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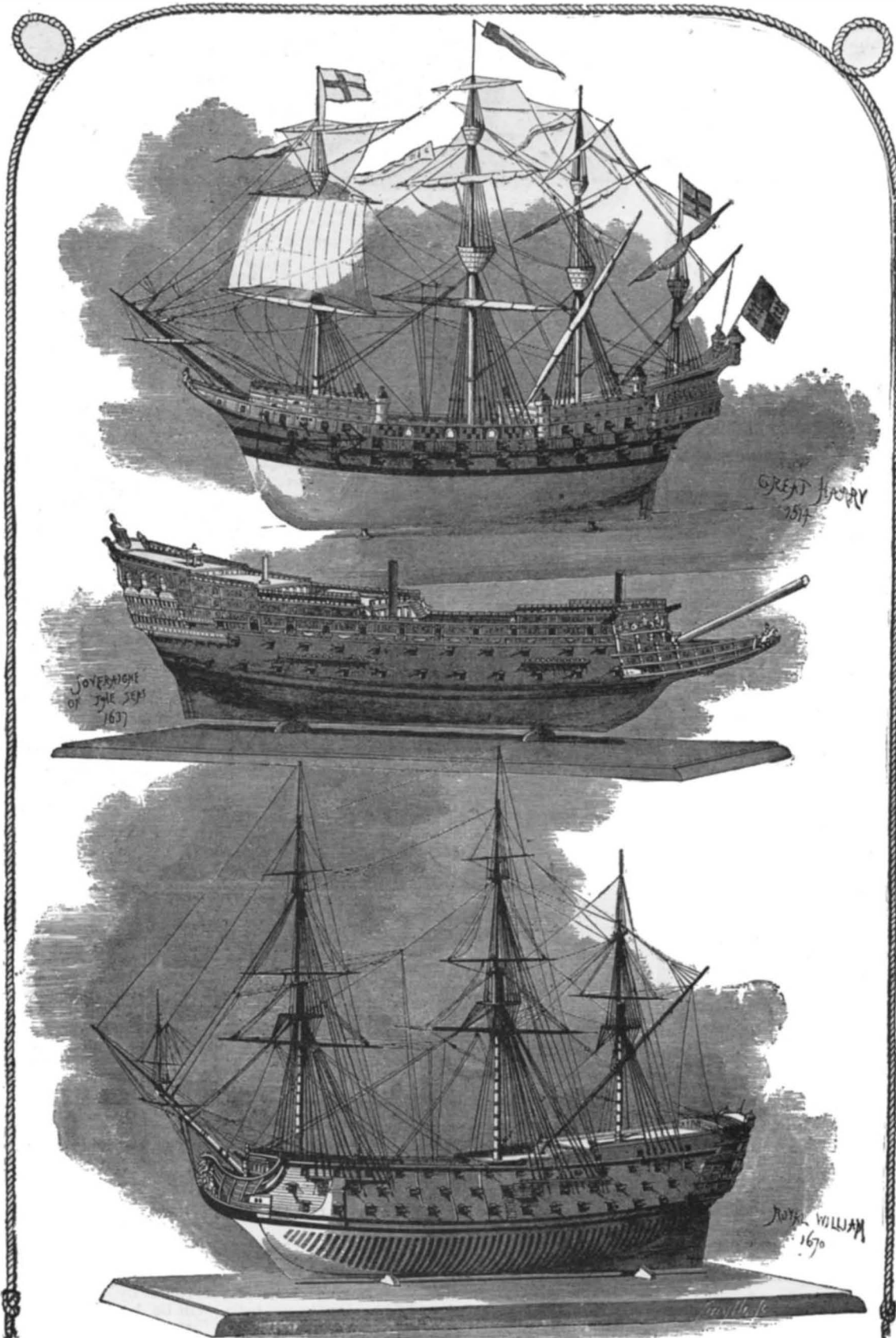
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### OLD ENGLISH SHIPS OF WAR.

THIS is an age of reform in all our fashions and institutions, which have, indeed, undergone many and various changes in the past four centuries, since the first Tudor reigns. The progress of naval architecture and naval warfare is not the least remarkable. Even within the personal remembrance of men who are not very old, going back to their childish years a little before the commencement of Queen Victoria's reign, there has been wonderful alteration. The present writer has a very distinct recollection of the old three deckers, the Britannia and the Caledonia, which lay as guard ships, successively, moored in the Hamoaze opposite Devonport Dockyard. He was acquainted with two or three gallant retired officers who stood on board the Victory when Nelson was killed at Trafalgar, in 1805, and with one who served under Rodney at the battle of Cape St. Vincent in 1781. The first rate line of battle ships employed in the latter part of the great French war remained on view, though no longer in active service, and were associated with the old methods of battle, when some of us were boys reading Southey's "Life of Nelson" and Captain Basil Hall's "Fragments of Voyages and Travels," then recently published. The largest were armed with a hundred and twenty guns, and those in the broadside were thirty-two or twenty-four pounders. Their wooden sides, rising to a great height above the water, could not escape being riddled by a hundred round shots in an hour of close fighting, as may be seen in the noble pictures that hang on the walls of the Painted Hall at Greenwich. The men who served those guns and the officers who commanded them, as brave Englishmen as ever lived, would have laughed to scorn the idea of being protected by armor plating. Their notion of maneuvering was to lay their own ship close alongside the biggest ship of the enemy, the yardarms of one almost touching the yardarms of the other, the British ship even getting, if she could, between two of the enemy's ships, anchoring fore and aft in that position, and pounding on for hours, to starboard and to larboard, until both her antagonists were compelled to strike their flags or were blown up or sunk. That was Nelson's habit of fighting. The carnage was dreadful. The victorious ship was often shattered and disabled from sailing. Here and there, a French or Spanish ship in flames was abandoned to her fate, while others lay helplessly afloat till the conquerors had leisure to pick them up. The crews were far larger than any now employed in the ships thrice as big which are now sent to sea. Eight hundred or a thousand was the ordinary complement of a line of battle ship. They had often to struggle against the enemy "boarding" with cutlass, pike, and pistol, on the upper deck, while showers of bullets rained down upon them from musketry aloft in the tops.

Such were the sea battles of our brave ancestors, whose manhood was abundantly proved in those fierce encounters the history of which we have read, and some of us have heard told by men who bore part in them. There is Nelson's old Victory still lying in the harbor of Portsmouth. The last century was the classic period of British naval warfare, for even Trafalgar, though fought a few years later, belongs to the old time in which Nelson and Collingwood and other heroes were

reared. There was no machinery, there was no steam, there was no science but the art of rough and ready seamanship, the bulldog practice of close fighting, the "wooden walls" of Old England afloat, and the "hearts of oak" never doubting that for England it was worth while to die. We turn, therefore, with admiring regard to the models of a few of our old warships, in the Museum of Naval Architecture at the Royal Naval College, which are delineated herewith.



MODELS OF OLD ENGLISH SHIPS OF WAR.

Their shapes are probably familiar to many of our readers. That of the Great Harry, the building of which is said to have been commenced by order of King Henry VII., but which was finished in 1514 under Henry VIII., may be considered the first important example of a ship constructed specially for the king's war service. The Plantagenet kings had been accustomed to rely on the Cinque Ports for the supply of shipping to be used in time of war. The kingdom of Scotland, at the beginning of the sixteenth century, was rather in advance of England in this department; in 1506 James IV. had a ship built called the Great Michael, which was far more powerful than the Great Harry, being 240 ft. long and 36 ft. wide, with sides 10 ft. thick. The Scotch Admiral, Sir Andrew Wood, was one of the

most renowned sea captains in early history. But the Great Michael foundered in a voyage to France in 1512, and the Great Harry was accidentally burnt at Woolwich.

Henry VIII., in 1513, had a ship called the Sovereign in his fleet of forty-five sail which engaged with the French fleet off Brest harbor. The Sovereign grappled with the largest French ship, the Cordelier, and both ships caught fire and were blown up. The Great Harry, on that occasion, was the flagship of Admiral Sir Edward Howard, who was killed in the action; and he called her "the flower of all ships that ever sailed." The king next built one of greater size, the Henry Grace de Dieu, which is said to have been of 1,500 tons burden. But of the 197 sail mustered by Queen Elizabeth in 1588 against the Spanish Armada, only thirty-four belonged to the crown, the largest of which were the Triumph, of 1,100 tons burden, and the White Bear, of 1,000 tons. Private and local enterprise, with the skill and valor of men like Drake and Frobisher, supplied the want of preparation on the part of the queen's government; and in the later years of Elizabeth's reign many ships were added to her fleet.

A great advance was made, under James I. and Charles I., by the ability of Mr. Phineas Pett, the first "Master Shipwright," who constructed the Prince Royal, in 1610, carrying sixty-four guns, and in 1637 completed at Woolwich the Royal Sovereign, or Sovereign of the Seas, the frame timbers of which were prepared at Newcastle. This ship, which was gorgeously decorated with carving and gilding, was of 1,860 tons burden, and was the first English three decker; but Spanish three deckers had fought in 1591 with Sir Richard Grenville and Sir Walter Raleigh. The Sovereign of the Seas was frequently employed in our wars with the Dutch. She carried a hundred guns and a crew of about six hundred men. Our naval administration was not neglected by Cromwell; and, after the Restoration, under the care of the Duke of York, who became King James II., considerable improvements were made, which are recorded by Pepys, then at the Admiralty, with much satisfaction. The Royal William, and a fifty gun frigate, also represented among our illustrations, show the progress made before the commencement of the eighteenth century, from which date Great Britain had to compete with the great naval power of France, often allied with that of Spain. The first ship bearing the name of Victory was not that commanded by Lord Nelson at Trafalgar, but was one of more ancient date, built in 1737, which was lost in the Channel, with Admiral Balchen and all the officers and crew, on the night of Oct. 4, 1744—as great a disaster as the sinking of the Royal George in Portsmouth harbor, August 29, 1782, "when Kempenfeldt went down with twice four hundred men." Has any reader kept one of the memorial snuff boxes made of the wood of the Royal George?—*Illustrated London News*.

For a good solution for waterproofing canvas horse and wagon covers that will be flexible, take boiled oil, 15 pounds; beeswax, 1 pound; ground litharge, 13 pounds. Mix and apply with a brush to the article, previously stretched against a wall or a table, washing and drying each article well before applying the composition.



## THE TRANSPORTING POWER OF WAVES.

It is only within comparatively recent years that engineers have become alive to the enormous power of waves in moving the material forming the bed of the ocean. Even now many members of the profession attach but small importance to the effect of wave motion in disturbing the bottom—in comparison, that is, with the transporting power of currents.

The statistics bearing on the subject are few and meager, and further data from actual observation are very desirable. Such facts as we have, however, seem to indicate tolerably conclusively that the disturbing effect of waves is in many cases much more important than that of any ordinary current.

Forty or fifty years ago engineers appeared to have a general opinion that ordinary stones, such as were used in the rubble foundations of breakwaters, were safe from disturbance at very moderate depths, as may be seen by the construction of the piers of that period, as well as by specific statements made by leading lights of the profession. In the case of upright walls founded on a rubble base, such as the piers at Holyhead, Portland, Cherbourg, Alderney, etc., it was not considered necessary to found the wall much, if any, below low water. Gradually since these earlier piers the rubble base has been kept lower, until at the present time it is usual to found the pier proper at least 15 ft. or 20 ft. below low water. For instance, the depth at the Tyne piers has been gradually increased as the piers progress seaward, until now the base is more than 20 ft. below low water; and, according to a paper recently read before the Institution of Civil Engineers, the breakwater at Colombo is founded on the rubble at 23 ft., at its outer extremity.

Among the statements made on the subject in former days must first be mentioned those of Mr. Scott Russell, as he was one of a committee of two appointed to report on the subject of waves to the British Association. The report was submitted in 1845, and while in some respects it is valuable, it appears to suffer from the defect of having been made on insufficient data. In founding a theory on experiment, it is before all things necessary to be sure that the experiments are sufficiently numerous and on a sufficiently large scale to justify the conclusions indicated being made general. In this particular case we are inclined to the opinion that the report went considerably further than the scale of the experiments justified, and subsequent observations of various engineers seem to confirm this view. The committee reported that the waves of the sea do not produce an agitation which extends to the deep parts of the water. This is, of course, a little vague, but we are able to value the unknown quantities by Mr. Russell's statement to the Institution of Civil Engineers in 1847, that "waves 10 ft. high only agitate the water 6 in. at a depth of 10 ft. below the bottom of the wave."

Other engineers of the period held very much the same opinions, whether based on independent observations or on those of the committee we are not aware. Sir John Rennie considered rubble would remain undisturbed at 9 ft. below the surface; Mr. J. M. Rendel at 15 ft. In his paper on Sunderland Harbor (1858), Mr. Murray states that small stones are undisturbed at 22 ft. In a pamphlet dated 1832, which displays a curious mixture of ignorance and research, Mr. Macgregor, surgeon R.A., states that waves do not disturb the bottom at a greater depth than 30 ft.

More recent experience, however, and indeed some which is not very recent, seems to be much at variance with the conclusion of Mr. Russell's committee, and appears to prove conclusively that the effect of the waves is often felt at very great depths. So long ago as the building of the Bell Rock lighthouse, Mr. Robert Stevenson observed that bowlders up to 2 tons weight have been thrown on to the rock by the waves; the depth from which they were moved is not stated, but the soundings on the east side of the rock increase rapidly to 16 fathoms, so it is more than probable that the bowlders came from a considerable depth. The lighthouse keepers have observed similar stones appear on the rock during storms on several occasions of later date.

Sir John Coode has stated from personal observation under water that the shingle of the Chesil Bank is disturbed by storms at a depth of 8 fathoms, and that  $3\frac{1}{2}$  million tons of shingle have been thrown up on the bank in one day.

Captain Calver, R. N., mentions that he has frequently seen waves of 6 ft. to 8 ft. in height change color when in a depth of 7 or 8 fathoms.

Bremontier observes that on the banks of Newfoundland the agitation of storms is felt at a depth of 160 meters.

Vionnois puts the depth of disturbance at St. Jean de Luz, Bay of Biscay, at 300 meters.

The late Professor Edward Forbes noticed that the "Venus Cassina," a large shell fish not known to live at less depth than 7 fathoms, is often thrown up during heavy gales on the coasts of Scotland, Ireland, and the Isle of Man.

Sir James Douglass has stated that coarse sand has been thrown from a depth of 25 fathoms on to the lantern gallery of the Bishop's Rock lighthouse, 120 ft. above low water. He also has alluded to the fact, well known among fishermen on coasts with an Atlantic exposure, that lobster traps are occasionally filled with coarse sand in depths up to 30 fathoms.

It is not unusual for vessels sunk in comparatively deep water to be broken up by subsequent storms; for instance, a steamer called the Pegasus, which sunk off the Goldstone, Northumberland coast, in eleven fathoms, was broken up by a later gale, and part of the wreck washed ashore.

In the face of these facts the deduction arrived at by Scott Russell\* as to the depth at which wave action is felt seems hardly tenable, and finding the theory deficient in one important particular, one is tempted to inquire further. Mr. Russell classed waves under four heads, two only of which are all we require to consider, viz., (1) waves of translation and (2) waves of oscillation. The first class includes the tidal wave, bores, ordinary ground swell, and the waves of Class II. when they reach much shallow water. The second class includes all other storm waves. This classification has been adopted by most subsequent writers, but it ap-

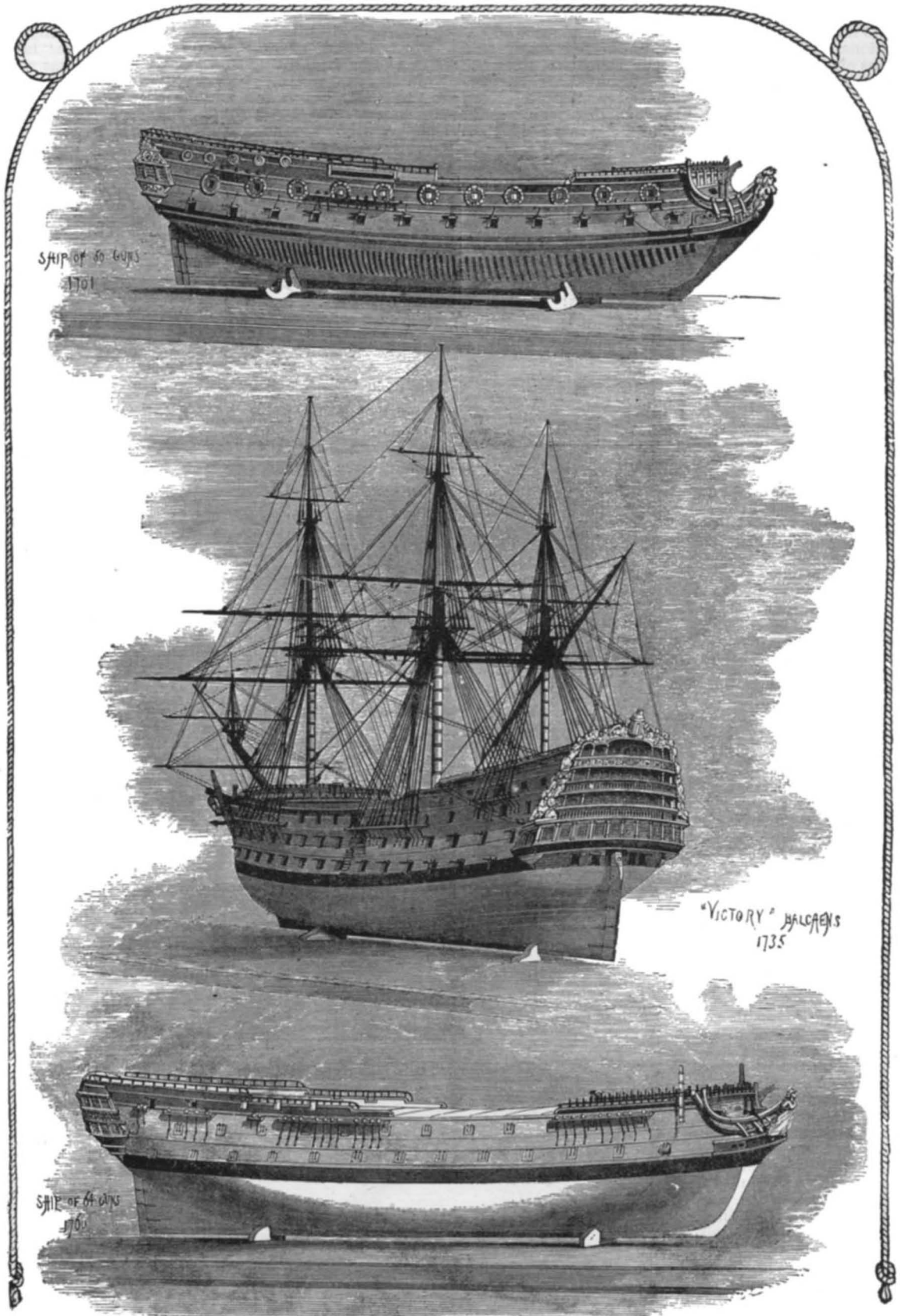
pears tolerably certain not merely that it has little value, but that it is very apt to induce erroneous ideas on the action and power of the waves. Rankine was of opinion that there is no such thing as a wave of oscillation, but he contented himself with generalization, and Scott Russell's papers have continued to be regarded as the chief authority.

The nearest approach to a wave of pure oscillation no doubt is the ripple produced by dropping a stone into water; as there is no horizontal force except that due to the pressure caused by the impact of the stone, it may be considered that is no actual horizontal movement of the fluid. But the conditions of waves produced by the wind are entirely different; there is an actual and continuous horizontal force applied, and there must be actual transference of water, and the velocity of movement will increase and be felt at greater depths with the continuance of the force, at any rate up to a certain point. When a gale lasts long enough, the current actually developed in even a tidal sea may

tory, and those in the Channel waves of translation; that is to say, that where there is an actual application of a horizontal force there is no motion of fluid produced, but miles away, where the force does not exist, there is an important movement of the water.

Storm waves can never be entirely oscillatory, though the amount of translation in them probably varies considerably according to the strength of the wind, the time it has been blowing, and other circumstances.

Mr. Scott Russell determined the motion of the particles to be ellipses, forward on the crest and backward in the hollow of the wave, and, as was further pointed out by Rankine, the ellipses become flatter as they are deeper in the water, until at the bottom the motion of the particles is simply back and forward in a straight line. The ellipse formed by each particle was supposed to be complete; that is, that each particle returned to the point in space from which it started, and no doubt\* in experiments conducted on a small scale it might not be possible to observe that this is not so, but in storm



MODELS OF OLD ENGLISH SHIPS OF WAR.

amount to a material figure. Thus in the Great Belt, where the ordinary tidal stream runs from 1 to 2 knots per hour, the current is increased during gales to 5 knots. On the eastern shores of the Baltic westerly gales occasionally raise the level of the sea from 3 ft. to 4 ft. in a day or two, a transference of water which implies a very important current. Similarly the level of the Mediterranean is affected by storms, and even a large tidal sea like the North Sea has its surface raised as much as 2 ft. during westerly gales in the Atlantic. Once admit that the water must be in motion and you attribute the character of Class I. to them; they are no longer waves of oscillation.

The chief characteristic of Class I. as defined by Scott Russell is that motion at the bottom is equal to that at the surface and in the same direction. Ground swell belongs to Class I.; in its ordinary form it is the effect of a storm at a distance; thus a heavy ground swell running up the Channel is caused by a westerly gale in the Atlantic, whose influence has not reached our shores except in this form. It may be calm in the Channel or there may be a contrary or cross wind blowing. Now according to the theory the waves out in the Atlantic where the gale is blowing are purely oscillatory,

waves the actual motion of the particles near the surface is probably more of the nature of a curtate cycloid formed by a rolling ellipse. At the bottom, motion will be back and forward in a straight line, but the forward stroke always a little longer than the return. When a strong gale has been blowing for some time, a considerable forward motion is imparted to the water, greater at the surface than at the bottom, but still forward throughout. Out of the influence of the wind the forward motion of both waves and water will be maintained by momentum, but the influence of the wind being absent, the motion of the fluid will be reduced at the surface to what it is at the bottom, making what is known as ground swell. The defect in Scott Russell's investigation seems to have been simply that the horizontal force of the wind was not taken into account.

If the idea of pure oscillation were correct, it would be difficult to account for several of the facts to which we have directed attention, but they all appear capable of explanation if it once be admitted that all waves partake more or less of the translatory character. No doubt some kinds of wave possess more of the oscillatory character than others, but the difference is one of

\* As the other member of the committee died before the report was made, the opinions are those of Mr. Russell only, and he is therefore quoted instead of the committee.

degree, and investigation would no doubt show that sea waves possess every amount of the one character and the other from the stone ripple on the one hand—almost or quite oscillatory—to the tidal wave on the other—almost quite transitory. But even the tidal wave may be considered a wave of the second order when it is remembered that the motion of a particle at the surface approximates to a flattened ellipse, of which the travel of the tidal stream during six hours is the major and the rise or fall of the tide the minor axis.

Before the theory of wave motion can be reconstructed to be of real value, it is necessary that observations should be made on a large scale from actual storm waves under various conditions; in the mean time all that can be said is that the existing theory seems to be far from accurate. That waves do exert great disturbing power at moderate depths, and that their influence is felt in deep water, is tolerably certain. But the nature of this action in even comparatively shallow depths is as yet almost unknown, and its extent can only be very roughly arrived at.

That in considering the question of the accumulation or removal of silt in moderate depths and exposed situations it is of as much or more importance to consider the direction of the waves as that of tidal or other currents, is a statement which a very moderate amount of observation will establish. Even where the material composing the bed is of a nature particularly favorable to movement by current, if the surface of the water be of sufficient area to allow of the production of waves in some degree proportional to the depth, one or two heavy gales will cause a greater amount of disturbance of the bottom than an ordinary tidal current in several months.

In an estuary where the bed is mud and silt, and the tidal currents run from 2 to  $3\frac{1}{2}$  knots per hour, we have observed as much silt thrown into an inclosure in a single storm as the tide deposited in the course of twelve months. The height of the waves would be about 5 ft. or 6 ft. at most and the depth of water decreasing slowly from 6 to  $1\frac{1}{2}$  fathoms immediately outside the inclosure. The amount of material held in suspension by the water may be judged from the fact that in an adjacent inclosure, quite sheltered from the waves, the average level of the bottom was raised about 6 in. in a year.

It was quite a common error formerly to neglect the influence of the waves in the formation of bars at the mouths of rivers falling into the sea. Lieutenant Ellis, in 1839, and Mr. J. Walker, in 1841, directed attention to the true cause of the existence of bars, and Mr. W. Stevenson has stated that in 1842 he reported that the bar at the mouth of the Dornoch Firth was produced by wave action. But the lesson taught by these gentlemen was learned very slowly, and even at the present day far more stress is often laid on the power of currents than on that of waves under circumstances peculiarly favorable to the action of the latter. In considering the probable effect of works in a land-locked or partially land-locked estuary, comparison cannot be made with similar works in an estuary open to the sea, because in nearly all exposed estuaries the waves will have more influence than currents, while the reverse is generally the case in sheltered basins. For instance, it would be palpably an error to attempt to draw a comparison between the estuaries of the Thames, Seine, or Ribble on the one hand and those of the Mersey or Tees on the other. The former are particularly exposed to wave action and the latter are sheltered, in the one case naturally and in the other by artificial works.—*Engineering*.

### THE HELICOIDAL ELEVATOR.

As none of the known systems of elevators is applicable to the great Eiffel tower (now being erected in Paris), it has become necessary to look about for some new arrangement that shall solve the problem of ascending to a height of 984 feet, practically and with the guarantee of the greatest security.

The Backman system, which has been presented to the tower committee by Mr. Eiffel, is particularly applicable in the upper part of the structure, for a height of 490 feet, where the elevator can be arranged vertically. The system embraces three essential parts: (1) A car designed to carry passengers or any load whatever; (2) a truck that carries the car through the intermediate of rollers, and that is provided with spirally arranged wheels which run upon a helicoidal track; (3) a metallic framework, 490 feet in height, inside of which are fixed the helicoidal track and the vertical car guides.

If a rotary motion be given to the truck, it is readily seen that it will rise or descend on the helicoidal track according to the direction of the rotation. Owing to the rollers interposed between the truck and the car, the latter will take part in the ascending or descending motion of the truck without taking part in its rotation, and will slide along the vertical guides, which will prevent it from turning. Before examining the mechanism that permits of setting the truck in motion, we shall describe in succession each of the three parts of the elevator.

**Car.** The car, F, is cylindrical and has two stories. It will hold a hundred passengers. In its center is fixed a hollow pivot around which the truck revolves through the intermedium of a circle of conical rollers that surround the pivot. The car is guided by sliders that rest upon two guides, G, which are exactly opposite and fixed to the framework. Rollers placed on each side of the sliders prevent the car from moving sideways, and are kept in contact with the guides by a spring that tends to bring them together.

The lower extremity of the hollow pivot, likewise, is guided by a crosspiece, H, so that the truck is always perfectly centered. As the pivot is thus held at its two extremities, it is submitted to no flexion.

**Truck.**—The truck, A, consists of a tube provided at its extremities with two collars that insure its rotation around the hollow pivot. To this tube are riveted the brackets that support the axles of the wheels. The boxes of these axles are provided with two Belleville rundles of  $\frac{1}{8}$  inch travel that permit of a better distribution of the load between the wheels, and that offset any slight inequalities that may exist in the helicoidal track. The wheels are five in number, and make 72 revolutions per minute, while the truck makes but 13. At its upper part, the truck is provided with a helicoidal wheel, C, with a drum, D, furnished with

clicks, and with a cog wheel, B, the operation of which will be explained further along.

**Framework.**—The framework consists of six uprights, properly crossbraced, to which are affixed the helicoidal track and the car guides. The track consists of a cast steel rail, the stiffness of which is increased by placing under it a flat iron turned edgewise. The inclination of the track is eighteen per cent., and the diameter of the cylinder is 13 feet. The two guides fixed to the uprights are very close to the tracks. In order to allow the wheels of the truck to move upon the track, the guides are interrupted wherever they meet with the helix, so as to make way for the axles of the wheels.

**Mechanism.**—Motion is given to the mechanism of the elevator by an endless metallic cable, I, actuated by a motor placed outside of the frame. The velocity of the cable is about thirty times greater than that of the apparatus. It is 48 feet per second, while that of the truck and car is but 1.6 foot. This great velocity of the cable has the advantage of rendering the stress to which it is submitted very feeble, and it has been possible to reduce its diameter to half an inch. Its tension is insured by a counterpoise suspended from a movable pulley. The cable always moves in the same direction, either for rising or descending, and it may be

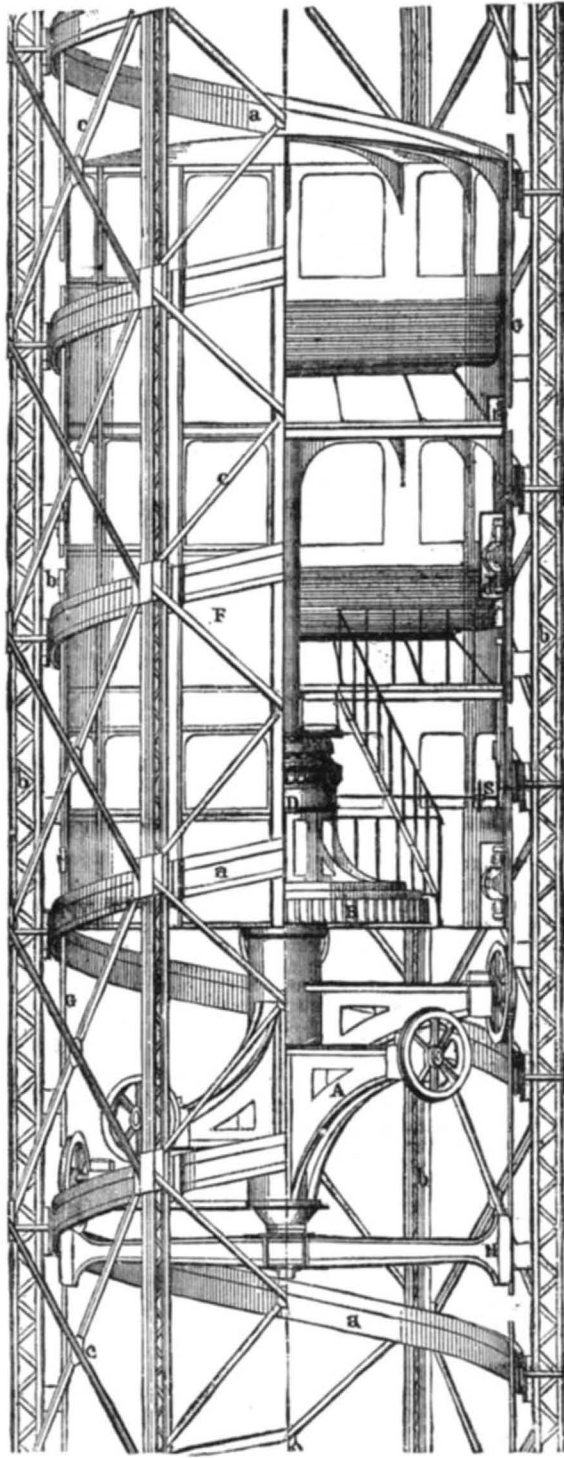


FIG. 1.—SECTION OF HELICOIDAL ELEVATOR.

in motion even when the elevator is stationary. To this effect, the cable, on entering the car, through the hollow pivot, first passes over an intermediate pulley, and then over the main pulley, L, which transmits its motion to the other members of the mechanism. Upon the axle of the main pulley are mounted two loose cone wheels, J and K, that are made fast to the axle through friction cones, M and N.

The elevator is made to rise by throwing into gear the cone wheel, J, which transmits its motion to the cone wheel, O. This latter is keyed to the same axle as the pinion, P, which gears with the toothed wheel, B, fixed to the truck, and consequently communicates its rotary motion to it.

The descent is effected by throwing into gear the pinion, K, which engages with the pinion, Q, keyed upon the same axle as the endless screw, R, which in turn revolves the helicoidal wheel, C. As this latter is fastened to the truck, it transmits its revolution thereto in a descending direction.

All the cone wheels are helicoidal, so that they may run more silently.

The throwing of the pinions, J and K, into and out of gear is effected by revolving the rod, S. This rod (which is threaded in opposite directions) in revolving separates or brings together the branches of two grips between which are two springs that may thus be compressed or loosened simultaneously. A revolution of the rod, S, will therefore have the effect of disengaging one cone and bringing the other near its pinion, as

well as of throwing the latter into gear if the motion is continued.

For its motion, the helicoidal wheel, C, is dependent upon the drum, D, which is provided with eight clicks, T, while the toothed wheel, B, fixed to the truck has seventeen ratchets. Through this arrangement, the wheel, C, is loose on the truck in the ascending direction, but becomes automatically fast in the opposite one.

The meeting of a ratchet and click gives rise to no

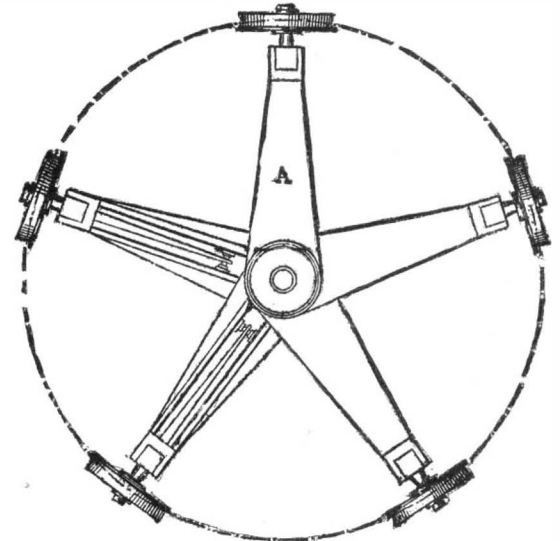


FIG. 2.—PLAN OF THE TRUCK.

shock, because, since the descent is made very slowly, such meeting will always occur before the truck has made  $\frac{1}{16}$  of a revolution. The pressure between the ratchet and click is afterward transmitted through the intermedium of the drum to the helicoidal wheel.

Rubber washers, X, interposed between the wheel and drum have the effect of rendering it easier to set the former in motion.

**Measures of Security.**—The apparatus, left to itself, would tend to descend by its own weight over the helicoidal track. In order to annul such tendency, the threads of the endless screw, R, are given an inclination such that the helicoidal wheel can never cause the screw to revolve. Since this wheel, during the descent, engages with the truck, it is necessary that the endless screw shall be revolved in order that a descent may be effected. The screw is consequently a permanent brake that forces the apparatus to remain in place when motion is arrested for any cause whatever.

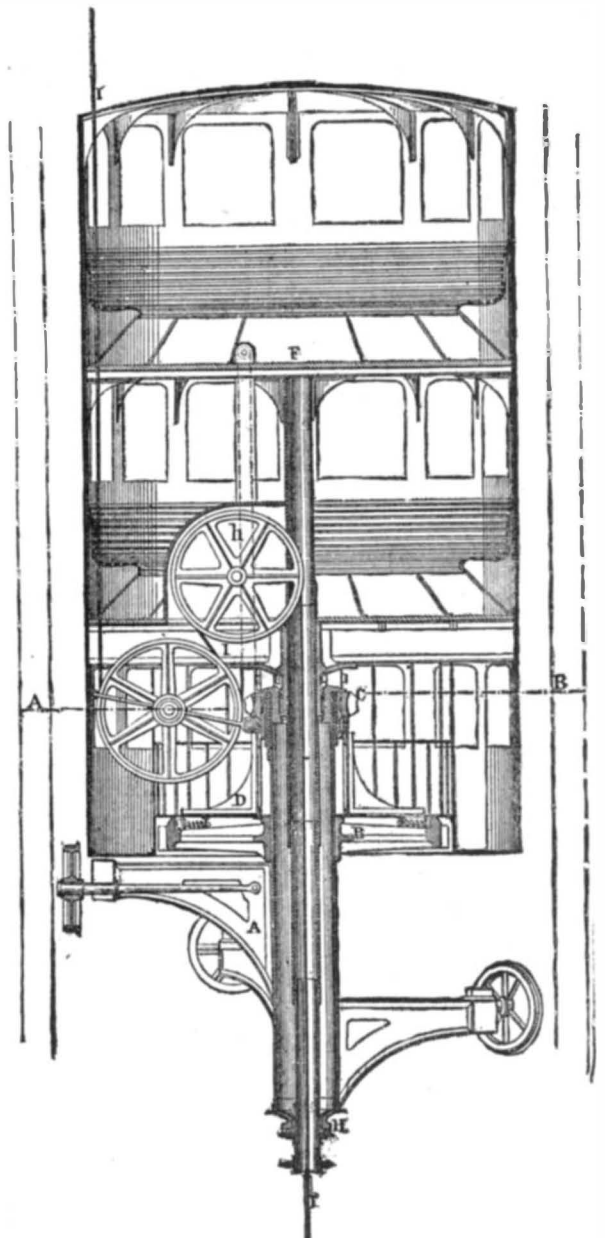


FIG. 3.—ELEVATOR CAR

Two steel brakes, U and V, are likewise within reach of the person who manuevers the elevator. They serve for stopping the latter, but are powerful enough to arrest any motion. They act upon the different parts of the mechanism, one of them upon the axle of the main pulley, and the other upon the pinion that controls the ascent.

As the endless screw prevents the descent of the ap-



paratus when motion is arrested, if the cable happened to break, all motion ceasing, the apparatus would remain stationary at the point that had been reached when the breakage occurred. It is to be remarked that such stoppage is accompanied with no shock, and that the apparatus behaves absolutely the same as it does in regular stoppages.

Finally, the threaded rod, S, which controls the grips and gearing cones, is actuated by a pitch chain, h, which moves in both directions. The automatic stoppage is produced by the meeting of a tappet on this chain and corresponding stops placed upon the rail or its frame.

It results from what precedes that the breakage of the cable offers no danger, since the parts of the apparatus are so combined that the car cannot descend by its own weight, and these parts, besides, are never exposed to shock. The parts designed to prevent the descent do not produce any friction during the ascent, and they may therefore, without inconvenience, be of very large dimensions relatively to the stresses that they have to undergo, and security may thus be increased as much as desired.

The arrangements described have the advantage of entirely suppressing the parachutes and racks necessary in all systems employed for great heights.

As the apparatus is independent of the motor's motion for the direction of its own, the maneuvering does not require the use of starting rods passing up the entire height, and which, when the latter is very great, are both inconvenient and dangerous.

The power of the motor may be estimated as of 120 horses, and the performance as 75 per cent. It should be remarked that this performance is independent of the height, contrary to what is found in the present

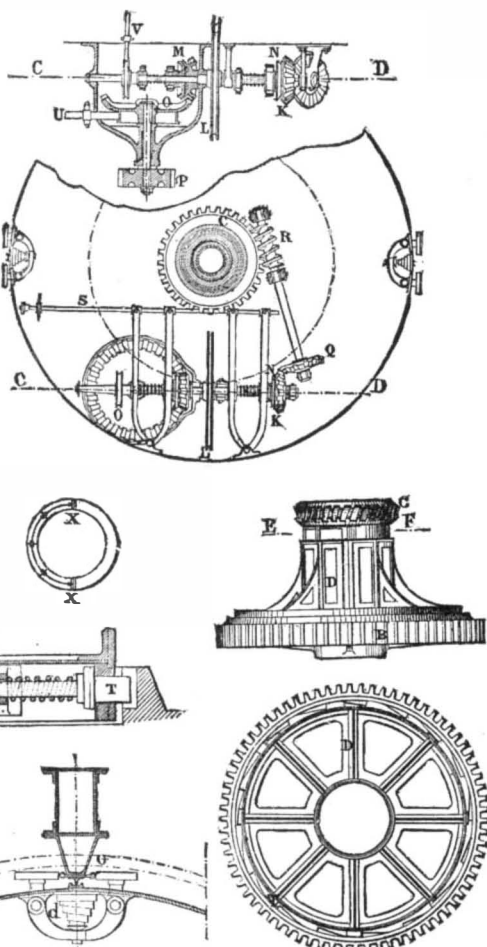
It will be seen how slow and costly transportation subject to such maneuvers must have been. Navigation of the Seine assuredly could not have been kept up under so unfavorable conditions, and commerce would have left the river entirely for the railroad had not the successive improvements effected since the beginning of this century made possible a competition between the boats and the railroad from Paris to Rouen.

The most important of these works were those undertaken by virtue of a law of 1846, for securing to navigation a minimum depth of five feet, by canalizing the river by means of movable dams of the type that had just then been invented by Engineer in Chief Poiree. This system of improvement, which is the only one of certain efficacy, consists in reproducing the natural state of the river and its division into a series of basins one above another. The movable dams established below these basins raise the level of the water when the quantity of the latter is not sufficient to furnish the necessary depth in the basins (called "reaches"), and disappear, on the contrary, when, at the period of freshets, the water naturally rises above the indispensa-

chance to examine the application that has been made of this new system at Poses, of which our engravings give general views and details.

The hinged curtains, which constitute the mode of closing all the new dams constructed upon the Seine, consist of a series of strips of wood superposed and connected by two rows of hinges fixed upon their upstream face. The curtain thus established forms a flexible surface which may be unrolled against the vertical supports of the dam in order to hold back the water, or be totally or partially unrolled for giving it an egress corresponding to the state of the river's supply. The rolling up and unrolling are effected through an endless chain running over the center of the curtain and set in motion by a small windlass which runs over a foot bridge. The vertical supports against which the curtain rests are of two kinds in the Seine dams, and the latter may therefore be referred to two types—that of Port Villev (curtains resting upon Poiree frames) and that of Poses (curtains resting upon uprights jointed to bridges above).

The two sketches herewith given show the essential arrangements and the mode of maneuvering the frames,



FIGS. 4 AND 5.—DETAILS OF THE MECHANISM.

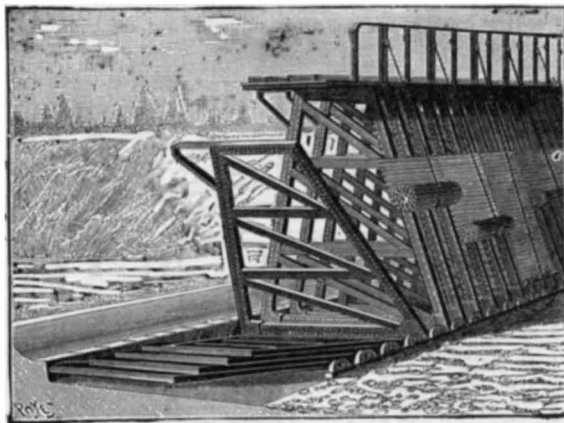
systems, where not only the dead weight to be lifted, but also the dangers and the difficulties of installation, very rapidly increase with it.—*Le Genie Civil*.

#### NAVIGATION ON THE LOWER SEINE.

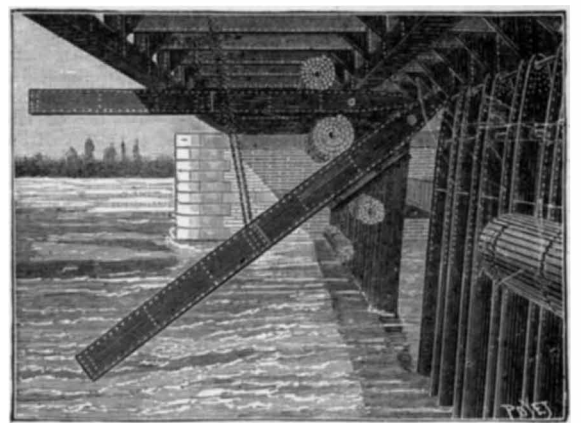
THE work of improving the navigation of the lower Seine terminated last year. It was executed by virtue of a law of the 6th of April, 1878, and secures a minimum anchorage of 10½ feet in this part of the river, which, connecting Paris with Rouen and the ocean, is destined to remain the most interesting of the navigable waterways of France.

Now that the canalization of the river and the use of steam as a means of propelling boats have rendered transportation by water easy and rapid, it is hard to realize the difficulties experienced by the old mariners of the Seine in getting their boats to Paris. Abandoned to itself, the river was formerly divided into a series of basins separated by shoals. In each basin the depth was considerable, the current was feeble, and the boats ran easily. But on the shoals the depth in summer descended to 2¼ feet, the current reached a velocity of 4½ miles per hour, and the maneuvering to be effected in order to cross these rapids was often troublesome and always dangerous. The shoal situated just above the Poses dam was one of the most dreaded ones, and the entire population of the village of Poses (about 450 men) was occupied in the maneuvers connected with the crossing of this bad passage by boats.

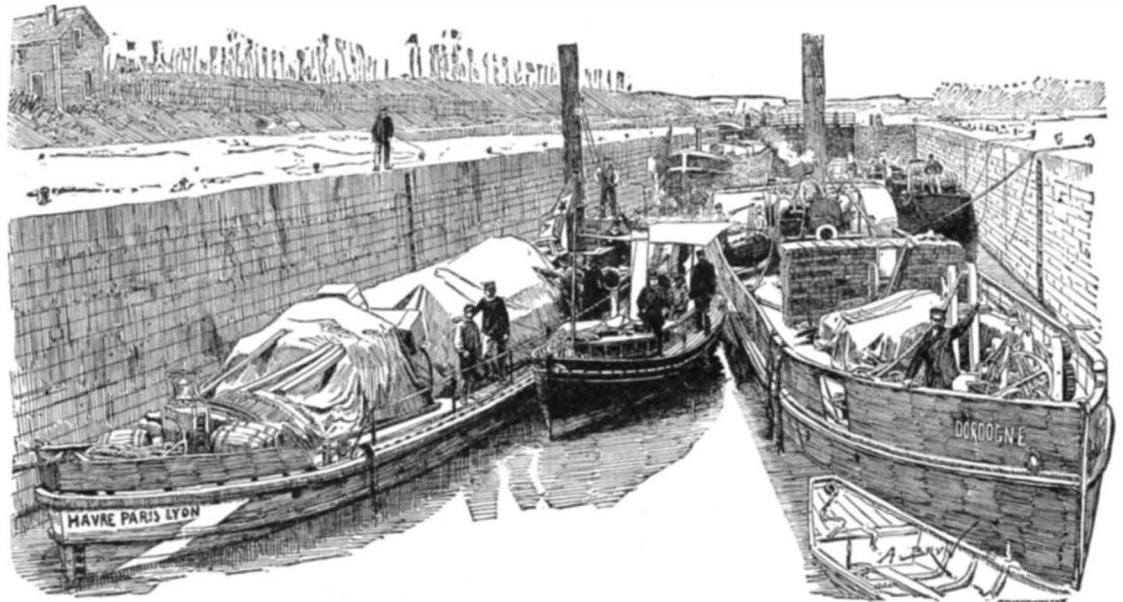
To the difficulties resulting from the nature of the river were added those derived from the construction of the bridges running from one bank to the other, and the foundations of which incumbered the river bed and thus created artificial rapids that were as troublesome to cross as the natural ones were. From this point of view, an examination of an old window in the ancient church of Pont de l'Arche is interesting. This window reproduced in one of our engravings from a photograph, exhibits a large number of the inhabitants of Pont de l'Arche, clothed in the costumes of the time of Charles IX. and Henry III., employed, both men and women, in hauling a boat under one of the arches of the antique bridge built in the ninth century, under Charles the Bold.



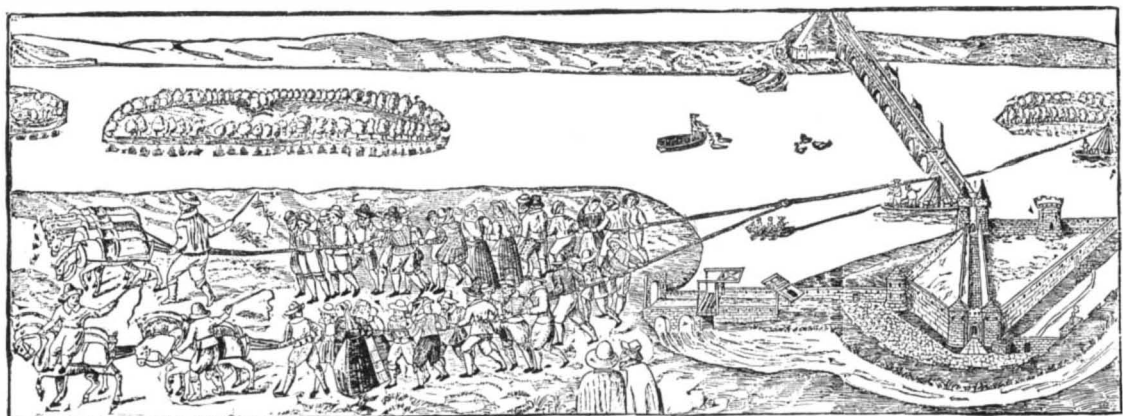
A CURTAIN DAM.



CURTAIN DAM WITHOUT UPPER BRIDGE.



WATER LOCK.



TOWING A BOAT IN THE SIXTEENTH CENTURY.

#### RIVER SEINE IMPROVEMENTS.

ble level. Lock gates placed in the vicinity permit the boats easily to cross the fall created by the dam.

The results obtained from the first works of canalization, executed between 1838 and 1886, bore no longer any relation, in 1875, to the importance of the commercial movement on the Seine from Rouen to Paris; and it was then that, taking up the propositions made previously by Engineers in Chief Belgrand & Krantz, the government decided on the execution of the new canalization work in order to render the Lower Seine ten and a half feet deep.

Had the application of the Poiree system permitted of putting up movable dams whose height (9 ft. at a maximum) would have sufficed to maintain a depth of 6½ ft. at the up stream extremity of the reaches, by raising the level of the water, it would have required some system to be found that would have rendered possible the erection of very high dams (that of Poses exceeds 16 ft.) to obtain a depth of 10½ ft. without needlessly multiplying the number of works. The new system by the use of which this difficult problem has been solved was devised by Engineer in Chief Camere. The invited guests of the municipality and of the chamber of commerce, on traversing one of the most picturesque parts of the river on the 3d of July, had a

and consequently allow the capital differences existing between this system and that applied at Poses to be understood. The lower cross piece of these frames consists of a horizontal shaft whose extremities run in bearings sealed into the masonry foundation of the work. During the period of freshets, these frames lie upon the river bottom. After the subsidence of the water, they are raised in succession by means of chains. When they are upright, they are connected at the top by the parts of a foot bridge over which run the cars that serve to carry and put the curtains in place, and also the windlasses used for rolling up and unrolling them.

When it is a question of very high dams, as at Poses, the use of frames presents some inconveniences. In order to avoid these, Mr. Camere has been led to study a new system of supports combined with the use of his curtains. Our engravings show the operation of the movable apparatus of the Poses dam. A metallic bridge extending across the river, and uprights of boiler plate assembled in fours in order to form frames, are suspended by a shaft around which these latter revolve. Against the up-stream face of the frames are placed the curtains, and on their down-stream face there is a small platform that can be folded against the



uprights, and which, when unfolded, forms one of the elements of the foot bridge over which run the windlasses that maneuvered the curtains. When the frames are erect, the base of the uprights abuts against granite stops sealed into the masonry foundation. It is then possible to let down the curtains to close the dam. When the freshets come on, all the curtains are rolled up, the parts of the foot bridge are folded, and, by means of the windlass located upon a bridge above the other, each frame and its curtain is lifted horizontally under the upper bridge and is hooked thereto.

With this system, the height of water obtainable is, so to speak, no longer limited. The use of it permits of diminishing the number of dams and of increasing the height of each of them. From this point of view, it may be economical in the establishment of a river canalization.

The Poses dam, which is an application of this system, is, among the movable dams hitherto constructed in France and foreign countries, the one whose height is greatest. It keeps up a depth of 10½ ft. in a reach 24 miles long, while the mean length of the reaches that correspond to the other Seine dams is but 12 miles. The work on this important undertaking was begun by Engineer in Chief Camere, the author of the project, and was continued and finished under his direction by Engineer Clerc.

The increase in the depth of the Seine has had a considerable influence upon the traffic of this navigable watercourse. It has even permitted of the establishment of a coasting trade as far as to Paris, where the steamers that ascend the river tie up at the new wharf of Saints-Peres bridge.—*L'Illustration*.

#### HERR KRUPP.

HERR ALFRED KRUPP, the proprietor of the celebrated steel works and gun foundry, died on July 14, at his villa near Essen. He was born on April 11, 1810, at Essen, where his father, Frederick Charles Krupp, had set up a small foundry. When his father died, Herr Krupp and his brother carried on the business in partnership with their mother until 1848, when Alfred became sole possessor of it, and developed it into the greatest steel-casting industry in the world. After patient and long-continued experiments and countless failures he succeeded in making steel in huge blocks. His great achievements in this branch of industry were honorably attested by his displays at various exhibitions in this country and abroad. The Krupp steel foundry a few years ago covered an area of 500 hectares, and employed 10,600 workmen, in addition to the 5,000 men employed in other undertakings of the firm. No fewer than seventy-seven steam hammers were constantly at work. Railway lines connected the works with the railway system of the country; and the establishment included a chemical laboratory, a photographing and lithographing house, and book printing and binding workshops. The articles produced included axles, wheels, machinery of various kinds, cannon, and shells and other missiles; some of the cannon rivaling in size and power the most tremendous productions of Whitworth and Armstrong. The Krupp cannon are, as is well known, loaded at the breech; and their merit has always consisted quite as much in the use of the

finest, strongest, and purest metal as in the peculiarity of their construction or "building." These cannon have been found to possess almost unsurpassable durability, accuracy, and range. The plentiful shell fire which harassed Lord Wolseley's forces at Kassassin was delivered from Krupp cannon purchased by the Egyptian government at Essen. Up to 1876 Herr Krupp had delivered to different governments 15,000 cannon, mostly equipped with carriages and ammunition. After the terrible conflict of 1870-71 had been ended, the German army was supplied throughout with the perfected field piece of Herr Krupp, and the whole of



HERR ALFRED KRUPP.

Head of the great Krupp Gun Works, Essen, Germany. Born April 11, 1810. Died July 14, 1887.

the German coasts are defended by battery guns of his design and construction. The firm possesses for its experimental practice a strip of land seven miles long, fitted up as a cannon range, near Dülmen, in Westphalia. The firm also carries on extensive mining and smelting works and owns much land, rich in iron ore, in Northern Spain, employing four steamers in the conveyance of the metal to Germany. Herr Krupp's genius came opportunely to the aid of his countrymen in the crisis brought on by Prince Bismarck's resolute efforts to attain German unity. The effect of the massing of numerous batteries of his latest and perfected cannon, with their concentrated fire directed on an attacking force, has yet, however, to be witnessed—it is to be hoped, at a very distant day. Our portrait is from a photograph by E. Schink, Essen.—*The Graphic*.

#### ROLLER MILLING.

RECORD OF TESTS AS TO THE POWER CONSUMED BY VARIOUS MACHINES USED IN ROLLER MILLS.\*

By Mr. HENRY SIMON.

BEFORE entering on the subject matter of the present paper, it may not be out of place nor uninteresting to many of the millers present to refer to a former paper which I had the honor to read before the Millers' Association in this hall, in the year 1879.

At that time roller milling was just beginning to excite some general interest in this country, and your association met to give me an opportunity of bringing the subject more prominently before them. The views that I then expressed on the advantages of roller milling were very freely criticised in the discussion which followed the paper, and one assertion, among others, was received with great incredulity, viz., my belief that in a comparatively small number of years rollers would have almost entirely replaced stones in the manufacture of flour in this country. This was thought to be highly improbable, if not altogether impossible.

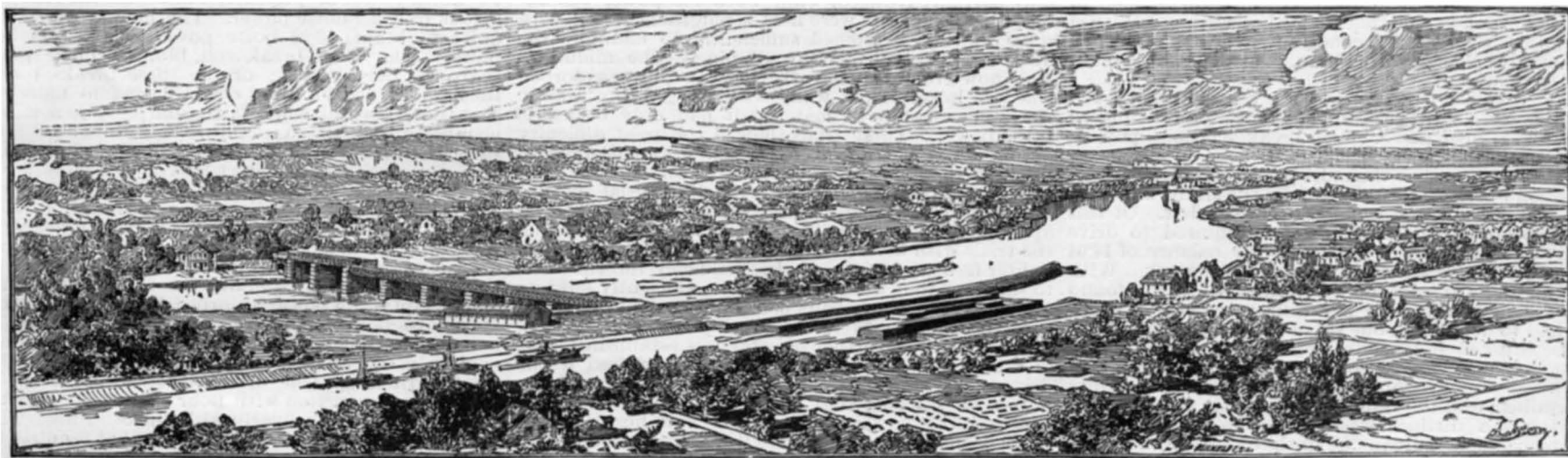
The few years that I have passed since I had last the honor to address you have more than fulfilled the expectations I then expressed. Roller milling has replaced stone milling, and the millers who are assembled here to-day have, during those years, passed through an experience that qualifies them to act as excellent judges of the importance or otherwise of this, the second subject which it has been my privilege to bring before your association, viz.:

*The Horse Power Absorbed in Roller Milling.*—It is never very pleasant for an assemblage of business men to sit and listen to a paper which tells them nothing but what they know already, or repeats what has often been told and written before. In dealing, however, with the power absorbed in roller milling, this paper treats of a subject on which, as far as I have been able to ascertain, there is a general lack of published information, and while I do not profess in every instance to tell something entirely new, yet it does not repeat what has ever been published before, and deals entirely with a prolonged series of special trials extending over a protracted period, and executed for me under the continued superintendence of Mr. W. Stringer, and for the accuracy of which I therefore can vouch.

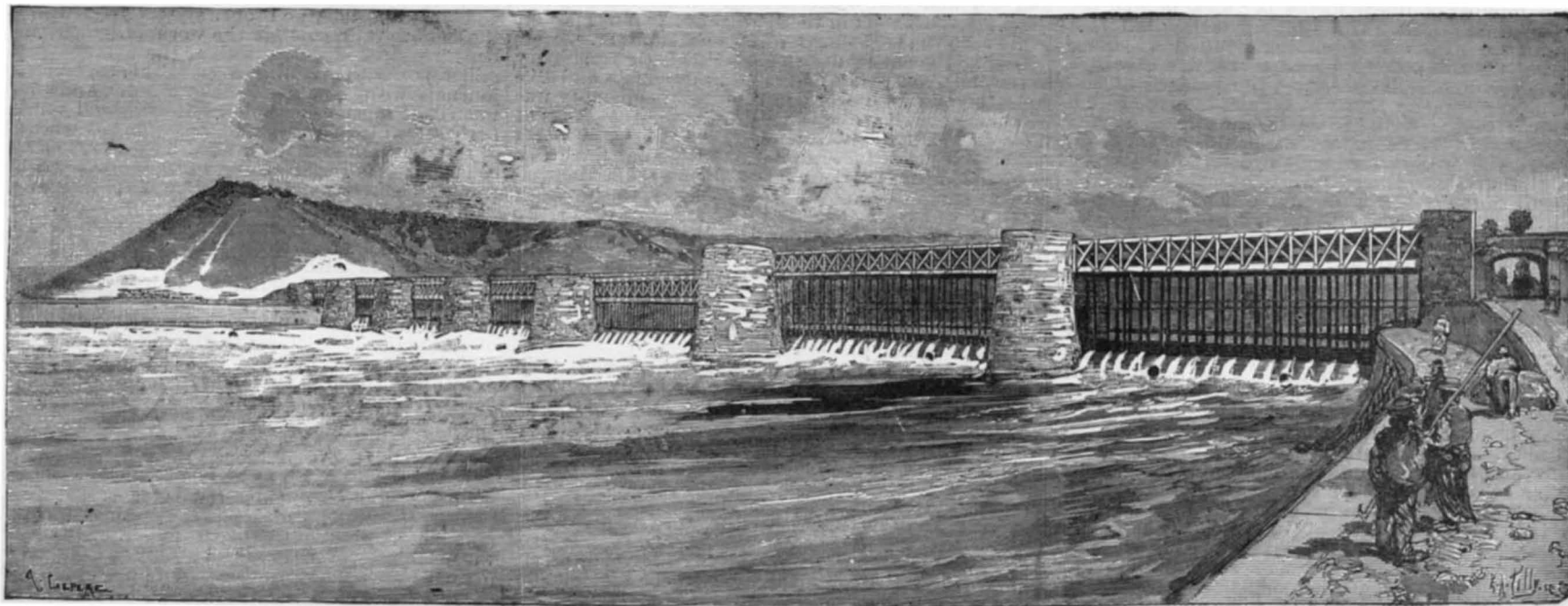
In instituting these trials, my intention was, by a series of accurate tests, to come to a reliable decision as to the power taken by the different machines used in roller milling when worked under varying conditions, and to determine what proportion of power was taken by the different sections of the roller system.

In carrying on my business as a milling engineer, I daily found the want of this information; and during the past years had collected an extensive record of the varying powers taken by the different plants which I have erected in the United Kingdom. While the experience gained in this manner had enabled me to approximate very fairly the amount of power absorbed by any particular work and any particular machine, I still thought it would be worth the expense and trouble of the trials if I could establish a reliable stand-

\* Paper read before the Millers' Convention at the Bakers' Hall, London, June 16, 1887.



GENERAL VIEW OF THE WORKS AT POSES.



THE POSES DAM.

#### RIVER SEINE IMPROVEMENTS.



ard of the power that the different classes of machinery used in roller mills should take when worked under fair conditions.

After consultation with Mr. Michael Longridge, who, as chief engineer of the Boiler Insurance Company, Manchester, has exceptional experience in the indications of power, he undertook for me the engineering superintendence of these trials and the taking and calculation of the engine indications, my principal miller, Mr. Stringer, being responsible for the general supervision of the milling, the setting of the rolls, and the regulation of the different machines.

The Kirkdale Roller Mills, Liverpool, where the tests were made, is a compact, well-built six-floored building, five floors of which are partially occupied by the roller mill. It is a first class eight sack plant on my system, and, having plenty of room and light, was for this reason a place particularly suitable for the trials, which were carried out by one double cylinder high pressure engine, with cylinders 16½ in. in diameter, and stroke 2 ft. 9 in., driving the whole plant; and a small 8½ in. diameter single cylinder engine, 14 in. stroke, which was placed on one of the mill floors, and to which the different machines, the powers of which were to be ascertained, were consecutively connected. The smaller engine was very sensitive, and capable of showing the slightest variation in power. During the trials indications were taken with the main engine, while the mill was running under very varying conditions, on a variety of wheats with large and small feeds, and at different speeds. With the large engine the mill was also indicated in sections, and the power consumed by each section was again and again checked, machine by machine, by means of the smaller engine, with which were also tested independently the elevators, worms, etc.

Indications were taken of the same machines under varying conditions as to pressure used in grinding speeds, etc., and a sufficient number of diagrams were taken to guard against error, in many cases several days having been spent over one series of indications in order that a thoroughly reliable result might be arrived at. All indications, whether with the larger or smaller engine, were, whenever practicable, checked independently, and every precaution taken that the results obtained should be not only approximately but, as far as possible, absolutely correct.

It would be impossible, in the limits of a short paper, to go into the details of those trials, though to many the particulars would be interesting; but as the taking of the indications, with the preparations for them, and the necessary calculations afterward, was the work of months, it will be seen that only a very condensed summary of the results can now be brought before you.

**Granulation.**—I shall first deal with the granulation, giving only such results as I think would be interesting to the general miller, omitting small fractions, except where the smallness of the total consumed power makes them absolutely necessary. The quantity of wheat that was on the mill during the trials of course varied somewhat from day to day. In order to simplify the figures, I have by calculation averaged the work to 8½ sacks (of 280 lb.) finished flour per hour, and the results given are based on this quantity. The mill was fitted up with six breaks, one pair of 24 in. by 10 in. fluted rolls being used for each break, the flutes of all being in good condition at the time of the indications. With a full speed of medium condition wheat, and when thoroughly cleaning the bran, the different breaks took as follows:

First break, 2.0 horse power; second break, 4.12 horse power; third break, 3.45 horse power; fourth break, 3.45 horse power; fifth break, 3.0 horse power; sixth break, 1.32 horse power.

It will be seen that the most power was absorbed by the second break, and the least by the sixth, while the next smallest power was required for the first. Of this total power, 3.30 horse power was required to drive empty the six pairs of rolls, and the balance of 14.04 horse power was absorbed in doing the work. With the mill on hard frosted Minnesota wheat, it was found that the breaks took 21 per cent. more power. This test had to depend on one set of indications, and could not be checked independently, so that I can only give these as approximately correct. The speed at which a break roll would require the least power was carefully ascertained, and the results showed that any excess of speed was a distinct waste of power, without any counterbalancing advantage in the quality of the work. It was also found that when the rolls were sharp there was no gain in power, nor any improvement in the material, by increasing the length of rolls beyond a certain number of lineal inches per sack of flour per hour on each break. The scalping of the full feed when the six breaks were running required 4.93 horse power, and of this power 1.6 horse power was absorbed in running the machines empty, the balance of 3.33 horse power being all that was required for the actual treatment of the feed. Some of the breaks having been scalped in the centrifugals and some in the reels, another series of tests were made to determine the relative power taken by the two classes of machines.

When running idle a double centrifugal scalper, three sheets long, used for the scalping of two breaks, took 0.55 horse power, while two four-sheet reels took 0.38 horse power, showing that more power was required for the empty double centrifugal than for the two empty reels.

A number of indications were also taken of the relative power absorbed in scalping; 30 cwt. of wheat was put into a one-sheet centrifugal scalper, and the scalping, independent of the machine, took 0.82 horse power, while the same weight of feed in a four sheet reel only took 0.51 horse power, proving that in the actual work of scalping or dressing a reel is also more economical than a centrifugal scalper.

**Smooth Rolls.**—In the mill were four sets of 20 in. by 10 in. and three sets of 20 in. by 9 in. three-high smooth roller mills. These were found to take in the aggregate 22.46 horse power, or 2.64 per sack of flour, and when running empty 7.52 horse power. Two 20 in. by 10 in. mills took all the first-class semolina and absorbed 6.74 horse power. One similar set of rolls and one set of 20 in. by 9 in. took all the fine middlings, and absorbed 5.46 horse power, while one set of 20 in. by 10 in. and two sets of 20 in. by 9 in. took the returns from the first centrifugals and all the second-class material and tails, and absorbed 10.26 horse power.

A trial of hard frosted Minnesota wheat showed the

smooth rolls taking 4.70 horse power per sack of flour, while a similar quantity of medium wheat only took 2.91 horse power. This was an increase of 78 per cent. The actual increase of pressure on the smooth rolls, however, was very much greater, for if we deduct the power required to drive the empty rolls, which was the same with both wheats, the power absorbed in the actual grinding of the middlings was 112 per cent. more than was required for those from the softer wheats. The power required to grind respectively light and heavy feeds was exhaustively tested, and the result conclusively proved that a very great deal of power can be wasted by overloading, or even by fully loading, smooth roller mills.

In one case a feed of coarse semolina on both pairs of a three-high mill was indicated, and absorbed for the grinding 3.36 horse power. When this same feed was put on one side of the mill only, it absorbed 5.93 horse power, or an increase of 77 per cent. to produce the same effect. This quantity was a fair feed for both pairs of rolls, and when put on one pair was a very heavy feed. Taking, again, another mill running with a light feed, both pairs took 2.54 horse power, while the same quantity on one pair took 8.0 horse power, or an increase of 18 per cent. In this case the feed was, as just stated, a light one when divided over both pairs, and was what would be called a full feed for the single pair. Another three-high mill had a very light feed, which took 0.57 horse power. A similar roller mill had about double that quantity, but still was not what is usually regarded as overfed, yet the grinding took 2.81 horse power.

In all cases the material was better ground when spread over the larger surface, so that a small feed on a smooth roller mill will not only take relatively less power than a larger one, but the work at the same time will be more satisfactory. Although the maintaining of the differential speed between rolls is generally secured by gear, yet in some machines it is secured by belt. Considering that it would be advantageous to test the relative powers absorbed by the different methods, a series of trials were carried out, and the results were very instructive. In the first instance a fully fed pair of rolls with gear were indicated, and absorbed 2.73 horse power for roll and grinding. The gear was then taken off, and the two rolls driven independently by belts. Now, in putting on the necessary grinding pressure, the fast drive belt began to slip, and both rolls practically ran at the slower speed, the result being that only a small portion of the material was sufficiently ground, while the power absorbed was 2.90 horse power. The fast roll belt was then thrown off and the second roll entirely driven by friction off the slow roll. The relief given by throwing off the slipping belt enabled the same amount of work to be done with 20 per cent. less power, the roll now working with 2.32 horse power instead of 2.9 horse power.

A stronger belt was then put on the fast roll, and immediately the slow roll belt began to slip, and both rolls ran at the quicker speed. The quality of the work was the same, while the power taken was increased to 5.63 horse power. The slow roll belt was next thrown off, and the springs of the rollers were tightened, so as to put an increased pressure on the material, but the work was still as unsatisfactory, the middlings being only partially reduced, while 7.6 horse power was absorbed. Both belts were next strengthened, and with some difficulty tightened sufficiently to maintain the differential speed without slipping. The middlings were now ground sufficiently, but the power absorbed was 5.15 horse power, while with the gear for exactly the same amount of material it had only been 2.73 horse power. These trials showed the great difficulty of maintaining by belt the exact differential speed when there is a full feed on the smooth rolls, and also established the fact that when the differential speed is not maintained there is a very great loss of power apart from the bad quality of the work. Continuing the trials with belt-driven rolls, it was found that with lighter feeds there is much less tendency for the belts to slip, and that where the work is sufficiently light to allow of fairly slack belts maintaining the differential speed, the horse power absorbed is practically the same as with gear. A further set of trials established that in a geared mill less horse power is required if the drive is first transmitted to the quick-running roll, the indication showing that with the driving belt on the fast roll the power required was 2.73 horse power, while with the slow roll drive it was 2.8 horse power, or a loss of 2½ per cent.

**Dressing Machines.**—In dressing the material from the reduction rolls, eight centrifugals were employed, four 2½ and four 3 sheets long. When running idle these machines took in the aggregate 4.73 horse power, while with the feed they took 5.98 horse power.

Taking the entire dressing and scalping machinery in the mill, consisting of twelve centrifugals and five reels, the power absorbed in running them empty was 7.96 horse power, while when dressing the 8½ sacks of flour it was 14.28 horse power. Of this, 8.30 horse power was used for scalping and dressing the break meal and the material from the breaks, while the balance was required, as we have seen, for the dressing machines following the reduction rolls; the entire scalping and dressing taking 21½ per cent. of the total power required for the mill. That this power could be very much reduced was proved by repeated experiments, several machines being run considerably below their normal speeds, resulting in every case in very much less horse power being required to do the same amount of work.

In one case a particular machine, which had on it a very large feed, when running at 200 revolutions, absorbed 1.43 horse power for the machine and work, while the same machine at 160 revolutions only took 1.07 horse power, being a saving of power of 25 per cent. Again, a centrifugal, scalping one of the breaks, took at 200 revolutions 1.56, while at 130 revolutions it only absorbed 1.15 horse power, being a saving of 26 per cent. In both these cases the work at the slower speed was as well done as at the 200 revolutions. On the further testing of the power taken by one of my three meter centrifugals, the average for a single machine running empty at 200 revolutions was found to be 0.71 horse power, which was divided among the several parts as follows: The center, shaft, and beaters took 0.51 horse power; the outside cylinder and rails carrying the silk, 0.12 horse power; and the collecting worm, 0.08 horse power.

**Purification.**—All the machines for purification in this mill absorbed only the small power of 4.66 horse power. Three semolina purifiers ran at 450 revolutions, and their fans at 900 revolutions. Under the purifiers were nine collecting worms, driven with cross shaft and bevel gear. The three purifiers, fans, collecting worms, etc., only absorb 2.55 horse power, or 0.85 horse power per machine.

A "Reform" purifier, running at 450 revolutions, fitted with filter and a quick-running fan, took only 1 horse power. Two tailing sieves, an exhaust fan, and a dust catcher absorbed only 1.11 horse power. From the small amount of power which is taken by the running of properly constructed purifiers, etc., it can be clearly seen that the better class of mill plants should require less horse power per sack of flour manufactured than an inferior system. There are no other class of machines that with such little power will separate the injurious material and send it direct to the offal sack. The rejecting of similar material, in the absence of purifiers, by smooth rolls and centrifugals, etc., in addition to injuring the quality of the flour, must, and decidedly does, take considerably increased power. There were in this mill sixteen elevators running from the top of the mill to the bottom, each 48 ft. high. They were all fair sized elevators, with 4½ in. cans and 5½ in. webbing; but the whole power required to drive them at their full speed, empty, was only 0.65 horse power, while when the full feed was on the mill, the additional power absorbed was only 0.69 horse power, the whole power required for the elevators at their full feed being 1.34 horse power. To convey the material from the smooth rolls to the elevators and collect the flour and offals, 316 ft. of worming was employed, which, running empty, absorbed 1.64 horse power. With the full feed on, the additional power required was only 0.48 horse power. A special test of a large 9 in. worm, carrying 24 sacks of flour per hour 47 ft., only absorbed 0.58 horse power for worm and feed.

**Summarizing briefly** the powers taken by the different sections, when packing 8½ sacks of flour per hour from a medium mixture of wheat, we find that the total power absorbed by the entire plant (exclusive of the friction of the engine and some shafting outside the mill) was 66.31 horse power.

Of this power the break rolls took 17.34 horse power, or 26.15 per cent. of the whole. The smooth rolls 22.46 horse power, or 33.87 per cent. The scalping and dressing machinery 14.28 horse power, or 21.53 per cent. The purifying machinery 4.66 horse power, or 7.02 per cent. The shafting 4.11 horse power, or 6.19 per cent. While the balance, 3.46 horse power, or 5.22 per cent., was absorbed by the worms and elevators, the whole plant on the medium wheat absorbing 7.8 horse power per sack of flour manufactured. Three fifths of the total power was required on the roller floor, the breaks, as we have seen, taking more than one fourth. This was with the rolls in good condition. During the earlier part of the trials, however, some of the rolls were dull and required refuting. A comparison of the relative powers taken by them when blunt and when in proper order for working is very striking. Not taking into account the power required to drive the empty rolls, which was the same in both cases, the fourth break, in a six-break plant, took with the blunt roll 6.8 horse power of pressure, while with the sharp roll it took only 2.9 horse power. The fifth break roll (not quite so blunt), 3.22 horse power, sharp 2.45 horse power. The sixth break roll, blunt, 3 horse power, sharp 0.77 horse power; or the three breaks took in the aggregate when blunt over 100 per cent. more pressure than they did when fairly sharp. When it is remembered that the expenditure of this increased pressure was employed in producing heat, injured bearings, and general discomfort, it will be seen how very important a matter is the keeping of the break rolls sharp and in good condition for working. But it is not only in the waste of power, but more especially in the injury to the material, that rounded corrugations are most injurious. The smooth rolls took one third of the whole power. Deducting the friction of the rolls when empty, the power absorbed in pressure was only 14.94 horse power, or almost exactly the same as the pressure on the breaks. This will probably be thought extraordinary, but it is not. It is simply the result of careful grinding. One of the most widely prevalent fallacies in connection with flour manufacture is that it is easy to grind properly with smooth rolls. There is nothing in practical roller milling that requires half as much skill and judgment; and a really good grinder is rarely to be met with.

It is not difficult to granulate, to purify, or to dress properly, if the miller is provided with the right machines and has the proper system, but to grind on the smooth rolls, so that the work is done at its very best, requires more skill than the average practical miller possesses; and, as a consequence, rolls sweat, journals wear out, gear make a noise, and power is wasted. Properly constructed smooth roll mills, properly set, will grind the middlings from any wheat, hard or soft, without sweating; and an exhaust to a smooth roller mill is never necessary, except to take away the troublesome effects of bad work. Too much pressure, badly fitted or too tight scrapers, or uneven setting, are the most usual causes of wasted power. To give an instance of overpressure:

A roller mill with a certain feed was set too closely, that is, after the material was properly ground, more pressure was put upon it. After a few minutes the machine began to sweat, and gradually through some of the material sticking to the roll the work became higher; another increase of pressure followed, and eventually the roll was indicated, showing that 6.19 horse power was being absorbed. The pressure was then reduced, the roll cleaned itself, the sweating gradually disappeared, and though the material was ground fully as low as before, the power required was only 2.87 horse power, or less than one half. The roller floor has supplied the material for most of this paper, principally because the power consumed on it is so much under the control of the miller. All the rest of the machinery of the mill took only 26.49 horse power in an 8½ sack plant, so that the importance of attention to the rollers is self-evident, if power is to be saved in a roller mill.

One of the most striking and instructive facts demonstrated during the trials was the paramount importance of having all bearings sufficiently and continually lubricated. The mill was fitted throughout with self-



acting needle lubricators, all of which were in good working order. Twice every twelve hours in addition all gearing was greased, and all the main bearings oiled by hand, so that the mill as a whole was exceptionally well lubricated. Indications taken of the entire plant, with engine and intermediate shafting, while doing 9.65 sacks of flour per hour, and while the oiling was thus carefully attended to, showed 90 horse power. A special oiling of every journal by means of ordinary oil cans followed, and another set of indications showed that only 83.6 horse power was being absorbed, which was a saving of seven per cent. This saving, I repeat, was on an already exceptionally well-oiled mill. Indications of machines wholly dependent for their oiling on the needle lubricators were taken when the machines had been but a short time running after standing for three days. These were compared with the indications of the same machines after being, or rather while being, thoroughly lubricated by hand, the better oiling showing a saving of 21 per cent. of the horse power required to drive them. Another set of indications showed that machines not fitted with automatic lubricators took, on the average, 10 per cent. more horse power half an hour after oiling than was required when the indications were taken during the process of oiling.

I think I cannot better conclude this paper than by giving my earnest advice to every miller to take care that his roller plant is not taking too much power. Throughout the series of trials the one broad fact was everywhere apparent that the amount of power that was being absorbed was a very good indication of the work that was being done; indeed, if the power required to drive the empty machinery is deducted, it is a really reliable basis on which to judge of the system of manufacture. All other things being equal, the miller who turns out his flour with the least power is doing the best work, and I will go further and say that, all other things being equal, the miller who takes the greatest power is doing the worst work. After the machinery is driven, the whole power absorbed is used in the separation of the inside of the berry from the outside, and the system that takes least power is that which separates it in the gentlest and tenderest manner. The inside of any properly prepared wheat berry is easily reduced to sizes smaller than that of the skin which covers it, and with an ordinary medium mixture of properly prepared wheat the power required to reduce the inside to flour is very small indeed. It is the skin, the straw, woody covering, that is hard to grind; and when once reduced it can never afterward be entirely rejected, and the miller in his endeavors to do so wastes more power and further injures his quality by re-rolling his granular flour in order to try and get it smaller than the branny particles that he had cut up and mixed with it. Let him remember that "prevention is better than cure," and that the using of excessive power not only increases the cost of production, but injures also the quality of the flour he manufactures.

## MANUFACTURE AND USES OF LEATHER.

By E. J. TANNER, Ph.D.

THERE is no other article, with the exception, perhaps, of paper, that finds such a variety of uses among all nations, in every department of life, as leather; hence the common expression, "nothing like leather." The soldier and the sailor, the artist and the artisan, the merchant and the mechanic, all have use for leather. Even the great iron roads make some use of it. In the stable and at the forge it is indispensable. It is a necessity in the ball room, a luxury of the boudoir, and plays the part of both in the library.

The antiquity of leather is very great, and the improvements of modern times in the manner of its preparation are not very remarkable.

Leather may be briefly defined as a material formed by the combination of the substance of the skin with any other compound which has the property of rendering it imputrescible, soft, pliable, tough, and non-transparent. Skins that have been protected against decay by drying do not fall under this definition of leather, nor is parchment a true leather.

The skins of all animals, both wild and domestic, are employed in the manufacture of leather, and even the denizens of the sea must contribute material for the insatiable leather maker.

Human skin is rarely tanned for leather, although medical students sometimes indulge in a pair of gloves or a cigar case made from the skin of a "stiff," and the author was once requested to tan a piece of negro skin after it had been removed from the body. Human skin has also been employed, in early times, for parchment; and in England some of the old cathedral doors were covered with the skins of pirates, and a tanned human skin was recently exhibited in the Versailles Museum.

The skins in more common use are those of oxen, cows, and horses, called *hides*; of yearling cattle, called *kips*; and of calves, deer, sheep, goats, pigs, dogs, seals, porpoises, and alligators. The hides of the buffalo and hippopotamus also find limited use.

All parts of the world are ransacked for hides, as those obtained from domestic animals slaughtered for food are quite insufficient to supply the demand. Immense quantities are imported from South America, India, and Africa. Those received directly from our slaughter houses in their natural state are known as "green hides." Those which come from a distance are either salted or dried. "Partial cured" hides are those which have been salted, but not long enough to be thoroughly cured; "green salted" hides are those which are salted and thoroughly cured; "dry flint" have been dried without salting; and "dry salted" have been salted while green, and then dried.

The dry hides used for making sole leather are principally imported from South and Central America, but some are received from Texas and California. The best grade of dry hides generally comes from Buenos Ayres and Montevideo. They are dried rapidly, to prevent putrefaction, and the loss of weight in this operation amounts to nearly two thirds of their entire weight; so that a hide which weighs sixty pounds when green will weigh but twenty when dry. This effects a great saving in the cost of transportation, and it is unnecessary to pay freight on such a quantity of water, as it can easily be replaced by soaking at the tannery.

The skin of animals, as well as that of man, consists of two distinct layers. The outer, to which the name of epidermis, or scarf skin, is applied, is without feeling, and does not bleed when cut. Beneath is the true skin, or derma, which is the portion actually used in making leather. Between the two skins, in man, is a layer of pigment, which gives to different races their characteristic colors. In the Caucasian it is nearly white, in the African black, in the Mongolian yellow, and the Indian red. A collection of water between the two layers constitutes a blister.

The conversion of hides and skins into leather is partially chemical and partially mechanical. The soluble constituents of the hide, which are likewise putrescible, must be rendered insoluble by chemical means. The extraneous and useless portions of the skin must be removed, and the substance rendered pliable and supple by mechanical means. Any substance capable of precipitating a solution of gelatine can be used in tanning. Among these are various metallic salts, and also certain organic substances known as astringents. Among the latter are a class of substances not identified in their properties, to which the general name of tannic acid is applied. This substance occurs in oak, fir, and hemlock barks, nut galls, sumac, quinine barks, catechu, gambier, cutch, divi-divi, kino, fern root, fustic, tea leaves, and coffee beans. In all its forms it possesses the characteristic property of producing a deep blue-black color with salts of iron. It is, therefore, generally employed in making writing ink, shoe polish, etc. The black stain that tea and coffee produce on a steel knife blade is due to the tannic acid they contain uniting with the iron.

Two different processes are employed in the manufacture of leather: In the one known as *tanning* proper, or red tanning, some of the above named sources of tannic acid are employed; in the other, which is known as *tawing*, or white tanning, the chemicals employed are salt and alum. In a third process, called mineral tanning, only recently introduced, metallic salts are employed, chiefly those of iron. Another method of tanning, which produces a very soft leather, but not waterproof, consists in treating the skins with oil or fats.

The art of tanning leather is of very ancient date. It is believed that it was practiced in Libya, and then carried into Egypt, from whence it came to Greece. The old national dress of the Persians was of leather, and the Gordian knot that was summarily cut in 330 B. C. was of leather thongs.

The process of tanning is very tedious, and involves a great number of operations, yet the product well repays the time and labor expended.

The first operation consists of soaking or macerating the hides in water. All hides require soaking to soften and cleanse them, but when dry hides are employed, more soaking is necessary to bring them back nearly to the condition of fresh hides.

The second operation consists in removing the hair. To prepare them for this operation, which is purely mechanical, the hides are either sweated or limed. When the former method of loosening the hair is employed, the hides after soaking are hung up, while still wet, in sweat pits or vaults, kept at a uniform temperature of 60 to 75°, until incipient putrefactive fermentation begins. The cells at the root of the hair become enlarged, until the hair will readily "slip." Instead of sweating, the hair may be loosened by the use of quick lime, sulphide of calcium, gas lime, or other depilatory.

The third operation is known as "beaming." Each hide is taken separately over a tanner's beam, or tree, consisting of a strong semicircular plank, and the remaining hair scraped off with a curved two-handled scraper. After the hair is removed the hide is turned over and the flesh scraped off by means of a similar knife. The skins are now washed with water, and are ready for the next operation.

The fourth operation is known as "bating," the object of which is to remove the lime and lime soaps, as well as dirt and animal impurities. Bran water, or a mixture of fowl or pigeon dung with water, may be used, the hides being kept in motion. The bate is then worked out by a sort of burnishing tool, or rubber, applied while the hide is on the beam. It is then thoroughly washed, and is ready for tanning.

Swelling, or raising, is an operation that generally precedes the actual tanning. It consists in opening the pores of the skin so as to render it more accessible to the tan liquors. Barley meal and sour dough, diffused in water, spent tan liquors, and very dilute sulphuric acid are among the substances employed for plumping or raising the skin.

The next operation consists in subjecting it to the tan liquor, where the conversion into leather takes place by the combination of the tannic acid with the gelatine of the skin. After plumping, the hides are placed in the vat. Here they are exposed to the action of tan liquors of gradually increasing strength for two or three weeks, during which time they are frequently "handled" with long hooked poles. They are next "laid away," as it is called, in vats of bark and tan liquor. Heavy sole leather receives five or six lay-aways of from ten days to six weeks each, so that the total length of time occupied in tanning it is about six months. Upper leather requires much less time.

The preparation of the tan liquor is an important part of the operation of tanning. Hemlock and oak bark make the best leather, but sumac and other like substances are largely employed. When the tan liquor is made from bark, the latter is first ground and then leached with warm water. Formerly the ground bark was introduced into the vats with the leather and water run in. In Germany the exhausted bark is pressed into cakes about six inches square, dried, and sold under the name of *lolekase* for kindling fires.

The next operation is "currying." Sole leather receives no currying beyond hammering or rolling, and a rough coating of cod oil on each side. Upper leather is shaved on the rough flesh side to reduce it in thickness and to remove irregularities. The knife employed has a T shaped handle at one end and a straight one at the other. It has a peculiar wire edge, kept in order by a burnisher. The hide is then pummeled with a semicircular block of wood called a grainer. It is provided with handles. The larger ones have a cushion at one end, on which the elbow rests, the arm passing under the strap, while the hand grasps the handle at the other end. The hide is then placed on large tables and stretched with a tool called a "slicker." It is re-

peatedly greased with oil and tallow, which are well worked in, "stuffed" as it is called.

It is now ready to be blackened. This is done by painting one side with a solution of oak bark, followed by one of green vitriol containing some blue vitriol. It is again greased, and finally polished with glass.

Although this is a general outline of the method employed in tanning, it admits of several variations in its details.

*Tawing*, or white tanning, is much simpler and more rapid, and is employed in making kid leather from sheep, lamb, and young goat skins. The hair is first removed by liming, and the skins "raised" in a fermenting mixture of bran and soft water. The skin next goes to the "white bath," made up of ten pounds of alum and two and one-half pounds of salt in twelve gallons of hot water. They are left in this hot bath ten minutes, then passed through a paste made of wheat flour and yolk of eggs, with alum and salt, in which they are afterward left for twenty-four hours or more. They are then stretched by hand, dried in the air, dampened, and placed in linen cloth, and trodden to render them soft; then planed, dried, planed again, polished by rubbing with heavy glass disks and the application of white of egg, gum, or fine soap, to give gloss to the hair side, which is finally dyed, the color being applied with a brush. The skins are afterward hung on hooks to dry, and finally ironed.

Tawing with oil is employed for wash leather, chamois, and buckskin.

The varieties of leather in the market are very numerous, the difference frequently consisting merely in the finishing of the surface, and imitations of all the finer kinds are made from the poorer sort, while cloth and paper are used to imitate the inferior kinds; so that deception and fraud are very frequent in made-up leather goods of all kinds.

Among the best known and generally recognized varieties of leather are the following:

Sole leather is the heaviest and stiffest kind of leather. It is made from the heaviest and choicest ox hides, tanned with oak or hemlock bark. The former imparts a light creamy color; the latter is deep red. The quantity of bark required is so great that this process can only be employed where bark is plentiful. A ton of bark will only produce 150 to 175 pounds of leather. In England gambier, divi-divi, and myrobolans are substituted. The tanning operation is continued until the cells of the hides are thoroughly filled with tannin. In currying none of the hide is removed, and no attempt is made to render it flexible. Its principal use is indicated in the name. It has been employed for trunks and helmets. In olden times corsets were made of sole leather a quarter of an inch thick; they were, of course, unyielding, and must have been about as comfortable as if made of cast iron.

Belting leather resembles sole leather, but is put through a special treatment to take the stretch out of it.

Harness leather should combine flexibility with strength, and the surface have a fine finish. It is made from lighter hides than sole leather, and no attempt is made to completely fill the cells with tannin. The surface is thoroughly worked, and it is well "stuffed" with tallow and grease. The surface is usually blacked; when not colored it is known as "russet," which is now much in vogue for fancy harness.

Upper leather, such as is generally used for boots and shoes, as well as for a thousand other purposes to which leather is applied, is lighter than either of the preceding. Thinner hides and skins are used; they are not treated with as strong tan liquors, nor for so long a time. In currying more of the substance is scraped off on the flesh side; they are more thoroughly worked to give them suppleness, and are more or less completely saturated with oil, tallow, and wax. Ordinary leather is finished on the flesh side. When finished on the hair side, and the grain brought out instead of being smoothed down and polished, it is known as "grain leather," and being less easily penetrated by moisture, is also called "water proof." When this unevenness, called grain, is buffed off, it forms "buff leather." Thick hides are often split, one of the splits being finished on the flesh side, the other on the hair side. A large part of the leather now made here is split, although it does not pass under that name.

Calf-skin, as the name implies, is made from the skin of calves. The finer qualities are bark-tanned, principally with oak, willow, or birch.—*Saddlery Journal*.

## WEIGHTS OF CAST IRON WATER PIPES.

THE following table shows the thicknesses, weights, and strengths of such pipes as we have adopted for standard use in ordinary cases. The smaller pipes are heavier than are, theoretically, necessary for most places, but in adopting a standard, one was taken that would be sufficient for the majority of places met with in practice.—A. H. Howland and George A. Ellis, in *Proc. Eng. Club*.

Internal diameter.	Thickness.	Weight per foot of cylinder.	Weight per foot of pipe, laid, including bells.	Weight per length of pipe to lay 12 feet.	Ultimate strength when made of iron having tensile strength of 18,000 pounds.	One-fifth of the ultimate strength.
inches.	inches.	pounds.	pounds.	pounds.	pounds per sq. in.	pounds per sq. in.
4	0.40	17.27	18.75	225	3,600	720
6	0.42	26.46	28.92	347	2,515	503
8	0.45	37.33	40.50	486	2,025	405
10	0.50	51.54	56.17	673	1,800	360
12	0.55	67.76	73.75	895	1,650	330
14	0.58	83.02	90.67	1,088	1,490	298
16	0.60	97.78	106.78	1,281	1,350	270
18	0.64	117.11	126.67	1,520	1,280	256
20	0.70	142.25	153.43	1,841	1,260	252
24	0.80	194.77	210.33	2,524	1,200	240
30	0.90	273.00	285.33	3,574	1,080	216
36	1.00	363.22	390.50	4,686	1,000	200
40	1.10	443.82	480.83	5,770	990	198
42	1.16	491.49	532.42	6,349	995	199
48	1.30	629.16	681.58	8,179	975	195



## PAVING IN REGULAR POLYGONS.

THE only regular convex polygons that can furnish continuous pavements are the triangle, the square, the hexagon, the octagon, and the dodecagon.

Upon taking for unit of angle the twenty-fourth part of four right angles, the numbers that express the angles of the polygons are 4, 6, 8, 9, 10. Let us represent the latter by X.

In order that these polygons shall form a pavement, it is necessary that the sum of the angles around a point shall equal 24. We shall, then, endeavor to find every arrangement of the above numbers in which the sum is 24, and, so as not to forget them, we shall arrange them in numerical order. We shall consider each

## APPARATUS FOR CONTINUOUS DISTILLATION AND RECTIFICATION.

MR. L. BECHAUX has devoted himself for many years to the study of a system of distillation and rectification of brandies and alcohols which presents none of the inconveniences of the ordinary apparatus in use, and which acts by the direct contact of steam for distillation, or in a continuous manner, through boilers and columns, for rectification, or by the use of the water bath for both operations.

After numerous tentatives, he has succeeded in devising an apparatus which is distinguished from its predecessors not only by its originality, but also by its structure properly so called. It does not, in fact, con-

various sections of the tubular arrangement, C, on coming from which each of them is analyzed and condensed separately.

These vapors, in fact, pass, according to the temperature at which they are produced, into one or another of the pipes of the series, *b*. First, the first two escape pipes traverse the analyzer and condenser, F, whence, after the condensation of the vapor, the liquid flows through N; and then they enter the condenser and cooler, which, in turn, condenses the ethereal vapor collected at J. Second, the other pipes of the series traverse the analyzer and condenser, K, in order to effect the condensation of the aqueous vapor, which upon liquefying passes out through the pipe, L, whose cocks serve to regulate the alcoholic strength of the distilled products. These pipes afterward run into the condenser and cooler, I, which effects the condensation of the alcoholic vapor directed by the two-way cocks, *s*, into one or the other of the pipes, M.

When no analysis is to be made of the products of distillation (for example, in the treatment of grape or fruit wines), they may be run into a single condenser and cooler; but, as the vapors have been classed by the very vaporization itself, they can be collected isolatedly or mixed upon their exit from the pipes, *b*, and be rectified apart. To interrupt the operation, it suffices to stop the flow of the alcoholic liquid in the pipe, C.

It will be understood that the distillation is operated in a rational manner by the very fact of the fractional vaporization combined with distinct condensation: first the most volatile vapors; second, alcoholic vapors of high degrees; third, aqueous alcoholic vapors produced in the last tubular elements of the water bath.

The worms, U and U', are heated by the water of condensation coming from the worm, X, so that the liquids in F and K are, at the end of the operation, at the temperature necessary for the proper working of the apparatus. This heating might be regulated by opening the cocks, *m* and *n*, the first of which lets in hot water and the second allows it to escape.

In the analyzers, F and K, the liquid used may be the ethereal oils derived from former distillations or a mixture of these with alcohol or water, with the effect of obtaining automatically, by the ebullition of these liquids, the different uniform and fixed temperatures for each of the analyzers.

These latter are closed, and are provided with safety apparatus. The vapors produced in K are led through S to T; then, after being condensed, they return to K through T'. A similar circulation takes place between the special condenser, D, and the analyzer, F.

At the beginning of a distillation, the cocks, *v*, *u*, *x*, and *z*, are opened to let out the air.

When it is desired to put water simply into the analyzers, the special condenser, E, and the heating worms are dispensed with. It will be understood that it is likewise permissible to employ the condensers, I, G, and E, in a complete apparatus, and the single condenser in a simple one, as wine heaters, for utilizing the heat derived from the condensation of the alcoholic vapors in the heating of the liquid to be treated. Finally, it is possible, through a furnace, to heat the water bath directly within which the automatic pressure regulator keeps up a constant tension regulatable at will, and consequently a uniform temperature.

The practical trials made of this apparatus have been most satisfactory. The advantages that it possesses over the ordinary distillery arrangements are due to the treatment of the liquids in thin strata, the use of the water bath at a low temperature for disengaging the alcohol from these strata, and to the continuity obtained in the operation of rectification.

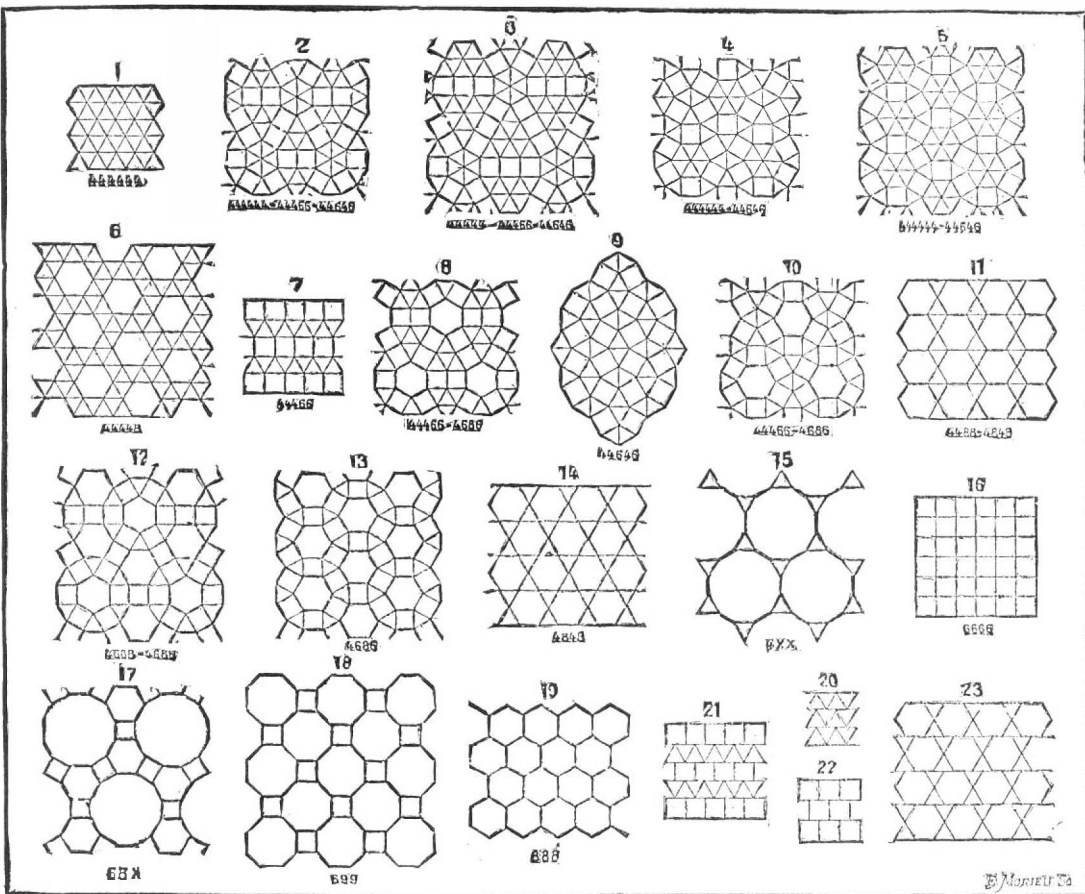
Distillation or rectification is thus effected in a few minutes, without pressure or obstruction of any sort in the apparatus with which the ethereal oil is first extracted, and then the alcohol in greater proportion and with less heat than usual. These vapors are disengaged without undergoing a prolonged contact with the essential and heavy oils, as occurs on the plates of distilling or rectifying columns.

It is possible to distill alcoholic worts or to rectify distillates in small quantities in an apparatus designed for a large production, to suspend and begin the operation, and, with a great saving in fuel, to obtain at once fine products of a certain alcoholic strength.

In all cases, a simple analysis of the alcoholic vapors given off yields, when it is desired, products that differ as to taste and strength.

Up to the present, heating by the water bath could be employed only for intermittent distillations, while this apparatus utilizes it for continuous distillation and rectification obtained through the progressive heating that the liquid undergoes in simply flowing in the parts of a water bath at a uniform temperature, which is kept automatically constant.

As the different substances in a mixed state compos-



## PAVEMENTS IN REGULAR POLYGONS.

arrangement as a number in which the first figure to the left is always of the same order. These 13 arrangements are as follows:

44444	4848
44448	4XX
44466	6666
44646	68X
4488	699
4668	888
4686	

It is easy to see that there is no other possible arrangement of these five numbers such that their sum shall be equal to 24. Any others that might be imagined would lead back to one of the preceding, the beginning of whose cycle would have been changed. We have in all cases selected this beginning in such a way as to know the smallest number. Upon assembling the polygons according to the indications given by these arrangements, we find that we can form but eleven pavements that are characterized by a special arrangement, a true formula. We can form many, but their apices are not of the same nature.

We give sketches of twenty-three of these pavements. Some of these are much used, and others, while less employed, will perhaps be deemed worthy of being more so. They are classed in the order of their formulas. They suggest various remarks. Let us speak of the first nineteen.

1. I., VI., XI., XIV., and XIX. may be considered as formed of equilateral triangles, a certain number of whose common sides have been suppressed.

2. Setting aside XVI., a pavement in squares which has given the French name\* to the entire family, and XIX., a hexagonal pavement almost as common as the preceding, and the five already cited, the twelve others may be considered as formed of triangles and squares of which a certain series of common corners has been suppressed. By this means, II. produces VIII., IV. produces X., and both produce XV.; III. produces XII.; V. produces XIII.; and the latter two together XVII. The pavements of the second group are formed of a union of triangles and squares around hexagons or dodecagons. Such arrangements may be multiplied and form pavements in indefinite number, that may be still further increased by the suppression of common sides. We have given only the simplest types. VI. derives from XIX. by the addition of triangles around each hexagon. Others might be added. VII. suggests nothing; but IX. is very curious, and we suspect that its elements are to be found in IV. and IX. This pavement, in which the imagination may see a confusion of leaves, four-pointed stars, and olives, appears to us to be as original as it is simple. We have seen it nowhere else.

Finally, I., VII., XI., XIV., and XVI., wherein we meet with indefinite straight lines, may, by sliding, each form an indefinite number of pavements. XI. and XIV. are converted one into the other, by a sliding equal to one side. Through a sliding equal to half a side, all these pavements give rise to the elegant solutions, XX., XXI., XXII., and XXIII.

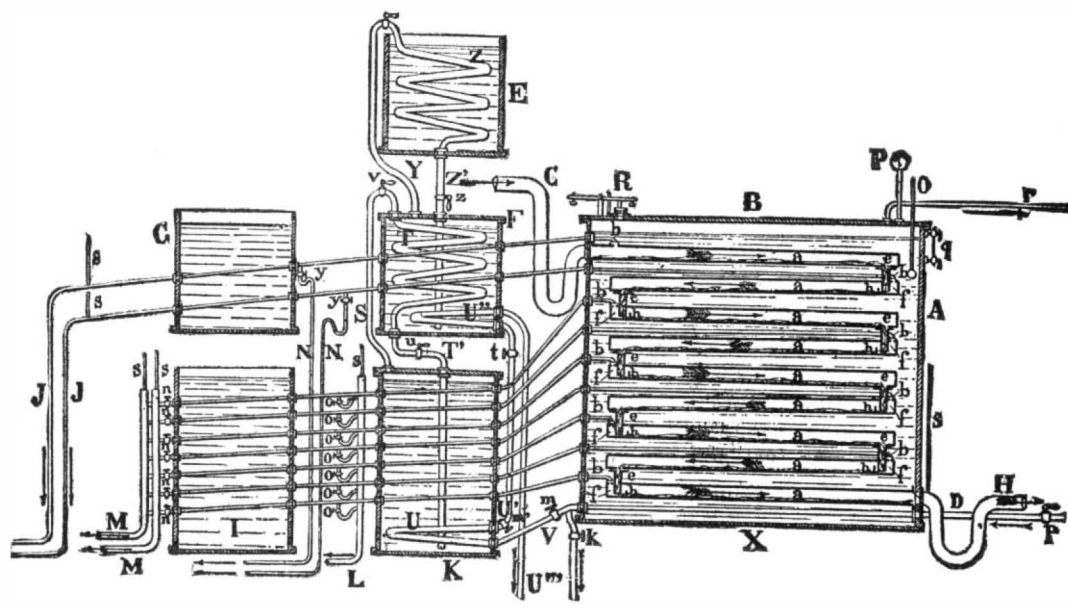
\* Carrelage.

sist in an improvement in detail, but is a complete transformation of the old methods, since the apparatus is accompanied with neither boilers nor columns, and for distillation and rectification utilizes the heat obtained from water-bath reservoirs, not by the aid of an open fire, but by means of direct steam. This system, besides, acts continuously and very rapidly, and with entire freedom from any internal pressure capable of preventing the disengagement of alcoholic vapor. The liquid to be distilled or rectified is treated in thin strata, and fractionally, thus permitting of the alcohols being collected in a few minutes entirely free from bad taste.

The liquid to be distilled or rectified enters the upper pipe of the water bath at C. If the fermented alcoholic materials have a pasty consistency, it is easy to pass them through a filter press. The liquids thus obtained furnish upon distillation a finer alcohol than if the material had been thick.

On making its exit from C, the alcoholic liquid spreads out in a thin stratum upon the first tubular element of the water bath, and reaches all the others in succession by traversing the tube, *c*, whose lower part enters the small reservoirs, *f*. This hydraulic guard prevents the alcoholic vapors from reaching the element situated above, while at the same time assuring the circulation of the liquid through an aperture at the bottom of the side, *h*, and permitting the apparatus to empty itself at the end of an operation.

The residua of the distillation carrying the essential oils, as well as the heavy ones, make their exit continuously through the conduit, H, while the ethereal and aqueous alcoholic vapors pass respectively into the



APPARATUS FOR CONTINUOUS DISTILLATION AND RECTIFICATION.



ing the wine or wort to distilled or rectified vaporize successively, the separation of the different vapors occurs in the order in which they are disengaged, contrary to what takes place in apparatus with boiler and column. The continuity of work, compared with the intermittent operation of certain boilers, presents also genuine economic advantages, independently of the elimination of the causes of the bad taste of alcohols obtained by the continuous discharge of wash and of heavy and essential oils in measure as the alcohol with which these substances were mixed is disengaged.

There is no longer any need of proceeding to triple rectifications for obtaining an alcohol of superior quality as regards purity and fineness of taste. The cognacs, brandies, and liquors of all kinds manufactured with the apparatus hitherto employed have to be kept for several years in order to improve their quality, because, during that time, the spirits become partially free from the acrid, harsh, and empyreumatic taste that they have contracted through the too violent action of heat and their staying too long in the alembic used to distill them.

In terminating this study, we shall add that this apparatus is easily managed, even by a person but slightly conversant with distillation with alembics. No explosion is to be feared, since the alcoholic vapors are disengaged without having any pressure to overcome, and consequently the leakage of alcohol through the joints is almost nil.—*Revue Industrielle.*

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### NOTES OF A RECENT VISIT TO SOME OF THE PETROLEUM-PRODUCING TERRITORIES OF THE UNITED STATES AND CANADA.

By BOVERTON REDWOOD, F.I.C., F.C.S.

A LARGE proportion of the crude petroleum produced in the United States is still obtained in what is known as the Bradford district. This oil territory, lying partly in central and northern McKean County, Pennsylvania, and partly in southern Cattaraugus County, New York, has an area of 133 square miles, 121 square miles of which are included in the Bradford field proper. The development of this territory dates from the year 1874, when the first successful well was drilled, and four years later—viz., in December, 1878—the average daily production of the Bradford district was no less than 23,700 barrels (of 42 American gallons) or about four-sevenths of the total daily production of the State of Pennsylvania. Two years later still the Bradford district supplied 63,000 barrels per day, out of a total production of 72,215 barrels per day. During recent years there has been a steady decline in the production of this prolific territory, notwithstanding the efforts made to maintain the output. Up to January, 1885, the Bradford district was estimated to have yielded 109,000,000 barrels, an average of about 820,000 barrels per square mile. The total production of the oil regions of Pennsylvania and southern New York up to the same date has been given on the authority of Stowell's statistics as 260,990,435 barrels. In December last there were in the Bradford district, according to Stowell, 13,505 old wells with an aggregate daily production of 17,887 barrels (1½ barrels per well), and 16 new wells with an aggregate daily production of 100 barrels (6 barrels per well).

#### THE WASHINGTON FIELD.

During the past year the attention of petroleum producers has been chiefly centered on the Washington field in Washington County, Pa. In December, 1884, a well was drilled on the Gantz farm, in this field, by the Citizens' Fuel Company, with the object of obtaining natural gas for use as fuel. At a depth of 2,200 feet, oil, and not gas, was obtained, and this discovery at once led to the drilling of other wells. In August, 1885, a flowing well known as the Gordon well was completed, and in the following year several other exceedingly productive flowing wells were drilled, one of the number, the Thayer well, yielding 2,000 barrels per day. The production of the Washington field reached its maximum of 16,000 barrels per day in August last, and had declined to 8,000 barrels per day at the end of the year. Stowell gives the aggregate daily production of the Washington field in December last as 7,720 barrels from 180 old wells (43 barrels per well), and 2,560 barrels from 33 new wells (71 barrels per well).

The daily production of the various oil fields of Pennsylvania, New York, and Ohio (expressed in barrels of 42 American gallons) on the 1st January, 1886, and 1st January, 1887, was as follows:

	1887. Jan. 1.	1886. Jan. 1.
Allegheny.....	5,800	6,400
Bradford.....	24,600	29,000
Kane.....	4,500	80
Cherry Grove.....	240	400
Cooper.....	450	750
Balltown.....	650	1,200
Grand Valley.....	2,100	*
Cogley.....	1,600	5,200
Tarkill.....	1,750	*
Baldrige and Thorn Creek.	2,000	1,400
Red Valley.....	800	*
Pontins.....	2,800	*
Oil Creek, Tidioute, Clarion, Armstrong, Warren, etc....	11,500	14,500
Washington.....	8,500	250
Shoustown.....	3,300	60
Macksburg.....	1,300	1,900
Total.....	71,390	63,140

The yearly production of crude petroleum in Pennsylvania and the contiguous States from the beginning of the year 1859 to the end of last year is given in the following table in barrels of 42 American gallons:

1859.....	5,000	1867.....	3,347,000
1860.....	500,000	1868.....	3,583,000
1861.....	2,113,000	1869.....	4,210,720
1862.....	3,056,000	1870.....	5,673,195
1863.....	2,611,000	1871.....	5,715,900
1864.....	2,116,000	1872.....	6,531,675
1865.....	2,497,000	1873.....	7,878,629
1866.....	3,597,000	1874.....	10,950,730

\* Not specified January 1, 1886.

1875.....	8,787,506	1881.....	28,447,115
1876.....	9,175,906	1882.....	31,051,165
1877.....	13,490,171	1883.....	24,090,000
1878.....	15,165,462	1884.....	23,520,817
1879.....	19,741,661	1885.....	21,600,651
1880.....	26,562,000	1886.....	25,816,000

During the past year the consumption of the United States crude petroleum, produced in the districts referred to, has been as follows:

	Barrels.	Barrels.
Total deliveries from the oil regions.....	28,803,400	
Deduct total exports.....	16,431,300	
Total home consumption.....		10,372,100
Total exports from the United States.....	16,431,300	
Add decrease in European stocks.....	150,000	
Total foreign consumption.....		16,581,300
Average daily home consumption.....	28,400	
Average daily foreign consumption.....	45,400	
		73,800

The consumption of crude petroleum for the year 1886 thus exceeded the production by more than 2,000 barrels per day, the deficiency being supplied from the stocks. These stocks held by the storage companies at the end of the year 1886 amounted to 34,156,605 barrels. The average price of crude petroleum in the United States during 1886 was 70½ cents per barrel.

The wells in the Washington field being several hundred feet deeper than those in the older fields, and being constructed in accordance with the most modern principles of drilling, may be taken as illustrating to the fullest extent the development which has taken place in this important branch of mechanics, and it will therefore be interesting to consider the details of construction of these wells.

The derrick employed does not differ materially from those erected in the older fields, but it is of somewhat greater height and strength, the greater depth of the wells necessitating the use of longer and heavier drilling tools. The structure is usually about 80 ft. in height by about 20 ft. square at the base, and is strongly braced by diagonal stays. The stems of the drilling tools are 4 in. in diameter, and the "string of tools," as it is called, consisting of a usual "bit," "auger stem," "jars," "sinker bar," and "rope socket," is frequently from 65 ft. to 70 ft. in length, and weighs from 3,000 lb. to 3,500 lb. The well is commenced by inserting a wooden "conductor," or iron "drive pipe," which extends from the surface, through the soft ground, to the top of the first stratum of rock. The drilling is then commenced, and it is usual in the Washington field to use for the upper part of the well a drill 13 in. in diameter. As the drilling proceeds the well is "cased" to support the walls and to exclude water. The casing employed for the upper part of a well drilled with a 13 in. bit consists of strong iron tubing, 10 in. in internal diameter, carefully screwed together in lengths of 17½ ft. to 20 ft. When this 10 in. casing cannot be lowered any further the drilling is continued with a smaller bit, and casing of a corresponding diameter is inserted. A further reduction of size is usually made before the well is completed. Thus a well which I visited was commenced with from 16 ft. to 18 ft. of wooden conductor, and contained on being finished 682 ft. of 10 in. casing, 1,060 ft. of 7½ in. casing, and 1,750 ft. of 5½ in. casing. Each "string" of casing extends downward from the mouth of the well, and the upper part of the well is therefore lined with three thicknesses of iron, the casing of such a well thus requiring nearly three-quarters of a mile of iron tubing.

The average depth of the wells in the Washington field is 2,400 ft., but at the time of my visit there was one well producing which was of the depth of 2,595 ft.

Only the most experienced drillers are able successfully to cope with the difficulties attendant upon drilling to such a depth as 2,400 ft., and even workmen of the highest skill occasionally fail, for there are wells in this field which have been abandoned with three sets of tools in the bore, after fruitless exertions in "fishing," as the operation of raising or attempting to raise the lost tools is termed. The chief difficulty arises from the caving of the rock as the drilling proceeds, and before the casing is inserted. The average time occupied in the drilling of a well in the Washington field is about four months, and the cost of each well is as much as £1,600. In the Bradford field the cost of a well was usually estimated at from £500 to £600. Drilling is paid for in the Washington field at the rate of 7s. to 8s. per foot, as compared with 1s. 10d. to 2s. 5d. in the Bradford field. At this rate of payment, the well owner furnishes the derrick (which costs about £100), the boiler, of 25 h. p. (costing about £100), the engine, of 20 h. p. (costing about £40), and the connections (costing about £20), while the drilling contractor uses his own cable and tools, and finds coal and labor. Occasionally the contractor provides the engine, boiler, and connections, and then is paid at a higher rate for each foot drilled. The gang consists of two drillers (who receive from the contractor 16s. each per day) and two tool dressers (who are paid 14s. each per day). The drillers and tool dressers work in pairs as a day and a night shift, so that the work proceeds continuously. The well owner is usually the lessee, for oil-producing purposes only, of the land. Oil leases in the Washington field are, as a rule, for five years, or as much longer as oil or gas is produced in paying quantities, and almost invariably it is provided by covenant that the lessee is to commence development within a year, or, in some cases, two years, or in lieu thereof is to pay a stipulated rent per acre. The land owner, or farmer, retains the right to use the land for agricultural purposes, the oil lessee being entitled only to so much of the surface as he may require for the purpose of petroleum production and for ingress and egress. The terms of such a lease frequently are that the lessor receives a cash payment of £20 per acre (if the district has already produced oil) and one-eighth of the oil produced (in kind).

#### THE TORPEDO.

The wells are invariably torpedoed on the completion of the drilling, with the object of shattering the oil-bearing rock, and increasing the flow of oil. The torpedo employed consists of a shell of tin plate filled with nitroglycerine. In the Washington field it is a common practice to torpedo a well several times, with increasing quantities of the explosive, the final charge

\* The statements of stocks at foreign ports other than European had not been received when this table was compiled.

amounting to 80 quarts, or, in some cases, as much as 100 quarts. The nitroglycerine is manufactured in the neighborhood in a manner which, it may be confidently asserted, would not receive the approval of her Majesty's inspectors of explosives, and is conveyed to the well in tin cans, holding from six to eight quarts, placed in padded compartments in a spring wagon. The torpedo cases or shells are usually about 10 ft. in length by 3½ in. in diameter. Such a case holds 20 quarts, and accordingly as many as four are employed when a charge of 80 quarts is to be exploded, the cases being successively lowered into the well as they are filled with nitroglycerine. The torpedo was formerly provided with a percussion firing head, and was exploded by dropping a "go-devil" or cast iron weight into the well, but, owing to the increased size of the bore of the wells this method of causing the explosion has been superseded by the use of a "go-devil squib," which is, practically, a miniature of the torpedo, provided with a percussion firing head, and suspended in the well in proximity to the torpedo proper by means of a cord on which a perforated leaden weight runs. The weight being dropped is guided by the cord to the head of the squib, and the explosion of the small torpedo being thus effected, that of the large torpedo immediately follows. The torpedo is generally fired under about fifty feet or more of water. The distance from the surface of the ground being so great, little or no sound is heard when the explosion occurs, but a slight tremor of the ground is usually felt, and the water and oil in the well are projected upward to a great height.

Nearly all the wells in the Washington field are flowing wells, the flow usually being continuous. The maximum regular yield per well is probably from 600 barrels to 700 barrels (20,160 to 23,520 imperial gallons) per diem, but one well in this field is estimated to have given 3,600 barrels (121,000 imperial gallons) per twenty-four hours for a week after it was completed. In consequence of the great expense of drilling in the Washington field, no well which yields less than 100 barrels (3,360 imperial gallons) per day is considered to pay, at the present price of crude oil.

Most of the crude petroleum produced in the Washington field is what is known as amber oil. Prior to the development of this field, such oil had never been found in large quantity, and petroleum experts accordingly predicted that the Washington field would not be found to be very productive, but subsequent experience demonstrated the small value which such predictions in matters relating to petroleum production possess. I have on the table an interesting representative series of samples of crude petroleum from the Washington field. The character of these samples is indicated in the following table:

No.	Name of Well.	Sp. Gr.	Color.
1	Mulholland, McKeevor & Co.'s Lead Works Lot.....	0.790	Yellow.
2	Cameron, 1.....	0.777	"
3	The Caldwell & Marsh.....	0.798	Amber.
4	Union Oil Co., McGovern.....	0.798	Yellow.
5	The Weaver, No. 1.....	0.800	Amber.
6	The Munhall & Smithman, R. D. Wylie.....	0.804	"
7	The Shiris, No. 1 Shiris Company.....	0.792	Yellow.
8	The People's Light and Heat Co., Gordon, No. 1.....	0.819	Amber.
9	Gordon, No. 2.....	0.775	Yellow.
10	Gordon, No. 4.....	0.820	Amber.
11	The People's Light and Heat Co., Hess, 2.....	0.801	"
12	Vandergrift, Weirich, No. 1.....	0.816	Brown.
13	Cradle Factory, Miller & Guffey.....	0.814	"
14	The Hallam & Co., on the Clark.....	0.828	"
15	Coast & Sons, on the Weirich.....	0.792	Dark brown.
16	Vandergrift, No. 1, Barre.....	0.788	Yellow.
17	Vandergrift, No. 2, Barre.....	0.771	"
18	Hall & Co.....	0.801	Amber.
19	The Gabby, Pew & Emerson.....	0.799	"
20	The Manifold, Pew & Emerson.....	0.780	Dark brown.
21	Willett's, No. 1.....	0.777	Yellow.
22	" No. 3.....	0.771	"
23	" No. 5.....	0.786	"
24	Union Oil Co.'s, No. 1, Taylor.....	0.772	"
25	Coast & Sons, Hayes.....	0.772	"
26	McKinney Brothers, Montgomery, No. 1.....	0.797	Amber.
27	Thayer, No. 1, Clark.....	0.792	"
28	" No. 2, Clark.....	0.814	"
29	Belmont Oil Co.'s, Smith, No. 1.....	0.808	"
30	Citizens' Oil and Gas Co., the Gantz.....	0.820	Dark brown.

The odor of all the samples is moderately strong, but not disagreeable.

The specific gravity and color of a representative series of samples from the older fields placed on the table for comparison are as follows:

Name of Field.	Sp. Gr.	Color.
Bradford.....	0.810	Reddish brown.
".....	0.819	"
Parker (Clarion).....	0.797	"
" (Karns City).....	0.789	"
Thorn Creek.....	0.802	"
Stoneham.....	0.802	Dark amber.
Macksburg.....	0.829	Reddish brown.

The crude petroleum found in the Washington field contains a considerable quantity of solid hydrocarbons, which to some extent crystallize out in cold weather. A sample of the paraffin which thus separates is exhibited.

I have also on the table a number of specimens of the oil sands from the same field, of which the following is a description:

1. "Manifold" sand. Small red and gray particles in equal proportions.
2. "Gantz" sand. Black, gray, and white particles in equal proportions.
3. "Fifty-foot" sand. Of a pale brown color.
4. "Stray" sand. For the most part of a grayish color, but with a few reddish colored particles intermixed.
5. "Gordon" sand. Similar to the "Gantz" sand, but of finer grain.

The following is the record of a well on the Israel Weirich farm in the Washington field, showing the

depths from the surface and the thicknesses of the oil sands met with:

	Depth, feet.	Thick- ness, feet.
Top of "Big" or "Mountain" sand.....	1,433	240
" " "Gantz" sand.....	2,080	30
" " "Fifty foot" sand.....	2,187	50
" " "Stray" sand .....	2,379	24
" " "Gordon" sand.....	2,404	35

The decline in the production of the Bradford field has given rise to some apprehensions of an approaching scarcity in the supply of crude petroleum in the United States; but although there are no indications which warrant the belief that another equally prolific territory will be discovered, it is certain that petroleum exists in very considerable quantities in many States of the Union besides Pennsylvania and New York. The petroleum of Ohio has already been referred to. The oil found in the Lima field in this State is described by Professor Orton, State Geologist of Ohio, as a "black, sulphureted, and rather heavy" oil. The specific gravity appears to range from 0.818 to 0.843. Considerable difficulty has been experienced in producing from this petroleum an illuminating oil of good quality. Petroleum is also obtainable in large quantities in West Virginia, Kentucky, and Tennessee. It is also found in Alabama, Florida, Michigan, Illinois, Indiana, Missouri, Kansas, Louisiana, Nebraska, Montana, Wyoming, Dakota, Colorado, New Mexico, and California.

The governor of Wyoming, in a report to the Secretary of the Interior, dated 1885, states that the most extensive oil basins of the Territory lie east of the Wind River and north of the Rattlesnake range of mountains, the principal deposits being apparently located in the Fort Washakie, Lander, Shoshone, Beaver Creek, Big Horn, Rattlesnake, Seminole, and Laramie ranges. A trial well drilled in the Shoshone basin to a depth of 72 ft. is stated to have yielded at the beginning of the year 1885, 40 barrels (of 42 American gallons) of oil per 24 hours.

I had occasion some time ago to examine a number of samples of crude petroleum from the Shoshone basin in Wyoming, and found them to possess the following characters:

No. of Sample.	Sp. Gr.	Color.	Odor.
1	0.912	Very dark brown	Strong and disagreeable
2	0.912	"	"
3	0.912	"	"
4	0.910	"	"
5	0.943	Brownish black	Slight and disagreeable
6	0.911	Very dark brown	Strong and disagreeable
7	0.945	Brownish black	Slight and disagreeable

The yield of commercial products from samples Nos. 6 and 7, portions of which are on the table, I found to be as follows:

No.	Naphtha.	Kerosene.	Intermediate and Lubricating oils.
6.....	2.5	27.5	52.5 per cent.
7.....	none	10.0	72.5 "

#### CALIFORNIA PETROLEUM.

Considerable attention has been given to the development of the petroleum resources of California, the local demand being, to some extent, supplied with refined oil, manufactured in the State from native crude petroleum, and I was glad to have an opportunity last autumn of visiting the principal producing territory, situated in Pico Canon, near the city of Newhall, in Los Angeles County. The existence of oil in this locality was discovered by Andreas Pico prior to 1857, but the development may be said to date from 1869, when the Pico well was drilled. It was not, however, till 1875 that drilling was actively commenced. Petroleum is also obtained in Ventura County, California, near Santa Paula, where drilling was commenced in 1874; from a small group of wells in the Santa Cruz mountains; from Puente, east of Los Angeles, where drilling first took place about 18 months ago; and in still smaller quantities from several other localities in the State of California. I was informed that the oil produced in the Ventura territory, which is from 35 to 40 miles west of Newhall, is conveyed by pipe to the seaboard, and thence in tanks by steamship to San Francisco, where it is refined. I was not able to ascertain the production of this territory, but I presume that it is very small, and I was told in San Francisco that the oil being refined there at the time of my visit all came from Pico Canon. The quantity of crude oil found in the Santa Cruz mountains is as yet very limited, the production not exceeding from 10 to 15 barrels per day. The oil is stated to have a specific gravity of 40° B. (0.830), and to contain a good deal of paraffin.

In the ravine at Newhall we found a little colony, where Mr. Mentry, the manager at the wells, and the workmen reside. The wells number 16 in all, and are from 700 to 2,000 ft. in depth. The petroleum is found in the tertiary formation in sandstone, but there do not appear to be any well-defined oil-bearing strata, the oil being found in greater or less quantity at almost all depths. The oil belt at present defined has a length of about two miles, and is about a quarter of a mile in width. The individual yield of the wells ranges from five to seven barrels up to forty barrels per day, and the aggregate production is stated to be 500 barrels per day. The oldest of the wells was drilled about 10 years ago, but has been deepened since, and all the wells are still yielding.

Only one of the wells is classed as a flowing well, but we were informed that all would flow if the gas pressure were allowed to accumulate. The flowing well was drilled about four or five years ago, and was at first pumped for about five months, but it has since flowed at intervals of about 20 minutes, and now yields 40 barrels per day. We saw this well flowing, and observed that the discharge took place with considerable force for the space of nearly five minutes. Each well is connected with a cylindrical iron vessel, through which the oil passes, and where the gas which escapes with the oil is collected and used as fuel, the steam boilers being heated exclusively with this natural gas. All the wells, with the exception referred to, are pumped once a day, a 1½ in. pump with 24 in. stroke, work-

ed in the usual manner through the medium of the rocking beam, being employed. Mr. Mentry stated that the oil did not, as a rule, vary greatly in quality, but one well (No. 13) yielded an oil containing so large a proportion of solid hydrocarbons that difficulty was sometimes experienced from the clogging of the pump tubing with paraffin. I obtained an average sample of the crude petroleum, to which I shall have occasion to refer later. The oil passes from the wells to a receiving tank holding 25,000 barrels, and is thence conveyed, partly by gravitation and partly by pumping through a 2 in. pipe, to Newhall, where it is run into tank wagons on the railway for conveyance to San Francisco. The whole of the Pico Canon oil field is now under the control of the Pacific Coast Oil Company, though there are still some separate subsidiary interests. The company have not drilled any wells recently, but they contemplate making further developments at an early date. The derricks used are 72 ft. in height, and the wells are usually commenced with a bore of 10 to 12 in., but this is necessarily reduced, on account of "caving," as the drilling proceeds, and although efforts are made to complete the well with a diameter of not less than 5½ in., some of the wells are at the bottom only 3¾ in. in diameter. What is known as a "stove-pipe" casing of sheet iron is generally used instead of a wooden conductor in starting the well, and this casing is commonly from 10 to 20 ft. in length. The wells are cased throughout, but are frequently not provided with any arrangement for shutting off the water, which is met with at a depth ranging from 100 to 300 ft. The drilling is exclusively conducted with cable tools, and the wells are never torpedoed. It takes from four to five months to drill to a depth of 1,500 ft. under favorable circumstances in the Pico Canon. Before drilling was commenced in this locality attempts were made to obtain petroleum by driving tunnels of 20 to 30 ft. in length into the hill side, and our attention was called to one of these tunnels, from which, at one time, about a half barrel of oil per day was obtained, and from which we saw a small quantity of petroleum still flowing.

While at San Francisco we visited the refinery of the Pacific Coast Oil Company, situated at Alameda Point, 11 miles from San Francisco. There is a small refinery at Newhall where a portion of the crude petroleum from Pico Canon is distilled, but the refinery at Alameda is the only one in California where finished kerosene is made. The present capacity of this refinery is about 500 barrels of crude oil per day, but the works are situated in an inclosure of considerable size, and it would be easy to increase the plant. At the present time, however, only the oil produced in the Pico Canon is being refined, much of the oil found in California being a black, heavy oil, not available as a source of kerosene, and the existing arrangements are amply sufficient for dealing with this. The crude oil, which has a specific gravity of 39° to 40° B., is stated to yield about 44 per cent. of kerosene of good burning quality, having a specific gravity of 44° B. and a fire test of 110° F., but as much as 65 per cent. of 110° test oil can, it is said, be obtained. Of what is known as water white oil, of a nominal fire test of 150°, the crude petroleum is stated to yield about 20 per cent. The yield of naphtha is given as about 15 per cent.

I have examined and subjected to fractional distillation the sample of crude petroleum which I brought from Pico Canon. The petroleum has a specific gravity of 0.844. It is dark brown in color, and has a rather pleasant odor. It yields, by the method of distillation I am accustomed to adopt—

Naphtha.....	15 per cent.
Kerosene.....	45 "
Intermediate and lubricating oils..	32 "

Before leaving San Francisco I had a lengthened conversation on the subject of Californian petroleum with Mr. Henry G. Hanks, formerly State mineralogist. Mr. Hanks, whose fourth annual report to the Californian State Mining Bureau contains a good deal of valuable information concerning the petroleum industry of the State, has been good enough to furnish me with the following interesting specimens:

1. Asphaltum in sand, Santa Cruz.
2. Crude brea-asphaltum, Los Angeles.
3. Crude maltha or tar, Sargent's Ranch, Santa Clara County.
4. Crude brea-asphaltum, Sargent's Ranch, Santa Clara County.
5. Refined asphaltum—artificial, Sargent's Ranch, Santa Clara County.
6. Asphaltum refined by natural process, Sargent's Ranch, Santa Clara County.
7. Crude brea-asphaltum, Coral de Piedra, San Luis Obispo County.
8. Maltha, so called "tar," San Luis Obispo County.
9. Asphaltum, San Luis Obispo County.
10. Asphaltum, San Luis Obispo County.
11. Asphaltum, San Luis Obispo County.
12. Bituminous sandstone, San Luis Obispo County.
13. Crude petroleum, Pico Canon, Los Angeles County.
14. Maltha, first yield of wells at Petrolia, Los Angeles County.
15. Crude petroleum, Tunitas Creek, San Mateo County.

Sample No. 1 consists of 19.8 per cent. of asphalt and 80.2 per cent. of sand. Sample No. 2 is from La Brea Rancho, so named from the Spanish word "brea," signifying pitch, which lies about six miles west from the city of Los Angeles. Mr. Hanks states that the deposits here, which cover a large area, consist mainly of bitumen and maltha, the latter occurring in the form of pools or wells. As at Carpinteria, in Santa Barbara County, the tar-like substance flowing from the numerous apertures becomes mixed with such quantities of mineral and vegetable matter that the whole mass has to be melted, and the impurities separated from the asphalt to fit the latter for market. To effect this the material is melted in iron kettles, and the impurities floating on the surface being skimmed off, additional material is thrown in until the kettle is nearly filled with comparatively pure asphaltum, when the charge is poured out into trenches dug in the earth. The pigs, on being broken up after cooling, constitute commercial asphaltum. From this locality the Catholic fathers obtained asphaltum for roofing the missions and other buildings put up at Los Angeles. San Gabriel, and elsewhere in the vicinity,

Samples Nos. 3, 4, 5, and 6 are from Sargent's Ranch, a few miles south of the town of Gilroy, in Santa Clara County. Petroleum is here found exuding from the sandstone at several points along Tar Creek. Upon exposure the liquid becomes converted into maltha and asphaltum, considerable quantities of which have accumulated. The petroleum, according to Mr. Hanks, exudes from the hillside in a thin tarry stream, with a motion that is almost imperceptible when the weather is cool, but which increases with the temperature of the atmosphere. Much of the asphalt presents a vitreous appearance, resembling that of the best quality from Trinidad. Some of the pools formed are as much as 10 ft. in diameter and of unknown depth. In cool weather the surface is sufficiently firm to admit of walking over it, but on warm days the surface is too yielding to bear the weight of a man. When dug up and thrown into heaps the hard asphaltum at common temperatures gradually softens and spreads out into a thin sheet.

At the point where the first deposits are met with going up the creek, works have been erected for purifying the brea by fusion and straining. Some 20 or 30 tons of asphaltum have been obtained here. Half a mile up the creek other large beds of asphaltum exist, which are fed from springs on the bank of the stream, and about 30 ft. above its bed. From these deposits seventy-five car loads of asphaltum have been sent to San Francisco. A mile and a half further up the creek a third, and by far the largest, bed of asphaltum in this series is met with, the deposits here covering several acres. The land at this place spreads out into a plateau, and the supplying springs, many in number, are located on the neighboring hillside. From the surface of the tarry pools bubbles of gas escape, similar to those observed at the Mud Lakes on the Colorado desert, and remains of birds and small animals which have become ensnared in the tar are to be seen. From this locality 200 car loads of asphaltum have been sent to market.

According to Mr. Hanks, the following comprise the more notable localities of asphaltum and maltha in the State: Santa Ynez and Kayamos Valleys; near Mission, San Buenaventura; at the Goleta Landing, seven miles west of the town of Santa Barbara; on the Laguna Todos Santos and Los Alamos Ranchos; in the vicinity of Dos Pueblos, and near Carpinteria, in Santa Barbara County; at the oil wells near Sulphur Mountain, Ventura County; Rancho La Brea, Los Angeles County; on the Corral de Piedra, San Luis Obispo County; about Buena Vista Lake, Kern County; and on Sargent's Ranch, Santa Clara County.

The quantity of asphaltum consumed in the State in 1884 was about 3,500 tons per annum, the annual receipts at San Francisco reaching 2,500 tons. The principal supplies come from Santa Barbara County, and the product from this locality being preferred, commands a price from 20 to 30 per cent. higher than that obtained for asphaltum from other deposits in the State. The wholesale price of asphaltum in 1884 was 13 dols. per ton for the best, and from 9 dols. to 11 dols. per ton for poorer qualities. The cost of extraction ranges from 2 dols. to 3 dols. per ton, according to the hardness of the material, it being necessary occasionally to resort to blasting.

The material is largely used in California, as elsewhere, for street pavements, cellar floors, and roofing. It has also been used in the construction of water pipes, the process consisting in coiling on a mandrel the cloth known as burlap, previously soaked in melted asphaltum, glazing the interior of the pipe thus formed by pouring in melted asphaltum, and finally rolling the pipes on a table covered with coke dust, whereby they acquire a smooth, dry, and hard surface. The pipe thus manufactured is light, durable, and cheap, the price, inclusive of couplings, being a sum per foot equal to the diameter of the pipe in inches multiplied by 10 cents. Thus, 2 in. pipe costs 20 cents per foot, 4 in. pipe 40 cents, etc. Such pipe is said to have been made to stand an internal pressure of 500 lb. per square inch.

Mr. Hanks states that the Californian petroleum-bearing rocks belong to the tertiary age, as shown by the fossils. At Pico Canon the sand rocks are stratified with much regularity, and are interstratified with plates or seams of gypsum. There also occur here a black shale and a coarse conglomerate.

According to Professor S. F. Peckham, who has devoted much attention to the subject, the maltha of Southern California passes by insensible gradations from a material scarcely to be distinguished from heavy petroleum to solid asphalt, and varies in specific gravity from 0.9996 to 1.10; the heavier description still remaining plastic, like mortar.

(To be continued.)

#### STORAGE BATTERIES.

THE electro-chemical means at present available for the storage of electrical energy cannot, either from a scientific or a practical point of view, be regarded as perfect, and it seems certain that they will be considerably improved in future years. The trite saying that the storage battery is still in its infancy is, perhaps, not inapplicable, but it would be a mistake to ignore the fact that important improvements have been made in this apparatus since—seven years ago—the cell of Gaston Plante was first modified by Camille Faure. Under the headings of "Storage Capacity" and "Weight per Horse Power Hour," I have jotted down from my notebook, in tabular form, some figures, sub-

TABLE I.—STORAGE CAPACITY OF VARIOUS SECONDARY CELLS.

Name of Cell.	Per lb. of Pb.		Per Kilo. of Pb.		Authority.
	Foot Pounds.	Watt Hours.	Kilogram-meters.	Watt Hours.	
Plante.....	12,000	4.52	2,664	10	Howard, (?) Hospitalier.
Faure.....	18,000	6.78	5,495	15	
E.P.S. L plates.....	48,000 (?)	18.09 (?)	14,600 (?)	39.8 (?)	
" " R ".....	36,080	13.6	11,010	30	
" " S nominal 22 lb. cell.....	31,800	12	9,540	26	Fitz-Gerald.
Elwell-Parker (old form).....	6,633	2.5	2,018	5.5	Prospectus.
Lithanode battery (old form).....	39,798	15	12,110	33	Fitz-Gerald.
Lithanode battery "Union" cell.....	47,170	17.8	14,071	39.16	G. Forbes.



TABLE II.—WEIGHT PER HORSE POWER HOUR CAPACITY OF VARIOUS SECONDARY BATTERIES.

Name of Battery.	Elements Only.		Cell Complete.		Authority.
	Lb.	Kilos.	Lb.	Kilos.	
Plante.....	.....	.....	396	180	Reynier.
Faure.....	.....	.....	88	40	Faure.
" (old model).....	.....	.....	165	75	Sir W. Thomson.
" (new model).....	.....	.....	198	90	Reynier.
E.P.S. L plates.....	.....	.....	134	61	Prospectus.
" S ".....	66	30	110	50	Reckenzaun.
Reynier Zinc posve.....	50.6	23	117.5	53.4	Fitz-Gerald.
Lithanode battery (old form).....	105	47.6	.....	.....	R. Tamine.
Lithanode battery "Union" cell.....	42	19.1	76	34.5	Fitz-Gerald.
	42	19	70	31.5	G. Forbes.

ject to correction and amplification, which in some measure illustrate this improvement, although there are other points of equal importance which require to be taken into account. The "lithanodes" mentioned in these tables were the subject of a paper which I read at the British Association meeting at Birmingham, and which will be found in the *Electrician* of September 10 last year. It is peroxide of lead—with more or less sulphate of the metal—in a coherent and highly conductive form, having generally a specific gravity between 7.5 and 7.9.—By Desmond G. Fitz-Gerald.

#### PRACTICAL ELECTRICITY.

**Lighting and Extinguishing Button.**—Fig. 1 represents a small, practical apparatus constructed by Mr. E. Salomon. It is designed to open and close a circuit successively by one and the same maneuver, and is particularly applicable to the lighting and extinguishing of lamps or to continuous electric bells.

It has the appearance and dimensions of the button of an ordinary electric bell. The mechanism comprises an 8-toothed ratchet wheel carrying four pins. The

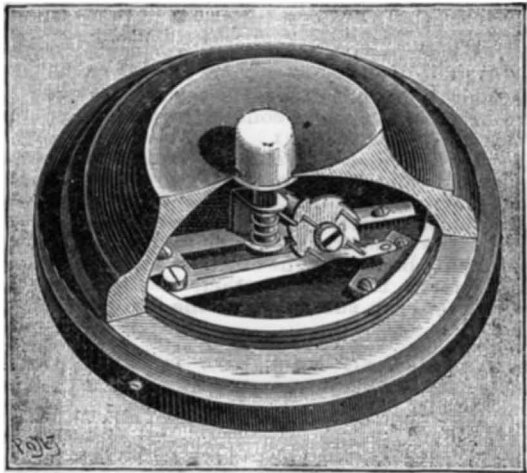


FIG. 1.—LIGHTING AND EXTINGUISHING BUTTON.

button itself carries a pin that extends to the teeth of the ratchet wheel. Every time the button is pressed, the ratchet wheel advances one tooth, from left to right, and makes an eighth of a revolution. Under the button there is a spiral spring that has the effect of pushing it out as soon as the pressure is removed—the ratchet wheel keeping the position that it has obtained.

The four pins, through the revolution of the ratchet wheel, press in succession against a horizontal strip of brass forming a spring that alternately opens and closes the circuit, according as one of the pins is or is not opposite the slightly curved part of the strip. Fig. 1 represents the button in the open circuit position.

To prevent the ratchet wheel from moving backward, a second flat spring engages with each tooth and holds it in place.

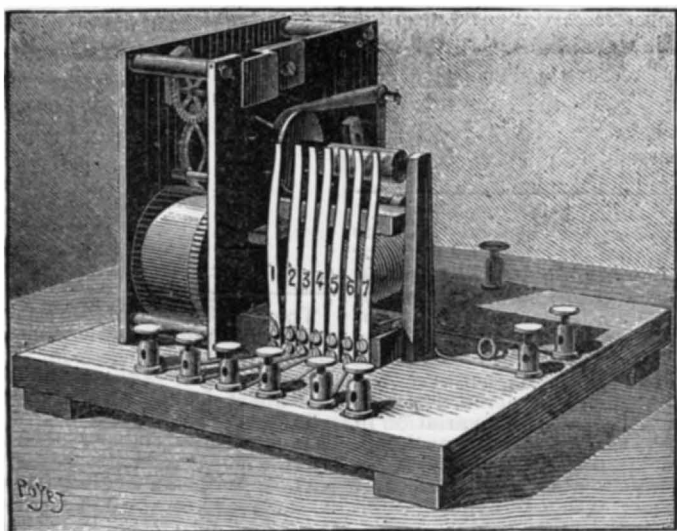


FIG. 2.—AUTOMATIC COMMUTATOR.

Since we are speaking of commutators, let us mention an elegant device got up by one of our subscribers, Mr. Grangier, of Dinard, for the purpose of lighting or extinguishing a lamp at a distance, from any number of points, by the sole aid of a button and two wires. The principle of it is very simple. It consists in actuating the electro-magnet of a relay commutator by pressing upon one of these buttons. The motion of the armature revolves a ratchet wheel one eighth of a revolution

at each maneuver. This revolution is utilized for effecting contacts through the aid of two springs that press against friction rollers provided with parts that are successively insulating and conducting, thus effecting an opening and closing of the circuit connected with the two springs.

**Automatic Commutator.**—The object of this apparatus, which also is constructed by Mr. Salomon, is to permit of effecting, in a certain measure, a nearly constant lighting by Leclanche piles, through a method of automatic substitution of several series operating one after the other, and depolarizing themselves during the periods of rest. The apparatus, when once wound up, gives 2,700 commutations before it has to be wound up again, but it is unnecessary to say that such a limit is not absolute, and that it depends solely upon the proportions of the apparatus and the weight of its spring.

The apparatus (Fig. 2) consists of a clock-work movement, which, every thirty seconds, every minute, or

the other, and thus perform, systematically and methodically, a maneuver that we have hitherto effected by hand, but quite irregularly.

In his last arrangements of the chlorine pile, Mr. Upward uses an apparatus whose function is exactly the same as that of the one just described, but the high price of it leads us to believe that the Salomon arrangement, slightly modified, would solve the problem in a simpler and more economical manner.

#### THE ELECTRIC WORKING OF METALS.

THE applications of the heat produced by electric energy are not limited to lighting by the arc and incandescence, and we have several times already mentioned other applications in which heat intervenes. Thus, for example, we have described the electric furnace of the lamented William Siemens, the manufacture of aluminum bronze by the Cowles process, and



#### ELECTRIC WELDING OF METALS.

more, according as need be, is thrown into gear, and causes the revolution of an axle a quarter, a sixth or an eighth turn, according as four, six, or eight series are used. This rotary motion changes the communications of the external circuit, puts a new series in circuit, and removes that which has just operated. This result is very easily obtained by means of metallic fingers fixed spirally upon the revolving cylinder, and which come successively into contact with springs, 2, 3, 4, 5, 6, 7, that communicate with the positive poles of the different batteries, the negative poles being connected with a common return circuit.

In order that the commutator may not work while the piles are not operating, an electro-magnet is placed beneath the revolving cylinder. As long as the lamps are out, the clock-work movement is locked, but as soon as the lamps are lighted, the electro attracts its armature, which throws the clock-work movement into gear, and the purely mechanical function of the commutator can then be produced.

According to Mr. Salomon, it would require six batteries of a special model to secure a continuous lighting of indefinite duration, at the rate of 1 ampere, 1.5 volt per element, in making commutations every thirty seconds, thus leaving a hundred and fifty seconds of rest between two successive periods of work.

We do not doubt the efficiency of this method, but it seems to us that the use of six batteries to supply a sin-

gle 1 ampere lamp leads to a somewhat costly *matériel* and a somewhat complex installation.

Mr. Salomon's commutator, however, by means of slight modifications, may be utilized with advantage for an analogous service—that of the charging of a series of accumulators through a small number of elements (bichromate or sulphate of copper). The commutator should, say every quarter of an hour, make the charging pile pass automatically from one series to

the electric welding of metals by means of transformers, through the remarkable processes of Mr. E. Thomson. It is likewise the heat disengaged by electric currents that Mr. De Benardos utilizes in his process of working metals.

The origin of these researches dates back to 1881. The first applications were made by Mr. De Benardos in the laboratory of the *Electricien* in the autogenous soldering of the leaden plates of accumulators. These first results, developed and extended to other metals, have given rise to a new industry, and have been the cause of the formation of a company for the electric working of metals.

The principle applied in this process of welding consists in the creation of a voltaic arc, a sort of electric blowpipe, between the points to be united, and in the use of a piece of carbon that is moved along the two surfaces (see engraving).

The current is furnished by a series of accumulators in tension kept constantly charged by a continuous current machine. The negative pole of this series of accumulators is connected with a cast iron table insulated from the floor and forming, as it were, a sort of electric anvil, upon which the pieces to be welded are placed, and the positive pole is connected with a carbon crayon which is maneuvered by hand.

The welding does not succeed so well, and even not at all, if the table is connected with the positive and the carbon with the negative pole. Upon lightly touching the piece with the carbon and then quickly removing it to a certain distance, an arc is formed that very rapidly melts the opposite pieces and furnishes a very strong and absolutely tight junction. When there is a long line to be welded, as, for example, when it is a question of uniting two plates of iron, for the manufacture of casks, it suffices to move the crayon along the pieces to effect a junction at once.

The intensity of the current depends upon the size of the pieces to be welded, and is regulated by varying the number of accumulators used. In the recent experiments made under the direction of Mr. J. Sarcia during the annual session of the French Society of Physics, the current was furnished by a Gramme machine of superior type charging Montaud accumulators capable of producing from 300 to 400 amperes.

As a general thing, it requires twenty-eight lead-lead accumulators in tension for obtaining a suitable arc. The intensity of the latter is regulated according to the size of the pieces to be welded by interposing a variable resistance in the circuit. The same process permits of making holes in iron plate; and if a metallic rod be afterward introduced into the aperture thus formed, and its two ends be melted, an electric riveting is obtained.

The brilliancy of the arc would be trying and even dangerous to the workman, through the frequent flashes of light, and for this reason he protects his eyes while at work by means of a frame provided with colored glass and with a handle that he holds in the left hand, while his right hand directs the carbon crayon.

In addition to the soldering of accumulators, which has been practiced for several years, a very important application has been made by Mr. P. Legrand in the construction of absolutely tight metallic reservoirs designed for the carriage of light petroleum oils and sul-

phide of carbon. The results obtained have been most satisfactory.

Electric welding has also been applied in the manufacture of copper and iron tubes and in the construction of light iron furniture for gardens, etc.

Electric welding, then, constitutes a simple, elegant, and practical process in every respect worthy of numerous other useful applications, and Mr. De Benardos is to be congratulated for having been able to convert a laboratory manipulation into an important industry of the present and future.

#### TELEPHONE INVESTIGATIONS.

By J. R. PADDOCK.

THE following investigations were suggested to my mind from observing the marked advantage gained in modern telephone transmitters by the use of granulated carbon. It occurred to me to try the effect of the same and other powders in the Reis instrument, particularly in the cubical box transmitter, as the latest commercial instrument has returned in many of the details of its construction to this form of a transmitter, viz., to a platinum diaphragm placed horizontally, with the other electrode suspended above it, and the intermediate space filled with granulated carbon. (See paper of Lockwood, Amer. Inst. of Elec. Engineers, May 19, 1886.)

My first experiment was to place a quantity of granulated carbon (made by drilling out carbon battery plates) upon the platinum patch of the Reis instrument, and the result was in accordance with my expectation. It transmitted speech under these circumstances clearly and distinctly. I next reduced the quantity of carbon dust or grains on the diaphragm, and found the result quite as good as before. I then removed all but a few grains between the electrodes. Still the instrument operated as a good transmitter. After a little time, however, these grains of carbon were scattered and had to be renewed.

I then prepared granulated platinum by drilling out pieces of platinum foil, and placed this granulated platinum upon the platinum patch of the diaphragm. The result was a harsh, grating quality of sound. Tried black lead dust from a lead pencil (A. W. Faber's No. 4) with much better results. The quality of the speech transmitted at once became smooth and at the same time more distinct. Recalling the experiments of Mr. Edison with lampblack, I prepared some soot deposited at low temperature from a smoking kerosene lamp, and placed a few grains of this upon the platinum patch. The results were very satisfactory, and the quality and loudness of the speech transmitted surpassed all previous results.

I next obtained finely divided platinum (known as platinum sponge) from H. M. Raynor, 25 Bond st., New York. Also soft and well annealed platinum foil from Baker & Co., and dioxide of lead, iodide of copper, and a ten per cent. solution of the bichloride of platinum, together with pure charcoal made from willow wood. The charcoal was heated to redness and plunged into the solution of bichloride of platinum and afterward pulverized, thus forming with the others a new series of metallic powders for trial.

I first tried the platinum sponge, which gave results that were not satisfactory. The sounds were harsh and grating. I next tried the charcoal impregnated with platinum, which gave better results, the sounds becoming more agreeable to the ear. The iodide of copper was equally good, but soon disintegrated under the action of the current. The dioxide of lead was then tried, and found to surpass all the other powders of this series, giving admirable results. The articulate speech transmitted by means of it was clear, distinct, and loud—and its efficiency closely approximated to that of carbon or lampblack. I next tried the following mixtures of powders: Platinum and lead, platinum and carbon, iron and carbon, each in equal parts. The results were not as satisfactory as when used alone. The addition of oil or sirups improved their action slightly.

Having noticed that the diaphragm when in vibration soon scattered the grains of powder, I made a cavity in the center of the platinum patch and placed the powder within it; but the volume of sound from the receiver was reduced one half thereby, and the deeper the point of the hammer electrode was immersed in the powder, the fainter the sounds became. Returning to a shallow indentation in the platinum patch, the sounds became louder. This was owing to the fact that the sides of the cavity offered comparatively free passage for the electric current; and I therefore constructed rings of non-conducting material, which, when placed on the platinum patch, overcame that difficulty and at the same time kept the powder from being scattered. The results obtained thereafter were entirely satisfactory.

The next step was to ascertain if possible *what was the principal agent in the variation of resistance by means of these powders*. Whether it was the loose contacts of the grains of powder among themselves or the surface resistance of the powder upon the electrodes, or both combined. After many trials it was found that, when the upper electrode was fixed so as not to be capable of movement itself, no sound proceeded from the receiver, notwithstanding that the particles of powder surrounding it were in constant agitation, and the intimacy of their contacts among themselves continually changing, under the action of the voice; and again, the upper electrode being removed, a piece of platinum wire, suitably connected to the binding post, was held in the hand, with one end dipping into the powder. In this way, by varying the rigidity with which the platinum wire was held, the instrument could be made to transmit speech or not at pleasure; and it was found again that the upper electrode required to be free to move up and down on the surface of the powder in order to obtain sounds in the receiver—which pointed to the surface contact of the upper electrode with the powder as the place where the principal variation of the electric current takes place, and tended to show that all other variation was exceedingly small in comparison. Still it appeared reasonable that the violent agitation of all of these loose particles would aid somewhat in producing the final result.

#### CAUSE OF THE EFFICIENCY OF POWDERS IN TELEPHONE TRANSMITTERS.

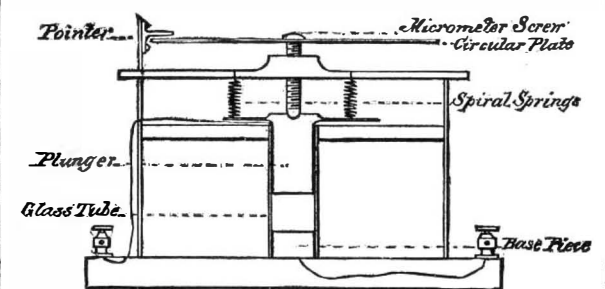
In order to throw additional light upon the subject, I have endeavored to ascertain the range of variation

in resistance due to surface contact and pressure when powders of this kind are introduced into an electric circuit, and for this purpose constructed an apparatus consisting of a glass tube, one centimeter in diameter, to which was fitted a fixed metallic base and movable rod or plunger (brass). This rod was moved by means of a micrometer screw, with 32 threads to the inch, the head of the screw being divided into 360 degrees. It was suspended by spiral springs, against the tension of which the screw moved.

The minimum measurement of the screw was  $\frac{1}{32}$  of an inch, but the error of the apparatus was so great measurements were taken with 10 degrees at a time, giving  $\frac{1}{16}$  of an inch, compared with which the error would be perhaps one per cent. The whole was suitably fixed in a solid framework and the metallic base piece and rod connected to binding posts, thus forming the electrodes of the circuit.

The space between these electrodes to the depth of one centimeter was filled with the powder to be examined. Each powder by this means formed a cylinder one centimeter in diameter and one centimeter in length. These dimensions were chosen as furnishing a basis for the estimation of the resistance of a unit cube or the specific resistances of these substances, provided the measurements proved of sufficient value.

The micrometer screw was first turned down to what I may call the zero line for each experiment, which line was always taken just below the contact surface, so as to give each powder an equal compression of its mass and also to render its surface conformable to that of the electrodes. After this the screw was reversed and the upper electrode raised. The measurements of resistance were then taken by means of the bridge method and with a mirror galvanometer.



The following table gives the result for three of the most important powders: Metallized carbon (from specimen of very fine French electric light carbons) peroxide of lead ( $PbO_2$ ), peroxide of manganese ( $MnO_2$ ), and also for a solid specimen of carbon taken from the same piece and of the same dimensions.

TABLE SHOWING VARIATION IN ELECTRICAL RESISTANCE FOR CONTACT SURFACE AND PRESSURE IN CYLINDER ONE CENTIMETER IN LENGTH AND DIAMETER.

Revolutions of Screw, showing Contact and Pressure.	Carbon, solid.	Carbon, powdered.	Peroxide Lead, powdered.	Peroxide Manganese, powdered.
	Ohms.	Ohms.	Ohms.	Ohms.
First contact.	99000	93125	149000	248000
$\frac{1}{16}$ inch.	24000	74000	60000	19548
$\frac{1}{8}$ "	16	59000	29000	9520
$\frac{1}{4}$ "	1.3	31857	14050	6246
$\frac{1}{2}$ "		20428	5977	5122
$\frac{3}{4}$ "		14000	1435	4035
$\frac{7}{8}$ "		11000	350	3287
1 "		9000	220	2795
$1\frac{1}{8}$ "		7670	95	2448
$1\frac{1}{4}$ "		6317	21	2160
$1\frac{1}{2}$ "	0.21	5000	11.2	1970
$1\frac{3}{4}$ "		3965	8.3	1776
$1\frac{7}{8}$ "		3199	7.1	1500
2 "		2703	6.5	1382
$2\frac{1}{8}$ "		2457	6.0	1290
$2\frac{1}{4}$ "		1590	5.6	1206
$2\frac{1}{2}$ "		1307	5.2	1127
$2\frac{3}{4}$ "		900	5.0	1054
$2\frac{7}{8}$ "		666	4.9	996
3 "	0.11	332	4.8	948
$3\frac{1}{8}$ "		170	4.72	913
$3\frac{1}{4}$ "		105	4.65	878
$3\frac{1}{2}$ "		52	4.57	843
$3\frac{3}{4}$ "		6	4.48	808
$3\frac{7}{8}$ "	0.10	3.4	4.40	773
4 "	0.067	0.638	2.15	502

By reference to this table it will be seen that the first contact that was measured gives 99,000 ohms for solid carbon, 93,125 ohms for powdered carbon, 149,000 ohms for peroxide of lead, and 248,000 ohms for peroxide of manganese. These figures, however, cannot be relied upon as accurate comparative measures, inasmuch as the certainty of making such light contacts is well nigh impossible. They represent, however, the relative resistances roughly, and by reference to the last figures in each column the range of variation in each is easily seen. In the case of carbon powdered, for instance, a pressure of  $\frac{1}{16}$  of an inch caused the resistance to fall to less than one ohm! In peroxide of lead, to a little over two ohms! While peroxide of manganese was reduced no lower than 502 ohms!

These results also show, as was anticipated, that by far the greater part of the variation in resistance is due to surface contact. The first three turns of the screw, representing  $\frac{1}{16}$  of an inch, reduced the resistance far more than the entire remaining pressure, which was nearly 16 times the first. In the case of solid carbon the range of resistance is plainly seen to be limited very nearly to surface contact.

It is evident that the difference in range of resistance shown between carbon solid and carbon powdered is largely due to the degree of intimacy of contact of the grains of the powder produced by pressure, and not to surface contact with the electrodes.

This comparison also indicates, when looked at in connection with the motion of the screw, that a powder furnishes a much wider range of vibration for the electrodes of a telephone transmitter, which is a decided advantage in most cases.

Peroxide of lead furnishes a range of variation in resistance easily compared with that of carbon, and it will be seen at first sight that the fall of resistance was much more rapid, which may be due to the fact that the peroxide of lead is very easily compressed under light pressure. The comparison is most significant, as furnishing the closest approximation to that of carbon, solid or powdered, of any substance experimented upon. Doubtless this was the reason why peroxide of lead was found in my previous experiments to be such an excellent substitute for carbon in telephonic operations.

Peroxide of manganese was found to have a considerable range of variation, but altogether too high a specific resistance for use in telephone transmitters.

Other oxides of the metals were tried with the same result, such as the peroxide of iron ( $Fe_2O_3$ ), which was too high for measurement.

#### HEAT EFFECTS IN TELEPHONE OPERATIONS.

Some years ago I accidentally discovered what was then new to myself, that microphone transmitters would also act as receivers, and subsequently that any loose contact in an electric circuit would reproduce sounds made at a telephone transmitter. That the heating effect of the current at the joint should have something to do with the reproduction of these sounds has always appeared probable, provided that the variations of heat were sufficiently rapid to coincide with those of the current. That such heat changes are sufficiently rapid in lamplack, for instance, to reproduce musical and articulate sounds, is demonstrated by the well-known experiments with a beam of intermitted radiant heat (Tyndall's exp.), and still more recently the "thermal telephone" has shown the same to be true for a fine metallic wire heated by means of the electric current. (Chas. R. Cross, 1885.)

In the case of a loose contact surface, therefore, we may consider whether this heat effect is in the same or in an opposite phase to that of the varying strength of the current passing through the joint. In the case of metals, the temperature coefficient being positive, resistance increases with the strength of the current; but in the case of carbon, whose temperature coefficient is negative, resistance decreases with the strength of the current.

In order to ascertain how important a factor heat might become at a light contact surface, I undertook the following experiments:

The powders whose resistances had been measured for contact and pressure were now measured for changes in temperature. In order to do this, the apparatus before described was immersed in a bath of water at the temperature of 25° Centigrade, and the screw having been brought down to a zero line chosen with reference to light contact, the resistance was measured for each substance by the Bridge method as before.

TABLE SHOWING VARIATION IN ELECTRICAL RESISTANCE FOR TEMPERATURE. In cylinder one centimeter in length and diameter.

Temperature in Centigrade Degrees.	Carbon Powdered.	Peroxide Lead Powdered.	Peroxide Manganese Powdered.
25°	2,000 ohms.	2,750 ohms.	5,520 ohms
26°	1,912 "	2,409 "	5,200 "
27°	1,811 "	2,061 "	5,000 "
28°	1,609 "	1,803 "	4,707 "
29°	1,459 "	1,586 "	4,450 "
30°	1,375 "	1,375 "	4,229 "
31°	1,237 "	1,100 "	4,070 "
32°	1,143 "	726 "	4,017 "
33°	1,054 "	575 "	3,960 "
34°	1,000 "	485 "	3,900 "
35°	910 "	408 "	3,838 "
36°	863 "	304 "	3,785 "
37°	807 "	255 "	3,762 "
38°	732 "	225 "	3,731 "
39°	695 "	208 "	3,687 "
40°	657 "	200 "	3,644 "
41°	621 "	191 "	3,600 "
42°	578 "	184 "	3,573 "
43°	530 "	176 "	3,545 "
44°	470 "	167 "	3,519 "
45°	no change.	162 "	3,498 "
46°	"	158 "	3,485 "
47°	sudden "	150 "	3,473 "
48°	185 ohms.	145 "	3,461 "
49°	152 "	140 "	3,449 "
50°	112 "	136 "	3,438 "
51°	71 "	133 "	3,431 "
52°	42 "	130 "	3,425 "
53°	21 "	127 "	3,418 "
54°	18 "	124 "	3,412 "
55°	15 "	121 "	3,406 "

The temperature of the bath was then raised one degree at a time, and the resistance measured for each degree of temperature from 25° to 55° Centigrade. Observations were taken at intervals of ten to fifteen minutes apart. The table above gives the results, and it will be observed that carbon (powdered) fell from a resistance of 2,000 ohms to 15 ohms, and peroxide of lead from 2,750 ohms to 121 ohms for 30° of temperature, that is, in being heated from 25° to 55° Centigrade. By reference to the first few degrees of temperature, the exceedingly rapid fall of resistance shows how powerful a factor in variation of resistance heat may become in cases of light contact.

It is also seen at a glance that both the oxides of lead and manganese have like carbon negative heat coefficients.

In order to ascertain the presence of thermo-electric currents, the battery was disconnected and the heat experiments were repeated, but such currents were very slight indeed, scarcely noticeable. The polarization or "storage" effect, however, was greater, and in the case of peroxide of lead a return current was quite marked after each experiment.

These experiments are intended to form a basis for

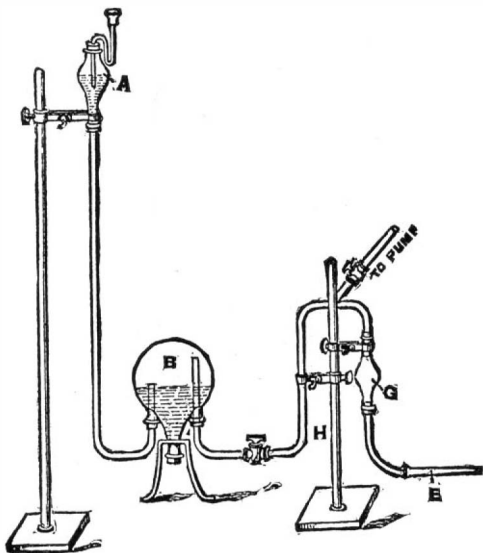


further investigation in the future. So far as carried they open an interesting field for study, and furnish suggestions for a better solution of the telephonic problem.

Stevens Institute of Technology, July, 1887.

#### VISCOSITY OF LUBRICATING OILS.

THE accompanying sketch shows the form of apparatus used for determining the viscosity of oils by the author's method. A is a Mariotte bottle filled with water, which serves to compress air in the reservoir, B, and to keep the pressure constant. B is connected by means of pipe and cock to the efflux apparatus, H, consisting of the bulb, G, provided with two marks, so that the volume of liquid to be discharged may be measured. E is a capillary tube through which the oil is dis-



charged. By using a series of three capillary tubes with diameters of about 0.5, 0.8, and 1.5 mm. respectively, and comparing the times of efflux of water and 80 per cent. glycerol from the first tube, of 80 per cent. and 100 per cent. glycerol from the second tube, and of 100 per cent. glycerol and a viscous oil from the third tube, the corrected time of efflux of water from every tube may be arrived at without knowing the diameter of the tubes. The time of efflux will thus be in direct proportion to the viscosity. The apparatus may be adapted to a water bath, so that determinations at high temperatures may be made if necessary.—Dr. T. Traube, in *Industries*.

#### A NEW PROCESS FOR ESTIMATING CARBONIC ACID IN COAL GAS.

THE APPARATUS BEING ALSO APPLICABLE FOR THE ESTIMATION OF AMMONIA AND (POSSIBLY) OF SULPHURETED HYDROGEN.

By JOHN T. SHEARD, F.C.S., Chemist to the Salford Corporation Gas Department.

NUMEROUS as are the methods in use, or that have been proposed, for the quantitative determination of carbonic acid, there is room, I am bold to think, for yet another. Those hitherto most chiefly relied upon are two, viz., the absorption and weighing of the impurity in U tubes charged with soda lime or stick potash, or noting the determination in volume of a measured quantity of gas in a closed vessel after absorption by potash or soda. The latter takes various forms, according to the different kinds of apparatus employed. Of other methods may be mentioned Wanklyn's, which consists in agitating a solution of barium hydrate in a measured volume of gas, and weighing the barium carbonate produced; and a peculiar method, proposed by Heine, founded upon the variations in pressure produced by different gases when exposed to radiant heat in a closed chamber. In a general sense it may be said, with regard to all these various methods, that where accurate they are tedious, and unreliable or inaccurate where expeditious; while in addition to being slow, the most reliable methods—those dependent upon weighing—involve the use of a delicate balance. It has therefore seemed to me that a method based upon volumetric principles of analysis, and thus doing away with the necessity for a chemical balance, and fairly expeditious, while at the same time as accurate (supposing equal care to be exercised) as the more tedious gravimetric methods, must be a desideratum in the laboratory of every well-equipped gas works. Such a method, I venture to hope, will be found in the process which it is the object of this article to describe.

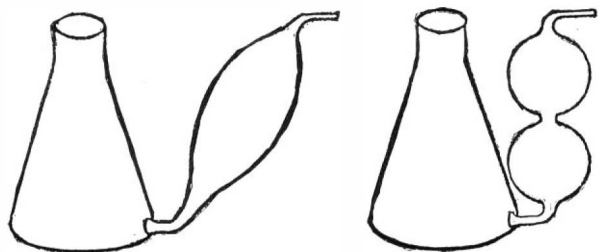


FIG. 1.—VOLHARD'S ABSORPTION APPARATUS.

The novelty of this process consists chiefly in the special form of apparatus employed; but, in addition thereto, some of the details of the method of estimating carbonic acid will, I believe, be found to be such as have not hitherto been taken advantage of for this purpose. It may be stated at the outset that the apparatus is a modification of Volhard's absorption apparatus, which latter is well known in chemical laboratories, and deservedly esteemed. In Fig. 1 two forms of Volhard's apparatus are shown, both of which, but specially the two-bulbed form, I have used now for many years as receivers for absorbing the liberated ammonia in the valuation of gas liquor by the distillation test. For this purpose, attached to the lower end

of an upright worm condenser, it is by far the best form of apparatus I have seen or heard of. At the end of the distillation, the contents of the receiver are titrated direct, without any intermediate washing out; and it is then that the advantages of the apparatus are most apparent. The liquid in the bulbs acts the part of a reserve; so that if, in titrating, apparently too much of the standard alkali is run into the receiver, it may be more than neutralized, on agitation, by the liquid contained in the bulbs. Having experience of the utility of the apparatus in connection with the analysis of ammoniacal liquor, I was led to try its capabilities in another direction, viz., for the estimation of the ammonia and other absorbable constituents of crude coal gas, by causing the gas to bubble through suitable absorbents. On making an experiment with a current of air, holding in suspension a known quantity of ammonia, I proved (what I had indeed suspected would be the failing of the apparatus) that the current of air carried forward mechanically some portion of the liquid from the bulbs, causing a loss of unknown extent, and precluding any possibility of obtaining accurate results by its means. To remedy this defect, I devised an addition to Volhard's apparatus, which constitutes the special characteristic of the apparatus about to be described. This was a continuation of the bulbs in the form of a wide tube, which could be partially filled with glass beads, or other inert substance, on which the drops of liquid carried forward by the current of gas or air might condense and be retained, or flow back into the bulbs beneath.

The improved apparatus, to which I give the name of the "gas absorption tube," and which is shown in Fig. 2, may therefore be described as consisting of three parts, viz., the reservoir, or body of the apparatus, the bulbs, and the scrubber, as the long tube filled with pieces of broken glass, or small glass beads, may be called. The apparatus is made of blown glass, and its total capacity is from 250 to 300 c. c. Not more, however, than about 40 c. c. of liquid, or the contents of rather more than one of the bulbs, can be employed in it for one estimation. When in operation, the pressure of the gas forces the liquid out of the reservoir into the bulbs, and there bubbles through it. To use the absorption tubes, a known quantity and value of the absorbing liquid is run into the reservoir, and a measured quantity of gas caused to bubble through it. The scrubber is subsequently rinsed with pure water, to wash down any portion of the absorbent that may have been mechanically carried into it by the gas; and the whole of the resultant liquid is titrated in the reservoir. As the weight of the scrubber,

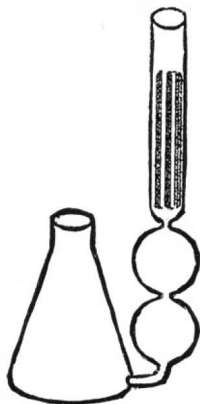


FIG. 2.

charged with beads, causes the absorption tubes to have an unstable support, I have arranged for their accommodation when in use a wooden stand, the construction of which is shown in Fig. 3.

The method adopted for the estimation of carbonic acid consists in absorbing it in a solution of barium hydrate of known strength; the resultant liquid being afterward titrated, in order to ascertain the amount of free hydrate remaining in solution, whence the amount of carbonic acid absorbed is deduced. So far the process is similar to Pettenkofer's method of determining the carbonic acid existing in the atmosphere. Instead, however, of employing turneric paper for indicating the neutral point in the titration (as in Pettenkofer's method), I use a solution of phenolphthalein, which is prepared by dissolving 0.5 gramme of that substance in a liter (1000 c. c.) of 50 per cent. alcohol. In presence of the hydrates of the alkalies and alkaline earths, this indicator gives rise to a beautiful purple-red color, which is destroyed on neutralization of the alkali by an acid. The end reaction is extremely sharp and distinct. Mr. Robert M. Thomson, in a paper "On the Use of Various Indicators," which he read before the Chemical Section of the Glasgow Philosophical Society, Dec. 10, 1883, and which subsequently appeared in the *Chemical News* (vol. xlix., p. 34), has shown that carbonate of barium, precipitated in a solution of the hydrate, does not develop a red color with phenolphthalein, but remains neutral. It follows that, the value of the barium hydrate solution employed being known, a simple titration of the liquid, after absorption of carbonic acid, will show the diminution in the amount of free hydrate present, and, inferentially, the amount of carbonic acid absorbed.

The solution of barium hydrate is obtained by dissolving the ordinary crystallized hydrate of baryta in water to saturation, and siphoning off the clear liquid into a well-stoppered bottle. The strength of the clear liquid is then determined very accurately by titration with decinormal hydrochloric acid, and should be approximately equal in strength to that acid, i. e., if (say) much more than 10 c. c. of the acid are required to neutralize this quantity of the baryta solution, a little water should be added to the latter to bring down its strength. The strength of the solution should be checked by titration from time to time, as, unless very carefully preserved from contact with the air, it gradually loses power through the absorption of carbonic acid.

The measures and standard solutions that I use are those of the metric system, now almost universally employed in chemical laboratories. Accurately graduated vessels on this system, and standard solutions of

definite strength, may now be obtained in most large towns. For the estimation of carbonic acid, in addition to the gas absorption tubes, an aspirator, two 500 c. c. flasks, two 50 c. c. burettes (graduated into 0.1 c. c., and provided with stopcock and glass float), a supply of soft water free from carbonic acid—which may be insured by boiling the water, and allowing it to cool—and a solution of hydrochloric acid of decinormal strength, are required. Each cubic centimeter of this latter solution is equal to 0.0022 gramme of carbonic acid (CO<sub>2</sub>). To obtain the result in the form of grains per cubic foot of gas, or percentage by volume, a calculation is required. This may seem to some of my readers a drawback to the use of a system of measurement founded on the gramme unit, and solutions based on the chemical equivalents of the reagents. It would, of course, be a comparatively easy matter to prepare solutions of such a strength that each cubic centimeter should be equal to a certain percentage, or number of grains per cubic foot, of carbonic acid. But, considering the facility of obtaining commercially the standard solutions described, and their general utility (to say nothing of the inconvenience of having in a laboratory several standard solutions of the same reagent, differing in strength), the advantages more than counter-

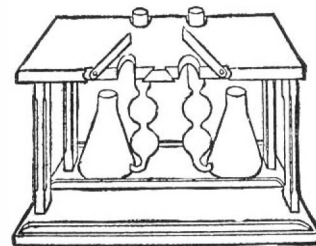


FIG. 3.

balance, in my opinion, the slight trouble involved in the very simple calculation that it required.

To make a test for carbonic acid (the gas being free from sulphureted hydrogen), a measured quantity—varying from 15 to 30 c. c., according to the amount of carbonic acid existing in the gas—of the barium hydrate solution is run from a burette into the reservoir of one of the gas absorption tubes, and from 10 to 20 c. c., likewise accurately measured, into another. If the smaller quantities mentioned are employed, an equal amount of the water is added; as the best results are obtained when the lower bulb of the first absorption tube is quite filled with liquid, as the current of gas bubbles through it. About 30 c. c. is, therefore, the proper charge of liquid. If much more than this is employed, it is liable to be carried forward into the scrubber. The absorption tubes are placed in the stand, and the apparatus connected up by means of India rubber tubing and stoppers pierced by glass tubes; the inlet of the first tube being connected to the gas supply, and its outlet to the inlet of the second tube; the outlet of the latter being connected, in its turn, to the inlet of the aspirator. In connecting the gas supply tube to the inlet of the first absorption tube, gas must first be allowed to blow away, and the India rubber tube pushed over the bent glass tube while the gas is issuing; care being taken that the pressure of the gas supply is not so great as to force its way through the liquid in the bulbs, without the aspirator being in operation. All being now in readiness, the measuring flask is brought under the tap of the aspirator, and water allowed to flow, so as to draw the gas in bubbles through the liquid in the bulbs. After making sure that the connections are gas tight (which is done by turning off the gas supply and the tap of the aspirator, and observing whether the level of the liquid in the bulbs remains stationary or not) the current of gas is continued until 500 c. c. have passed, as shown by the water that is run out of the aspirator. (The best speed of current, I find, is obtained when the flow of water from the aspirator is adjusted to the point at which it breaks from a series of drops into a nearly continuous stream. The gas supply is then disconnected from the inlet to the first tube—which is best done without stopping the flow of water, by slipping off the India rubber gas tube as the water in the flask passes the mark—a fresh flask brought under the aspirator, and a further quantity of 500 c. c. of air drawn through the apparatus, in order to drive forward the gas remaining in the reservoirs of the two absorption tubes at the end of the first aspiration. The tubes are afterward disconnected, and a little water (free from carbonic acid) run through the scrubbers, in order to wash down any of the barium hydrate solution that may have been carried forward mechanically by the gas. A few drops of phenolphthalein solution are added, and the liquid is titrated

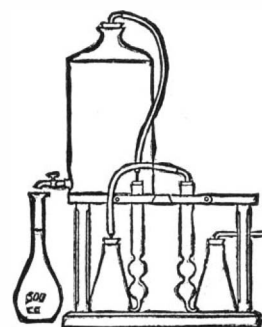


FIG. 4.

with decinormal hydrochloric acid; the point of saturation being shown by the disappearance of the purple color imparted to the liquid by the phenolphthalein. (In titrating the carbonated liquid, the acid must be added a little at a time, and allowed to run down the sides of the reservoir, not dropped directly into the liquid; the liquid being gently agitated after each addition of acid.) The difference between the quantity of free barium hydrate found at the close of the experiment and that which was run into the tubes at its commencement shows the bulk of carbonic acid absorbed; and from this the amount of the latter impurity existing in the gas may be calculated into grains per cubic foot or percentage by volume.

**Example.**—Two gas absorption tubes were charged, the first with 30 c. c. and the second with 20 c. c. of barium hydrate solution, and 500 c. c. of gas, followed by an equal quantity of air, drawn through them in the manner above described. After rinsing the scrubbers with water, and adding phenol-phthalein, the liquid in the tubes was titrated; 21.6 c. c. of decinormal hydrochloric acid being required to neutralize that in the first tube, and 21.4 c. c. for the second. The titre of the barium hydrate solution employed being 1 c. c.=1.09 N

c. c. — acid, therefore :

	First Tube.	Second Tube.
Equivalent of barium hydrate employed.....	32.7 c. c.	21.8 c. c.
— acid required to neutralize		
10		
resultant liquid.....	21.6 "	21.4 "
Equivalent of barium hydrate neutralized.....	11.1 c. c.	0.4 c. c.
$100 \times 0.0022 \times 11.5$		
0.914		

(the weight of 500 c. c. of  $\text{CO}_2$  saturated with moisture), which may be shortened to  $11.5 \times 0.241 = 2.77$  percentage by volume of carbonic acid; or  $11.5 \times 1.92 = 22.08$  grains of carbonic acid per cubic foot of gas.

The entire operation, from its commencement to the end of the titration, occupies not more than 15 or 20 minutes; and with duplicate apparatus two tests can, of course, if necessary, be kept working simultaneously.

It will be obvious, from what has gone before, that the gas absorption tubes may be used in a similar manner to their employment in the carbonic acid estimation, and with equal advantage, for the estimation of the ammonia existing in crude gas. For this purpose, decinormal sulphuric or hydrochloric acid is required as the absorbent, and a solution of pure ammonia, of corresponding strength, for the subsequent titration—the indicator being cochineal. Operating upon a comparatively large volume of gas, they may also be applied to the determination of the minute quantity of ammonia sometimes present in purified gas. I am in hopes that it will further be possible, by means of the absorption tubes and a suitable absorbent, to estimate the sulphureted hydrogen in unpurified gas with the same ease, and as great accuracy, as in the case of carbonic acid. This, however, I have not as yet been able to establish. I have tried a dilute solution of iodine; but with disappointing results. Arsenious acid in hydrochloric solution may perhaps answer; but I have been unable up to now to put it to the test. As opportunity serves, however, I shall make further experiments in this direction. If a suitable absorbent for sulphureted hydrogen, neutral to carbonic acid, can be found, the gas absorption tubes will furnish a most valuable means of estimating readily, in one operation, the three chief removable constituents of crude gas—a consummation not only "devoutly to be wished," but of imperative necessity, if the era of ammonia purification is fully to come.

There remains only to add that the gas absorption tubes were supplied, to my instructions, by Messrs. Mottershead & Co., laboratory furnishers, of Manchester, and that their cost is very slight. The entire outlay (including the provision of burettes, reagents, stand, and other apparatus necessary) need not be more than about 30s.—*Four. Gas Lighting.*

#### EXPERIMENTS WITH KITES.

WITHIN a few months of sixty years ago, I made use of kites with a scientific object in view. It was then a question of electric researches, and I had read my first paper to the Institute during the course of the year, and showed therein that the current produced by electrical machines, Leyden jars, and even the electricity of the clouds, was capable of deflecting the magnetic needle and of establishing a relation between the effects of the Volta pile and the electricity produced by friction, or even that of the clouds.

In the fall of 1827 I came to Switzerland, bringing my galvanometer with me, and renewed my experiments in perfectly calm and rainy weather. After ascertaining that in calm weather it suffices to ascend about 325 feet in order to have visible and tangible signs of positive electricity, and after showing that the tokens of electricity upon a mountain are sensibly the same as they are 2,300 feet lower in the plain, and that they have the same intensity, I endeavored in rainy weather to measure the electricity of the clouds, and for this purpose undertook to reach an elevation of a thousand feet above ground. I made these experiments with kites of medium size, formed of canvas and provided with conductors of silver wire running round the cord; but, rather than construct a kite of extraordinary size, I used three kites attached in succession, one back of the other. In fact, if we give a kite more cord than it can lift, it goes forward well, but it no longer rises, and the cord drags on the ground. But attach the kite to another one, and the second will rise to double the height of the first, and a third kite attached to the back of the second will treble the height. I thus reached an elevation of nearly a thousand feet with a conducting cord.

These experiments have to be performed with caution if one wishes to keep from getting struck by lightning as Reichmann was. I performed these experiments at the country seat of a relative near Geneva, and, knowing the subject, I had taken care to bury in moist earth a bar of iron that extended up to the window, where it ended in a ball. I operated in a large room having high windows. I paid out the cord with a glass windlass, and finally attached my kite with a long silk cord in the room, allowing the sparks to jump from the ball at the end of the cord to the one connected with the earth, which they did with a sound like that made by a small pistol. I then had a beautiful spectacle that filled me with enthusiasm. It did not thunder out of doors, but the electricity led by the cord, which was in all 1,300 feet in length, continuously escaped and produced sparks ten feet in length that formed zigzags and were white, red, and violet in color. I ran to look for my relative, in order to have him enjoy the spectacle but he was more than seventy years

of age, and saw with eyes different from mine. He did not understand electricity, and thought that his house was in danger from the lightning, as it had no lightning rod, and he begged me to stop the experiment. Fortunately I had had the time to see what I wished, and I put an end to the experiment and my relative's

which, after serving as a motor to carry up the tube and basket, unhooked, leaves the kite, and, acting as a parachute to the basket, slowly descends.

To this effect, a wire,  $ee'$ , properly bent, serves as a point of suspension, and, on reaching the stop, B, placed near the kite, unhooked itself. After this, the



FIG. 1.—EXPERIMENT WITH A KITE.

fears. In the summer of 1844, I was a neighbor, at Cologny, near Geneva, of my brother-in-law, Mr. Perier Ador, who had passed his youth in England, and made commercial studies there. Married in Switzerland in 1841, he had left his commercial career to devote himself to the study of infusoria, and then, as a pastime, he had amused himself in constructing an immense kite having a surface of about four feet. The kite was of canvas, with a frame of bamboo, and was provided with a nine hundred foot cord made especially for it. With it Mr. Ador amused himself in sending

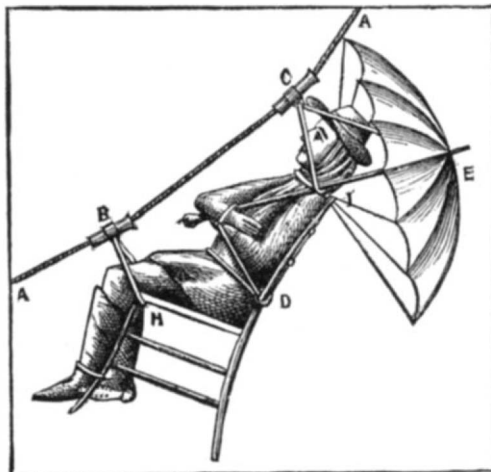


FIG. 2.—DETAILS OF A DUMMY MAN RAISED BY A KITE.

baskets of flowers and fruit to his relatives in the vicinity.

Every one is acquainted with those little cardboard disks called messengers that are placed on the string of a kite, and, thrust by the wind, rise, and do not stop till they reach the upper end of the string. It was with a device on the same principle, but one that could detach itself, that Mr. Ador sent up his baskets. To this effect, he constructed parachutes that he sent up along the cord tautened by means of an ingenious apparatus which, on arriving within two or three yards of the kite, unhooked itself with the motive apparatus that

tube, being no longer held by the parasol, H, runs down the cord.

This experiment suggested to me a bolder one, and that was to send up the figure of a man of natural size seated upon a chair and drawn by an umbrella that had the appearance of shading him from the sun.

The figure weighed a little less than thirteen pounds, and I prepared it as follows: An eider-down coverlet weighing about a pound was inclosed in a blouse and placed upon a Florence chair weighing four and a half pounds. A head with a mask, a colored handkerchief, and a hat were added. The figure had two arms sewed in the blouse, and these were crossed upon the breast, while the hands held a huge umbrella which was to serve as a motor, and the ribs of which were strengthened so that the umbrella could not be turned inside out. Two legs represented by light boots were attached to the chair, and the whole was very well arranged. One day, when the wind was blowing with violence, I brought out my man duly harnessed to the chair. We used two tubes, one for the upper part of the body and the umbrella, and the other for the chair, as shown in Fig. 2, where AA is the taut cord, B and C are the two tubes just mentioned, H D I are the points of attachment of the chair, and E is the open umbrella, whose position is such that it serves as a propeller under the wind's action. Upon the latter's producing its effect, the figure was raised to a height of 650 feet, to the great amazement of the curious, who abounded on the road. A stage coach which was passing stopped for some moments, and a goodly number of the curious took the dummy for a genuine man (Fig. 1). In the former experiment, the baskets always arrived in the same direction. I proposed to Perier to send the balloon to the right or left at will, and I set about it in this way: If the belly band were shifted a little to the left in a kite, the latter would deviate to the left; and if it were shifted to the right, the kite would deviate to the right. If we had a double belly band out of center and a double cord, and a stop that would not permit of exceeding certain limits, the kite might be able to deviate a third of the length to the right and a third of the length to the left, and we would thus have with 900 feet of cord a kite that could vary 300 feet to the right and 300 to the left, and would obtain a divergence of 600 feet. This experiment succeeded well, and we were enabled to reach points whose distance at right angles with the direction of the wind varied about 600 feet. As Cologny was only 325 feet from the lake, we projected the construction of a kite to be sent across the latter. To this effect, we constructed a kite of ordinary size—

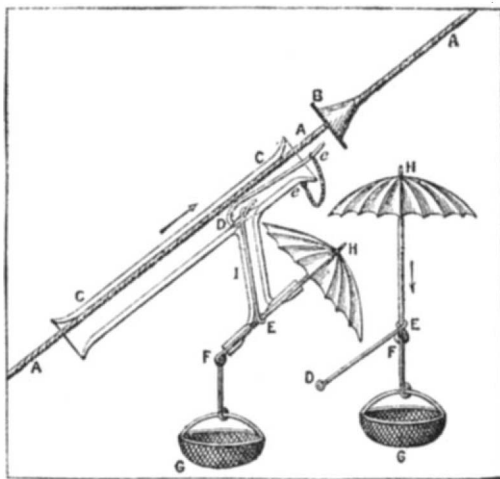


FIG. 3.—PARACHUTES FOR A KITE.

served as a parachute. The device is shown in Fig. 3. A A A is the cord of the kite. C C I is an apparatus composed of a tube designed to ascend along the cord, and the appendage, I, of which serves to hold both the basket of flowers or fruit and a kind of parasol,

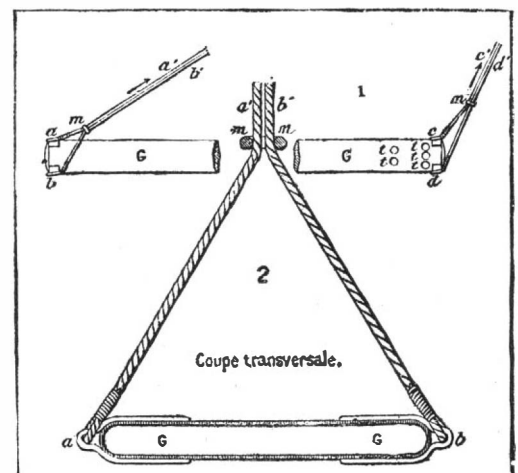


FIG. 4.—A PROPOSED FLOAT FOR BALLOONS.

of about half the dimensions of the large one—and, with the double belly band, we made it draw to the right to traverse the lake, and we added to it a float that was to serve to hold it in the wind and at the same time retard it. We had a board that did the retarding



and steering at the same time, and we gave it a fixed inclination by attaching it at the two extremities. We could not follow our float and kite, but, as long as it was possible, we beheld it crossing the lake in the direction of Versoix or Coppet.

When I recently learned that Messrs. Lhoste & Mangot had succeeded in crossing the English Channel with a float, this kite experiment came to mind; and I have thought that in such passages as fail for want of a breeze, it would be infinitely simpler to have a float that would be able at will to swerve the balloon and give it the most favorable direction. Messrs. Lhoste & Mangot used a cylinder that they could fill with water or empty, but they did not utilize the property that is possessed by the flat float held by both ends, and that permits of moving at right angles with the wind or at any other angle.

I here call attention to the double cord method, which permits of presenting the obstacle to the direct wind, and of tacking, as with a ship.

G G and G' G (Fig. 4) are the extremities of this float, which are held by the two cords, *a a'*, *b b'*, at the extremity, G, and by *c c'*, *d d'*, at the extremity, G'. These four cords pass in pairs through two rings, *m* and *m'*, and are connected near the car, where they are held in place. *t t t* are apertures that permit of filling the float with water or of emptying it. With such a float it is permissible to attempt a crossing, even in a wind that has a direction that follows the axis of the channel, or any other direction.—D. Colladen.

#### THE RACING CAMEL.

THE animal represented in the engraving is a mehara obtained from the Touarag Foghas. It has belonged to me for three years, and, although a little aged, is still rendering me excellent service nearly every day.

The mehara, or racing camel, is to the pack camel what the pure blooded horse is to the cart horse. It is the product of a long selection. Urged to a full trot, the mehara is capable of attaining a speed of nearly 18 miles an hour, but I have no need to say that it could not long keep up that gait.

The mehara has three gaits: the ordinary gait, in which the Arabs say simply *iemchi*, "he goes," or "he walks;" the long step, in which he says *isir*; and the amble, in which he says *iraouel*, "he goes ambling." This latter gait, which the animal can keep up for days at a time, gives a speed of from 6 to 8½ miles an hour, and is in nowise fatiguing to the rider.

The Biskra Society of Races inaugurated camel races in January, 1885. It was a question of making the trip from Touggourt to Biskra (126 miles) in the quickest time possible. The first mehara arrived 26 hours after the start, and the other competitors were all at Biskra in the three hours following. From the three latter we must except a mehara that arrived at almost a dead heat with the first, but this animal lost his rider at Saada.

It is well to say that all the racers stopped five consecutive hours at Saada (18 miles from Biskra), on account of a rain that had rendered the road very slippery, this being a grave inconvenience for the feet of camels. Upon the whole, the trip was accomplished in 21 hours of effective travel, that is to say, at a sustained gait of 6 miles an hour. It is possible, with well urged animals, to make this distance in 20 hours at a maximum, provided that the rider is strong enough to endure a fatigue of this kind and to urge his animal on.

The race of 1886 was insignificant. Only two animals took part in it—one of bad stock and the other of good, but not trained. I was enabled to judge of this myself, for I rode him at Touggourt on the eve of the day of the race.

As for the race of 1887, I was in France at the time, and have not been informed as to its results.

In short, it will be seen from what precedes that the

#### THE ARTESIAN WATER OF OUED RIR'.

By G. ROLLAND.

IN two preceding communications to the Academy, we have briefly described the nature of the artesian water of Oued Rir', a large oasis situated to the south of Biskra, and to which attention has been called by the remarkable borings of Mr. Jus and, more recently, by the colonization enterprises which this country has been the scene of in recent years.

We now propose to furnish a few complementary details upon the artesian basin of this region, on account of the interest, both scientific and practical, that attaches to an accurate knowledge of it.

Let us recall the fact that Oued Rir' is a valley that descends from the south to the north, and that along this valley there is a great reservoir of water at a mean depth of 230 feet beneath the surface. This subterranean sheet feeds a numerous series of spouting wells, whose total discharge is 1,050 gallons of water per second. It is recognized for a length of 98 miles, but its



ARTESIAN WELL WITH A DISCHARGE OF 830 GALLONS PER MINUTE.

width is limited as compared with its length. We have compared it to a sort of subterranean artery.

The instinct of the aborigines therefore does not wholly deceive them when, in their imaginative language, they speak of the "subterranean river" of Oued Rir', which according to them, runs from the south to the north. The word "river" well translates the idea of our elongated zone, of our liquid artery; but this word makes us think of a rapid flow, of a stream having an appreciable velocity. Now such is contrary to what is really the case, and, from this point of view, the word artery is not much better.

The subterranean water of Oued Rir' is evidently not stagnant, nor inclosed in a tight reservoir and having no motion, as this would be contrary to the ordinary laws of nature. It has a real and continuous flow between the springs that feed it and the points at which it emerges; but it is a question of a general flow of imperceptible velocity, save in the immediate vicinity of certain points of entrance and exit. This flow, moreover, takes place from the north to the south, and not *vice versa*; for the supply of the subterranean water of Oued Rir' and upper Sahara is derived from the north, as we have already explained, and this water comes for the most part from the Atlas mountains.

On the surface of Oued Rir', when heavy rains fall, water is seen to flow along the *thalweg* of the valley, and run toward the north. But care must be taken not to confound this line of superficial water with the subterranean deposit of Oued Rir'. These two aquiferous levels are entirely distinct, and a continuous mass of

valley, but is of the most capricious character. The artesian artery meanders under the impermeable covering of the superposed earth, and exhibits variations in width of from 2½ to 8½ miles, and sometimes divides in two, as in the region of Ourlana, where it forms an irregular X.

Finally, it would be inexact to imagine a river occupying a hollow channel limited by banks. The subterranean water infiltrates through a continuous mass of permeable sand. Laterally, the liquid zone is not isolated; it is situated in the midst of a network of aquiferous veins and secondary sheets in innumerable quantity. Now, just as the arteries carry the blood from the heart to all parts of the human body, just so the artesian zone of Oued Rir', continuously fed subterraneously, incessantly forces its surplus of water into the permeable portions of the surrounding earth, wherein it spreads and disperses, and whence it rises to the surface and finally evaporates.

This granted, it is easy to answer the question that has often been asked of us, viz.: In multiplying the borings in Oued Rir', are you not afraid of injuring the present wells and of exhausting the artesian basin? Although the spouting wells of Oued Rir' are the most apparent points of emergence of the water of the artesian basin, they are far from being the sole ones. In fact, the greater part of the water that flows subterraneously finds an outlet through the waste that occurs all around the artery, through lateral filtrations as well as leakages through defects in the covering. Let a bore hole be made, that is to say, let an outlet free from resistance be offered to the compressed water, and it is clear that it will change its course and flow, by a certain radius, toward such point. The entire volume of water that the wells of Oued Rir' are now discharging is so much the less lost through evaporation at the *chotts* or at the side. But, since what is still lost much exceeds what goes to the wells, and as the radius of action of each well is quite limited (½ to 1¼ mile, according to the region), it may be said that, in the present state, a new sounding made at a sufficient distance from the existing wells is effected not at their expense, but at the expense of the waste water—that is to say, it realizes a gain.

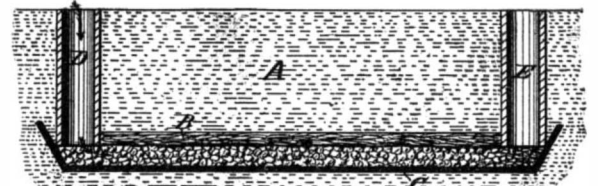
There will assuredly be a limit, for the artesian basin of Oued Rir' is not able, any more than any other, to furnish an indefinitely increasing discharge. When will such limit be reached? Experience alone will teach; but we believe that we are yet far from it, especially if future soundings be made by preference in regions where the artery has not yet been tapped, and if the French colonists persevere in this way (which is our own) of creating new oases outside of the old ones and even far from them.

However this may be, it is certain that it will be well, before all, not to jeopardize what has been acquired, and that the present absence of all control in what concerns the borings in Oued Rir' is not without danger. After this, then, it would be expedient to take the necessary measures to protect existing interests, while at the same time to let private initiative have its full swing; and, to conciliate all, the simplest way would be to form a sort of syndicate of the landholders of the country in which the government, the inhabitants of the oasis, and the French colonization societies would have representatives, and which would play the part of a committee of surveillance over the borings in Oued Rir'.—*Le Genie Civil*.

#### SUB-IRRIGATION.

By H. C. HOVEY.

CONSIDERING the importance of artificial watering of gardens and farms, especially in hot and dry regions, every new idea will be welcomed on the subject. Several different methods of irrigation are advocated by agriculturists. A very ancient method is that of flooding level fields and retaining the water for a time over them, until it has deposited the mud held in suspension and saturated the soil with moisture. Another plan has been to apply currents of water by means of conductors and drains, either catching the surplus so as to be used over and over again, or letting it flow down on some lower meadow to be utilized there. Still another method has been that of upward irrigation, by which the water that would otherwise be carried off by drainage is forced up through the soil. This has been adopted quite extensively in Germany; the plan being to lay earthenware pipes intersected by vertical shafts in which are slits through which the water rises to be distributed through the soil. The English method is by ditches from which the water flows by conduits built at right angles, being gently backed up by stop-



ping the mouths of the main drains, and the excess being removed by sluices.

Most treatises that I have noticed on the subject deal with the question on a large scale, as applicable to extensive regions, or at least to considerable tracts of land. The demand for some practical method for small gardens has been successfully met by the experiments recently made by Mr. Clark Marsh, formerly of Bridgeport, Conn., but now of Silver Beach, Florida. The results, as detailed by the *Florida Agriculturist*, are extraordinary. It is claimed that ten times as much may be raised on a given space by this means as could be had without it.

The plan recommended for sub-irrigation, on Marsh's method, is to lay off the garden in beds five feet wide and of any length desirable. The soil is then removed to the depth of two feet or more, according to circumstances. The sides are sloped inward toward the bottom of this trench. The bottom of the bed must be made perfectly level, so that the whole contents may be equally moistened. A cheap way of leveling is by a wooden square with a plumb bob hung as a pendulum. The bottom should then be thoroughly tramped down, and covered by Portland cement three quarters of an inch thick, the whole basin being thus



THE MEHARA, OR RACING CAMEL.

mehara is a swift riding animal, and one that has bottom, and that it might render very great services if used in the army of Africa, and if a corps of mehara scouts were organized, for, in addition to its speed and bottom, the animal easily walks in sand in which horses could not move forward; and, moreover, it can do without drink for seven or eight days.—F. Foureaux.

marly and impermeable earth, 210 ft. thick, separates them. Nothing is more false, then, than the widespread idea that the subterranean river under consideration represents an ancient water course—the old Igharghar—that has disappeared beneath the sand and continued to flow at a depth.

Moreover, the course of the subterranean water of Oued Rir' is not by far so simple as that of a river in a

made water tight. When the cement is seasoned, it should be covered by a layer of shells, or pebbles, or brickbats, to the depth of three inches. A six inch pipe may now be placed at each end of the bed, into one of which the water supply will go, while through the other it can be seen whether the water works freely through the bed. The shells should be covered with two inches of straw, leaves, or other mulch; and the rim of the cement basin should rise an inch or so above this layer. Finally, replace the soil, enriched by whatever fertilizers may be required, and level the bed off for planting. The soil will act like a sponge, absorbing the water from below by capillary attraction, and distributing it uniformly and constantly so as to keep the entire bed properly moistened.

A quarter-inch supply pipe will suffice for a bed 5x50 feet in size. In cities the water may be had from the usual system of supply. In country, from tanks or streams or artesian wells. Even if the water has to be obtained by pails from cisterns or wells, it will pay to use this method. One advantage is that no fertilizing material is lost, but remains in the soil till it is used by the plants growing in it. Another is that the supply of water can easily be regulated so as never to be in excess of what may be needed; thus obviating the objection usually made to stagnant water as compared with a running stream.

Obviously, this system is better adapted for a southern climate than a northern, where the winter's frost would make havoc of the cement bed, unless carefully guarded against. Mr. Marsh's beds, which have now been in use for three years, surprise every visitor with their rich abundance of vegetable life. The methods might easily be modified so as to be practicable in greenhouses and conservatories, where they would involve less labor than the usual methods of sprinkling, besides securing a more uniform moisture.

#### SIMPLE METHODS OF FINDING THE AXIS OF A PRISM.

By WARD A. HOLDEN, A.B., M.D., Cincinnati, O.

It is often desirable when prisms have been prescribed to find whether the optician has placed them in the frames with the axis at the proper angle, and there is often doubt as to the correctness of the axis mark on test case prisms. It is not surprising that the optician marks prisms incorrectly, when we see the rough methods of finding the axis that he uses. Some opticians place a prism in the angle of a hinged rule, so that one leg of the rule touches each surface of the prism, and then turn the prism to the point where it spreads the legs of the rule furthest apart, and here mark the axis along the edge of the rule. And they regard as satisfactory such rough tests as this.

It is proposed here to glance over some simple practical methods of finding the axis of a prism.

I. A prism when looked through produces a false image displaced in the direction of the summit of the prism. If, both eyes being open, a prism is held before one eye, two images are seen, one true and one displaced, and a line between similar points in the two images corresponds to the axis of the prism. When a line is observed and the prism is rotated, at some point the true and false images of the line become fused at their near ends and continuous. The false image here is displaced, but it is displaced exactly in the direction of the line, so the line is not broken, and this line corresponds to the axis of the prism. A card may be placed half way across the prism, so that its edge coincides with the line observed, and along this edge the axis of the prism may be marked.

This test is more satisfactory if the test line is vertical, and the observer should have no insufficiency of the recti muscles. It works well with strong prisms, but for weaker prisms other tests are better.

II. If a line is observed with one eye closed while a prism is held a few inches in front of the other, a displaced image of part of the line will be seen through the prism, while a true image of part of the line will be seen outside of the prism. When the prism is rotated, the two images of the line become continuous. At this point the line corresponds to the axis of the prism. A card may be placed partly over the prism as before, so that its edge coincides with the unbroken line, and the axis may be marked from the edge.

This test is very accurate, and can be used on the weakest prism.

III. If a person having one eye closed looks through a prism with the other, he sees a *strong* image displaced in a direction toward the summit of the prism. This image is formed by rays coming directly through the prism. If the object observed is luminous, a secondary *faint* image will be seen displaced more than the strong primary one, but displaced in the same direction. This image is formed by rays which are twice reflected within the prism before emerging from it. These rays pass through the prism, and, striking the surface next the eye, they are reflected back to the other surface. This in its turn reflects the rays, and they, passing a third time through the prism, emerge from it. The direction of the rays is changed by this double internal reflection, so that when they emerge they are turned further toward the base of the prism than those which pass directly through, and the projected image appears nearer the summit. A line between similar points in the two images here also corresponds to the axis of the prism.

This faint secondary image is often, by the way, a source of confusion to both patient and oculist in tests with prisms. It can be cut off by covering the prism with a card having a small hole in it, through which the direct rays alone can pass.

IV. If a prism is held so that rays of light pass through it and fall on a screen, the rays are deflected, and instead of falling on the screen directly behind the prism, they fall to one side.

Behind the prism where no rays fall, the screen shows a dark patch in the position in which the shadow would be if the prism were opaque. At one side where the deflected rays fall, there are double the number of rays and a patch appears here lighter than the rest of the screen. When the prism is held near the screen, the light and dark patches are overlapped, and appear small and near each other.

But when the prism is removed some distance, if the rays are coming parallel, the two patches will each be the size of the prism and a distance apart, and this distance increases as the prism is removed from the screen.

The deflection is toward the base of the prism and in the line of its axis. A line then connecting similar points in the patches is the line of axis of the prism, *e. g.*, if the prism is rotated until the two patches become tangent to a horizontal line on the screen, then the axis of the prism is horizontal.

V. When a prism is held before the eye, a double reflection of objects behind the observer may be seen. Each surface of the prism reflects rays which form an image. From the surface near the eye the rays are reflected back directly. The rays reflected from the further surface pass through the prism twice and their direction is changed. Thus two images are formed which appear some distance apart. The distance between them increases as the object or prism is removed from the eye, and increases with the strength of the prism. Corresponding points in the two images are in the line of axis of the prism.

This is one of the simplest and most accurate methods of finding the axis of a prism. To perform it easily, a person may stand with his back to a window, after selecting a cross bar of the window frame that is of the height of the eye. Then the prism may be held before the eye on a level with it, and in a plane parallel to the plane of the window, and two images of the horizontal bar are seen. As the prism is rotated, the two images fuse at the ends and form a single line. If the prism is not held properly the line will be bent. But when the prism is held at the height of the eye and window bar, and held with one surface in a plane parallel to the window, the two images fusing form a single straight line, and the line corresponds to the axis of the prism, which may be marked from the edge of a card, as in the other tests.

VI. When two prisms of equal strength are placed together with bases in opposite directions, the external surfaces of the combination are parallel, and the combination has simply the effect of a plain glass.

To find the axis of a prism whose degree is known, a prism of the same degree (or a combination equal to it) having a correctly marked axis, may be placed with base in the opposite direction against it, and this combination held before the eye. A line is then observed while the prisms are rotated. If the image of the line seen through the prisms does not move, and is always continuous with the image of the line seen outside the prisms, the axes of the two correspond. If there is some movement of the image when the prisms are rotated, or if the line does not appear always continuous, one prism may be turned on the other and the test repeated until the line appears always continuous, and is not altered by the rotation. Then the axes of the two correspond, and from the correctly marked prism the other may be marked.

Some of these tests may often be found useful. And if oculists were to check the axis marks, they would be surprised to see how few prisms except those made by the most reliable houses really have them correct.—*Amer. Jour. Ophthalmology.*

In this week's issue the interesting articles "Paving in Regular Polygons," "Practical Electricity," "Electric Welding of Metals," "Experiments with Kites," "The Racing Camel," are from *La Nature*.

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