showing that the thermal energy applied to the junction of the metal strips has been transformed into electrical energy.

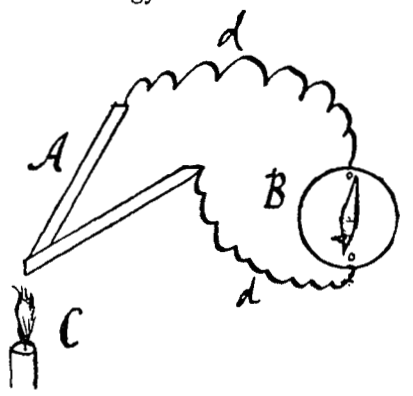

FIG. 3.

Fig. 3 represents diagrammatically a simple thermopile in action. *A* is the couple of dissimilar metals; *B* is the galvanometer showing a slight deflection of its needle; *C* is a gas or other flame engaged in warming the junction of the couple *A*; *d*, *d* are connecting wires.

This is the simplest form of thermopile. If we take a thermopile, composed of several such metallic couples properly arranged, we can ring electric bells, and have other proofs of the presence of electrical energy.

To re-transform electrical energy so obtained into its original form, we may by using a very powerful thermopile produce considerable heat. For instance, thermopiles have been used to light incandescent electric lamps, and if we attach the conducting wires of a suitably arranged thermopile to a cautère of an electro-cautery apparatus, it will become white hot and ready for use in the same way as if connected to its ordinary battery.

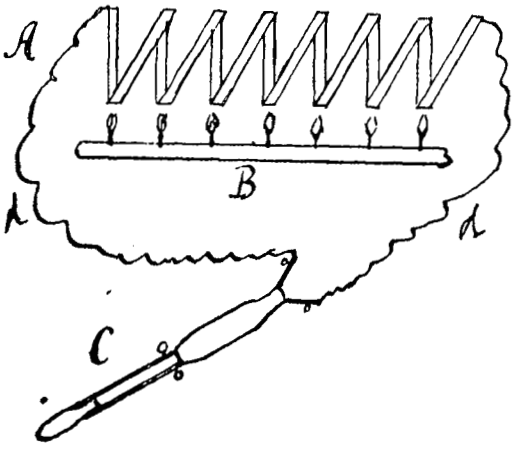

FIG. 4.

Fig. 4 represents diagrammatically the arrangement of apparatus for experimental proof of the thermal energy cycle. *A* is the thermopile of many couples; *B* is the heating apparatus; *C* is the electro-cautère; *d*, *d* are connecting wires.

Again we have completed our energy cycle. Thermal energy transformed into electrical energy, and this electrical energy re-transformed into thermal energy. Loss, however, takes place in the process as before.

Loss of Energy.

In speaking as we have done of the loss of energy we do not wish it to be understood that any energy can be really lost. It is rather dissipated as regards the immediate use we wish to make of it. The doctrine of the conservation of energy prohibits all idea of actual and permanent loss. When we speak, therefore, of loss of energy in its transformation from one form to another, we mean that we cannot so control the transformation that the entire change shall take place in the exact direction we desire, and that machinery and apparatus never give out in a form available for useful work all the energy put into them.

Electric Generators.

The transformation of energy into electrical energy is usually known as the generation of electricity, and the apparatus or machines by which the change is effected are called electric generators.

We have, therefore, referred to three classes of electric generators—(*a*) mechanical, (*b*) chemical, and (*c*) thermal.

Similarity of Electric Currents.

It is sometimes supposed that the electricity generated by the different kinds of generators is not the same, but this is an error. Exactly the same kind of work may be done by electricity generated mechanically as by that generated chemically or thermally, provided the generators are suitably constructed.

We cannot catch electricity to examine it and determine its colour, construction, and general appearance. We can only judge of it by its action, and so long as we find that electricity generated by either of the above-named classes of generators is capable of the same chemical, mechanical, thermal, and physiological action, we have no right to assume that the method of generation makes any difference in the character or quality of the electricity generated.

Wherever a current flow of electricity is set up two factors are necessarily present. These factors are electro-motive force and current-strength.

The physical similarity of electric currents, however generated, lies in the presence of these

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