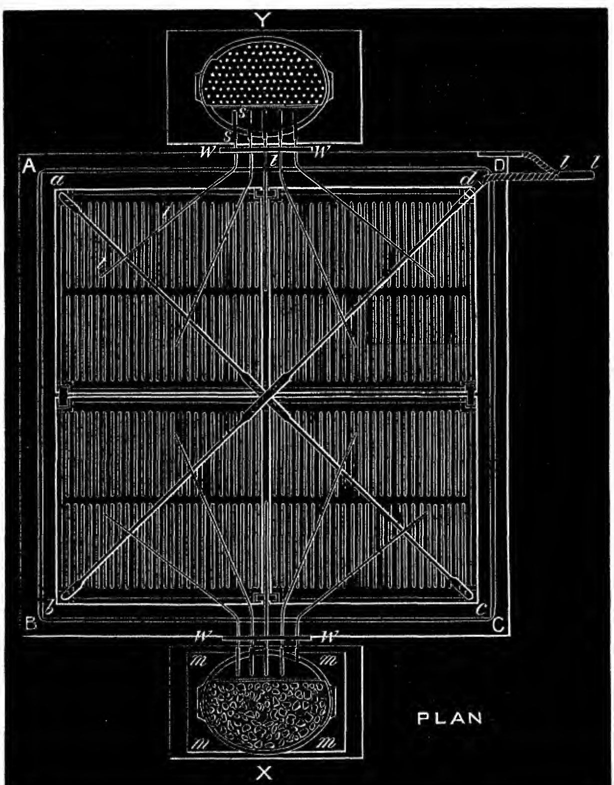
the central image are not comparable, and one of us has a Rutherfurd grating in which the infra-red rays in the 1st order are absent after λ9000. In conclusion we may say that the radiation apparently varies as to mq^T, where m and q are constants and T the temperature.

XV. "On a Gravity Daniell's Cell of very small Internal Resistance." By J. T. Bottomley. Communicated by Professor Sir William Thomson, F.R.S. Received May 29, 1884.

I beg leave to describe a new arrangement of gravity Daniell's cell which I have found manageable and convenient for supplying

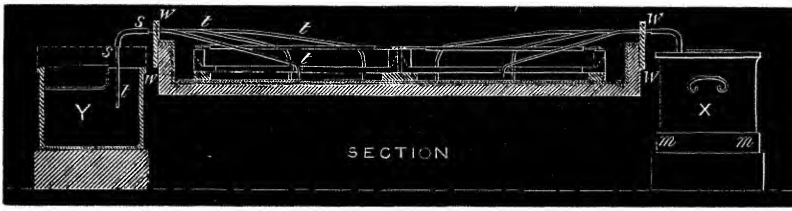
Fig. 1.



continuously and steadily a very powerful current of electricity. It has proved of great service for graduating ampere-meters and for such purposes.

Fig. 1 shows the cell in plan, and fig. 2 the same in section. The outer containing vessel is a large shallow tray of wood, very strong, but quite roughly made, and lined with sheet lead. The tray is

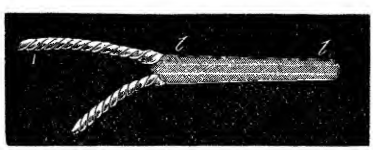
Fig. 2.



$3\frac{3}{4}$ inches deep, and with this small depth the lead can be beaten in, and autogenous soldering is unnecessary. The lead tray is very carefully varnished with spirit varnish, several coats being applied; and on the bottom of it is laid a thin sheet of copper (0·2 millim. thick), or rather several sheets thoroughly connected together, as I have not been able to obtain a single sheet of copper large enough for my purpose. The copper sheet, varnished on the lower side, is attached in many places to the lead lining of the trough by soldered slips of copper, the solderings being thoroughly coated with varnish or marine glue. This copper sheet forms the copper plate of the Daniell's cell.

The zinc of the cell consists of four of an unusually large size (56 centims., 22 inches square) of the gridiron zincs used in Sir William Thomson's well-known tray Daniell, which is largely employed at most of the submarine telegraph stations in connexion with the Siphon Recorder, and is a modification of the constant Daniell's battery described "Proc. Roy. Soc.," 1871, p. 253. These gridiron zincs rest on small blocks of wood at the four corners of each, and they are connected together by strong copper slips at the corners, and by means of two diagonals of thick copper rod which are soldered at the outlying corners and at the four meeting corners in the middle of the square.

Fig 3.



Very powerful pairs of electrodes are soldered on at each of the four corners of the cell, though only one of these pairs is shown in the diagram at D. These electrodes are formed of flexible copper rope, terminated with two thick slips of copper which are fastened together mechanically, but electrically insulated, and form the flat duck's-bill shaped piece *ll*, shown in section, fig. 3. The electrodes of any instrument which is to be connected with the cell may be also terminated with two copper slips, which are pushed on *over* the piece *ll* and held on by india-rubber bands.

The mode of supplying the cell with sulphate of copper still remains to be described, and it is this which constitutes its most important peculiarity. The liquid contained ordinarily in the tray Daniells is somewhat dilute solution of sulphate of zinc (sp. gr. 1·12 to 1·14), the lowest layer of which is saturated with sulphate of copper. The sulphate of zinc solution is kept at the proper density by occasionally drawing off quantities of strong liquor and replacing by pure water, testing by a hydrometer or with specific gravity beads. The sulphate of copper is supplied by dropping a proper quantity of blue vitriol in crystals into the cell round the edges. This is sufficiently easy when the cells are of moderate dimensions, and where a large number of them is being constantly used and regularly attended to in a business-like way, as at a telegraph station. When, however, the size of the tray is very large, and when the cell is being used intermittently, this simple method becomes difficult and unsatisfactory; and, owing to want of uniformity of the solutions, the cell is rarely obtained in such a condition as to be ready to give the results which ought to be expected from it. The copper sulphate supplied in crystals does not dissolve sufficiently quickly and spread itself over the whole surface of the lower plate, and difficulties arise as to the dilution of the sulphate of zinc without stirring up from the bottom remnants of unused sulphate of copper.

To avoid these troubles, and to make the starting and stopping of the action of the cell easy and rapid, I have arranged to supply the sulphate of copper in the state of solution, and to deliver and to remove it very gently but very quickly, and also simultaneously, at many parts of the bottom of the cell.

X and Y are two earthenware tubs placed one on either side of the cell; and it should here be remarked that the cell is raised up from the floor on common building bricks. From these vessels a number of siphons or delivering tubes, *t*, *t*, *t*, of which ten* are shown in the diagram, proceed to different parts of the cell. The tubes are of thin glass, except the bend *ss*, which is of flexible india-rubber tubing, and enables the extremities to be taken with ease out of the vessels X and Y for clearance or for starting of the siphons. The tubes are held in position by passing through holes in the boards *w*, *w*, and the glass portions are bent in a gas flame to the proper shape for

* I have recently doubled the number with great advantage.

delivering to the various parts of the bottom of the cell. The vessels X and Y are furnished each of them with a shelf of thin sheet copper perforated with many holes, the level of the shelf being considerably above the level of the extremities of the siphon tubes. On these shelves a large quantity of sulphate of copper in crystals is placed.

To raise the vessels X and Y up, and cause the siphons to run, two boards are provided which are pushed in beneath the vessels. One of these, *mm*, is shown beneath the vessel X in the figures. The boards are made of exactly the proper thickness to cause a layer of chosen depth to be run into the cell out of the vessels, or out of the cell into the vessels, according as the vessels are raised up on the boards or are lowered down when the boards are removed. The thickness of the boards depends, of course, on the relative sectional areas of the two vessels and of the cell. The depth of the layer which is spread over the bottom of the cell should be not more than one-eighth of an inch. The bottom of the cell must be very carefully levelled in order that the layer of charged liquor may be uniformly distributed, and that the half-spent liquor may be uniformly drawn off.

In setting up the cell in the first instance I commence with the cell charged with weak solution of sulphate of zinc (sp. gr. 1·12), while the vessels X and Y are charged with nearly saturated sulphate of zinc solution. This liquor is still able to take up a very large quantity of sulphate of copper; and water saturated with both sulphate of zinc and sulphate of copper is much more dense than saturated solution of either salt alone. When the cell is to be started the two reservoirs are raised into position. The thin layer of dense liquor spreads itself over the bottom in a few minutes, and the cell is ready for use. When the use of the cell is to cease the reservoirs are lowered down, and nearly the whole of the dense liquor runs back into them. This should always be done at night, or during any considerable time when the cell is to be out of use.

During the action of the cell sulphate of zinc is constantly being formed, and it is necessary frequently to run off a portion of the contents of the cell and fill up with pure water. I have planned for a system of tubes (arranged similarly to those just described) for siphoning off into independent vessels, and with a cell of very great dimensions, such as I am now constructing, they will probably be necessary. With the cell which I have been using for nine months, however, I have been able to dispense with them.

It only remains for me to give the dimensions of the cell now in use, and of a new one in process of construction. The tray of the former is 47 inches square inside measurement, and $3\frac{3}{4}$ inches deep. The zincs are each 22 inches square, and are raised up $\frac{3}{4}$ inch from the bottom. The copper sheet is about 0·2 of a millim., or 0·008 inch thick. It is probable that it would be better a little thicker. With this cell I can command about 45 amperes for hours together at any time, only requiring to take, now and then, a fresh supply of sulphate of copper from the reservoirs. The new cell which is in process of construction is 69 inches long by 46 inches, and $3\frac{3}{4}$ inches deep. It has four reservoirs, and six zincs placed in two rows of three each.

Received June 19.

P.S.—In the foregoing paper, I have described the construction and capability of a cell, whose dimensions are given, constructed about the beginning of July, 1883. It was found necessary, almost whilst I was writing, to take the cell to pieces, as it had become blocked up with copper deposited in the natural course of nine months' working. In putting the cell together again, with attention to *small particulars*, which I shall not describe as they will naturally occur to anyone who desires to use the arrangement, but which, I need scarcely remark, make, with such great currents, all the difference between success and non-success, I have obtained, through a current galvanometer of which the resistance is $\frac{1}{500}$ of an ohm, a current of 63 amperes, which was quite steady.

J. T. BOTTOMLEY.

June 16th, 1884.

XVI. "On the Permanent Temperature of Conductors through which an Electric Current is passing, and on Surface Conductivity, or Emissivity." By J. T. BOTTOMLEY. With a Note by Sir WILLIAM THOMSON, F.R.S. Received June 17, 1884.

(Preliminary paper.)

The experiments of which an account is given in the following paper were commenced several months ago in connexion with a theoretical investigation by Sir William Thomson, "On the Effect of Clothing," showing the dependence of the effect on the relation between the dimensions of the covered body, and the dimensions and physical properties of the covering. A primary object of the experiments was the determination, for practical purposes, of the temperature of electric light conductors. The preliminary experiments have led to results which seem to be of considerable importance, and they point to the necessity for a fresh determination of the "emissivity"

FIG. 1.

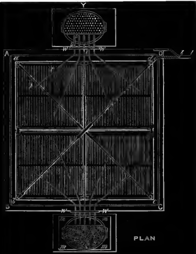


FIG. 2.

FIG 3.