Royal Institution of Great Britain.

WEEKLY EVENING MEETING,

Friday, March 24, 1905.

SIR WILLIAM CROOKES, D.Sc. F.R.S., Honorary Secretary and Vice-President, in the Chair.

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A Pertinacious Current; or, the Storage of High-tension Electricity by means of Valves.

IT is well known to physicists and engineers that currents of electricity can be of three principal varieties. The first and oldest variety is a continuous or steady current, of constant strength in one direction, like a river. By such a current a great quantity of electricity can be conveyed from place to place, though under conditions that it is easily stopped by any trivial obstacle, either an accidental bad joint or a purposed switch or interrupter—which is a familiar arrangement for introducing into the stream an air-gap or other narrow non-conducting obstruction, and thereby completely stopping the flow, save at the first moment of attempted stoppage, when the impetus or momentum of the current succeeds for an instant in bursting through the obstacle, with spark and flame.

The second variety is an intermittent or jerky current; which is analogous to the supply of water by an ordinary intermittent pump, such as a fire-engine or a garden-engine without its air-chamber, from whose nozzle the water issues in jerks, unless there is some elastic reservoir or chamber of variable capacity in which it can be stored under pressure, and out of which it can emerge with fair regularity.

The third variety is the important case of the well-known "alternating current"; wherein there is no progression of electricity at all, but simply a surging or oscillation to and fro, maintained by a rapidly reversed force of propulsion, such as is seldom applied to liquids; though it is applied to solids in many forms of reciprocating machine, and in several other oscillating or vibratory examples, of which the best-known variety is concerned with musical instruments. An alternating current of liquid, however, occurs in Nature, on a large and slow scale, in the tides; and it may be set up on a small scale in a churn.

An alternating electric current is characteristically produced by nearly all the magnetic methods of exciting a current discovered by Faraday, i.e. by those methods which generate a current by means of a combination of magnetism and motion, as exemplified in the ordinary dynamo. It is true that these currents can be rectified, and so transmitted in one direction over a portion of the circuit, by means of some kind of commutator; but such an arrangement never operates over the *whole* of the circuit; there is nearly always one part of the circuit, and that the generating part, where the quantity of electricity oscillates equally to and fro. The so-called "unipolar" machines are an exception. It is, however, possible to interpose something in the path of an alternating current so as to prevent the passage one way and permit it the other, that is to say, to introduce into the circuit a one-sided kind of conductivity, such as is possessed by a trap or valve, which permits ingress but prevents egress—a kind of gate, such as is sometimes used for public gardens or parks, whereby people can go out but not come in. Or like a mouse-trap, which lets creatures in but will not let them out.

If such an arrangement exists in an alternating-current circuit, it changes the current into an intermittent or jerky one, with the progress either wholly in one direction or more in one direction than in the opposite. Such an arrangement may be conveniently called an electrical *valve* or *trap*. By the use of such valves I have found it possible to store up electricity, supplied by intermittent jerks, in a reservoir, until the tension is raised to a high value; and it can then be allowed to leak or overflow in a constant continuous stream or trickle, which, though not transmitting a very large quantity of electricity, can nevertheless overcome very considerable obstacles, pertinaciously flowing in spite of opposition, like a stream down a steep hillside. This is what I call for the moment a pertinacious current. It could always be produced by means of an electrostatic machine—either the old-fashioned frictional machine, or a Holtz or Wimshurst inductive machine—and about the pertinacity of such a current there was no dispute; but unless such machine were of enormous size, the quantity propelled was very small, and the current was essentially a weak one. Moreover the generating machine was necessarily of a delicate laboratory description, such as could hardly be regarded as appropriate for engineering practice on a large scale.

It has been always theoretically possible also to produce a high-tension or pertinacious current by means of a voltaic battery of an enormous number of cells; and by some experimenters, such as De la Rue and others, a battery of this kind was actually employed. In the case of a voltaic battery the quantity put in motion is considerable, but the difficulty was to raise the propelling force to the required amount—usually it is very weak; and in order to imitate such effects as are easily producible by a large Wimshurst machine, some considerable fraction of a million would be the number of cells necessary. The expense and trouble of such a battery would be prohibitory to most people, and to most undertakings; especially since the cells have but a temporary and rather brief life.

By the use of electric valves, however, I find it possible to employ

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a current generated by mechanical and magnetic means, to convert it into an intermittent current at very high pressure, and then to store the quantity thus propelled, in reservoirs supplied with valves which prevent the flow back; so that the whole quantity transmitted in successive impulses accumulates, until the reservoir becomes full and overfull, so that it overflows, giving a steady stream or trickle through great resistances, and maintaining the continuous high-tension current required. It is as if a reservoir were being charged by a water-ram, or by waves which splash up into it through a hole, the hole being provided with a valve whereby the water supplied is trapped and not allowed to flow back again each time in futile manner, but is kept stored and accumulated until the pressure has increased to an enormous extent: the process is, in fact, exactly like pumping air through a valve into a closed reservoir, by intermittent strokes of a pump, and then allowing the reservoir to leak through a small hole, as soon as the pressure has become sufficient.

On the plan customarily used for obtaining Leyden-jar sparks in spectrum analysis, etc., the jar is charged at every break of the coil, but the charge immediately subsides through the wire of the coil, and so the jar is perfectly empty in a minute fraction of a second after the discharging impulse; accordingly unless the overflow spark occurs instantaneously it will not occur at all. There is no accumulation of impulses, and only a short spark can be obtained. But when a valve is inserted, then the charges do not sink back through the generating coil, but accumulate, and the overflow spark length now may be very much greater.

The chief use to which I wished to apply this arrangement was to the dissipation of fog or smoke, or the deposition of metallic fume, and the principle of that application is shown by attaching to the jar a wire which leads to a point immersed in some fog or smoke in a bell jar or other vessel; and now, by a momentary excitation of the coil, the jar or reservoir is filled up to bursting-point with electricity, which at this high pressure continues to discharge or fizz from the point for some time, say ten seconds or thereabouts, by which time the fog has completely disappeared.

In order to fill a vessel with an atmosphere of fog or smoke, almost any plan serves; one way is to burn smouldering brown paper, but that is not at all a good plan, since the smoke is not dense, and being hot it hovers about at the top; another is to burn tobacco, which does better: in fact, very fairly well; another plan is to burn magnesium wire, which is a cleanly and good method, and the smoke being solid and white, it illustrates the process of dissipation very well; another is to make a chemical smoke by the use of hydrochloric acid and ammonia, or by burning sulphur in an ammonia atmosphere; indeed, there are plenty of plans known to chemists; but the method I prefer for the present purpose is to make artificially a mist or fog of water vapour. It may, for instance, be