armature weighs ten tons, the armature core six tons, the side castings eight tons, the copper in the magnets two tons, and in the armature 1,320 pounds. If a short circuit should occur in the works, the armature will be subjected to an action like that of a brake, but it will not have the bad effect which would be produced if the armature did not itself constitute the fly wheel. There are, as will be observed, only two bearings, one on each side of the machine. The two sets of cables are connected in parallel at the switch board, where the requisite instruments are fitted up, so that the pressure in either half of the machine or in the shops can be noted. and suitable cut-outs are fixed.

Lighting is effected by 116 arc lamps, two in series, using 10 amperes, and by 200 16 candle power incandescent lamps. The current for the latter is taken from a ring main supplied by 24 feeders, and the total loss of pressure is 7 volts when all the lamps are lighted at once. The ring and feeders are of bare wire, except in cable tunnel. All the motors are of the Gramme type, with two windings. The base plate and the top yokes are attached together in casting to allow of boring the interior easily, and the magnet cores are cylinders of wrought iron shunt-wound. Carbon brushes are used on the motors, and have so far given no trouble. The electrician would not be able to occupy his time were it not that he has also to attend to the arc lamps and replace their carbons.

The following is a list of the motors used throughout the works, or rather the list of those which were ordered at first:

Situation.	Horse power.	No. of motors.	Guaranteed efficiency.
Mainshop	16	9	87 per cent.
Wood-working department.	21	1	87 "
Forge	37	2	89 "
Stamping and drawing shop.	16	1	87 "
" " "	7	1	84 "
Feed pump	10	1	85 "
Fans	3	1	80 "

The average efficiency can, of course, be obtained by multiplying the number of motors by their respective efficiencies. Taking this sum and dividing by the total number of motors, this gives 87·2 per cent.

Eventually the 7 horse power motor was countermanded, and a 16 horse power motor put down for the polishing shop and one of 21 horse power for the cartridge shop. On some of these motors the load is very variable, and several are exposed to dust and dirt, so that with 90 per cent efficiency of the dynamos, 98 per cent of the conductors, 87 per cent of the motors, the net result is 76·6 per cent power delivered. As the lost work in belt driving is practically a constant quantity for all loads, or at least is usually, considered to be, the power required to turn the shafting, pulleys, etc., at the normal speed when no work is being done on the machines, it follows that taking 79·4 per cent as the final output in two cases, one of electrical and the other of mechanical transmission, we find that at a load of 20 per cent the electrical system would still give 47·2 per cent useful effect and the mechanical nothing at all. From careful experiments which have been made in actual practice, it has been clearly proved that to drive all the machines idle needs more power than to drive the shops in the ordinary course of work; whereas 11 electrical horse power is required when driving all the tools idle, only about 7 electrical horse power is needed in ordinary work, of which 4 electrical horse power is used to drive the shafts, belts, etc., alone; this clearly shows how small a part of the power produced by the engine is actually used in useful work at the tools.

Such satisfactory results of the application of electricity to factory driving must attract attention and will doubtless lead to great changes in transmission, both in this country and on the Continent. Whether in the case of large machine tools it would not be better to discard shafting and belts altogether, and supply a special motor to each tool, is a question which must be settled for each individual case which may arise; the current could be switched on or off just as easily as the belt is now thrown from the loose to the fast pulley, and *vice versa*.

We give an engraving from a photograph of the engine, which was built by the Société Anonyme des Anciens Ateliers de Construction Van den Kerchove, of Ghent, and erected by them.

It is designed to develop 450 horse power, but gives without difficulty 530. The high pressure cylinder is 19 inches in diameter, the low pressure 32 inches and the stroke 5 feet. The number of revolutions is 66 per minute, with a pressure of 90 pounds. The dynamo, as will be seen, is placed between the high and low pressure engines, the armature being sufficiently heavy to dispense with a fly wheel.

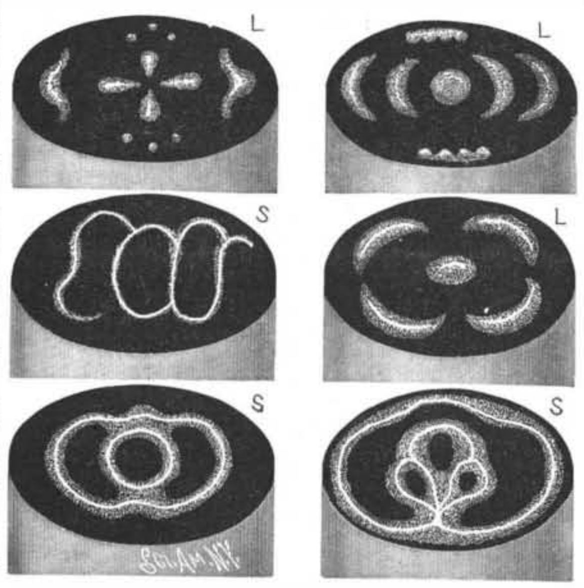
The Compagnie Internationale d'Electricité, of Liege, have put in the electric plant with complete success. The regularity in running of the engine is all that can be desired, the governor keeping it under perfect control. Running light the engine indicates 28 horse power and loaded 530 horse power, which gives an efficiency of 94·7 per cent. The consumption is about 13·25 pounds of water per horse power per hour. We are indebted to the *Engineer* for our illustrations and the foregoing particulars.

DUST AND SAND FIGURES ON MEMBRANES.

T. O'CONOR SLOANE, PH.D.

Some attention has recently been excited by what are known as dust figures produced on the surfaces of vibrating membranes. They are virtually Chladni figures, and the membrane on which they are produced can be made to give good results with sand and lycopodium. Of course, the outlining of loops and nodes on vibrating membranes is old, but by substituting for the violin bow usually employed a more active system of obtaining vibrations, very curious and interesting results have been obtained.

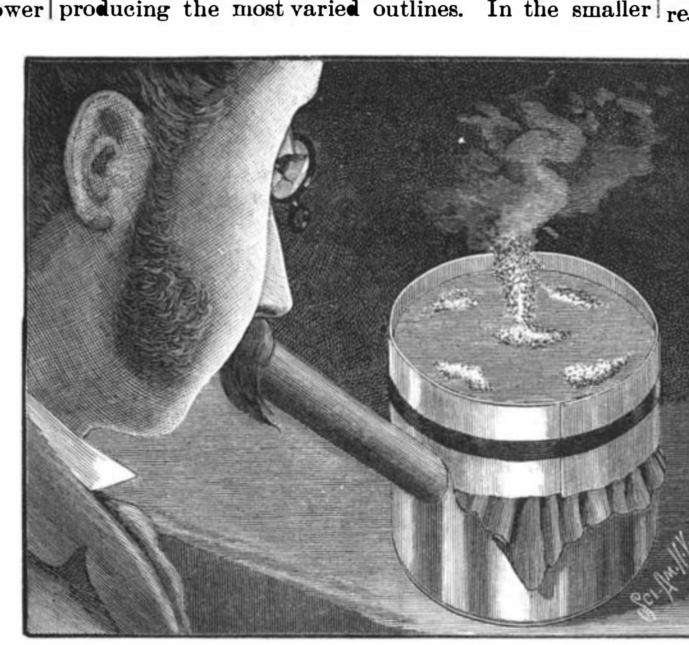
In the cut we illustrate an exceedingly simple apparatus for this purpose. Over the top of a cylindrical box a sheet of very thin India rubber is stretched, and



APPARATUS FOR PRODUCING LOOPS AND NODES ON A MEMBRANE.

held in place by a rubber band. Around the edge is a band of paper, projecting about half an inch above the surface of the rubber so as to form a species of fence or wall. A hole in the side of the box admits a tube. If, now, a note is sung into the tube, the India rubber is thrown into vibration with a production of loops and nodes whose position varies with the note produced. An endless variety of figures can thus be formed.

Lycopodium gives perhaps the most effective results. When the experimenter sings strongly into the tube, if the lycopodium has been scattered over the sheet, it begins to gather itself into most peculiar shapes; sometimes little circular heaps of it form which are maintained in perpetual agitation, the loops and nodes producing the most varied outlines. In the smaller cuts, the three diagrams marked L represent lycopodium diagrams.



DUST AND SAND FIGURES PRODUCED ON A VIBRATING MEMBRANE.

A great point in producing the figures is to cease the note suddenly and without changing its pitch. One is very apt with cessation of sound to change the pitch and produce confusion. If, while the lycopodium is on the sheet rubber, the intensity of the sound is increased, some of the lycopodium is thrown in the air, and if the sound is made strong enough, a perfect cloud of the dust is maintained, sharply localized over the points of agitation, representing the Chladni figures in a very beautiful and interesting manner.

With sand, three of whose figures are shown in the small cuts under the letter S, the results produced are less impressive, perhaps. At any rate, in precision of outline they do not, as a rule, compare with those given by brass or glass Chladni plates. Like the lycopodium figures, they give results which surpass those of solid plates in complexity and in the prevalence of curved outlines. The usual types of Chladni figures can hardly be obtained.

For the box, any tin or pasteboard box can be used. The rubber should be very light, and for even figures should be evenly stretched, but by stretching it with different tension in different directions the figures can be considerably modified. The appliances are all so simple that the experiment can be recommended as really a very interesting one.

One experimenter is said to have produced fixed relief maps of the curves by the use of plaster of Paris. In such cases the note must be uniform and must be maintained until the plaster sets hard.

In old violins dust balls are sometimes found. The experiments described give the clew to their formation. The vibrating wood of the violin acts to gather the dust into balls. The same action can be seen in the lycopodium on the vibrating membrane.

THE NEW STEEL STEAMER EL RIO.

This new American steamer, built of steel by the Newport News Ship Building and Dry Dock Company, recently made her trial trip in this harbor, when she attained a speed of 17 knots per hour. The vessel has taken her place on the line between New York and New Orleans.

El Rio is a freight vessel of 4,500 tons register and of the following general dimensions:

Length between stem and after side of propeller post, 380 feet; breadth of beam moulded, 48; depth from top of keel to top of upper deck beams of lowest part of sheer, 33·9; length over all, 406.

She has three decks and a partial orlop deck at fore-end of forehold. On the awning deck are steel houses. She is rigged with two steel pole masts and the necessary booms for handling cargo, together with steam hoisting engines located at the different hatches, to work in connection with them. Freight hatches and ports are located so as to handle cargo expeditiously.

The vessel is steered by steam from the forward pilot house or by screw hand gear from the after house.

A steam windlass and steam capstans are provided for handling anchors, hawsers, etc., as well as a steel rope with drum aft for towing.

She is propelled by a vertical triple expansion engine with three cranks, placed at angles of 120°. The cylinders are 32, 52, and 84 inches diameter by 54 inches stroke of piston, working under 167 lb. of steam, which is generated in three double-ended cylindrical steam boilers with three corrugated furnaces at each end. There are two fire rooms and one smokestack.

The vessel is lighted throughout by electricity.

The Newport News Ship Building and Dry Dock Company, at Newport News, Va., is one of the largest and most fully equipped ship building establishments. Several fine vessels of steel have already been constructed, and others are in progress. Among them are El Sud and El Norte, two splendid steamers, each of about 4,500 tons. Another, El Cid, is on the ways, same dimensions as El Rio.

Some idea of the extent of the works of this company may be had from the following:

The ship yard contains 75 acres of land; frontage on the water, 2,600 feet; buildings cover 7 acres.

Dimensions of Dry Dock.—Length on top, 600 feet; width on top, 130; width on bottom, 50; width at entrance, 93; draught of water over sill, 25; time required for pumping water out of dock, 1 hour and 30 minutes.

Dimensions of Buildings.—Office building, 3 stories, brick, 40 × 200 feet; pattern and joiner shop, 3 stories, brick, 60 × 300; machine shop, iron and brick, 100 × 300; boiler shop, iron and brick, 100 × 300; blacksmith shop, 100 × 300; bending shed, iron and brick, 60 × 127; framing shed, frame, 344 × 270; ship fitters' shop, iron and brick, 60 × 320; ship blacksmith shop frame, 120 × 208; pipe fitters' shop, frame, 50 × 208; power house, brick, 40 × 130; lumber shed, 2 stories, frame, 40 × 300; pump house, brick, 43 × 60; paint shop, brick, 50 × 160; fitting-up shop, brick, 50 × 175; stable, 2 stories, brick, 40 × 60; timekeeper's house, frame, 50 × 40.

Piers.—No. 1, 60 × 900 feet; No. 2, 60 × 350; No. 3, 80 × 350; No. 4, 60 × 550; outfitting basin, 900 × 500.

Ship Ways.—Nos. 1 and 2, each 400 feet long; Nos. 3 and 4, each 450: Nos. 5, 6, 7, and 8, each 650.

The various shops are fitted with machinery of the latest pattern, and are capable of handling the largest work known in ship building.

The machine and boiler shops are supplied with power-traveling cranes of 50 tons capacity, and the appliances throughout the yard for handling material are of novel design, enabling work to be done with dispatch and in an economical manner.