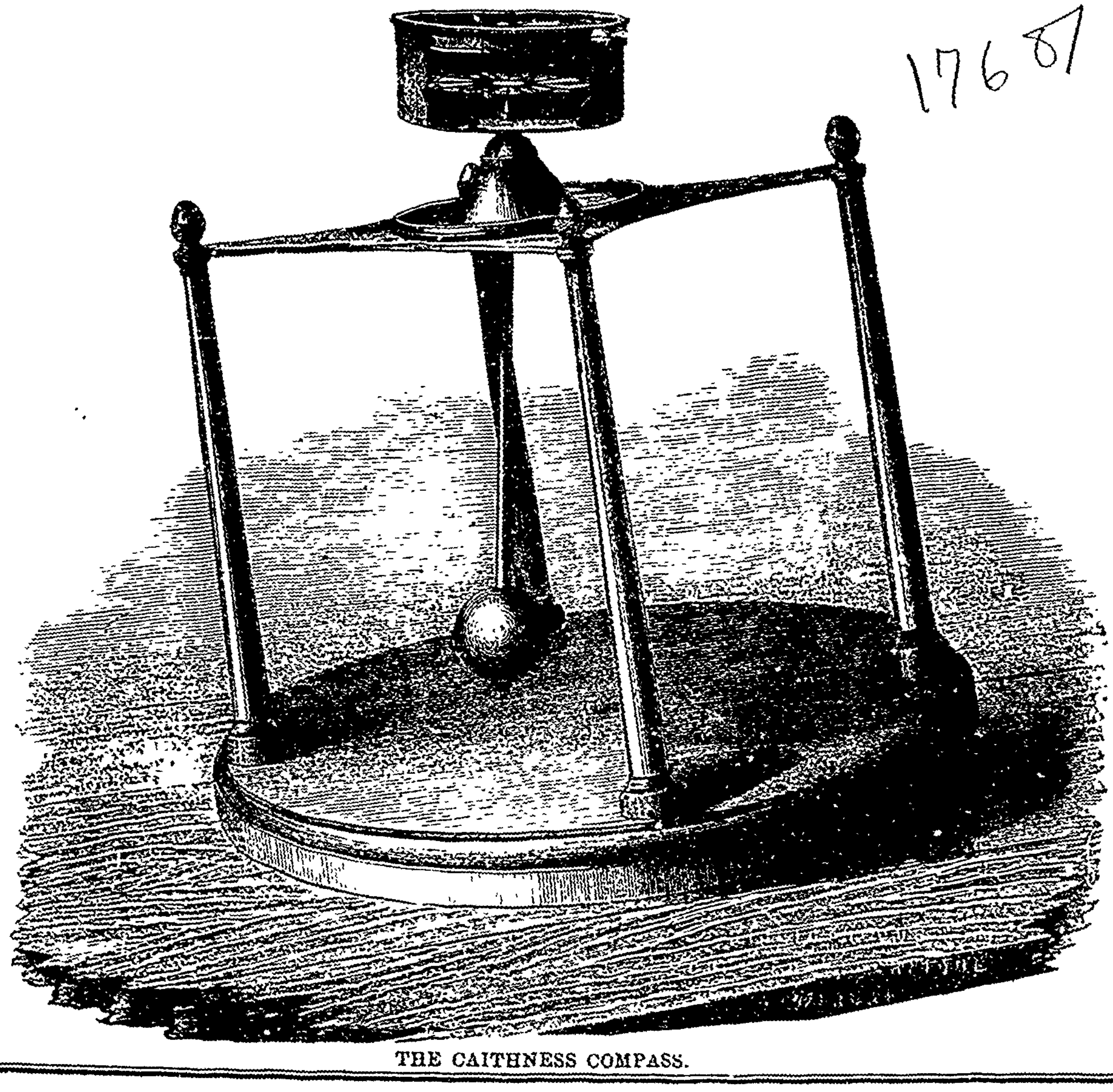


THE CAITHNESS COMPASS.

THE EARL OF CAITHNESS GRAVITATION COMPASS.

A new mariner's compass remarkably devoid of complication in its various parts, has recently been invented by the Earl of Caithness, F R S. The ordinary compass is mounted upon gimbals, that is to say upon two axes at right angles to each other, for the purpose of allowing the compass-box the power of swinging freely in all directions, the necessary result being that the bottom of the compass-box is kept by the force of gravitation, parallel, to a great extent, to the plane of the horizon, whilst its mountings move in various directions, as influenced by the motion of the ship. The essential feature of the Caithness compass is that instead of its being mounted upon gimbals it is mounted upon the top of a pendulum which swings in a ball-and-socket joint. The gimbals of the ordinary compass are intended to give the compass-box the power of moving in a true circle; but they do not absolutely give that power, and never can, since there are two points in the performance of the circle in which there is a slight catch which tends to make the box oscillate, first to the right and then to the left or *vice versâ*, as the case may be.

The new Caithness compass consists of a ball close underneath the compass-box working in a socket fixed at the top of a conical support. The pendulum is about 2ft. in length, and is attached to the small ball, which has thus the power of giving a perfect rotation. It works in a perfect circle and it does not matter how much the ship rolls. The Earl of Caithness calls it the "gravitation compass," because the pendulum always points to the centre of the earth. He says that it will bear very great rolling and pitching of the vessel—in fact, a roll of more than 30 deg.

In the course of a voyage across the Atlantic, made about the middle of October last, in the Java (Captain Martin), by the Earl of Caithness, he tried experiments with the compass on a large scale, the result being that the maximum vibration of the compass-card was about a quarter of a point, whilst heavy standard compasses on board gave much larger vibrations.

The engraving on page 1 represents the compass. The little ball underneath the compass-box has a small slot in its side; a corresponding pin goes through the socket and falls into the slot, thus preventing the compass-box from rotating upon its vertical axis, and keeping the "lubbers point" in a straight line between the axis of the compass needle and the head of the vessel. This "lubbers point" marked inside the compass-box is a guide to steer by, since it shows the position of the head of the vessel in relation to the points of the compass.

When in use the compass is suspended at the top of an ordinary binnacle, which is regulated in diameter so as to give scope for the play of the pendulum, and to confer a power of moving to the extent of 40 deg. The longer the pendulum the steadier of course would be the compass-box; but a very long pendulum would require room for a large swing, and on board ship every inch of space is valuable. A pendulum 2ft. long is found to be sufficient, the advantages of still further elongating it being more of theoretical than of practical value.

THE "CHALLENGER" IN THE SOUTHERN OCEAN — KERGUELEN'S LAND.

The following extracts from the "Occasional Notes" of a contributor to the *Hour* will be read with interest, especially those referring to the visit of the ship to Kerguelen's Land, which, it will be remembered, is one of the spots selected for the Transit of Venus Expedition.

The *Challenger*, having been thoroughly refitted during six weeks' stay at the Cape of Good Hope, steamed out of False Bay on Wednesday, November 17, 1873, bound for Marion and Prince Edward's Island, the Crozet Group, Kerguelen's Land, Heard or M'Donald's Island, and afterwards as far south as could be reached without actually getting amongst pack ice, and from thence to Australia. Besides the ordinary purposes of the expedition — deep-sea exploration in all parts of the world—one of the objects for which the ship was ordered to Kerguelen's Land was to investigate its numerous fords, creeks, and harbours, with a view to selecting the most suitable place from which to observe the Transit of Venus on 9th December, 1874. The information was to be sent home from Australia, and would reach before the expedition left England. It was also intended to leave an account of the proceedings in a cairn in Christmas Harbour, and Betsy Cove. We sighted Marion and Prince Edward's Islands on the 25th December, in the evening, but, as the weather was very thick and misty, and the coast little known, we were compelled to heave to until morning. On the morning of the 26th surveying and exploring parties were landed, the ship remaining under way surveying, sounding, and dredging. The kelp extended fully 160 yards from the ashore, and grew in the water at a depth of 50 fathoms; it floats in long strings, and makes a most effectual breakwater. We landed on large rough boulders, covered with slippery weeds, where a little stream from the hills ran into the sea. Ascending the hillside from the beach you come on soft boggy moss, beautifully green. At first one seemed to walk with great ease, as the ground was so springy, except when you occasionally sank over your ankles; but after a time it was found very tiring, and it was with the greatest relief one came upon a bit of comparatively hard ground. There were many albatross (*Diomedia exulans*) sitting on their eggs on the high ground, where they looked, from a distance, like sheep grazing on the side of a hill. They allowed you to approach without taking the least notice, but if you showed that you had designs on their eggs they stretched out their necks and snapped their beaks; but it was not the least difficult to shove them off the nest with your foot, without injuring them, and take the egg. The nests are mounds about two feet high and about seven feet round the base, made of moss, with the top side concave to hold the egg. We never saw more than one egg in a nest. We strolled along the shore for a couple of miles, keeping a look-out for seals. We came to a penguin rookery, and three kinds were seen — the king penguin (*Aptenodytes rex*), the grey penguin (Johnnies, they are called by the Cape people, but I cannot find them described or named), and the crested and rock-hopper (*Eudyptes chrysocome*). This is the first time we have seen the king penguins; they look very fine, drawn up like a regiment of soldiers, with their bright yellow necks and breasts. The Kerguelen cabbage (*Pringlea antiscorbutica*), grew in considerable quantities in crevices and ravines leading down to the water-courses, in fact, in all sheltered situations. When cooked, although not unpalatable, it has a peculiarly bitter aftertaste, which made me dislike it, but some of my messmates relished it highly. I afterwards tasted it mixed with potatoes and fried with meat, when I thought it good. The ship's company had quantities cooked, and most of them relished it very much. On shore out of the wind the sun was very hot, and one was glad to take off some of the special clothing, but when exposed to the wind, particularly in the afternoon, it was bitterly cold. Occasionally the clouds and mist cleared off the peak (3,000 ft. high) and range of mountains in the background, which were covered with snow; the line of perpetual snow was estimated at about 1,000 feet from the sea, and, although it is now near Midsummer, patches of snow were within 800 ft. of the water. When Captain Cook passed this island he said he thought he saw trees, but we discovered no signs of even a shrub. The rocks and moss upon one of the hills rather resemble underwood when seen at a distance, but you are undeceived on nearer approach. The ground gradually rises from the sea, but is very rough, and broken by numerous water-courses. As the Island so closely resembles the description of Kerguelen's Land, we were surprised at not finding ducks, more especially as there is plenty of cabbage-seed for them to feed upon. But nothing was found except the elephant sea-birds, and their parasites; and there were no traces of either goats or hogs seen by any of the shore parties.

On the afternoon of the 2nd January Possession Island was occasionally seen through the mist. Steam was got up, and, the mist having cleared considerably in the evening, we steamed into Navire Bay. Several very fine cascades were observed, the water tumbling down from the high cliffs to the N. W. of the bay outside. Inside the bay a small hut, with a boat and some casks, were seen; a gun was fired to attract attention, but there were no signs of any sealing or whaling party. A most remarkable appearance was seen on the eastern side of the bay, were the sun was shining brightly on the high red lish cliffs above the belt of mist which obscured most of the land. A very heavy swell was setting into the bay, which prevented anchoring, so the ship steamed out and made sail. A high perforated rock, through which it is said a vessel might sail, stands out more than a mile from the coast to the westward.

On the evening of the 6th January, we observed Bligh's Cap on the starboard bow, but as it was too late to get into Christmas Harbour, we hauled to the wind and stood off for the night. In the morning Bligh's Cap was again seen, and soon after Cape Francis, steam was got up, and we proceeded for Christmas Harbour. On entering the harbour there are high rocky cliffs on the right hand or northern side, the barren appearance of which is most agreeably relieved by patches of bright green. The point to the left is lower. The arch in a detached piece of rock described by Cook does not open until you are well within the outer bay, in which the coal is found. Further up the harbour the shore on the north side is less precipitous, but on the south side a most remarkable boulder, some 600 ft high, almost overhangs the water; at the head of the harbour the ground rises gradually some 300 ft.; but in the background, on every side, a high range of mountains completely encircles the anchorage. It was blowing very hard right out of the harbour, with squalls coming down from the hills. We had to go ahead full speed and could well imagine the difficulty a sailing vessel would have in getting to the inner anchorage. Ross was a couple of days doing it, and had eventually to warp up.

Since this expedition was fitted out, a visit to Kerguelen's Land was looked forward to with perhaps more pleasure than any other of the numerous places on our route, on account of its being so rarely visited and little known. It well merits the name of the Island of Desolation, as nothing can be more barren than the appearance of the high rocky mountains, covered with snow even at this season of the year, which corresponds with July in the northern hemisphere; and although the bright green renders the shore rather pretty, yet our previous experience told us that it was only moss and a kind of grass growing on a soft boggy soil, and gave no promise of useful vegetation. It was a matter of great interest to the sportsmen on board to know if there were wild ducks on the island. The old voyagers Cook and Ross mention their existence, and say that they were good eating, and a sealer we met at Tristan d'Acunha who had passed a season at Kerguelen told us that they were in great numbers. But not having seen any at Marion, we were doubtful on the point, afraid that they had been confounded with shag. It was, therefore, with considerable satisfaction that whilst pulling towards the beach at the head of the harbour an unmistakable wild duck flew over the boat. I carefully marked it down in some grass about a hundred yards from the beach. The landing was very good on a smooth beach of black sand, with a number of penguins, sheath-bills, and tern-petrels on it.. The ducks are smaller than mallard, but larger than widgeon. The plumage is dark-brown, prettily speckled on the breast, neck, and part of the back with grey feathers. The drake is a larger bird than the duck, more grey in the breast plumage, and very handsome wings with dark-blue, brown, and black feathers. They live principally on the seed of the cabbage, their crops being full of it, and the stalks of the plant were seen to be bitten. The weight of the drake was 16 ounces, and of the duck 14 ounces. These birds do not appear to have been named or described by naturalists; probably the variety is only to be found on the islands in this part of the world.

Seeing that most of the ducks took to the hills, we then struck up towards the snow, expecting to find a lake on one of the ridges which ran along the side of the mountain, but there were very few. Even where the ground is quite bare of grass it is very soft in places, particularly at the small streamlets which run down in almost every direction. We picked up some crystals, and kept our eyes open for diamonds.

On the 8th January, the weather appearing settled it was determined to go south at once and have a look at the different places, with a view to selecting the most suitable for the transit observers, so we weighed anchor and steamed out of Christmas Harbour and made sail. Passing between Swain's Island and Home's Foreland, in the afternoon we sighted Mount Campbell ahead, so called by Cook. It is a remarkable object, the surrounding country being low; it is about 600ft. high and round-topped. We went outside the Rocks of Despair and Kent Island, and ran in for Accessible Bay. Got up steam, and proceeded into Betsy Cove, opposite King's End Point, where we anchored. It is a little bit of a place, scarcely room for the ship to swing, and a great quantity of kelp growing close to the shore, but a very snug harbour well sheltered from the prevailing winds.

On January 14 a party was organised to dig for petrels and their eggs in the moss. It was good fun digging; the petrels, tern, and shag all burrow in the soft moss, a great number of eggs and young were obtained, sometimes three or four feet in the ground. A dog would have been very useful to tell the burrows that were inhabited. We were greatly amused watching some king-penguins on the march, the leader would advance a few yards and halt, then the main body moved up, leaving a rearguard; the rearguard would then close, and they appeared to have a grand consultation, when the manœuvres would be repeated. The same bird always led; when they came to the stream, which was only ankle-deep in parts, running very rapidly over a rough stony bed, the marches became shorter. Occasionally one would fall, but he generally recovered himself and got into his place like a good soldier.

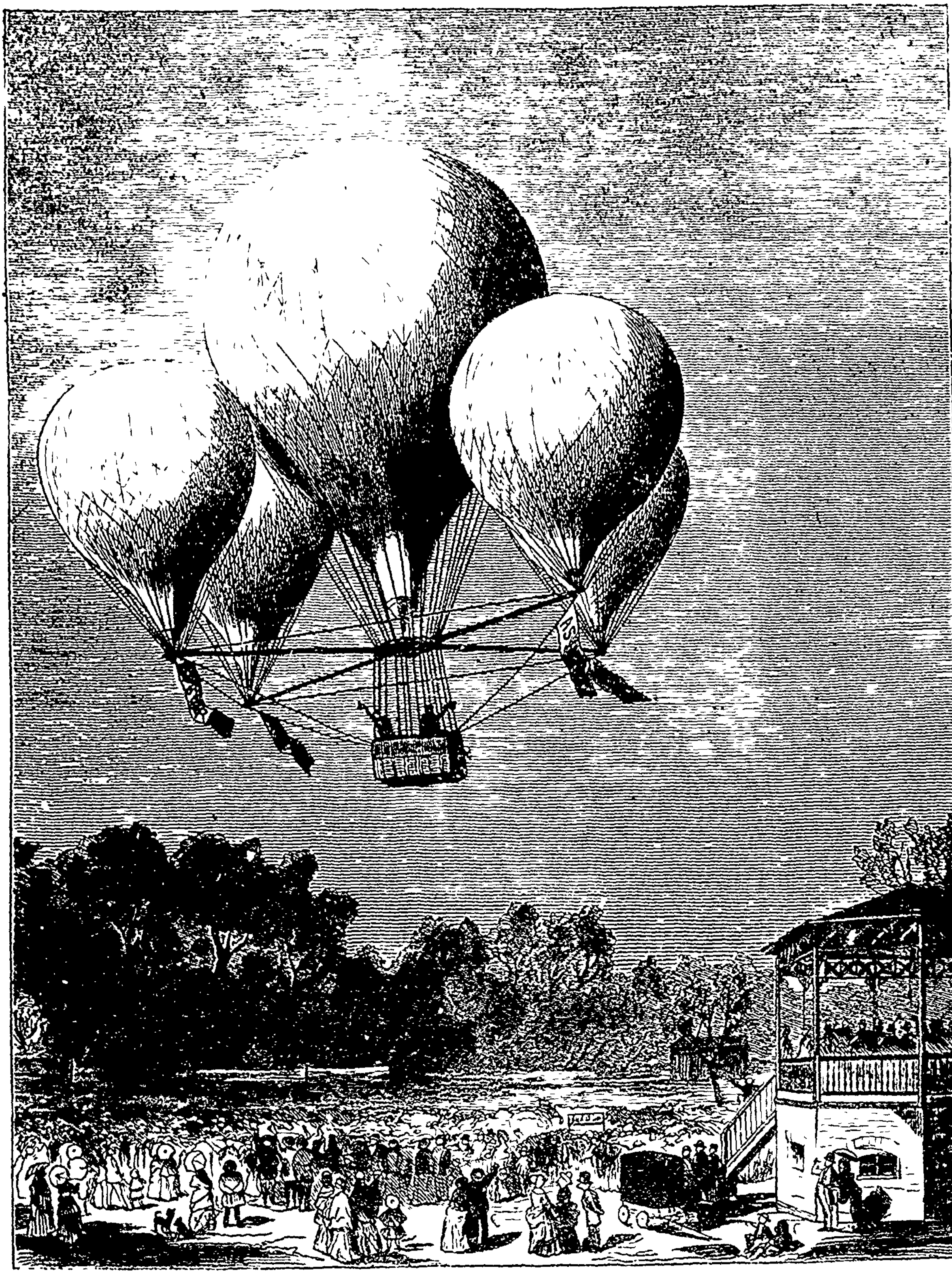
We remained at Kerguelen until the 31st of January, on which day the ship's company built a large cairn on the hill on the N E. side of the harbour, which in all probability will remain for ages as a memorial of the visit of the *Challenger*, into which the report, with charts, &c., of our proceedings whilst at the island, soldered up in a tin case, were deposited, for the information of the expedition for observing the transit of Venus on the 9th of December, 1874. Not the least sign of a tree was seen on the island; the largest plant is the cabbage, and that rarely exceeds two feet high.

At noon on the 6th of February we sighted Heard Island, and shortly afterwards anchored in Corinthian Bay. The bay, which opens to the eastward, is completely surrounded by hills, except at its head, where there is a low beach of black sand extending across the island to the western shore, a distance at this point of about seven miles. The hills on the northern shore are topped with snow, but it does not come down to the water's edge. A point of land runs out into the bay, but it appears to be quite free of vegetation. There was a little green on one of the hills in the background, but the moss does not grow in anything like the luxuriance of Kerguelen, and cabbage does not exist. On the south-western and southern shores there are magnificent glaciers, extending to the water's edge. The mountain was clear to a height of about 800ft., but above that clouds and mist completely obscured it. The total height is variously estimated by sealers and others at from 6,000 to 12,000ft, but that is mere guesswork, as it does not appear that any one has made the calculation by angles. Of one thing we were quite certain—there must be immense fields of ice on the high ground to feed the glaciers, which we were told extended the whole length of the island to the southward on both sides.

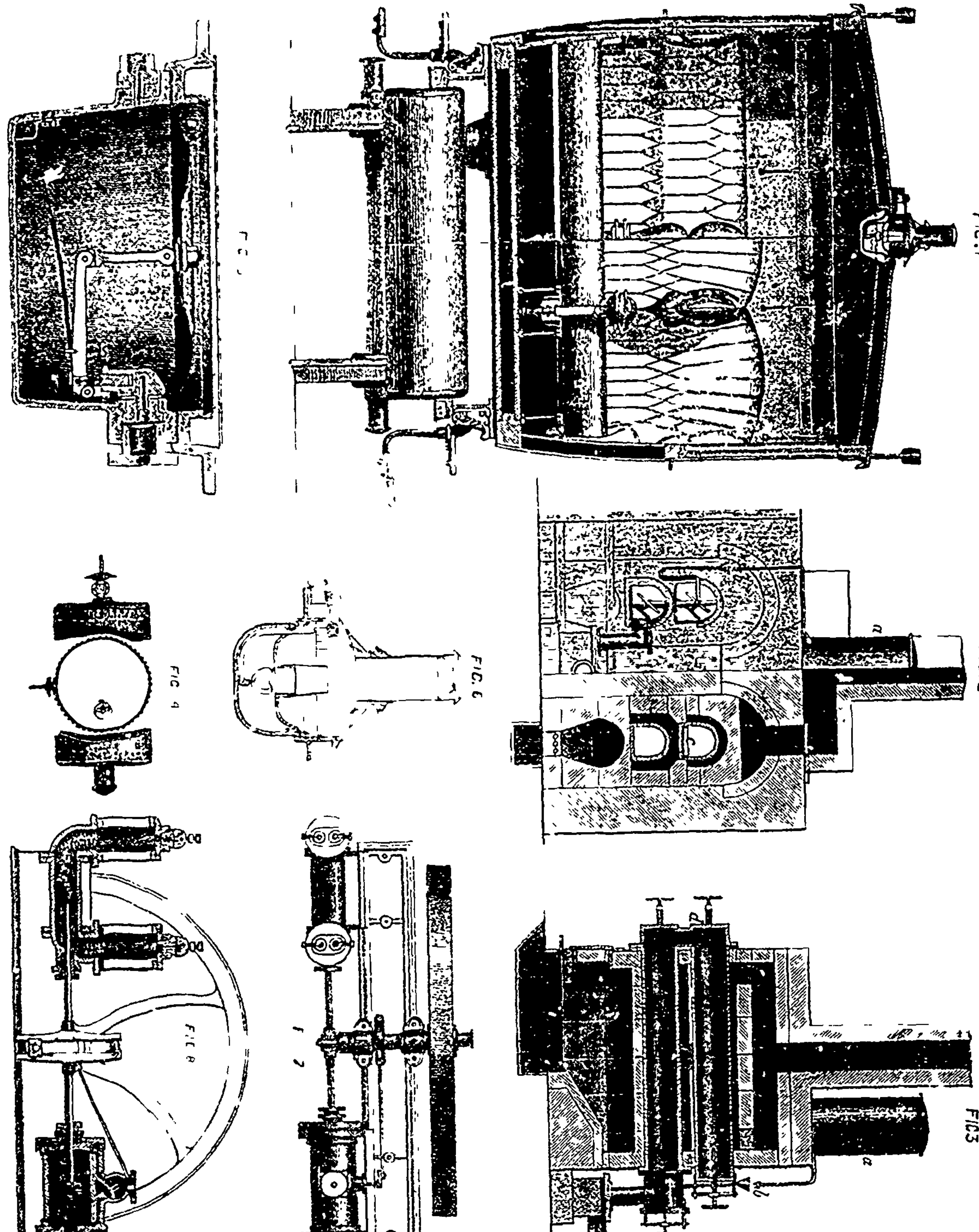
Leaving the neighbourhood of Heard Island, we proceeded to the southward. The icebergs met with by us were usually from ¾ to 1 mile in diameter and about 300ft. high; the highest measured was 350ft. high, but it was evidently an old berg, floating on a large base; the largest was seen further south, in lat. 66° 43' S: it was certainly three miles in length, and was accompanied by several others nearly as large. They were all remarkably clear of rocks or stones, although each time we have dredged sufficient evidence has been brought up that the bottom of the sea is fairly paved with the *debris* brought by them from the Antartic lands. In shape they are nearly all tabular, the original top surface of the glacier remaining uppermost, or inclined at a slight angle to the horizon. In this cold climate they could not be otherwise, unless they broke up in consequence of some local weakness.

To the eastward of 92° E. long. icebergs were very numerous, and continued so as we ran to the eastward, even when we were at a distance from the pack. Their absence further to the westward, between 70° and 80° E. long., except when close to the pack edge, was so marked that, coupled with their absence on the same meridian in lower latitude, as shown by the ice charts, it is thought that there can be no land for a considerable distance south in that neighbourhood, and that a very high latitude could be gained there if desired.

The pack ice consisted chiefly of small saltwater ice-pieces from 30 to 50 feet in diameter; 100 miles inside the pack edge Ross found them to be 200 yards in diameter. The single season's ice was about 3 feet in thickness, the hummocky ice, formed by several layers of this heaped one upon another, and frozen compactly together, was 7 to 8 feet thick, the upper portion of each piece being covered by a layer of snow about a foot in thickness. Scattered about in the pack were a few



SIVEL'S RECENT BALLOON ASCENT AT LEIPSIC, GERMANY.—(See page 6.)



PINTSCH'S APPARATUS FOR LIGHTING RAILWAY CARRIAGES WITH GAS.—(See page 6.)

I encountered berg pieces of all sizes, some of them frozen into the saltwater ice All the latter was much honeycombed by melting, but it was evidently still of sufficient strength to give a very dangerous blow if accumulated against a vessel's side, or to a vessel forcing her way through the pack. A properly-fortified ship could have made way through most of what we saw and it certainly does not deserve the name of a "barrier," given to it by Wilkes, although he was perfectly justified, with his unfortified ship, in keeping outside it. In the pack were numerous icebergs, but they were not in greater numbers than we found in the open water, and certainly not numerous enough by themselves to form the nucleus for the pack to form upon.

On the 27th February we shaped our course for Melbourne, and very soon left the regions of icebergs far behind, reaching Melbourne on the 17th March, 1874.

A NOVEL BALLOON ASCENT.

The French nation has long been foremost in aerial navigation. Pilâtre de Rozier became famous as the first who ventured to ascend in a fire balloon, the invention of the renowned Montgolfier. This was on October 15, 1783, a few animals having previously been sent up, which safely returned to earth. Soon after, Pilâtre again went up, taking with him the Marquis d'Arlandes; and gradually it became so fashionable to take a trip into the higher regions that many persons fell victims to the aerial fever. Pilâtre himself lost his life, being precipitated into the Channel in attempting to cross. It is to him that the idea of using balloons for war purposes is to be ascribed, as on his suggestion the Convention authorized the formation of a company of *Aerostiers*, who were employed in reconnoitering the enemy. Two officers made the observations, and communicated with earth by means of flags, or by messages written on paper and weighted to prevent their being lost. The last experiments of this kind were made in Algiers, in 1830, but with so little success that the company was dissolved.

Aerial navigation, however, assumed great prominence again in the late war, especially, as we have often described in these columns, during the siege of Paris. It was in this excellent school for aeronauts that Theodore Sivel, one of whose remarkable ascents forms the subject of our illustration, was educated. He traveled after the close of the war, with his beautiful balloon *Koloss*, in Sweden and Denmark, and then in Germany. His mother-in-law, Madame Poitevin, a well-known aeronaut, was probably his instructress. The ease and elegance of Sivel's balloon in ascending created a general sensation.

In Leipsic (in the fall of 1873) he was descending rapidly, with five other voyagers, and seeing a great danger, he boldly discharged the gas at once (by a suitable mechanism for slitting up the balloon), after the anchor had taken hold, and obtained thereby full control over the empty balloon, without any loss or accident. His most remarkable ascent, however, was made on May 20, 1874, from Leipsic, when he ascended with five balloons, fastened together, which was, as he himself stated, the grandest experiment ever undertaken in this line. This ascent is the subject of our picture. Around the main balloon *Europa*, were secured the four smaller ones, named Asia, Africa, America and Australia. The ascent was made at 5 30 p. m, Sivel and one passenger being in the basket. The strong wind carried the balloons, which turned playfully around on their axes, in a westerly direction; and they were visible at an elevation of 9,000 feet, as their great bulk made them very obvious at that height. At about 7 o'clock Sivel detached the smaller balloons, and succeeded in drawing them down to the basket and hooking them thereto. He then opened their valves simultaneously, and descended, safely and majestically, to the earth near the railroad station at Durrenberg. A few days after this ascent a double ascent was undertaken, Sivel rising in the before mentioned *Koloss*, and Madame Poitevin traveling in the balloon *Zenith*, making an almost unique display in aeronautics.—*Scientific American*.

There are said to be over 47,000 pieces of metal in every locomotive and tender made at the Baldwin Locomotive Works, Philadelphia.

APPARATUS FOR LIGHTING RAILWAY CARRIAGES WITH GAS.

One of the most needed improvements in railway matters is a better system of lighting. The means at present generally adopted are very inadequate and many travellers never go without a portable lamp by which they are able to read at night with some degree of comfort. It is evident that some form of gas must sooner or later come into use and we illustrate on page 5 a system, the invention of Herr Julius Pintsch, of Berlin who has long been known in Europe as a maker on a great scale of gas-meters and gas fittings. As far back as 1867 he placed himself in communication with the officials of the Niederschlesisch-Markische Railway, and proposed a new system of lighting railway carriages with gas They co-operated cordially with him, and after more than three years of experimenting all difficulties were overcome, and the Pintsch system of lighting has been adopted regularly on the railway in question, and is being rapidly applied on eight other lines, including that from St Petersburg to Moscow, and the Australian "Nord-Kaiser Ferdinand"

The system says the *Engineer*, consists in fitting each carriage with a reservoir of wrought iron, into which gas is forced to a pressure of about six atmospheres, or 90 lb. The gas then flows from this reservoir through a very simple and ingenious regulator to a lamp made of cast iron and of the simplest possible construction, which is placed in the roof of each compartment in the ordinary way. Now all attempts to use *coal* gas in this way have been failures, for the reasons already explained; but Herr Pintsch employs *oil* gas, which is quite unaffected by the pressure when made as he makes it. The oil-making apparatus consists of a double-storey retort. The oil, which may be whale oil, dead oil, common blue shale oil, coarse petroleum, fat—in fact, almost any cheap hydrocarbon will do—is introduced in a continuous stream into a tray in the upper retort. Here it becomes partially volatilised, and then circulating through the lower retort the process is complete, and the gas is passed through a short length of pipe provided with a tar-well, and thence to a purifier charged with sawdust and lime, and thence to a gasholder. On the Niederschlesisch-Markische Railway the cylindrical portions of two old locomotive boilers with flat ends riveted in, are used to hold the gas, which is pumped in by a small compressing engine operating not on the gas directly, but on oil which rises and falls with the pistons in a way which will be readily understood. The gas is pumped into these at a pressure of 90 lb. At the side of a convenient piece of rail several small s and pipes are erected, which are in communication with the compressed gas reservoirs, and from these, by the aid of a stout india-rubber hose and coupling, the reservoirs under the carriages are filled much as the bags are filled on the Metropolitan Railway. About eight minutes are required to supply a long train with gas. The gas is led to the lamps on the roof by small pipes ¼in. bore and the fittings are so contrived that the burner, which is of the batswing type, of steatite, is readily turned back out of the basin of the lamp to permit the latter to be cleaned The glass bowls can be replaced, if broken, in a few minutes A reflector is placed over each flame, and though this reflector passes a flat chimney, the air for combustion comes down outside this chimney, finding its way in through small perforations, and at the highest speeds no flickering of the flame is perceptible. This lamp is in itself worth the attention of railway companies, even if it were to be used with oil, as it possesses many advantages over the ordinary lumbering contrivance. Before the gas reaches the lamp, however, it has to pass through the regulator, and this is one of the essential features of the whole design. It consists of a small cast iron box placed under each carriage out of the way. This vessel is divided into two portions by a diaphragm of dressed sheepskin, which is partially supported by a small lever and spring. The lever acts on a little conical valve, and the moment the pressure becomes too much the diaphragm rises and shuts off the gas. We have seen this regulator tested, and its action, we can say from personal observation, is perfect; and it is found that the gas improves the quality of the leather, being, as it is, free from acids and rather oily in its nature. It is unnecessary here, we think, to enter into farther descriptive details, as we have fully illustrated the apparatus in another place.

As regards the results, it will be asked first, for how many hours can gas be carried? and, secondly, what is the light given? As regards the first point, we may state that a composite carriage has been fitted up on the London and North-Western Railway. This carriage has been running for some weeks. It carries gas enough in a receiver, made of wrought iron ¼in. thick, 5ft. 10in. long, and 1ft. 4½in. diameter, at five atmospheres pressure to run twice to Holyhead and back, sufficient gas being left for a further run to Chester, if necessary. In other words the carriage carries gas for over 1000 miles. It may be imagined that the gas would waste away, or lose its illuminating power during so long a run, but this is not the case. We found the carriage after two runs to Holyhead and back, and having stood at Euston three days, still carrying a pressure of one atmosphere, as tested by a Bourdon gauge, put on for the purpose of ascertaining the pressure. But the point has been set at rest by Herr Gust, of the Neiderschlesisch Markische Railway, who filled a receiver, and left it untouched for eight months, at the end of which time it was found to contain gas under a considerable pressure, and of good illuminating power. The apparatus in use at Euston for making the gas is temporary and of the rudest description; two pieces of 3in. wrought iron piping about 4ft. long constitute the retorts, which are heated by coke burned in a sheet iron furnace. The purifier is about as big as a hat, and the gasholder was made by a tinsmith; the oil used is that drained from the carriage-lamp bowls, and is, we need not say, sufficiently filthy stuff, the pumping is done by a couple of men. As regards the second question to which we have referred, we may state that the oil gas is probably of nearly 40-candle power, and the light in the carriage is about 7 to 4 in favour of the gas.

We have spoken thus fully of Herr Pintsch's system because it appears to have been well and carefully thought out. The labour involved is partly proved by the enormous number of patents which have been taken out from time to time to cover improvements. The use of this system on the Continent is an accomplished fact, and the results obtained on the London and North-Western Railway really appear to leave nothing to be desired but its more extended adoption. Of course, it is quite possible that better systems of lighting may be used, but we venture to think that they have to be yet invented. We have said nothing about relative cost, that is a matter of detail little affecting the public, and not possessing scientific interest enough for discussion here; we believe, however, that the expense of the light is found on the Continent to be about 70 per cent. cheaper than oil lamps.

In our illustration on page 5 Fig. 1 shows a portion of a railway carriage with the gas reservoir; Figs. 2 and 3 show the gas making apparatus with the superimposed retorts; Fig. 4 is a section of the reservoir, Fig. 5 shows the regulator, the construction of which will be understood at a glance; Fig. 6 shows one of the lamps complete with tube in place, while Figs. 7 and 8 show the small engine used for compressing the gas into the reservoirs.

The camphor of commerce, it is well known, is the produce of "Camphora officinarum," a tree of China and Ja[pan]. To obtain it the wood is cut up into pieces and boiled [in] water, when the camphor is deposited. It is afterwards purified by sublimation, and further refined after its arrival in this country. Immense quantities of this article are imported from Singapore, and though so valuable in European commerce, in Sumatra and Borneo a much higher value is put upon that known as Sumatra camphor, which is obtained from "Dryobalanops aromatica, or camphora," which does not come to this country as an article of trade. Besides these there is a third kind of camphor, known in China as Ngai camphor; this, in point of value, stands between the ordinary commercial article and the Malayan or Sumatra camphor. Its botanical source has for a long time been doubtful, but it has generally been attributed to an unknown species of "Artemisia." Mr. D. Hanbury, however, who has done so much in clearing up doubts on the botany of many of our important articles of trade, more especially in relation to drugs, has recently, in a paper read before the Pharmaceutical Society, identified the plant with "Blumea balsamifera." It is a tall, herbaceous plant, and has long been known for the powerful smell of camphor emitted from the leaves when bruised. It is common in Assam, Burma, and indeed throughout the Indian islands.

GUMPEL'S RUDDER.

We illustrate, on page 7, a new form of balance rudder which was recently tested in England. It is described as follows in *Engineering*.

It may be described as a balance rudder which always keeps its fore edge in the middle line of the vessel like an ordinary rudder hinged at the fore edge.

The ordinary balance rudder, as is well known, is pivoted near its middle, and can, with a large rudder area, be easily put over to large angles. But it has certain disadvantages which have prevented its being adopted in any except a few very large steam vessels in the Royal Navy. It stops the way of the ship at slow speeds, and is uncertain in its action when the vessel is under sail. This is supposed by many to be due to the fact that the fore part of the rudder is on one side of the ship while the after part is on the other side, and the idea of Mr Gumpel's rudder is to retain the advantage of the ordinary balance rudder as to ease of turning with a large rudder area, and to obviate its drawbacks by k[eeping] the whole of the rudder on the same side of the ve[sse]l for any degree of inclination.

The means by which Mr. Gumpel accomplishes this can best be described by reference to Figs. 1 and 2, on page 8, which are taken from photographs. The fore part of the rudder is kept in the middle line of the vessel by the guide rod [at] its upper fore corner, which is capable of sliding forward [an]d aft in a groove or slot under the vessel's counter. The inclination of the rudder is obtained by making its axis, which is near its centre, move round on a crank on what usually forms the rudder head. A spindle goes down through the rudder centre, round which the rudder is capable of revolving, and this spindle with the arms at the top and bottom form the crank which carries the rudder centre out of the middle line, and the direction of the plane of the rudder is regulated by the guide rod at the fore end being compelled to slide along the middle line.

It will easily be seen that the advantage which this rudder has over the common rudder in point of power is mainly at large angles, and this may be illustrated by Figs. 3 and 4, which will be found fully discussed in Mr. Gumpel's paper before referred to.

In Figs. 3 the ordinates to the line B E C measure the turning power required for the ordinary rudder at the different angles of inclination marked along the base line, and the ordinates to B C N measure the turning power required for an equal sized Gumpel's rudder, from which it will be seen that there is a point, between 35 deg and 40 deg, at which no power would be required to hold the latter in position. This perhaps will be better understood from Fig. 4, in which O represents the sliding guide rod at the fore edge of the rudder, P the centre of pressure and spindle of the rudder, S the rudder head leading up through the counter of the vessel, and P S the arm of a crank. In this diagram R S represents the moment to turn the rudder at the different angles, and it will be seen that when P S becomes perpendicular to O P the rudder is perfectly balanced and no force is required to hold it in position.

The chief objection raised to Mr. Gumpel's rudder is that it seems complicated. It certainly does appear more complicated on paper than when seen fitted to the vessel, and the ease with which it could be worked, although the steering wheel was small, and a half-turn of it put the rudder hard over, was a subject of much remark on the trial. That it would be of great advantage to river steamers and other craft requiring good steering powers, there can be little doubt, but it would be premature to pass an opinion on it for sailing vessels. The tendency appears to be rather in favour of small rudders for sailing vessels of the mercantile marine, although in yachts they are sometimes of considerable area in proportion to the size of the vessel. It is obvious that the advantages of a balanced rudder of any kind is felt chiefly where large rudder area is required.

A large hill, consisting almost of pure sulphur, was discovered about two years since, 900 miles west of Omaha, and thirty miles south of the Union Pacific Railroad. It is almost pure sulphur, containing only 15 per cent. of impurities. The deposits in Sicily, from which most of the American supplies are obtained, contain 35 per cent. of impurities.

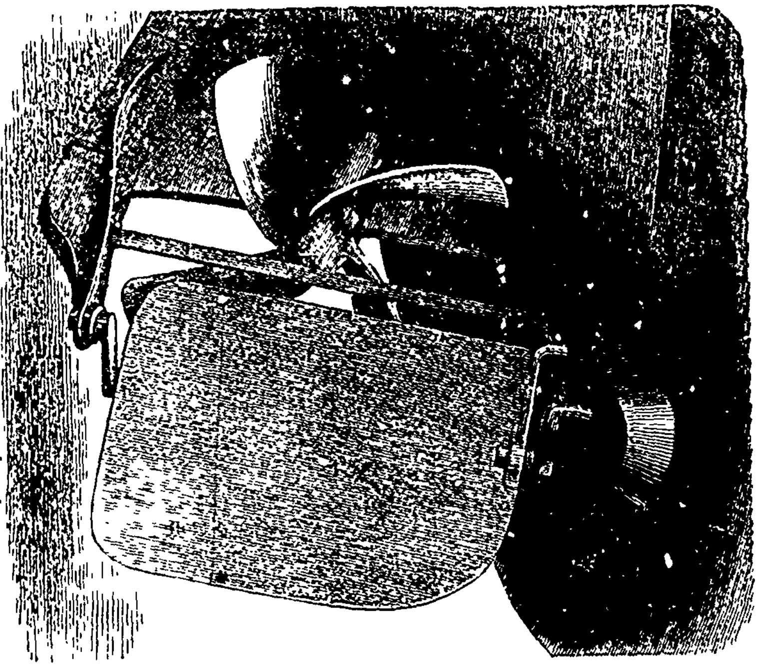


FIG 1

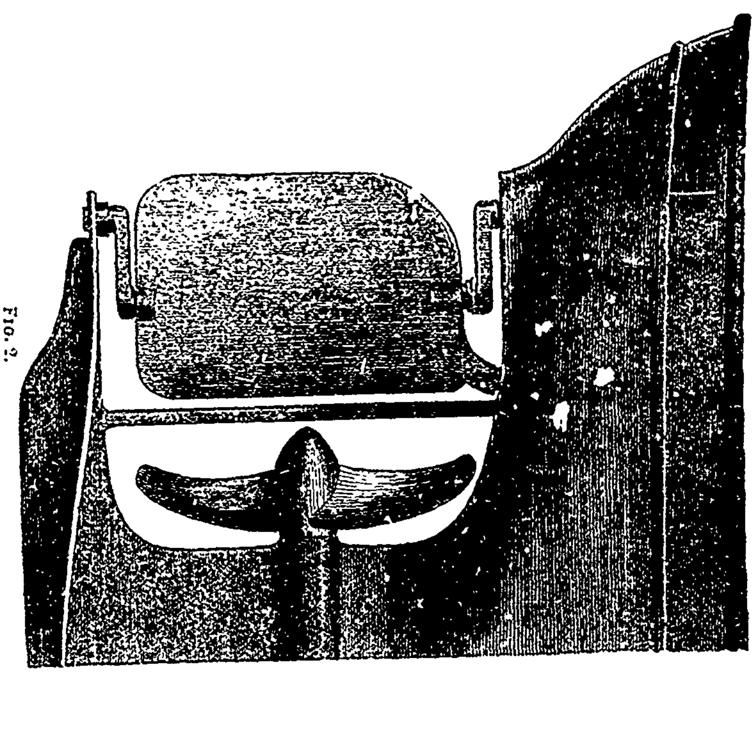


FIG. 2.

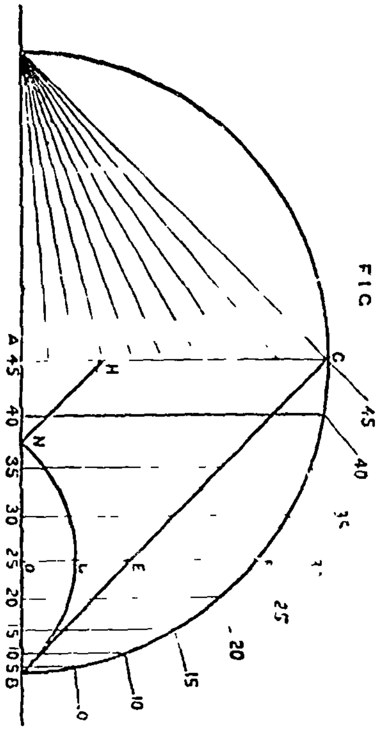


FIG 3

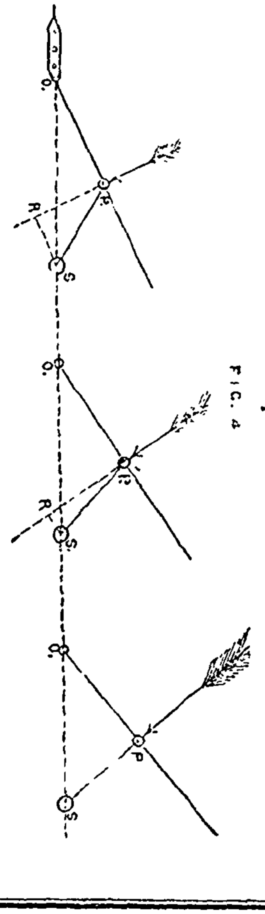
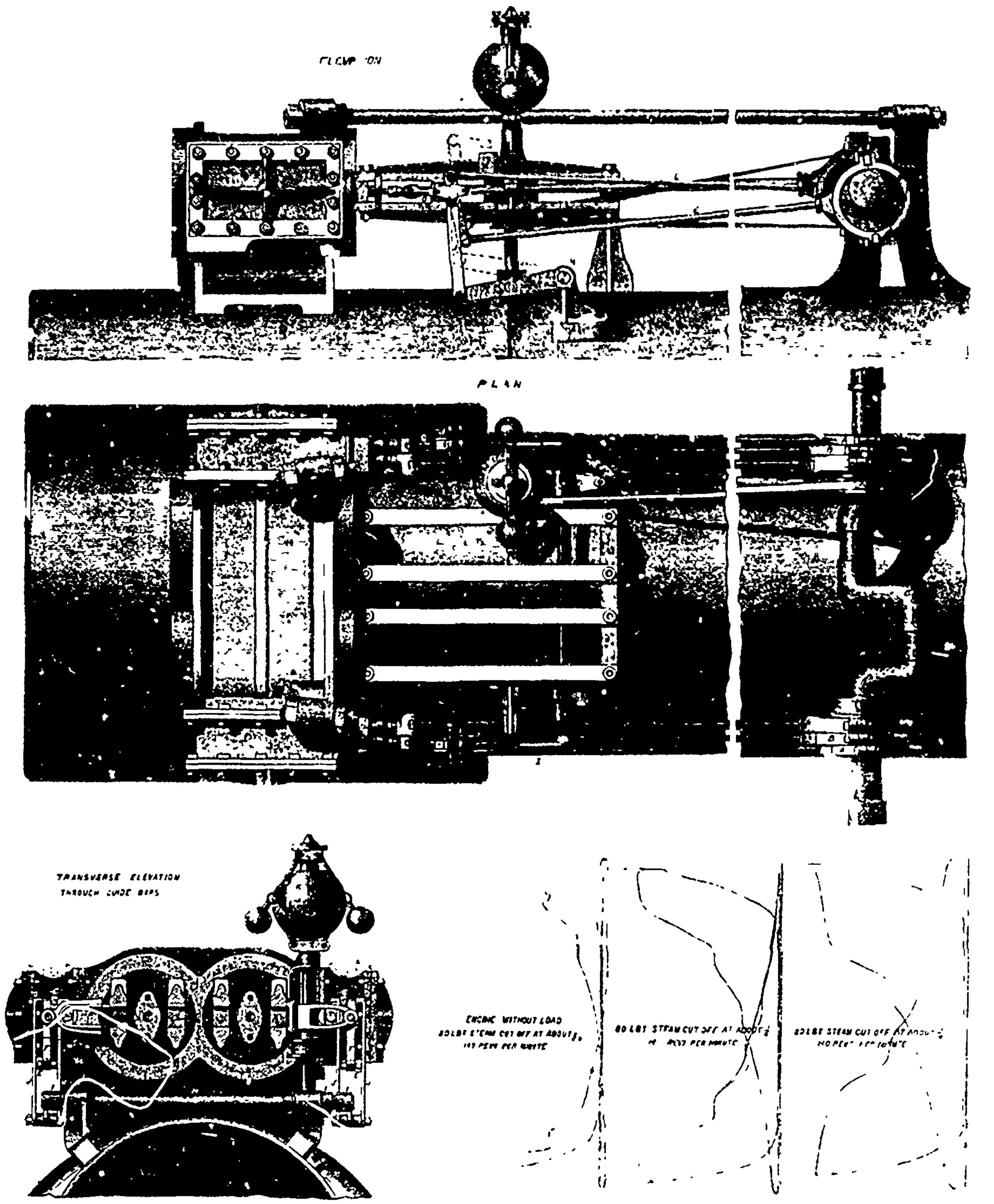


FIG. 4

[illegible] BALANCE RUDDER.—(See page 7.)



TWELVE-HORSE POWER PORTABLE ENGINE.

TWELVE-HORSE POWER PORTABLE ENGINE.

We illustrate above, from *the Engineer*, another Exhibit at the International Exhibition recently held at Kensington. The above journal describes it as follows:

One of the best specimens of mechanical skill at the South Kensington Exhibition is the 12 horse power double cylinder engine manufactured by Messrs. Ransomes, Sims, and Head, and employed to drive Messrs. Allen Ransome and Co.'s sawing machinery. This engine is fitted with all the latest improvements which can be applied to this class of engine. The boiler is constructed to burn sawdust and shavings, as well as coal or wood, and is also supplied with Head and Schemioth's patent apparatus for burning straw, reeds, or cotton stalks, which has already been described in our columns, and bids fair to form an important link in the history of the steam engine. The boiler has 303 square feet of total heating surface, with fifty-seven tubes 2¼in. diameter. The feed pump is double, and connected with a reservoir in the smoke-box in such a manner that one pump supplies the reservoir with cold water which is then heated to nearly 212 deg. Fah., and then co flows into the second pump, which forces it into the boiler at a high temperature. This arrangement is calculated to save nearly 1 lb of coal per horse-power per hour. The cylinders are double, 8½in in diameter, with 12in. stroke, and are steam jacketed as well as the covers. The slide valves are double; the inner one is of the ordinary gridiron type, and worked by immovable eccentrics on the shaft; the outer or cut-off valve is connected with the governors, and arranged to admit more or less steam into the cylinder according to the load upon the engine.

This improvement, which we have illustrated, is the invention of Mr. T. C. Brown, of the Orwell Works, Ipswich, and has been found to work admirably in practice, especially for driving circular and upright saws, mills, and other similar machinery where the work is often suddenly thrown on and off. The following is a description of the invention:—The apparatus consists of two small eccentrics A and B fixed on the crank shaft C, and furnished with straps D and rods E fitted in the usual manner. The extreme ends of each pair of rods are connected together by a solid link F, to the middle part of which—between the ends of the eccentric rods—is attached the rod of the cut-off valve, and through this hollow block the solid links are capable of sliding vertically. The weigh shaft H, the arms I, and supporting rods J form the connection between the links and governor K, which is on the Porter principle. The action of the whole is as follows:—The eccentrics A—the rods of which are attached to the lower ends of the links—are fixed at such an angle in relation to the crank as to effect an early cut-off, whilst the eccentrics B attached to the top of the links are set so as to allow a late suppression of the steam. When the load on the engine is diminished or increased the governor instantly begins, and continues to revolve above or below its normal speed, until, by the rise or falling of its arms and balls, it shifts the links and brings the adjustable valves more or less under the influence of the early or late cut-off eccentrics, thus regulating the supply of steam to the altered load until the engine again makes its proper number of revolutions per minute.

Many inventions have been patented for cutting off steam at various parts of the cylinder by the action of a single eccentric connected with the governor, but although the steam is cut off regularly in accordance with the load on the engine, the exhaust is always more or less throttled when a single eccentric is used. The accompanying diagrams will, however, show that this is not the case in the present arrangement, and the exhaust is left perfectly free at whatever portion of the stroke the steam is cut off by the action of the governors.

EASTERN ARTISANS.

By F. H. Wenham, C.E., in the *English Mechanic*.

In offering some random observations on this subject I do not pretend to bring forward any new discovery in the way of mechanical construction, from workmen who, from the long habit of using Nile mud only in their building operations, and of dabbing together various articles for domestic use of the same material, have consequently but a very crude notion of making anything, either straight, square, or round. A few points, however, attracted my attention, that may bear curious comparison with the refined mode of working in other countries

During a stay of several weeks in one place on the banks of the Nile, some half dozen men brought down on the backs of donkeys a quantity of second-hand timber, of every variety of shape and dimension. One of the gang set to work on a large bag of old bent rusty nails of all sizes, and proceeded to straighten them by laying them in a charcoal fire, picking out the hottest as they came, with a pair of forceps, and flogging them out upon a block of granite. I soon saw that it was their intention to build a candjia or small trading boat for sailing up the river, from the banks of which another man fetched a number of basket-loads of mud, and built up an arrangement for melting pitch, this was constructed of mud only and bore a grotesque resemblance to a common laundry copper.

With a proper selection of crooked pieces of wood, and others made to suit by diligent adzeing, the framework of the vessel was quickly set up bottom uppermost, each rib as it was added being held in place by a temporary stretcher, aided beneath by props of mud. No mould-boards were used, that I could perceive, nor reference made to any plan; the model was arranged apparently by sight. The ribs, when all in place, presented a very fair outline of the usual Nile form of hull, that is, with the heaviest draught forward. As to the formation of these ribs, they had to cut their coat according to their varied stock of cloth, and no one matched the other in size and quality of timber. For example, there would be a square section of rib on one side, and the opposite one consisted of a round piece of wood, if it happened to suit in outline, and perhaps a long rib in another pair would be matched by several short bits, to make up its fellow, but these irregularities were distributed judiciously with regard to strength. Next came the planking, and in this they displayed their best skill. The only cutting tool employed was the "quadoom," a kind of short-handled adze, which they used very dexterously, trimming the edges of the planks to a pretty close fit where they came together. The back of the adze served as a hammer, and as in all their kit they only had the fragment of a saw, most of the planks were cross-cut by notching on each side, breaking off the piece and trimming the end with this universal tool. In order to economise wood (which is very scarce and dear in the country) the planks were not cut to match, or to waste, but laid on in all sizes and lengths. As soon as there was sufficient planking to hold the ribs together, the vessel, by dint of much heaving and shouting, was rolled over so as to lie in all positions, for convenience of working. The seams were caulked just the same as here, and when this rudely-constructed vessel was finished and payed, it was surprising how well and shapely she looked. Like all of her class, with cargo on board, the gunwale would be only just above the water level, therefore the most crazy planks were reserved for the barrier of wash-boards, made water-tight, and fortified outside by a stately embankment of Nile mud, which in that country dries again very soon after it is wetted. Treenails were not used in the construction, for of these they seemed to have no idea; in fact, they had no augers in the proper sense of the term. If a hole of extra large size was required it was rimered out from a smaller one, with a cross-handled implement having a flat bit, shaped like the blade of an oyster-knife. The whole hull was fastened together by an enormous amount of nailing, and as this required a vast number of holes to be bored, these were made with an ease and celerity that would have put our best modern gimlets to shame, for much of the wood was acacia, and rather hard. The tools used were a kind of drill constructed as follows: a short stout piece of iron wire was driven into the end of a straight stick or staff, about one inch in diameter, and from twelve to eighteen inches long. An old ferrule or a few coils of wire, prevented the ends from splitting. An inch of the other end of the staff was cut round as a shoulder, and the projecting piece whittled into a kind of knob, which was forced into a hole bored in a nut of the Doum palm. This knob must be rather larger than the entrance of the hole in a nut, and this having been scooped hollow when the staff is driven in, the nut, though quite loose, cannot fall off again. This served the same purpose as the handle of a joiner's centre brace, and as the ivory-like substance of the nut is of an unctuous character, the rubbing parts do not chafe, but acquire a fine polish. This tool is used by grasping the nut as a handle, and rapidly rotating the staff by a drillbow, consisting of the leaf stalk of the date palm, strung with a thong of hide. The various sizes of wire were quickly sharpened by merely hammering the end on a piece of iron and then rubbing them on a lump of grit-stone.

This leads to a description of the way in which the Turkish pipe-stems are bored. Curiosity prompted me to ascertain how this was done, for some of the stems are six feet long and drilled quite true and central throughout. The best sticks are said to come from the country near Constantinople, and are cut from a kind of dwarf cherry, specially cultivated for the purpose, and trained to grow perfectly straight; many are, however, obtained from Oleander bushes in the valley of the Jordan. If the sticks are not quite straight when they reach the pipe-maker's hands, he soaks them and dries them again under due pressure. The workman squats before a log of wood driven into the ground or floor. In the top of the log there is an upright iron pin about an inch and a half long; a bobbin exactly resembling a common cotton-reel fits freely upon this pin. In the top of the bobbin is driven an iron-wire punch less in diameter than the intended bore of the pipe; the upper end of the wire is spread out by hammering, and made sharp like a bradawl. A conical centre hole is dug out in the end of the stick to be drilled, this is set on the top of the sharp wire, which is rotated rapidly to and fro with a bow, the thong of which passes round the reel. For convenience, the work is usually begun with a short wire drill, and when all of this has entered a longer piece with its attached reel, is substituted. The drills acting vertically, the fine borings fall directly out without clogging, or the necessity of withdrawing the drill till the work is completed. There is, however, one very important condition essential to the success of the operation. While the stick is being drilled, it must be held somewhat loosely in the hand, so as to be continually shifting round; if this is not attended to, the bore is sure to run out of the centre of the stick. This may be exemplified by the operation of drilling up a brass wire for the purpose of forming a tube of small bore. If we attempt to accomplish this by fixing the wire in a vice, however carefully the drill is used it will run out to one side before it has gone an inch deep. But if, on the other hand, the drill (formed of a piece of steel wire sufficiently long) is held as a fixture in the vice, and the wire to be drilled rotated on to it with a bow (the wire having a reel thrust on to it for that purpose) the bore will continue exactly in the centre of the wire. One end of this is pointed to run in the breast-plate, and the other is marked with a centre punch, so as to run true on the drill point, this will come out at last precisely in the centre or point of the wire.

Digressing from the question, in certain cases of moving the tool or the reverse in rotating work, it may be remarked, that in screwing wires, a far truer thread is obtained when the work is turned into the dies, and skilled gas-fitters well know that they get a thread free from drunkenness by fixing their die-stocks in the vice and screwing the gas-pipes into them.

Analogous to the pipe-stem boring, is the operation of the machine employed at the small-arms factory at Enfield, for drilling out the long hole in wooden gunstocks for containing the ram-rod. This is done with a long shell auger, but if this alone revolved the hole would never continue straight, but tend to follow the grain of the wood, as the slender bit is elastic and yielding. In order to prevent this, while the bit is rapidly revolving, the gun-stock also revolves more slowly in an opposite direction; this causes the hole to run true, however cross-grained the wood may be.

I once entered an armoury in the East, where they were stocking and putting together common flint-lock horse-pistols, a brace of which every swaggering fellow likes to carry in his belt during an excursion. I, however, left in disgust, seeing that there was nothing to learn. They had no work-benches, but were all seated cross-legged on the ground, some using their naked feet to hold the work, a very common practice throughout the country, for when a man has gone all his life-time without shoes and stockings, his toes get properly exercised and developed, and become rather prehensile. At Cairo I once stopped to look into the stall of a man who had mounted a grindstone, and gained his living by grinding edge-tools. There was no treadle fitted, he sat at the stone bicycle fashion, and turned the handle directly with his foot, hooking his great toe on to the iron crank-pin, round the end of which it had worn out a soft luxurious hollow, having an exquisite polish.

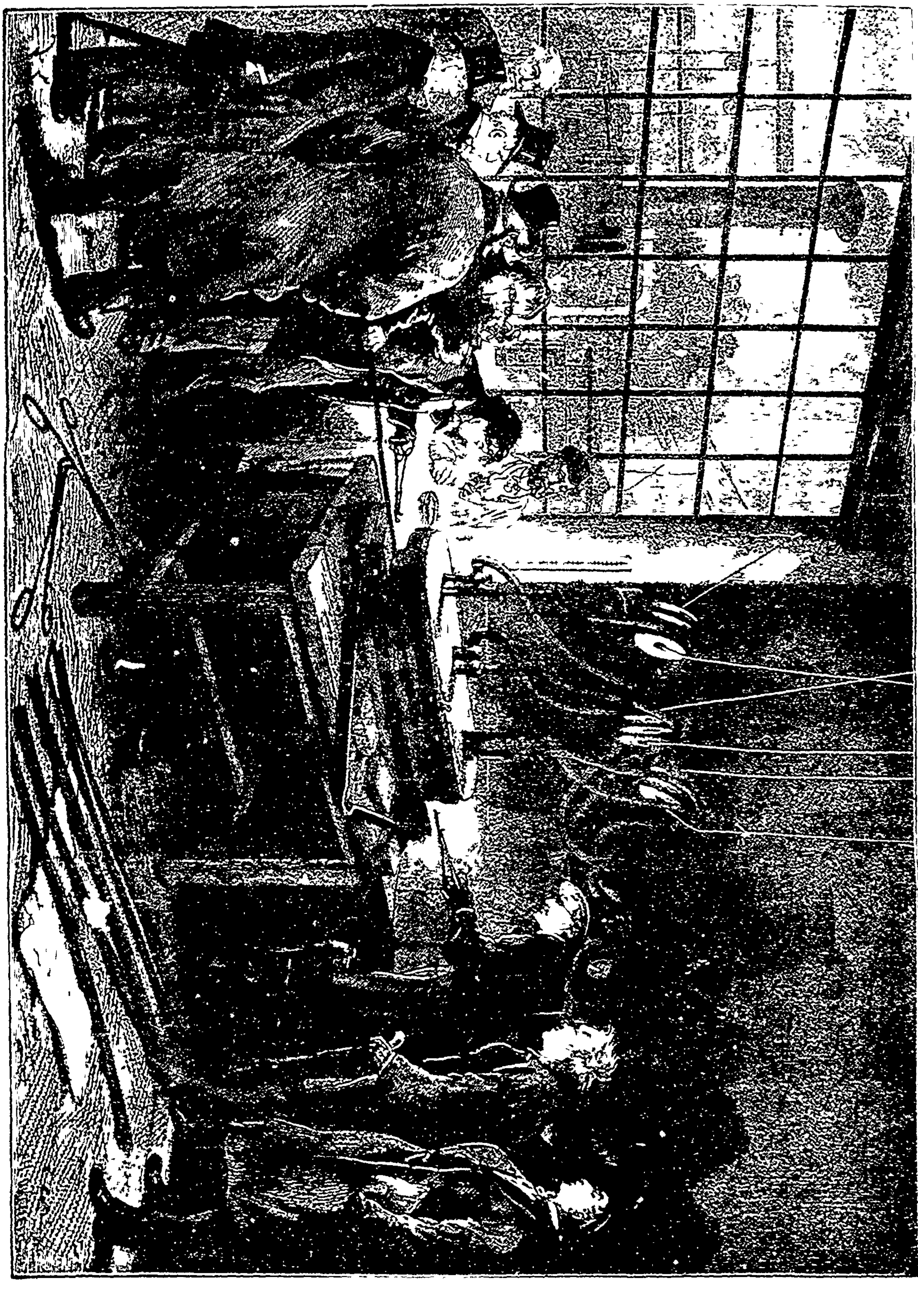
A number of fire-arms of the rudest construction are yet made in the East by the Arabs, but they all appeared to me to be very insufficient and harmless, and the old match-lock is still carried by some of the wandering tribes. During our travel through a part of Samaria, it was considered prudent to hire a Government escort, as the authorities then, to some extent, became responsible for any outrage upon travellers. Accordingly we were provided with two "soldiers," mounted on pretty fleet horses, but the men had nothing, in dress or appearance, to denote a military calling, or anything in their favour to distinguish them from the thieves against which they were sent to protect us. One of them was armed with a long spear only, the other had dangling at his side a most ridiculous abortion in the shape of a blunderbuss of native manufacture, only eighteen inches in length. This, suspended by a single sling from his neck, danced frantically about as he rode. The stock was too short to be held to the shoulder and it would have to be fired pistol-fashion. The muzzle of the barrel was as large as an egg-cup, and the bore dwindled down to the size of a candle-socket at the breech. Irrespective of the moral effect its appearance might produce, I concluded that practically this must have been more a weapon of castigation than destruction, for if loaded with a charge of slugs, and fired into a group of men at a few yards distance, from its scattering proclivity, it would probably hit them all, and might perhaps break the skin and draw blood in a bare place without the risk of penetrating.

An Arab once undertook to guide us to a place where sport was to be had in shooting hares. He himself was armed with a native flint musket, tremendously long in the barrel; this was fastened to the woodwork of the stock by some dozen brass bands or ferrules, which he prided himself in keeping particularly bright. He soon shot a sitting hare, creeping up as close as possible. He asked us to reload his piece; this we were about to do with three drachms of English sporting powder. He said that this would not do, as his gun would not kill unless it had six or eight drach[illegible]: this we gave him on his own responsibility, thinking it n[illegible] unlikely that with our powder his frail piece would be blown to bits, as the substance of the barrel was scarcely larger at the breech than at the muzzle. When he fired again he neither hurt himself nor the game. An examination of the weapon explained the mystery, for the touch-hole was quite one quarter of an inch in diameter, thus acting as a kind of safety-valve, giving vent to more than half the force of the powder, while the surplus was driving the charge. Barbarous as these weapons are, both in design and workmanship yet the barrels of some of them are fine specimens of forging. I particularly remarked one piece; it was a short carbine with silver bands to hold the barrel to the stock, which was also ornamented with silver. The barrel had not been bored, and was of a very curious pattern, not a spiral twist like ours, but an assemblage of fine bright fibres crossing in every direction. I was told that this was made at Damascus, and during my stay at that city I entered a smithy where arms were made.

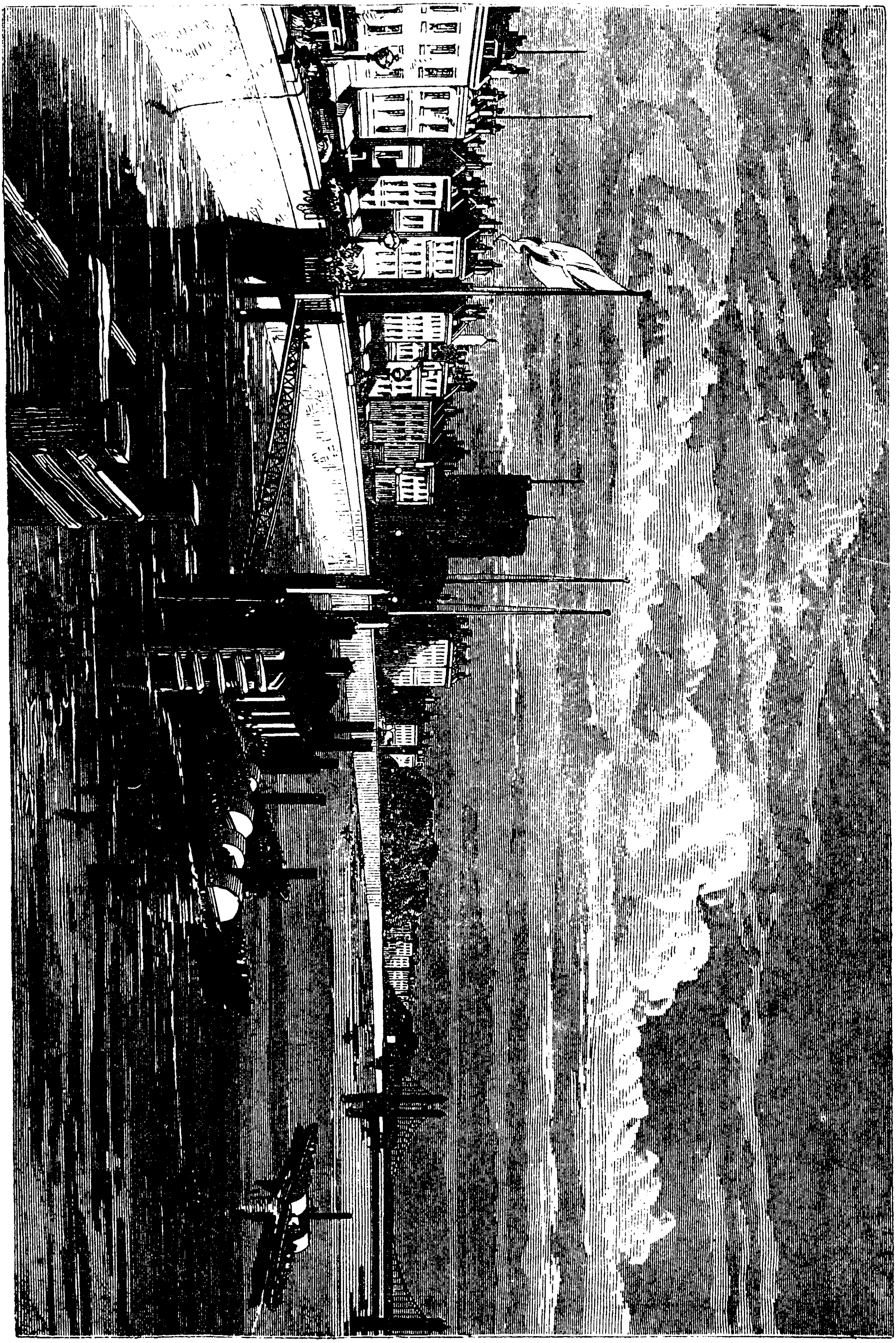
The only fuel used was a fine quality of hard wood charcoal. The bed of the forge was raised the same as here, but the curious feature was the back, which consisted of a slab of a light porous kind of the fire-stone. Under this the blast entered, the tuyere appeared to me not to be a round aperture as with us, but was extended horizontally about two inches. Opposing the back there was a similar slab of fire stone which was set at various distances, according to the magnitude of the work to be heated. If this was small there was not more than an inch between the slabs for containing the ignited charcoal. The faces of the stone acquired a white heat which thus confined and reverberated on to the work, with but a small consumption of fuel. There were two single bellows of a circular form, connected by a rocking staff, so that while one of them was being brought down the other was being raised and filled, thus giving a continuous blast. It might be supposed from this description that the arrangement was rather a primitive and ineffective one, but the work done proved quite the contrary. The superiority of all iron work forged with charcoal is well known, but if this were used in our form of forge with weighted bellows, it would be rapidly blown away. In the Damascus forge the pressure is obtained by the direct muscular force of the arm so that the smith can regulate his blast by feeling, and instantly increase or diminish its force, or stop altogether according to the state of the work; and the charcoal being confined in a narrow space between two walls of non-conducting fire-stone, the escape of heat as well as of fuel is prevented.

At a recent meeting of German engineers a new method of joining gas pipes was described, which may interest some of our readers:—Instead of the usual projecting end, the pipes have channels around them. When placed in contact end to end, a strip of soft lead is bound about them, and pressed tightly against the pipes by a wrought iron ring. The advantages claimed are that the pipes are lighter and more easily cast; less lead is required to make the joint tight; no heat is required for applying it; it is quickly done; and especially that the joint is somewhat elastic, and will last longer in soft ground, or when heavily loaded.

The Pennsylvania railway annually carries 10,000,000 tons of freight and 6,000,000 passengers.



MELTING OF PLATINUM INGOT AT PARIS.—(See page 14.)



THE THAMES EMBANKMENT AT CHELSEA

MECHANICS' MAGAZINE.

MONTREAL, APRIL, 1874.

ILLUSTRATIONS:

CONTENTS:

THE BENGAL FAMINE.

The connection between this great calamity and works of a mechanical and engineering character is closer than would at first sight appear. The nature of the climate and of the soil of the district affected is such as calls for the construction of irrigation canals on a very large scale, and, it is said that were these once carried out the probability of a recurrence of the evil would be extremely remote. There seems to have been no lack of willingness on the part of British capitalists to engage in such works, in the same manner as they have already engaged in Indian railway enterprize to the extent of about a hundred millions sterling. No fewer than ten irrigation schemes are described in the columns of *Engineering* as having been projected, some of vast extent and others smaller. The difficulty seems to have lain in the unwillingness of the Indian Government authorities to countenance these schemes. In fact of the ten projects mentioned but two were countenanced, one of the two but partially. The following is given as the history of the project which bears principally on the case in point.

"The Bahar Project, a very large scheme, taking its supply from the river Son, and irrigating a very large tract of country in and beyond the province of Bahar, the country in which the so-called Bengal Famine now exists, where millions of inhabitants are now suffering from starvation, distress, and its concomitants, disease and ruin; and for the relief of which a loan of ten millions sterling has been asked from the British Parliament by Lord Salisbury, now Secretary of State for India. This project was also negatived by the Government, who declined to give any guarantee of interest on the capital required; the result being that instead of guaranteeing interest on a capital of about eight millions in 1867, providing irrigation and so avoiding the horrors of famine, they have now, in 1874, to spend about the same amount of capital in an unremunerative manner. It is unfortunately this same unwise policy which, extended to the whole of India, continues to be its ruin; and there is little doubt that were the inhabitants of these countries not imbued with Oriental fatalism, apathy, and resignation, they would exclaim loudly against such treatment, and probably not confine themselves to exclamations. It is even possible that should this suicidal policy be adhered to, the English in India may yet have to suffer severely; we have witnessed the mutiny in 1857 of the soldiery, the greater part of whom were inhabitants of Oudh, which was only too plainly the result of confiscating the rights of the Oudh landed proprietors or talukdars, seizing property worth several millions sterling, or, as it is called, the resettlement of 1856, and we may yet see greater things than those.

As regards this Bahar Project we may, however, at present briefly mention that from one-third to a quarter of this project has been adopted by the Indian Government, and that portion will be carried out by the Indian Public Works Department, who commenced it only about two years ago, and may finish it, like the other departmental canals, in a quarter of a century, or more."

The government, however, has done its best to alleviate as far as possible the suffering of the inhabitants. Food was poured into the country as fast as possible, but the difficulty of transport was great. A temporary railroad was constructed from Chumbughant to Durbanga, the rails in many places having to be laid right upon the earth. This road carried 1000 tons of rice per day. About 2000 ox carts, similar to those in our illustration were required to transport this into the interior. This service was one of great difficulty owing to the scarcity of the water and the bad condition of the roads. During one short period 200 carters abandoned the service taking away their oxen and carts—a fact that demonstrates pretty clearly the difficult nature of the work the government found itself obliged to perform.

INTERNATIONAL METRICAL SYSTEM.

During the year 1868 and for some time subsequently a commission composed of delegates from more than twenty States of Europe and America met, at intervals, at Paris to consider the question of the adoption of a uniform system of weights and measures. The commission came to no definite conclusion but it was acknowledged that the French decimal system is at once most rational and most simple. While the system was not at once adopted by any of those governments it was determined that sets of standards, exactly similar to the originals in the French archives, should be made and a complete set furnished to the government of each nation represented at the commission. The manufacture of these standards was entrusted to French Savants and the work has just been taken in hand. It was resolved to make them of an alloy of platinum and iridium as affording a substance which would be least subject to change from the various causes of fire, chemical action, shocks, variation of temperature, &c. Our illustration, on page 12, represents the melting of the metals at the *Conservatoire des Arts et Métiers*. The apparatus used was the largest of the kind ever constructed. It consisted of a number of oxyhydrogen burners and the heat attained during the process of melting reached the point of about 4,172° Fah. The lump of metal, when placed in the crucible measured 44 8 inches long by 6.6 inches broad, and 3.1 inches thick. Its value was $50,000 and it much exceeded in size any lump of platinum ever before melted. The melting process occupied about two hours. The appearance of the melted metal was that of a glowing silver white fluid with a mirror-like surface; when cooled the ingot was silver-like with a roughened surface. The ingot will be rolled to 77 times its present length and cut into bars and shaped into the standards by very careful mathematical measurements.

During the past few months a little model of a railway on the funicular, or rope, system—which has already been successfully in use for five years at Buda—has been exhibited at Rome for the purpose of ascertaining the advisability of its adoption for the proposed line between Naples and the crater of Mount Vesuvius. The general opinion has been favourable to this system, which is noted for its great safety, and the regularity of its movement. One of the features of last year's Vienna Exhibition was a short funicular line up the hill of Kahlenberg, in the environs of Vienna, the incline being a maximum of 33 in 100. This line was one of the most favourite resorts of visitors, being used on some days by more than 5,000 persons. The Austrian Government, before authorising the working of this line, as also that at Buda, wished to prove the solidity of its construction, and to this end the metallic cords were several times cut while the carriages were in motion; owing to powerful breaks, however, the carriages were stopped immediately.

The Company of the Mount Vesuvius Railway, represented by Mr. E. E. Hlieght of Rome, is now negotiating with the Italian Government for the necessary concessions for the new scheme, an illustration of which we give on page 29. The plans of the line have been made, whence it appears that the railway is to be 26 kilomètres in length, three of which are to be worked on the funicular system, and the remaining twenty-three, which do not present any notable inclines, in the ordinary manner. The funicular railway will commence at the foot of the mountain, and will be divided into two sections. The first, 1,200 mètres long, with a maximum incline of 20 in 100, will reach to Adrio del Cavallo, where will be placed the winding machine and a station, and the second section, 1,100 mètres long, with a maximum incline of 35 in 100, will terminate at the distance of a few feet from the great crat r This station will have a large vaulted roof in lava, built in such a manner as to protect the line in case of an eruption by separating the lava torrent right and left. For this purpose also, the line will be raised from the surrounding ground, while the steepness of the incline will also prevent the lava from accumulating. In planning this line the statement of Professor Palmieri that all recent eruptions came nearer and nearer his Observatory has not been forgotten, and on this account the line will be constructed on the opposite side of the mountain. At a short distance from Adrio del Cavallo is the large projecting ro f Monte Somma, behind which, should an eruption take place, all the rolling stock could be stored in safety, and in addition telegraphic communication will be established between the Observatory and the station, so that all important observations may be at once made known. The line also will be made in such a manner that the only danger possible from an eruption would be the destruction of a few hundred feet of rail.

The expense of construction is estimated at less than £160,000.

THE CHELSEA THAMES EMBANKMENT.

This vast and useful public work, which we illustrate on page 13 was opened publicly a few weeks ago by the Duke and Duchess of Edinburgh. Our view shows its appearance on looking down the river from Battersea bridge. Such grand and useful public works as these are exponents of the vitality and constant increase in size and wealth of the metropolis of England.

THE JARDIN DES PLANTES AT PARIS.

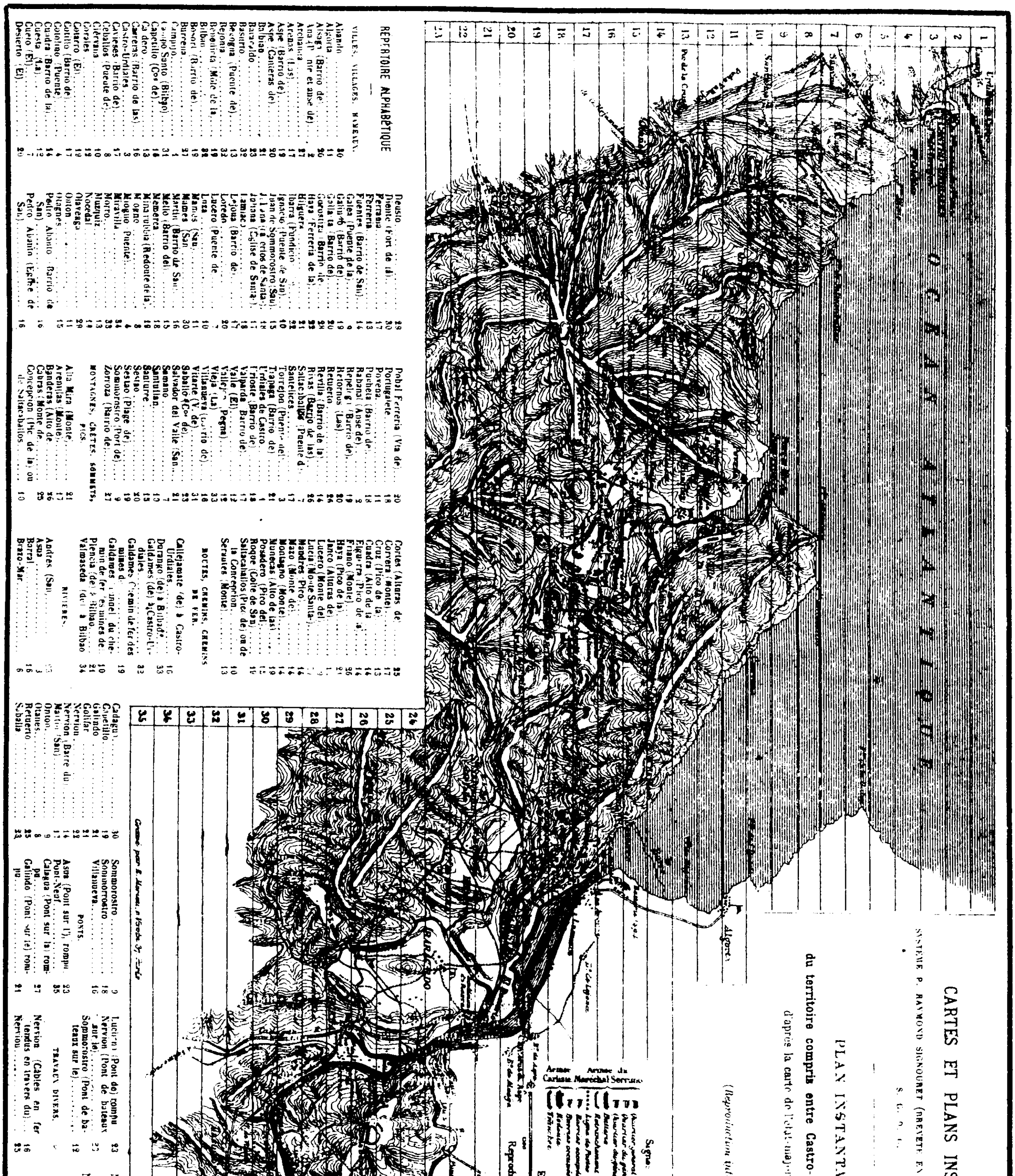
We illustrate on page 28 the new buildings just erected at Paris for the collection of reptiles at this great abiding place of zoological specimens. The buildings consist of two pavilions joined by a gallery, and the arrangements made are such that the habits of the interesting inhabitants are observed with the greatest ease, the lighting being perfect and the space ample. The arrangements include large stoves and air heaters which will maintain a temperature suited to each class of the reptiles.

In our last we gave an illustration of one of the principal entrances to the New Opera House in Paris. In the description of this splendid structure it is stated that the key note of the edifice is found in the grand stair case. An illustration of this staircase will be found on page 32 from which it will be seen that the praises lavished on it are not undeserved. The steps are of white marble from Serravezza, the rails in green Swedish marble and the balusters in red antique marble. The galleries of each storey look out on this staircase from balconies in gilded bronze, except in the case of the first stor y whose balconies, in rare marbles of different shades project from the side or the staircase.

The map which we publish on page 17 is from a recent number of *Le Monde Illustré*. In describing it *Le Monde* says that the best way to show the usefulness and excellence of an invention is by making it pass from theory to practice, which it has done in the case of this new system of maps and plans. This system is the invention of M. Raymond Signouret and it certainly has some points of novelty and excellence—especially in the fact that however closely crowded such maps may be with names, it is a matter of but a moment to find the exact locality of any of them. For example in this map of the seat of the war in Spain, suppose it was wished to find Murquiza. The name is looked up in the alphabetical list and found to precede the figure 13. Casting the eye along the line running across the map from this figure at the side of the map, Murquiza is at once found on the river Sommorostro. The map will, doubtless, besides illustrating the most recent improvement in map drawing, be useful to our readers in following the operations of the Spanish war.

We understand, says the *Nautical Magazine*, that a new suggestion has been made by Captain J. W. Webb, of the British Navy, showing how seamen's ordinary duck trousers may easily be converted into lifebuoys in cases of emergency. The manner in which Captain Webb's suggestion is to be carried out would appear to be as follows: — First, securely fasten the bottoms of the trousers, each leg separately, with a piece of twine or rope yarn; then wet them either in a bucket of water, or over the side of the vessel, and wave them sharply round so as to inflate the legs, and, when inflated, quickly grasp the top and secure it with another piece of twine or rope yarn. The inflated trousers will form a lifebuoy, which Captain Webb has found by experiment to be capable of keeping a man afloat for a considerable time.

THE BENGAL FAMINE: BULLOCK CARTS.—(See page 14.)



NEW FRENCH SYSTEM OF MAPS.—(See page 15.)

PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES.

By John Richards, M.E.

This, and the succeeding articles under the same title were published simultaneously in the *Journal of the Franklin Institute*, Philadelphia and in *Engineering*.

MECHANICAL ENGINEERING.

These articles, as already explained, are to be devoted to mechanical engineering, and in view of the difference of opinion that exists as to what mechanical engineering comprehends, and the different sense in which the term is applied, it will be proper to explain what is meant by it here.

I am not aware that any one has defined what constitutes civil engineering, or mechanical engineering, as distinguished one from the other, nor is it assumed to fix any standard here further than to serve the purpose of defining the sense in which the term will be used; yet there seems to be a clear line of distinction which, if it does not agree with popular use of the terms, at least seems to be furnished by the nature of the business itself. It will therefore be assumed that mechanical engineering relates to works that involve machine motion, and comprehends the conditions of machine action, such as centrifugal strain, intermittent and irregular strains in machinery, the endurance of wearing surfaces, the constructive processes of machine making and machine effect in the conversion of material—in short, agents for transmitting and applying power.

Civil engineering will be assumed to refer to works that do not involve machine motion, nor the use of power, and deals with the strength, nature, and disposition of material under constant strains, or under measured strains, the durability and resistance of material, the construction of bridges, factories, roads, docks, canals, dams, and so on; also levelling and surveying.

This corresponds to the most common use of the term civil engineering in America, but differs greatly from its application in Europe, where civil engineering is understood as including machine construction, and where the term engineering is applied to ordinary manufacturing processes for the production of staple articles.

Civil engineering, in the meaning assumed for the term, has become almost a pure mathematical science; constants are proved and established for nearly every computation, the strength and durability of materials, from long and repeated tests, have come to be well understood, and, as in the case of machine tools, the uniformity of practice among civil engineers and the perfection of their works attest how far civil engineering has become a true science, and argues that the principles involved are well understood.

To prove how much is yet to be learned in mechanical engineering, we have only to apply the same test, and when we contrast the great variance between the designs for machines and the diversity of their operation, even when applied to similar purposes, their imperfection is at once apparent. Even if the rules of construction were uniform, and the principles of machine operation as well understood as the strength and arrangement of material in permanent structures, still there would remain the great difficulty of adaptation to new processes that are continually being developped. If the steam engine, for instance, had, forty years ago, been brought to such a state of improvement as to be constructed with standard proportions and arrangement for stationary purposes, all the rules, constants, and data of whatever kind that had been collected and proved, would have been but of little use in adapting the steam engine to railways and navigation in the present day. I revert to this change in machine adaptation that is constantly going on to warn the apprentice of the task he will find before him. Mechanical engineering has, by the force of circumstances, been divided up into classes, such as engineering tools, railway machinery, marine engineering, and so on, either branch of which constitutes a profession within itself, and the most thorough study will be needed to master general principles, and then a further effort to acquire proficiency in some special branch, without which there is but little chance of success at the present day. But few men, even under the most favourable conditions, have been able to qualify themselves as competent mechanical engineers sooner than forty years of age.

To master the various details of machine manufacture, including draughting, founding, forging, and fitting, is of itself a work equal to most professional pursuits, to say nothing of manual skill, and when we come to add machine functions and their application, generating and transmitting power with other things that will necessarily be included in practice, the task assumes proportions that make it appear a hopeless one; besides, the work of keeping progress with the mechanic arts calls for a continual accretion of knowledge, and it is no small labour to keep informed of the continual changes and improvements that are going on in all parts of the world, which may at any time modify and change both machines and processes.

One of the earliest cares of an apprentice should be to divest his mind of what I will call the romance of mechanical engineering that is almost inseparable from the views acquired in technological schools He must remember that it is not a science he is studying, and that mathematics deal only with one branch of what is to be learned; special knowledge, or what does not come within the scope of general principles, must be gained in a most practical way, at the expense of hard work, bruised fingers, and a disregard of much of what the world calls gentility.

Looking ahead into the future, he can see a field for the mechanical engineer widening on every side; as the construction of permanent works becomes more settled and uniform, the application of power becomes more diversified, and develops questions of greater intricacy. No sooner has some great improvement, like railway and steam navigation, settled into a system of regularity, than new enterprises begin.

To offset the undertaking of so great a work as the study of mechanical engineering, there is the very important advantage of the exclusiveness of the calling—a condition that arises out of its difficulties. If there is a great deal to learn, there is also much to be gained in learning it. It is seldom, indeed, that an efficient mechanical engineer fails to command a place of trust and honour, or to accumulate a competence by means of his calling.

If a civil engineer is needed to survey railways, construct docks or bridges, buildings or permanent plant of any kind, there are scores of men ready for the place, and qualified to discharge the duties, but if an engineer is wanted to design and contruct machinery, he is not so easy to be found, and if found there remains that important question of competency: for the work is not like that of constructing permanent works, where several men may and will perform the undertaking very much in the same manner, and perhaps equally well With machinery its success will be directly as the capacity of the engineer, who has but few precedents and still fewer principles to guide him, and generally has to set out by relying mainly upon his special knowledge of the operation and application of the machines that he is to construct.

ENGINEERING AS A CALLING.

It may in the abstract be claimed that the dignity of any pursuit is or should be as the amount of good it confers, and the influence it exerts for the improvement of mankind.

The social rank of those engaged in the various avocations of life has, in different countries and in different ages, been defined by various standards. Physical strength and courage, hereditary privilege, and other things that once recommended men for preferment, have now lost their paramount importance, and nearly the whole civilised world have agreed upon one common standard, that knowledge and its proper use shall be the highest and most honourable attainment to which people may aspire.

It may be useless, or even wrong, to institute invidious comparisons between different callings which are all useful and necessary, and the matter is not introduced here with any view of exalting the engineering profession, it is even regretted that the subject is to be alluded to at all, but there is too much to be gained by the apprentice having a pride and love for his calling to pass over the matter of its dignity without calling attention to it.

Besides the gauntlet has been thrown down and comparison provoked by the unfair and unreasonable place that the politician, the metaphysician and the moral philosopher have in the past assigned to the constructive arts. Poetry, metaphysics, mythology, war and superstition have, in their time, engrossed the literature of the world, and formed the subject of what alone was considered education. In a half century past all has changed; the application of the sciences in manufacturing, the transportation of material, the preparation and diffusion of printed matter, the utilisation of natural forces, and other great matters of human interest, have come to shape our laws, control commerce, establish new relations between people and countries—in short, have revolutionized the world. So rapid has been this change that it has outrun the powers of conception, and people wake up as from a dream to find themselves governed by a new master.

Railways have done more to develop civilisation than all the influence exerted since the world began by what was, a century ago, called "learning."

Considering scientific progress as consisting primarily in the demonstration of truths, and, secondly, in their application to useful purposes, we can see the position of the engineer as an agent in this great work of reconstruction that is now going on around us; it is certainly a proud one, but not to be attained except at the expense of great effort, and a denial of everything that may interfere with the acquirement of knowledge during apprenticeship and the study that must follow.

The mechanical engineer deals mainly with the natural forces and their application to the conversion of material and transport; his calling involves arduous duties; he is brought in contact with what is rough and repulsive, as well as what is scientific and refined. He must include grease, dirt manual labour, undesirable associations and danger in apprenticeship, or else be content to remain without thoroughly understanding his profession.

THE CONDITIONS OF APPRENTICESHIP.

Were it not that moral influences in learning mechanics, as in all other kinds of education, lie at the bottom of the whole matter, the subject of this article would not have been introduced; but it is the purpose, so far as possible, to notice everything that concerns an apprentice and learner, and especially what he has to deal with at the outset.

To acquire information or knowledge of any kind successfully and permanently, it must be a work of free volition, as well as from a sense of duty or expediency, and whatever tends to create love and respect for a pursuit or calling, becomes the strongest means for its acquirement.

The interest taken by an apprentice in his business is for this reason greatly influenced by the opinions that he may hold concerning the nature of his engagement.

The subject seems in the abstract to be one of commercial equity, partaking of the nature of ordinary contracts, and no doubt can be so construed so far as an exchange of "considerations," but no further. Its intricacy is established by the fact that all countries where skilled labour exists have attempted legislation to regulate apprenticeship and define the relations between the master and apprentice; but, aside from preventing the abuse of power that has been delegated to masters, and in some cases enforcing a nominal fulfilment of engagements, such legislation, like that intended to control commerce and trade, or the opinions of men, has failed to attain the objects for which it was intended.

This failure of laws to regulate apprenticeship, which existing facts fully warrant us in assuming, is due in a large degree to the impossibility of applying general rules to special conditions, it may be attributed to the same causes that make it useless to fix values, or the conditions of exchange, by legislation

What is needed is that the master, the apprentice, and the public, should understand the true relations between them—the value of what is given and what is received on both sides. When this is understood, the whole matter will regulate itself without any interference on the part of the law.

The subject is an intricate one, and is, moreover, so changed by the influence of science and machinery, and a corresponding decrease in what may be called special knowledge, that rules and propositions that would fifty years ago apply to the conditions of apprenticeship, will at the present day be wrong and unjust. Besides, the distinction between hand skill and mental skill, as I will term them, the exclusiveness or general character of the business, the irregularity of value, both of what is learned and the labour given in return, with other conditions not easy to determine, even in a special case, make the subject of apprenticeship a most difficult one to consider

Viewed in the commercial sense, as an exchange of considerations or values, apprenticeship can be regarded like other engagements, but, as intimated before, the analogy ends here. What the apprentice gives as well as what he receives are alike too conditional and indefinite to be estimated by ordinary standards.

The apprentice exchanges unskilled or inferior labour for technical knowledge, or for the privilege of the means for its acquirement.

The master is presumed to impart special knowledge, that has been collected at great expense and pains, as a premium for the assistance derived from the unskilled labour of the learner. This special knowledge may be imparted in a longer or shorter time, it may be thorough and valuable, or not thorough and almost useless.

The privileges of a shop may be such as to offset a large amount of labour on the part of the apprentice, or this privilege may be of such a character as to inculcate erroneous ideas, and teach inferior plans of performing work.

On the other hand, the amount that an apprentice may earn by his labour is governed by his natural capacity, and by the interest he may feel in advancing, also from the view he may take of the equity of his engagement, and whether he is able to place a proper estimate upon the privileges he may enjoy and the instruction received.

In many branches of business, where the nature of the operations carried on are measurably uniform, and have not for a long time been much affected by changes and improvements, the conditions of apprenticeship are more easy to define; but mechanical engineering is the reverse of this; it lacks uniformity both as to practice and what is produced, and is rapidly and continually changing. As a rule, apprentices overrate their services, especially at the beginning, and set a value on what they perform far in excess of the true one.

To estimate the actual value of labour in an engineering works is not only a very difficult matter, but, to some extent, impracticable even by those of long experience and skilled in such computations; and it is not to be expected that a beginner will be able to understand the conditions that govern the value of his labour, and he is generally led to the conclusion that he is unfairly treated, that his services are not sufficiently paid for, and that he is not advanced rapidly enough.

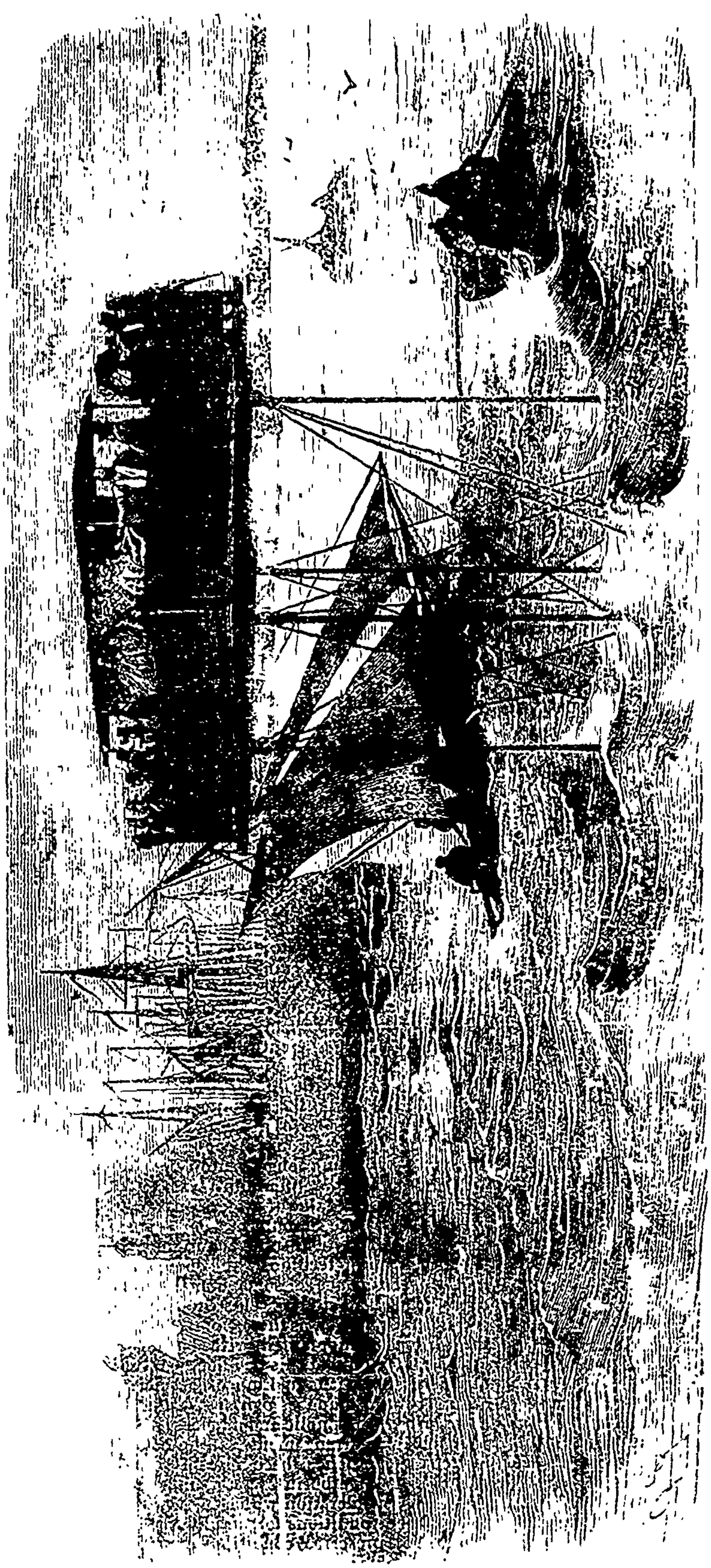
With these conclusions in his mind no great progress can be made, and hence the introduction of the subject here. There is no hope of explaining the position of an engineering apprentice satisfactorily to those who have not passed through a course themselves, and acquired experience as a learner, workman, manager, and master. It is impossible to form correct opinions of matters that we do not understand, and besides what may be pointed out here, there will remain many points which the apprentice must accept upon the grounds of precedent and custom

Technical knowledge and skill are considerations that may be brought or sold, but cannot be transferred from one person to another—they have a commercial value, but cannot be gained as an education for commercial considerations, but must be paid for in a long term of labour, partially remunerated, both during apprenticeship and for a time in after practice The commercial value of professional or technical knowledge is generally as the amount of time, effort, and unpaid labour that has been devoted to its acquirement.

This value of technical knowledge is sometimes modified by the exclusiveness of some branch that has been made the object of special study. This exclusiveness is, however, becoming exceptional, as the secrets of manufacture and special knowledge are supplanted by the application of general principles, and should at this day not be estimated as a condition of importance; it is a kind of artificial protection thrown around certain branches of industry, that must soon disappear as unjust to the public and unnecessary to success.

In business arrangements, technical knowledge, and professional experience become capital, and offset money or other assets of a business; not under any general rule, nor even as a consideration which the law can define the value of, or prescribe conditions for, and for the same reasons that the law cannot prescribe conditions upon which such knowledge may be acquired.

This view of technical knowledge in relation to money in



ROLLING BRIDGE AT ST MALO.

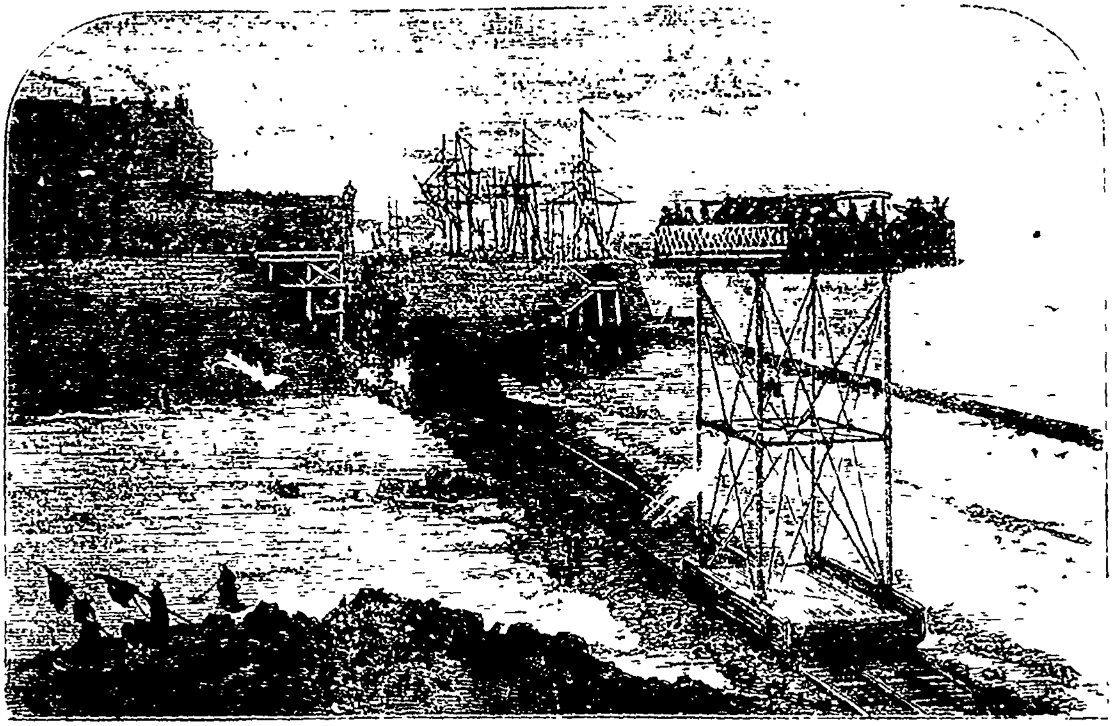
the organisation of business firms, and wherever it becomes necessary to give it a commercial value, is the best and almost the only source from which the apprentice can form a true idea of the value of what he is to acquire during his apprenticeship.

(To be continued.)

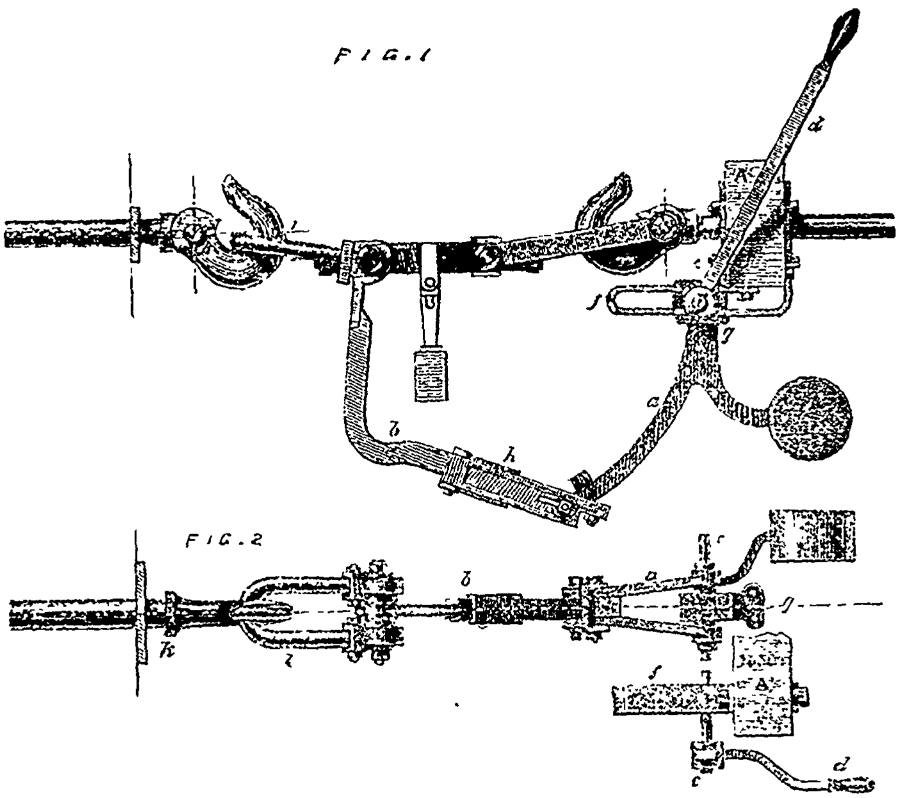
ROLLING BRIDGE BETWEEN ST SERVAN AND ST. MALO.

We illustrate here a very curious flying or rolling bridge used to establish communication between the towns of St. Servan and St. Malo. These towns are separated by the river Rance, or more strictly by the arm of the sea into which the river falls. Until the bridge we illustrate was constructed communication between these towns could only be effected by boats or by going a long way round to a bridge over the river when the tide was in. The tide rises and falls through a height of several yards at St Malo, and for almost four hours twice in the 24 hours, it is possible to cross over the bed of the estuary by descending steps at one side and climbing again at the other. It need not be said that the slimy road thus available is not pleasant. To avoid such inconvenience as we have referred to M. Leroyer, town surveyor to St. Malo, and architect to St. Servan, designed and had constructed the bridge we illustrate. It consists of a platform supported on wheels which run on rails laid on the bottom of the estuary. The platform is supplied with accommodation for horses and vehicles at either side, and two classes are provided for passengers, the fares being five and ten centimes respectively The platform stands level with the quay at each side, so that nothing is more easy than access to it; and, as our illustration shows, it is worked at all states of the tide with perfect safety. Our engravings are reproduced from those which have appeared in our French contemporary *L'Illustration* The bridge appears to be exceedingly popular with the inhabitants of St. Malo and St Servan. It is novel in design, and reflects no small credit on M. Leroyer.

Opening of a Bridge over the Ganges.—The first bridge built over the Ganges has been opened for traffic.



ROLLING BRIDGE AT ST. MALO.



AUTOMATIC CAR-COUPLING.—(See next page.)

AUTOMATIC COUPLING OF RAILWAY WAGGONS.

It is known to many of our readers that the Society of German Railway Companies offered a prize in June last year for the invention of an arrangement by which the coupling of railway waggons might be done without requiring the coupler to go between the waggons. A great variety of couplings have of late appeared, many of them bearing the evident stamp of impracticability. We have here, however, to call attention to one devised by M. Fuchs of Prague, on which the *Deutscher Polytechnischer Verein* of that place have pronounced a favourable judgment (based on trial). It is described in a recent number (1 May) of *Dingler's Journal.*

The considerations by which M. Fuchs has been guided are (1) that the coupling should be applicable without alteration; (2) the apparatus should act simply and surely in all circumstances; (3) the expense of fitting up should be in suitable proportion to the advantages to be gained. The coupling is shown (side view and plan) in the figures on page 21 which are about 1 15th of the natural size. It is a screw coupling so modified that it can be attached or detached without going between the waggons The last member *i* of the coupling chain is connected with a bent lever *b*, which can be raised or lowered by movement of the arm *a*; so that the link *i* is taken out of the hook *k* and allowed to hang down; or again, that the same link can be lifted and hung on the hook. The movement of the arm *a* is effected by means of one of the two handles *d*, which are fitted, right and left, near the side of the waggon, or a shaft fixed in the breast beam A of the waggon. With the handles *d* the movement of *i* can be produced as if directly by the hand.

The connection of the arms *b* and *a* is not made a rigid one, but elastic, through insertion of the strong spiral spring *h*. To facilitate the manipulation in curves, the shaft at its middle slit bearing *g* is movable round a vertical bolt, and the side bearing *f* is furnished with longer slits than *g*, so as to allow of the sharpest turning of the shaft *c*. The weight *e* serves to relieve the arm *a* and the bent lever *b*; in consequence of which the working of the handle *h* is very easy and simple, and can be done by the attendant without any danger.

HOCK'S PETROLEUM MOTOR.

Among the few novelties to be seen in the galleries of machinery in motion at the International Exhibition, is a new Petroleum Motor Engine, the patented invention of Mr Julius Hock, Ely Place, Holborn (a Viennese engineer), which may be regarded as the latest outcome of the research for a substitute for coal as a fuel, and steam as a motive power, by the utilisation of the natural hydrocarbons; and as such it merits attention for its ingenuity and success.

The course of invention hitherto in this direction may be said generally to have tended to the employment of hydrocarbons as fuel in aid or supersession of coal, for the generation of steam; and mainly in three distinct and definite methods, of which the crudest and most unsatisfactory consisted in the simple admixture thereof with ordinary solid fuel in the furnace. Another method, more advanced and successful, consists in their vaporisation in forming what is known as an "air-gas," which is conducted by pipes into a tubular boiler, and there burnt in numerous jets, as in an argand burner. Lastly, there is the "Aydon" system which consists in the combustion of the liquid hydrocarbon in the form of spray, injected into a furnace, by means of a steam injector.

The conception of Mr. Julius Hock, however, as represented by the engine now exhibited at South Kensington, and illustrated in the annexed engravings, goes a stage further, and, dispensing with the intervening appliances of boiler and furnace, cumbrous, costly, and dangerous, utilises the power latent in the hydrocarbon directly by its combustion or explosion, in minute quantities, in the form of spray, within the cylinder of the engine itself: the power thus developed being transmitted by the ordinary mechanical expedient of a piston moving within the cylinder.

In Figs. 1, 2, the engine is shown in side and end elevation, and Fig 3, is a plan, on a somewhat smaller scale; whence it will be seen that it consists chiefly of three separate parts, viz., the petroleum tank or cistern, a gas generator, and the engine proper, comprising the working cylinder and piston with the other mechanical appurtenances. In the enlarged drawings of details, Fig. 4, shows the petroleum cistern and jet in section; Fig 5, the gas generator and igniting apparatus; and Fig 6. the regulating mechanism or governor. A, is the cistern, tank, or receptacle for the petroleum, which is filled by a funnel through an orifice in the cover, closed with a screw-plug; the surface of the petroleum is open to atmospheric pressure, which is the operative agent for forcing it into the cylinder, and its level is indicated by the gauge A'; B, is a metallic plunger, serving to regulate the level of the petroleum within the cistern; B', a cock, whereby the communication between the cistern and the cylinder is established arrested, or regulated, C, the hand-wheel and screw whereby the plunger is raised or lower [ed] as requisite; D, the liquid fuel, petroleum, or hydrocarbon; E, the connecting pipe between the cistern and the cylinder, fitted with a valve-chamber and valve E', to prevent the reflux of the fluid by the pressure caused by the explosion, F, F', nozzle and valve for the admission to the cylinder, of the jet of air whereby the petroleum-jet is dispersed in spray and vapour; H, the gas generator, containing the naphtha from which the combustible gas is generated, whereby the ignition and explosion of the petroleum spray and vapour are effected, at the injector nozzle and jet J, in an intermittent flame, J', the gas outlet and pipe, from the gas-generator to the intermittent burner J; L, M, the gas-holder or receiver for regulating the supply of gas from the generator, which maintains, through the pipe N, the continuous flame at the burner N, whereby the intermittent gas jet J, is ignited as it passes into the cylinder, N'', is a sheet iron screen or guard between the continuous flames N', and the orifice of the cylinder; O, the crank shaft and driving-pulley by which the power is transmitted. In connection with the gas-generator, H, is the apparatus for forcing air through the naphtha, an air-pipe P, forms the communication between the bottom of the generator and the quasi-pump R, which is a hollow hemisphere made of caoutchouc affixed to an iron plate, serving the purpose of an air-compressor, and having a cock Q, and caoutchouc valve S, for regulation of the communication between its interior and the external atmosphere; T, the buffer, worked by rod and eccentric from the crank-shaft, and by its reciprocating action alternately compressing and releasing the caoutchouc hemisphere R, whereby intermittent puffs or jets of air into the generator, and thence of air-gas to the injector J, are created and propelled; this apparatus acts as an intermittent air-pump U, is a pump for the injection of cold water into the hollow casing of the cylinder, for the purpose of keeping the temperature of the cylinder and piston from becoming excessive, and thus avoid over-heating; V, is the fly-wheel on the crank-shaft; Z, Z, the inner and outer cylinder casing, the intervening space Z' being kept full of water. In connection with the cylinder Z, there is a valve-chest X, and regulating mechanism; in the valve-chest are two valves, one *b* for the admission of air, and the other *c*, for the emission of the products of the combustion or explosion of the jets of petroleum spray within the cylinder, the former is maintained in one continuous position, with a larger or smaller aperture, or none at all, according to the work to be done, and the degree of opening is fixed and regulated by means of a bent lever R'', attached to the valve and operated upon by a hollow adjustable arm *d'*, with spiral spring *d*, and screw spindle *e*, for regulating its tension, passing through a screw nut or collar *g*, carried on the end of the short arm of a bent lever, whereof the longer arm *g'*, is acted upon by the governor balls *f*, *f*. Thus the regulation of the speed of the engine according to the work to be done, is effected simply by increasing or diminishing the quantity of air admitted into the cylinder with the petroleum. Finally, for the discharge of the products of the combustion or explosion, the valve *c*, is opened and closed at the proper interval by means of the eccentric rod W, and spring W', worked by an eccentric on the crank-shaft; a stove pipe, as shown in Fig. 1, is attached to the exterior of the valve-chest, to convey away to the chimney shaft or other suitable outlet, the products of combustion (steam and carbonic acid, mixed with empyreumatic gases). These gaseous products have a high temperature, and may therefore be employed for warming workshops, &c., by means of a system of pipes, just as exhaust steam is now frequently so utilised.

In further elucidation of details it may be noted that, as regards the use of the plunger B, in the petroleum-reservoir the height of the surface level of the liquid in the reservoir influences the power of the engine, within certain limits, the higher the petroleum stands therein the more power is developed and work done, with a proportionally greater consumption of liquid fuel; and the lower the surface-level the less the power, work, and fuel-consumption.

As regards the gas-generating apparatus—which is entirely independent of the supply of petroleum to the engine, and is merely required to maintain the flame, whereby the explosion of the petroleum itself is effected within the cylinder —the liquid contained in the gas generator H, is a hydrocarbon of a specific gravity not higher than 0.69, such as naphtha, by the vaporisation whereof the compressed air, in passing through under pressure, becomes converted into an inflammable air-gas. The force with which the intermittent jet or flame is emitted, so as to enter the cylinder, depends upon the degree of compression of the caoutchouc hemisphere produced by the buffer T, as determined by the eccentric. When the cock Q, is opened, it is obvious that the intermittent current of air through the gas-generator will be arrested, and there will be no pulsating flame to enter the cylinder and ignite the petroleum spray, so that the action of the engine will cease. The adjustment of the power of the engine to its load is effected simply by varying the proportion of air and petroleum. On producing rarefaction in the cylinder by the forward motion of the piston, the pressure of the air forces petroleum in through the valve and nozzle E', E; while air is similarly forced in through the valve and nozzle F', F, and the valve *b*, the former being a small constant, for dispersion only of the petroleum into spray, the latter being variable; thus the valve *b*, regulates, in fact, indirectly the quantity of petroleum admitted to the cylinder and the explosive power of the inflammable mixture. If, by means of the screw *e*, the tension of the spring *d*, is made to exceed the ordinary atmospheric pressure, the valve *b*, will be kept closed and an excess of petroleum will be admitted; on the other hand, by relaxing the spring, so that the valve is not weighted at all, nothing but air will pass through into the cylinder; and at all intermediate states the proportions of air and and petroleum will be varied accordingly. The position of the dispersive air-jet F, may of course be varied, and more than one may be used.

The action of the engine in its entirety will readily be understood, the first essential preliminaries being the ignition of the continuous flame N', the closing of the cock Q, and the opening of the cock B'; on turning the fly-wheel, as the piston moves forward, the air and liquid fuel rush in to fill the vacuum, so that at the quarter-stroke that end of the cylinder is filled with air and petroleum in a finely-dispersed, partly vaporised condition. At this point the buffer hits the caoutchouc air-compression pump, causing a jet of combustible gas to shoot out and enter the cylinder, catching fire at the permanent flame, and igniting or exploding the gaseous mixture within the cylinder, the combustion taking place at a high temperature, and with proportionate pressure. All the admission valves are closed by the force of the explosion, which acts upon the piston, to complete the stroke, and is thus absorbed and taken up in the form of work. On the completion of the stroke the eccentric and rod of the emission valve come into action, opening the outlet for the products of combustion, which thus escape from the cylinder as the piston makes its return stroke through the action of the fly-wheel; and so on in sequence, the engine being in action. As the speed of the engine increases, the governor-balls act on the air-valve *b*, through the spring *d*, so as to diminish the pressure on the valve, thus at the next injection more air and less petroleum enters, the explosive force is diminished, and the speed slackens, and *vice versa*. Motion may be entirely arrested and the engine stopped, as explained, by opening the cock attached to the caoutchouc hemisphere; or equally by closing the cock attached to the petroleum cistern. In continuous action the prejudicial effect of the increments of heat upon the cylinder and piston is counteracted by the continued circulation of cold water between the double casing of the cylinder by means of the cold water pump, or by other appliances, as, for example, in the gas-engines of Otto and Langen.

The special points of novelty which the inventor claims in this engine are—(1) the direct employment of the liquid fuel in the working cylinder of the engine, without previous volatilisation, by separate generators; (2) the variability at will of the liquid fuel in the cistern, whereby, within certain limits, its consumption can be varied, suitably regulating the speed and the work done; (3) the disposition and arrangement of the injector, rendering possible the use of liquid fuel, and particularly its dispersion by one or more currents of air; (4) the combination of the injector and the air-valve regulated by the spring and governor, varying the proportions of air and liquid fuel; (5) the ignition and explosion of the prepared mixture in the cylinder, by intermittent jets of compressed gas, ignited by a permanent flame.

Mr. Hock claims for his new motor that it is a cheap source of power for small industries, safer, more convenient, and more economical than steam, and applicable in many cases where steam cannot be used. These engines, we understand, are not as yet manufactured in this country, the English patent being for disposal, but they have for some time been made and used in Austria at the "Eisen und Maschinen Fabrics Actien Gesellschaft in Wien," as also at the Viennese Imperial Printing Office, and other works, having given complete satisfaction. We may remark that the engines are made from one to six horse-power, costing £150 to £400 in Vienna; the dimensions of a one horse-power engine are about 100 inches by 40, or a little more than three yards square, and the consumption of petroleum, which may be of the cheapest kind, is a quarter of a gallon per horse-power per hour.—*Iron.*

FINAL TEST AND OPENING OF THE ST. LOUIS BRIDGE.

The final test of the strength of the St. Louis bridge was made on the 2d of July, under the supervision of Capt. J. B. Eads, the chief engineer. He was assisted by Col. Henry Flad, Oscar Schoultze, Messrs. Klemn, Varrelman, Schmidt, Cooper, and Devon, with ten assistants, and Mr. Schaler Schmidt, of the Baltimore Bridge Company. Col. H. B. Carrington, United States Army, Professor of Dynamic Engineering at Wabash College, was also present, and expressed his satisfaction at the result of the tests. At a given signal there were fourteen locomotives ready to obey the command of Capt. Eads and Col. Flad and their assistants. At about 10 o'clock seven locomotives, crowded with people on pilot, cab, and tender, moved in a body, coupled together, and ascended the approach; and when arriving on the two 56 feet spans over Front street and the levee, east of the abutment pier, they halted and by a signal notified the other caravan of seven iron horses to come up to the track, and they followed up, and the test was begun in earnest.

The following is Capt. Eads' summary of the result of tests made upon the Illinois and St. Louis bridge with fourteen locomotives:

"Seven locomotives were placed upon one track of each span. This produced a deflection of 2½ inches on centre span and 2⅛ inches on each side span. Seven locomotives were then placed on each track of the west approach, and both trains of locomotives, fourteen in all, were moved out abreast and simultaneously over each one of the three spans. The locomotives weighed from 35 to 51 tons, averaging 40 thus each, making 560 tons in all. The two trains thus formed were stopped on each span, and the effects of this load carefully noted. The deflection of the middle span was 2½ inches, of each side span, 8 inches. The two trains moving abreast upon each arch was the severest possible test to produce distortion of the curve of each arch. Ten locomotives were then coupled together, and these were run over each track on each side of each arch of the entire bridge, covering the entire track of each span, and throwing the whole weight of the train, 400 tons, on one side of each span. This test was applied to each side of the bridge, and produced the severest twisting strain to which each arch can be subjected. The vertical deflection produced by this test on the centre span was two and one half inches. The locomotives thus coupled were run at a speed of ten miles per hour. The local traffic on the upper roadway of the bridge was uninterrupted during the progress of the tests. Various other observations in detail were made, noting the effects of the load on the arches as it entered upon and left the different spans, but this possesses no special interest to the general public. The result of the tests agreed almost exactly with the theoretical computations previously made, and the whole trial proved

HOCK'S PETROLEUM MOTOR.—(See page 22.)

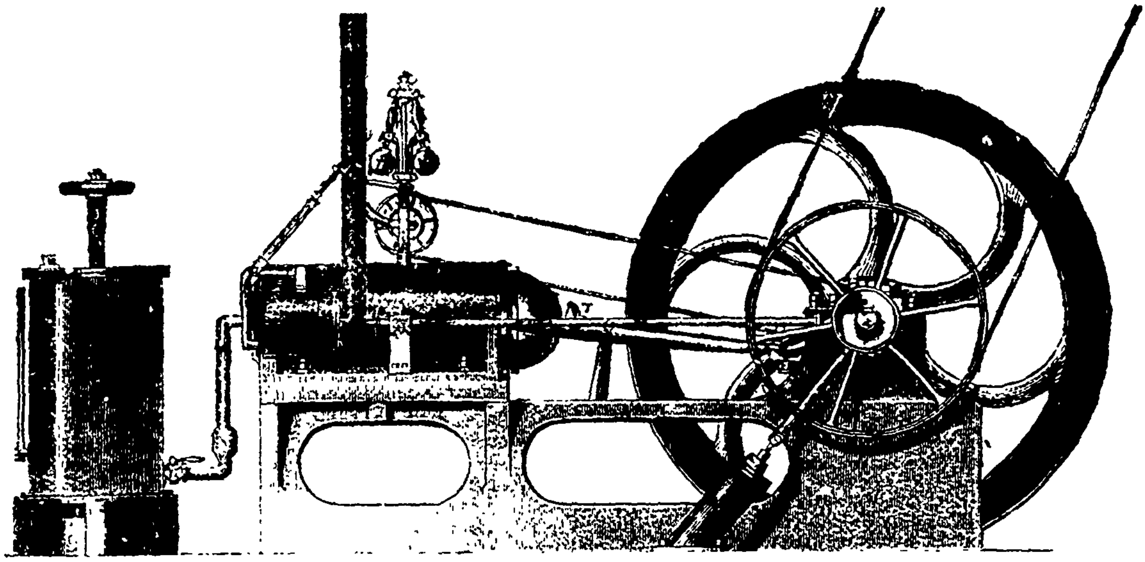


Fig. 1.

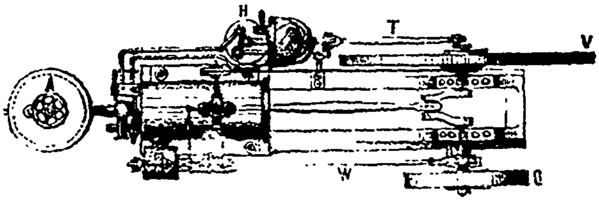


Fig. 3.

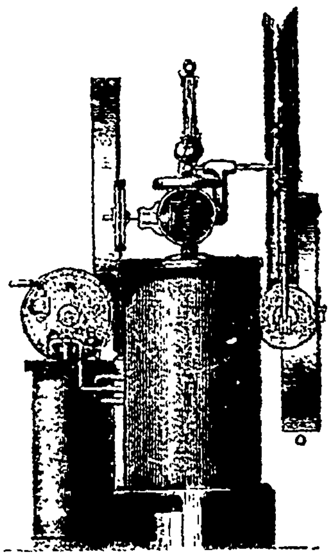


Fig. 2.

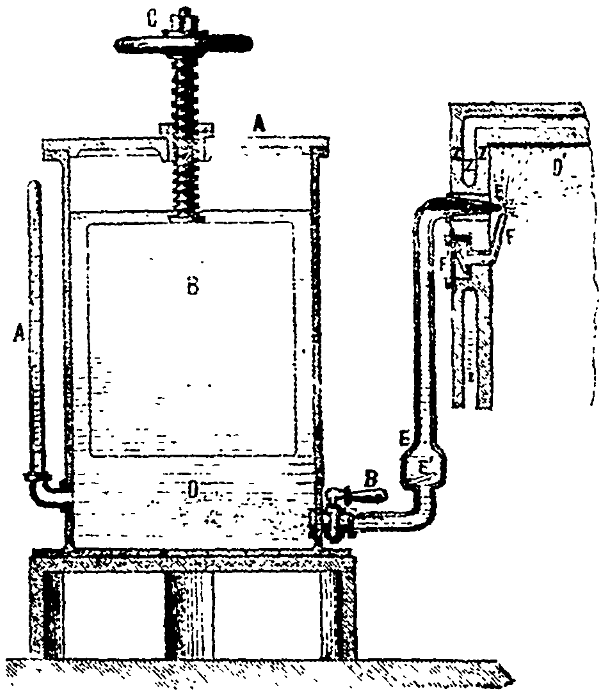
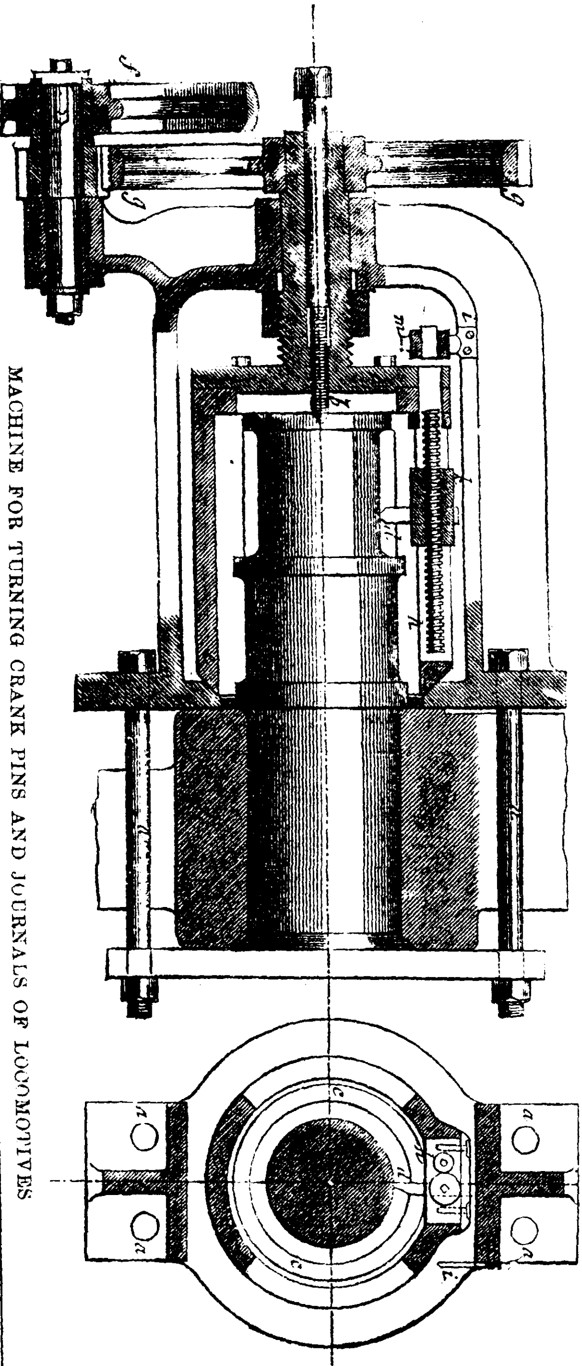


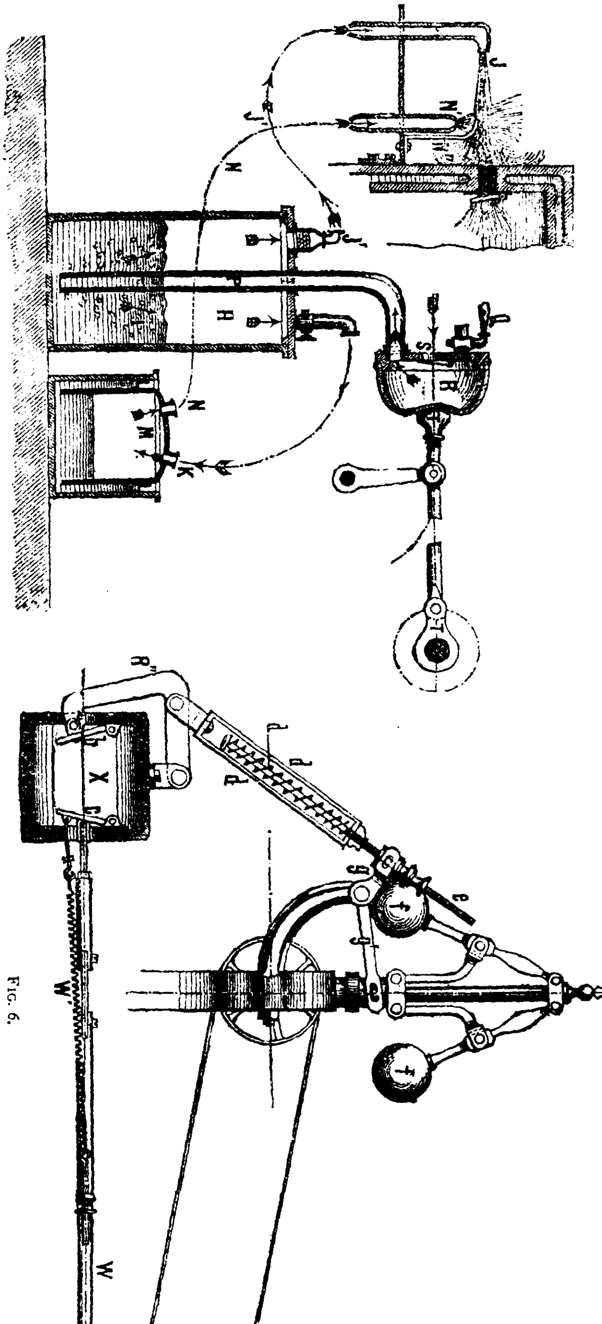
Fig. 4.

eminently satisfactory. The instruments failed to detect any side motion whatever during the tests."

The river is spanned by three arches, of which the central arch has a span of 520 feet, the other two of 5[illegible]2 feet each. The arches are composed of cast steel, and the bridge is really a double structure, consisting of two arches placed side by side. The arches are made of steel tubes, each twelve feet in length.—*Scientific American.*



MACHINE FOR TURNING CRANK PINS AND JOURNALS OF LOCOMOTIVES



HOCK'S PETROLEUM MOTOR.

FIG. 6.

MACHINE FOR TURNING CRANK PINS AND JOURNALS OF LOCOMOTIVES.

In this apparatus, an engraving of which we give on page 25 the tool is fixed immediately against the pin or journal by four strong screw bolts, *a*, and is set in motion by the driving pulley, *f*, to which a belt is carried; centering on one side is effected by the point, *b*, and on the other, by the ring of the pin and the annular piece, *c*.

The tool, *d*, which acts on the cylindrical surface, is placed on the circumference of a tool carrier, *e*, which is rotated by the pulley, *f*, through the cog wheel, *g*. The advance motion of the tool, parallel to the axis of the pin, is gained by means of a screw, *h*, at the rear extremity of which is fixed a wheel *m*. Each time that this wheel strikes a shoulder, *i*, the screw turns, and the support, *k*, advances with the tool. The working of the apparatus is readily understood from the illustration.

NOVELTY IN SHIPBUILDING.—The New London *Telegram* says: —" A vessel is being built at East Boston without a frame as an experiment, the hulk being made of spruce logs a foot square and fastened together every six inches by inch bolts three feet long. Forty per cent less of wood is to be used in her construction than in an ordinary vessel of her capacity, and it is expected that it will be less liable to decay than vessels with frames, while any leak in her can be stopped from the inside."

TAKING COLD.

By J. R. Black, M D., Newark, Ohio, in the *Sanitarian*, (New-York.)

Of all the erroneous notions pertaining to the preservation of health, no one is fraught with more mischief than that about taking cold. According to the popular, and I may also say to some extent professional view taking cold is the greatest disease and death producer in the world. Fully eighty per cent. of those who consult physicians premise by saying they have taken cold. If a relapse occurs during convalescence, ten to one the blame is laid on the action of cold. "My pain is greater, I must have taken cold, I do not feel as well this morning, I think I have taken cold, but I don t see how," are expressions which the physician hears a dozen times a day. The latter is thereby often led to the reflection that if it were not for death-dealing colds he would have little to do, and convalescence would seldom be interrupted. But if the physician takes the trouble to think a little more upon this subject, he will be convinced that to his own craft is due this stereotyped and never-ending complaint of his patients about taking cold. The sick and their friends nearly always take their cue about disease and its causes from the trusted family doctor, and he accounts very often indeed for an aggravation of the symptoms of those under his charge (the cause of which aggravation, by the way, may be, and often is, very difficult to detect) by the easy and satisfying explanation of having taken cold. In this way he gets over the trouble of attempting to make plain to untutored minds what is often a puzzling problem to the most trained intellect, and at the same time shifts the responsibility for the relapse on the uncomplaining and much abused weather So it is that men and women have been led to regard climatic changes as the greatest enemy to their health, it it were not for them, their health would be next to perfect from the beginning to the end of the year. Thousands of consumptives, especially in the first and second stages of the disease, are firmly of the opinion that if they could only escape the malign influence of one cold after another, their recovery would be assured. To this end precautions of the most thorough character are scrupulously observed, and yet cold after cold is taken; the patient, mother, or nurse knows not how.

To the physician, the taking of cold means the suppression to a greater or smaller degree of the sensible and insensible perspiration, and a temporary diversion of the blood from the capillaries of the surface to some internal part. There is, however, reason to believe that the characteristic effects of what is known as a cold in the head may be unattended with any interference of a proper functional activity of the skin. The respiration of very cold and damp air may produce direct derangement in the action of the lining membrane of the nostrils, throat and windpipe. More especially is such an effect liable to arise from breathing for hours a very warm, dry, house air, of a temperature of sixty degrees or upwards, and then in less than a second of time, the cold, damp air outside, of a temperature at zero, or even far below it. In my estimation this is the main cause of that exceedingly prevalent complaint, chronic catarrh of the head. The capillaries and follicles of the mucous membrane of the nostrils are every day repeatedly swollen and engorged with blood by highly heated air—so much so as to arrest for a time the usual mucous excretion—and then shrunk and chilled with cold. This sudden and oft-repeated alternation is too much for the vital harmony of the part, it becomes irritated, deranged, and diseased, just as even the tough skin of the hand will become irritated and inflamed by being repeatedly plunged in cold and then in hot water. In primitive times, when houses were more open and consequently of temperature more nearly that of the ambient air, such a thing as ozena was almost unknown.

It has long been a familiar fact that cold, as a disease producing agent gives rise to no uniform results. Let a wave of cold air sweep over a continent, and how diverse the results upon the inhabitants? Upon some the result is a cold in the head, upon others an attack of rheumatism, upon others an attack of neuralgia, or of pleurisy, or of ague, or of lung fever, but upon the huge majority the effect is a very opposite of a diseased condition, that is, the cold air braces, tones, and enlivens the whole body. Why such diverse effects? — why should an external condition be the source of disease to one and of increased health to another? If cold is *per se* necessarily antagonistic to health and life, why should the larger part of mankind feel better and stronger under its influence? One of the plainest rules of logic is that a cause cannot produce opposite effects, or that putrid pus injected into the blood of two living animals will not produce increased health in one, and disease in the other. The absence of uniformity in the effects of cold upon the body, either in the production of a characteristic disease, or in the presence or absence of this state, indicates that it is not necessarily a cause of disease, and that when it becomes so the effect properly arises from some special abnormal condition of the body In other words, a cold is simply a developer of a diseased condition, which may have been latent or requiring only some favouring condition to burst out into the flame of disease.

That this is usually the correct view of cold as a disease-producing agent under all ordinary circumstances may be made plain by reflection upon personal experience even to the most ordinary understanding. When the human body is at its prime—with youth, vigour, purity, and a good constitution on its side, no degree of ordinary exposure to cold gives rise to any unpleasant effects. All the ordinary precautions against colds, coughs, and rheumatic pains may be disregarded and no ill effects ensue. But let the blood become impure, let the body become deranged from any acquired disorder, or let the vigour begin to wane, and the infirmities of age be felt by occasional derangements in some vital part, either from inherited or acquired abuses, and the action of cold will excite more or less disorder of some kind, and the form of this disorder, or the disease which ensue, will be determined by the kind of pre-existing blood impurity, or the pre-existing fault of the organic processes. If the pre-existing fault be in a deficient excretion of lactic and uric acids by the kidneys and skin, the disease developed by the cold will be rheumatic; if the lungs be at fault, either by acquired or inherited abuses, inflammation will be likely to ensue, or if there be conjoined with the pulmonary fault an impure condition of the blood from the long continued re-breathing of breathed air, consumption will not unlikely show itself. In no other way can the influence of cold in the development of diverse diseases be accounted for, developing this disease in one, and that disease in another; this disease at one time in a person, and another disease at another time; while at other times and seasons, great and prolonged exposure to cold is harmless.

It follows from these facts and considerations that the secret of avoiding the unpleasant consequences thought to spring wholly from the action of cold upon the body has very little dependence upon exposure, but a great deal upon an impure and weak condition of all the vital processes. In other words, with an average or superior constitution and an intelligent observance of all the laws of health, men and women could not take cold if they wanted to, they might be exposed to the action of cold to a degree equal to the beast of the field, and with like impunity. But in the case of persons with feeble constitutions, and who disregard, knowingly or otherwise, and most frequently otherwise, the conditions of healthy existence, no degree of care will prevent the taking of cold, as it is termed. They may live in houses regulated with all the precision of a hot-house—they may cover themselves with the most highly protective clothing the market provides, and yet they will take cold. I do not think the consumptive person lives, or ever will live, even if kept in a temperature absolutely uniform, and clothed in a wholly faultless manner, in whom the well-known signs of one cold after another will not be apparent. But, on the other hand, there are those who, like the late Sir Henry Holland, of good constitutions and living in accordance with the laws of health, may travel as he did from the tropics to the artics again and again, clad only in an ordinary dress coat, and yet scarcely know what it is to have a cold, or sickness of any kind. The truth is, that in order to avoid taking cold from ordinary, or even extraordinary exposure, the vital processes of the body must be made strong enough to rise above the untoward influence of external conditions. If the body is not thus superior, if it is so weak that it can only act harmoniously under the most favourable conditions, a continued state of health is not among the possibilities. No more will a weak body maintain itself without harm amid great external disturbances than will the weak machinery of a steam vessel maintain itself without injury amid a severe storm. The avoidance of elemental disturbances are not possible in the one case any more than in the other, yet it is precisely what persons by the ten thousand are to-day seeking to accomplish in the preservation of their health. The study is not how to make their blood purer, their bodies stronger, but how to dodge the ugly weather.

The conclusion from all this is, that neglecting the conditions upon which strength of constitution and purity of blood depend, and then striving to avoid in a sedulously careful manner the evil influence of colds upon the body, is like neglecting the substance for the shadow of health; or more properly, it is like one who starves his body, and then strives to keep quiet in order that his strength shall not be exhausted. Let food be taken, and the exhaustion from exercise will not ensue; let all the conditions of health be observed, and then the natural changes of the weather will fall harmlessly on the healthy functions of the body.

SCIENTIFIC NEWS.

A few drops of sulphuric acid will prevent any decay in solutions of gum arabic. Herschberg says that by this acid the lime is precipitated as a sulphate.

M. Schalbe has found that by adding to 20 grammes of milk a drop of oil of mustard, it does not coagulate by rest, but the caseine is transformed into albumen.

Powdered chalk, added to common glue, strengthens it. A glue which will resist the action of water is made by boiling one pound of glue in two quarts skimmed milk.

The Society of Arts offers the gold medal or 20 guineas for an improved lamp for illuminating railway carriages. It must be capable of supplying a clear, steady, durable, and safe light. Specimen models, suitable for testing, must be sent in not later than Nov. 1, which in effect means that they must be at the Society's house on or before Saturday, October 31.

The committee for the trial and inspection of boilers of the State of Saxe-Anhalt, Germany, recommend the following composition for coating steam pipes: — 132 lb. limestone, 385 lb. coal, 275 lb. clay, and 330 lb. sifted coal ashes. This is finely pulverised and mixed with 660 lb. water, 11 lb. sulphuric acid at 50 deg. B., and 160 lb. of calves' hair, or hog bristles. The compound is applied to the pipes in coats of 0.4 in. thickness, repeated until a thickness of 1½ in. is obtained, when a light covering of oil is given.

Silver wire has been run through plates of rubies to the length of one hundred and seventy miles, in which the most delicate test could detect no difference in diameter in any part. Gold and platinum have been drawn to a "spider line" for the field of a telescope, by coating the metal with silver, drawing it down to the finest number, and then removing the coating by acid, leaving the almost imperceptible interior wire which, in an experiment made in London, was so attenuated that a mile's length weighed only a grain.

At the Seance of the French Academy on the 1st inst., an interesting paper was read by General Morin, in presenting an ingot of 250 kilogrammes of an alloy of platinum and iridium, made for the International Metric Commission. The preparation of the iridium was accomplished by M. H. Saint Claire Deville, not without considerable difficulty. For this metal is found mixed with osmium, and the vapours of osmic acid may seriously injure those who have to do with it. M. Deville illustrates the enormous toxical power of osmic acid, by saying that, with the 8 kilogrammes of osmium which he separated from the iridium, he could poison the whole world. 1 milligramme is sufficient to render dangerous the atmosphere of an apartment of 100 cubic metres size.

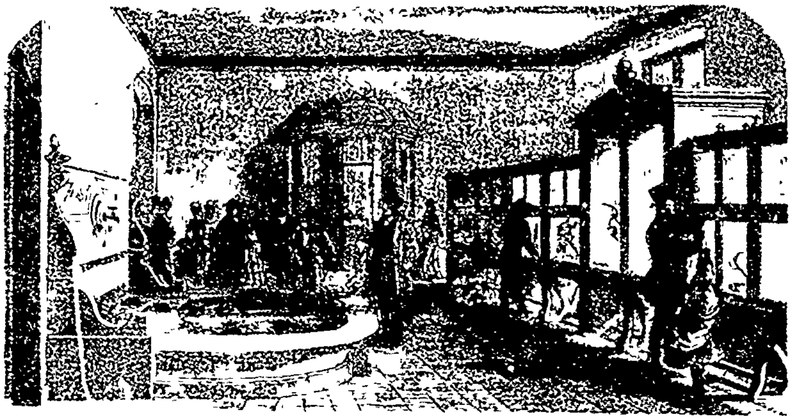
In an article on the cremation of dead bodies (*Moniteur Scientifique* for May), Professor Reclam of Leipsic, advocates the adoption of Siemens' regenerative system for the purpose, as being "the most simple of all cremations, and that which best satisfies the piety of families." He has had a special apparatus constructed and experimented with. According to his proposal, "before the friends of the deceased have assembled, the body is let down (in or without a coffin, into a walled and empty space; it is merely in contact with the air raised to a white temperature, and the oxygen of which combines with the atoms of the organic tissues. It burns without odour in this hot medium, as a candle is consumed without odour in air. There remain simply the ashes unmixed with foreign bodies. The combustion is so perfect that I have never observed in the chimney the presence of vapour or of smoke, but merely that of hot air."

The following details of a new theory of waterspouts are from the *Journal of the Franklin Institute*.—"It has been hitherto assumed that the column of air which revolves to produce a waterspout is an ascending column. M. Faye, the astronomer, has recently maintained before the French Academy the theory that the air in these columns is a descending one. Precisely as in a river, vertical layers of water, moving with different velocities, form whirlpools in shape like funnels, drawing the water away from the centre, so, when currents of air above the clouds move in different directions, or in the same direction with different velocities, they produce upon their borders a gyratory motion of the interposed air. This air descends like the water in the whirlpool, and if the gyratory movement be powerful enough the tube of rotating air may reach the earth. At the same time the centrifugal force determines the matter to the exterior, and causes a partial vacuum in the interior, thus explaining the lifting of objects over which the whirlwind passes, and in the case of water producing waterspouts. Of course the barometer in the centre experiences a sudden fall. The solar spots Faye explains in this way, supposing them to be whirlwinds seen vertically. The solar gas drawn into them being cooler, appears as the dark umbra."

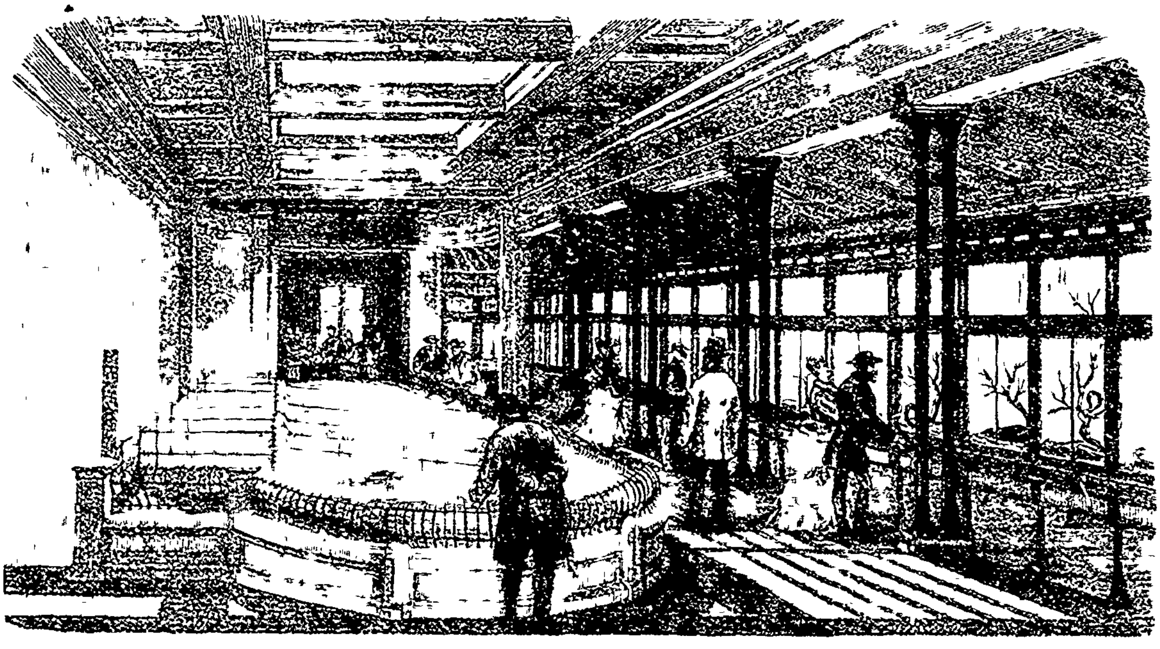
The iron dome of the Capitol at Washington is 300ft. high, and is surmounted by a metallic statue. In reply to an inquiry, as to whether there was a daily movement of the statue, due to the heat of the sun, the architect, Mr. Clark, gives the following particulars. The statue on the Capitol has a motion resulting from the unequal expansion of the opposite sides of the dome. The entire length of the line of oscillation of the plummet from the eastern limit to the western limit is only 4¼in., which would make the inclination in the morning 2¼in. to the west, and in the afternoon the same distance to the east. This apportionment of the distance for morning and evening, however, is not strictly correct, and for this reason: that in the morning the east side of the dome is rapidly heated, while the west side is chilled by radiation through the night. Now as the sun passes to the western side of the dome, this side is heated, but as the east side still retains a good portion of its heat, the expansion is more nearly equalised on both sides, and the inclination of the statue to the east to some extent counteracted, so that the inclination to the west is a little greater than toward the east. The variation is probably about the same all the year round, the extra contracting by cold on one side of the dome during the winter producing the same effect as the extra degree of expansion by heat on the other side in the summer.

Concerning the formation of deposits in boiler flues, about which a considerable amount of speculation has been published, Prof. Hayes gives the following opinion in a late issue of the *American Chemist*.—These are of two kinds, both of which are capable of corroding the iron rapidly, especially when the boilers are heated and in operation. The most common one consists of soot, nearly pure carbon, saturated with pyroligneous acid, and contains a large proportion of iron if the deposit be an old one, or very little iron if the deposit has been recently formed. The other has a basis of soot and fine coal ashes, silicate of alumina, filled with sulphur acids, and containing more or less iron, the quantity determined by the age of the deposit. The pyroligneous deposits are always caused by want of judgment in kindling the fires. The boiler being cold, the fires are generally started with wood; pyroligneous acid then distils over into the tubes, and collecting with the soot already there from the first kindling fires forms the nucleus for the deposit, which soon becomes permanent and more dangerous every time wood is used in the fireplace afterward. The sulphur acid deposits derive their sulphur from the coals used; but the base, holding their acid, is at first occasioned by cleaning or shaking the grates, soon after adding fresh charges of coal. Fine ashes are thus driven into the flues at the opportune moment for them to become absorbents for the sulphur compound distilling from the coals, and the corrosion of the iron follows rapidly after the formation of these deposits.

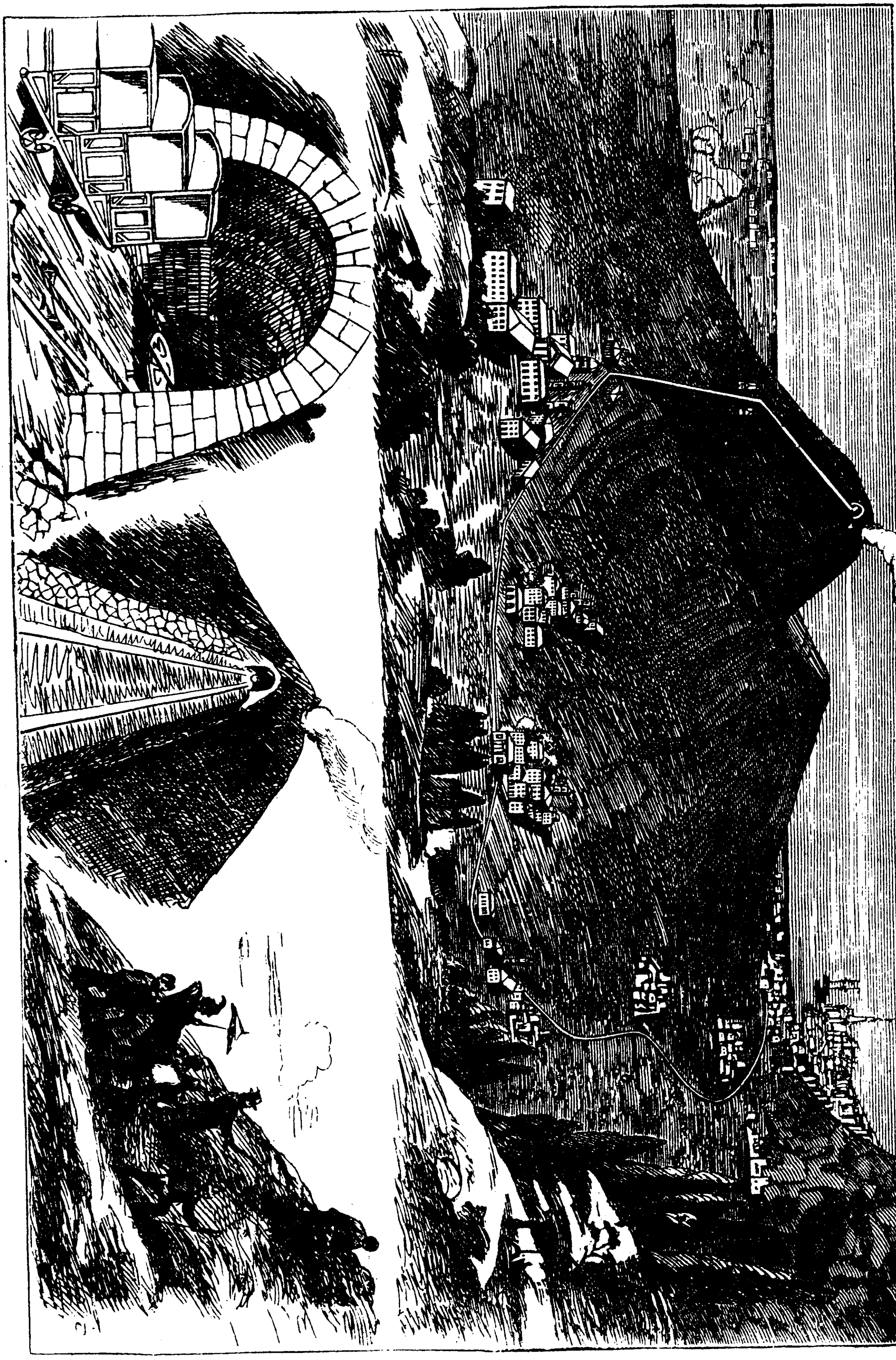
NEW BUILDINGS IN THE JARDIN DES PLANTES, PARIS: EXTERIOR OF REPTILE PAVILION.—(See page 15.)



HALL FOR VENOMOUS SERPENTS



HALL FOR AMPHIBIA



PROPOSED RAILWAY FROM NAPLES TO THE CRATER OF MOUNT VESUVIUS.—(See page 15.)

ICE AND ICE-MAKING MACHINES.

Apropos of the hot water, into which we seem now fairly to have launched, the above subject may not be uninteresting, either from a merely refreshing or even profitable point of view. Ice is now adays an article in quite large and popular demand, and how best and cheapest to meet this heavy demand during the hot months is the basis of many commercial speculations at present. Some considerable portion of this demand is no doubt supplied from the natural ice storehouses, and these were for a long time the only source of supply. It is but comparatively lately, however, that a cheaper and more abundant supply has been obtained by direct manufacture by refrigerators or freezing machines. It is these latter that we shall proceed to investigate, and endeavour to explain fully to our readers.

It may not, perhaps, be known to our readers that they have all within their own reach a most simple arrangement by means of which water may be very much cooled, if not frozen, even in the midst of summer. This can always be effected with proper arrangements on clear starlight nights. It may be effected in this way:—A large shallow vessel made of porous earthenware, filled with water, is placed on a bed of straw in the most exposed and open place attainable, and left there all the starry night. In the morning, if the place be open and exposed, without many surrounding objects, the water will be found covered by a film of ice. This effect is produced by two causes—the radiation of heat from the water to the surrounding space, which is not returned to it by counterradiation, if there are no clouds or surrounding objects; and also the porosity of the vessel causes a constant exudation of water to the exterior of the vessel where it is evaporated, taking up by reason of its change of form, a large quantity of latent heat, which must be abstracted from the rest of the water and the vessel. The straw is laid down as a non-conductor of heat between the vessel of water and the earth. This simple expedient is frequently made use of, and is well known in the torrid plains of India, where ice-cold water may be thus produced over night and kept for use during the day in porous vessels. This method we may look upon as the first and most primitive plan of producing artificial cold.

The machines, however, in use at the present day are diverse, highly scientific, and complicated; by means of any of which ice can be manufactured to an unlimited extent, and under any circumstances of weather or climate. There are three principal distinctive forms of apparatus to effect this purpose:—1. By the evaporation of ether by mechanical power. 2. By the evaporation of ammonia by heat, its condensation and re-evaporation by doing work. 3. By the mechanical compression and expansion of air or other gas. We will give a slight sketch of the principles of each of these methods.

The other refrigerator consists essentially of an engine to give the motive power to the various operations. To this engine is attached, probably on the same piston-rod, a vacuum pump. This pump has its suction pipe on the one side attached to the refrigerating vessel, which is partially filled with ether. By reason of the reduction of pressure in this vessel produced by the pump, a portion of the ether evaporates, being an exceedingly volatile liquid. In evaporating, the ether renders latent a large quantity of heat, thus extracting it from the remainder of the ether, producing a very low temperature. This reduction of temperature is made use of by circulating through the ether in thin pipes a fluid such as brine, or chloride of calcium, which will not freeze at 32 deg. Fahr. This circulating medium is then made use of to freeze water in blocks for commercial purposes. The circulation is effected by means of a suitable pump. On the other side of the main vacuum pump the volatilised ether is delivered at slight pressure into a pipe, circulating through a large tank, through which a constant stream of cold water is flowing. This causes the recondensation of the ether into a liquid, which then falls by gravitation back again into the main refrigerating vessel. Thus a constant circulation, without loss of the ether, is kept up; the heat abstracted in the refrigerator by evaporation on the suction side being carried off by the constant stream of cold water on the delivery side. This is the most usual form, perhaps, of refrigerating machines, and may be represented by the machines made by De Siddeley and Mackay, of Liverpool.

In the ammonia refrigerator machine an ammoniacal solution is placed in a boiler and heated in the ordinary way by a fire underneath. The ammonia is given off rapidly as a gas, and is collected at pressure in a coil of pipes placed in a tank, through which a constant stream of cold water runs. The ammonia is here liquefied, both by its own pressure and by the extraction of all heat above that of ordinary cold water. From this liquefied condition the ammonia will, on removal of the pressure, fly at once into gas. The liquefied gas is then used in a species of water engine or meter, which serves to pump back the reunited ammoniacal solution into the boiler again. The liquefied gas, after having here done its work, immediately on release flies into gas, and this re-evaporated gas is conducted in circuitous tubes through the freezing tanks or chamber. By reason of this sudden re-evaporation of the ammonia, upon release from high pressure, a large quantity of heat is taken up and rendered latent, and this is of course abstracted from surrounding objects, or from the liquid to be frozen. After having served its purpose, the ammonia is led into a chamber, meeting and mixing with the water from the boiler, out of which the ammonia has been evaporated. It is thus reabsorbed and then pumped, by the water engine before referred to, back again into the boiler. The ammonia thus is continually circulating round; first evaporated by heat, giving the motive power to the arrangement; next becoming liquefied by virtue of its own pressure of from eight to ten atmospheres, and being cooled by a stream of running water, it then re-evaporates in doing work, thereby causing a large absorption of heat, and effecting the freezing operation. It is lastly remixed with the unaerated water from the boiler, and is pumped back, as a solution, once again into the boiler.

Lastly. There is the simple, but still complex, mechanical machine in which the atmosphere may be used as the medium by which freezing is effected. This depends on the following natural laws:—When air is compressed, considerable increase of temperature is made sensible, exactly proportioned to the work done in compressing. If, now, this heat be extracted when sensible, upon reduction of pressure and increase to normal volume, the air will be minus the amount of heat which has been abstracted from it by the water. In this way, by compression, cooling, and after re-expansion, intense cold is produced, quite accidentally, by the use of compressed air, operating mining engines; the cold of the exhaust air being intense. This production of cold in the one machine is effected by a pump, alternately compressing and again allowing to expand a given quantity of air. When the air is compressed, and its heat is sensibly raised, its position in the machine is determined by a second non conducting piston, which causes the air when hot and under compression to be always on the one side, and when cold and expanded to be always on the other. Upon that side at which the heated air is always collected is a hollow cover, through which a constant stream of cold water is running in order to abstract the heat as it is rendered sensible. On the other side to which the expanded and cold air is driven is another hollow chamber with large surface, through which is driven the brine or other solution whose temperature it is required to reduce below freezing point. The compressed air—always the same quantity, but rising in density as the cold increases—thus acts as a carrier of the heat from the liquid to be frozen to the constant stream of cold water which carries it away. Kirk's machine is, perhaps, the best example of this class of refrigerator; but we do not think that there have ever been many made on this principle, though it should be equally cheap, or even cheaper, in its manufacture than the preceding classes of refrigerators. —*Iron.*

Production of Iron.—The official report of the Vienna Exhibition gives the annual "output" of iron in the producing countries, as follows:— England (1871), 134,664 227 cwt., Zollverein, German Bund (1871), 33,296.042; France (1871), 23,620,000; Belgium (1871), 11,406,480; Austrian Hungary (1871), 8,492,122; Russia (1871), 7,208,141; Sweden and Norway (1871), 6,133,347; Italy (1872), 1,474,180; Spain (1866), 1,474,180; Switzerland, (1872), 150,000; total for Europe, 227,793,099. North America, (1872), 46 900,000; South America, 1,000,000; Japan (1871), 187,000; other countries of Asia, (approximated), 807,000; Africa, 500,000; Australia, 200,000; total for the world, 276,500,000 cwt. It appears from this statement that England produces more than one-half of the whole amount, North America about one-fifth, France about one-twelfth, and Belgium one-twenty-fourth; these four constituting the great iron-producing countries of the globe.

RAILWAY MATTERS.

The Union Pacific Railroad Company are about to develope their coal lands, and propose to establish a rolling mill for the purpose of making their own rails from ore found on the line of the railroad.

No country upon the face of the habitable globe, having a railroad system in operation, is so carefully guarded against the possibility of collision as the Republic of Costa Rica. It rejoices in a single locomotive.

The iron manufactures of Pittsburgh until recently, have never sent a pound of their productions to British America; but they are now receiving numerous orders from Nova Scotia, New Brunswick and the Canadas.

The narrowest gauge in use in the United States is said to be on a short road from the Matilda Furnace in Huntingdon Country, Pa, to the Pennsylvania Railroad at Mount Union The gauge of this line in 27½in., the rails are 16 lb. to the yard, and it is worked with an engine weighing six tons.

Mr. McQuisten, City Surveyor, who has made a trip over the M N. Colonization Railway, as far as Lachute, reports that the grading throughout this distance is almost completed. —His report, it is, understood, will be very favorable. The abutments of a couple of bridges have been commenced, and it is thought the road will be in operation next spring as far as Lachute.

It may not be generally known that the ton used in the returns and calculations of the United States census is invariably the net ton of 2000 lb., and that the on used by the U. S. Treasury Department in its statements of imports and exports is invariably the gross ton of 2240 lb. It is also worthy of note that values of foreign imports are given in gold, and of domestic exports in currency.

The Grant Locomotive Works, U.S have received an order for 65 anthracite coal burning engines for a railroad in Russia. Of these 22 engines are of the ordinary American pattern, with 17 x 24 cylinders and 5½ ft. driving wheels; 43 of them will have eight wheels coupled. The cylinders of the latter will be 20 by 24 inches and the wheels 4 ft. diameter. The fire-boxes are to be 9 ft. long, with water grates and iron flues.

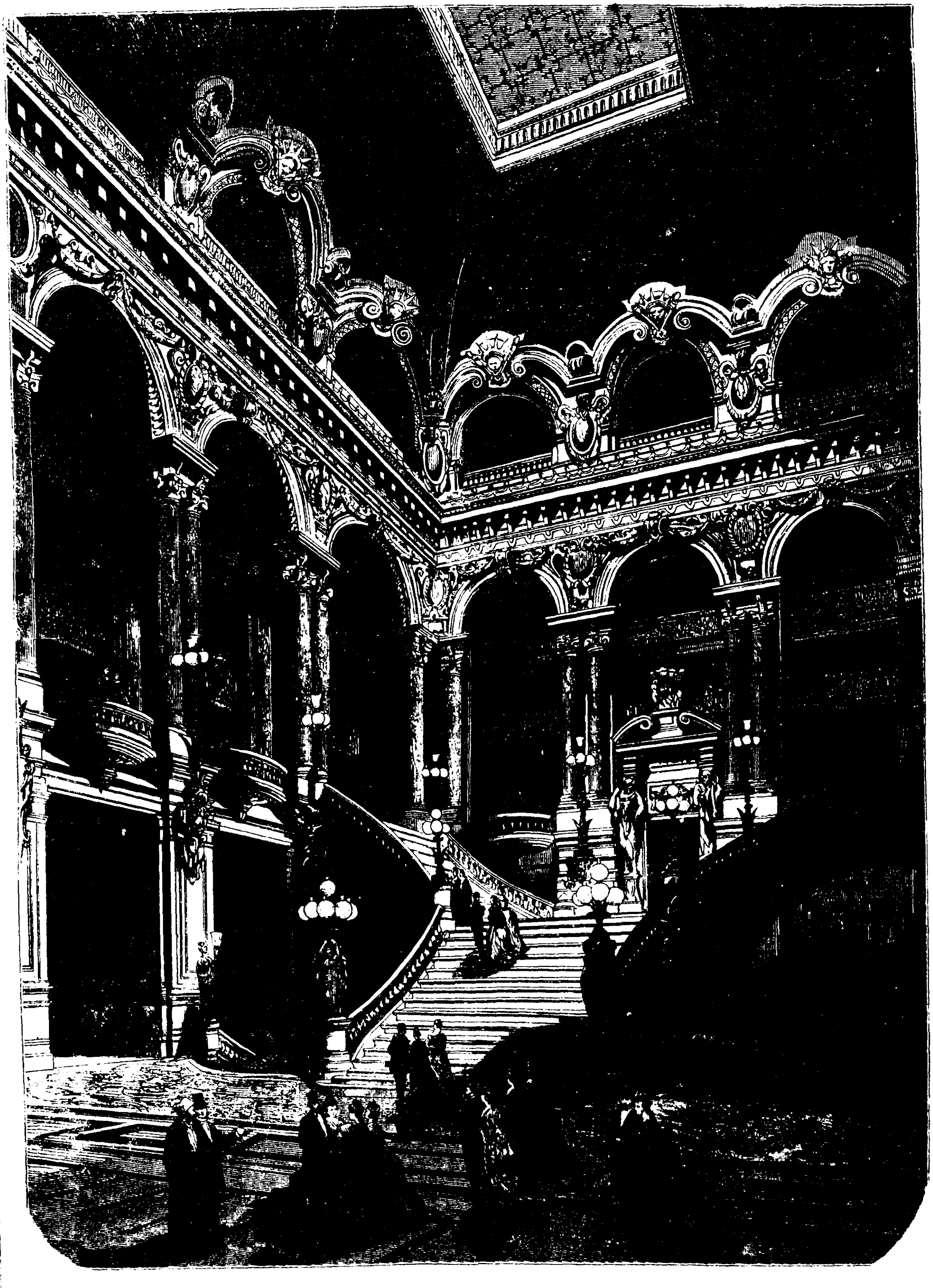
A special commission of the Co-operative Society of Russian Manufacture and Trade has reported in favour of the construction of a railroad line between Russia and China, through Siberia. The road, with its connections, would traverse for the most part a thickly populated country, and open up immense cattle and wool growing districts which are now isolated from the business world. It would have to be built in sections, commencing with a fortified town in Western Russia and ultimately reaching Pekin.

It is the intention of the Pennsylvania Railroad Company, says the "Travellers' Official Railway Guide," to separate its freight and passenger traffic entirely between Newark and Jersey City, and with that view it has erected the numerous new buildings and trestle-works on the Hackensack meadows. With its immense freight rolling stock out of the way, and with the Bergen cut widened, as it soon will be, so as to admit of additional tracks, quick transit for the passenger trains will be greatly facilitated on this division of the road.

New Danger Signal.—MM. Lartique and Laforest have recently invented a novel device, intended as a danger signal, which the *Revue Industrielle* states is now in successful use on some of the French railroads. A whistle is arranged on the locomotive so that it will, when once opened, continue sounding until shut by the engineer. The same device which turns the disc signal, so as to show the danger side, is intended to transmit a current of electricity to a little projection between the rails. When the engine passes over this spot, a metallic brush hanging between its wheels strikes on the projection and sweeps over it, at the same time transmitting the current to an electro-magnet which pulls the whistle open. The latter, by continuously sounding, warns the engineer.

The *New York Times*, in the course of an article on railway management, speaks thus of the qualifications necessary in the would-be manager :—" Of the degree of ability necessary for the successful management of a great railroad, nothing affords a more forcible illustration than the difficulty of procuring it when needed Almost all our great railroads have materially suffered, at one time or other, from the want of a competent man at the head, and a good many of them are thus suffering now. We do not here allude to cases where improper men have been voluntarily placed in such positions, but only to those where no one known to be a suitable person could be obtained One of the sources of difficulty, however, relates more to physical endurance than mental strengh. Very few men can do the work. The great responsibility, the incessant strain of mind, the necessity for remembering a thousand different items, and, above all, the frequent need of rapid and immediate thought and action in matters of extreme importance, will soon break down any constitution, except one of the most vigorous kind."

Of the Levis and Kennebec Railway the Quebec *Mercury* says:—Though the public have not heard much of the enterprise lately, the contractors, Messrs. Larochelle and Scott, have been pushing their work with vigour since the suspension of outdoor operations last fall. All the material necessary for the construction of stations, platforms, buildings, fencing, etc., has been got out during the past winter, and the contractors have upwards of sixty thousand cubic feet of square timber delivered along the line, to be used for superstructures, part of which will be for sale when the line opens. The Montreal Telegraph Company are going to extend their line over this road, and the necessary poles are now ready for distribution; some 2,500 cords of firewood have been cut and distributed at different points for the use of locomotives this year, and a portion will be sold in Levis The bridge over the Etchemin River at St. Anselme, which will be completed in a few days, is of the Howe-truss pattern, but instead of having all wood, the vital parts are made of iron; similar bridges are now in use on the "Montreal and Chambly Railway," and from their success, this system will likely be adopted on most of the roads in Canada where expensive iron structures cannot be afforded. The construction train is now at work on the line between St. Henry station and St. Anselme, and track-laying and ballasting progresses rapidly. The rails and fastenings will arrive from England by special steamer in a few days, as also the second locomotive from the celebrated Rogers Locomotive and Machine Works, Paterson, N J. The progress made has been very satisfactory; we understand the first section from Levis to St. Mary will be open for trafic in August, and we must say great credit is due to the gentlemen who have with such perseverance carried through this enterprise. One of the gentlemen connected with the financial negociations of Levis and Kennebec Bonds in London, is now in the city.



GRAND STAIRCASE OF NEW OPERA HOUSE, PARIS.—(See page 15.)