an equal degree, as, for instance, when an astatic couple is to be made, a second pair of sliding bars may be provided, and placed at a distance corresponding to that between the two poles of the (horseshoe) magnet.—*Chem. Notizblatt.*

NOTE ON THE ABSORBING POWER OF VEGETABLE CHARCOAL.

BEING called upon as an expert before court to determine whether a certain sample of charcoal had at a certain time previous to the trial been soaked in water, Jaillard made a series of experiments to ascertain how long the quantity of a liquid absorbed by charcoal remained in the pores of the same. The sample in question, and another one obtained from the same kind of wood, but entirely dry, were exposed to the same degree of heat for the same length of time, when it was found that both samples had lost 9·8 per cent. of water. He then prepared new samples from one piece of wood, one of which he soaked in distilled water, the other remaining dry. Both were then exposed to the air for three days, and then kept at a temperture of 230° F. for some time. On weighing them, it was found that the amounts of water lost by them respectively were equal. Experiments with charcoal prepared from different woods gave the following results:

Wood of the	eucalyptus	lost	9·22	per cent.	of water.
"	" oleander	"	9·04	"	"
"	" orange	"	9·90	"	"
"	" olive	"	9·35	"	"
"	" button tree	"	9·10	"	"
"	" oak	"	9·20	"	"

It was also observed that the quantity of water contained in charcoal changes the hygroscopic condition of the atmosphere.—*Repert. de Pharm.*

INFLUENCE OF THE DIFFERENT COLORS OF THE SPECTRUM ON THE DEVELOPMENT OF ANIMALS.

By E. YUNG.

REFERRING to earlier researches on this subject, the author states that M. Beclard placed the eggs of *Musca carnaria* under glasses of different colors, and remarked that they were developed very unequally, those under the blue and violet ray being the most developed, and those under the green ray the least so. He arranges the rays, as regards the development of larvæ, in the following order: Violet, blue, red, yellow, white, green. The author has carried on for three years a series of observations on the eggs of the common and esculent frog, of the trout, and of *Lymnea stagnalis*. These eggs were placed in vessels plunged respectively into violet, blue, green, yellow, red, and white solutions, while one vessel was kept in a dark closet. Violet light accelerates the development in a remarkable manner, and is followed in this respect by the blue, the yellow, and the white. Red and green light appears injurious, as the author was not able to obtain the complete development of ova in these colors. Darkness did not hinder development, but retarded it, contrary to the results of Higginbottom and MacDonnell. The colors may be arranged in the following series of diminishing activity: Violet, blue, yellow, and white (which are nearly equal), darkness, red, and green. Tadpoles deprived of food died more rapidly of inanition under the violet and blue rays than under the others. The general mortality seemed lowest in white light.

THE government of Zurich has prohibited the use of all coloring matters containing compounds of lead, arsenic, copper, chrome, zinc, antimony, bismuth, and mercury for coloring and decorating esculents, wearing apparel, packages for chocolate, coffee, tea, chiccory, tobacco, etc., toys, covers, and cushions of children's carriages, carpets, curtains, window blinds, lamp screens, wafers, or earthenware table services. Poisonous organic matters, *e. g.*, gamboge, picric and picramic acids, and the aniline and phenol colors are not to be used in coloring confectionery, wines, liqueurs, and sirups.

GOLD and palladium are precipitated from their neutral solutions in a finely divided metallic state by a current of pure coal gas.

DYNAMO-ELECTRIC MACHINES.

By PROFS. EDWIN J. HOUSTON and ELIHU THOMSON.*

DURING the recent competitive trials made at the Franklin Institute as to the relative efficiency of some different forms of dynamo-electric machines, the authors, having been intrusted with the work of determining the relations between the mechanical power consumed and the electric and thermic effects produced, took the opportunity thus afforded to make a careful study of many interesting circumstances which influence the efficiency of these machines.

It is purposed in the present paper to select from the many circumstances thus noticed a few of the more interesting, reserving the others for future consideration.

It will readily be understood that, from the comparatively new field in which we have been working, no reliable data of the electrical work of these machines having before been obtained, difficulties constantly arose, owing to necessary conditions of operation, and new developments, as to the behavior of the machines under varied conditions, were constantly met.

A convenient arrangement of the particular circumstances we are about to discuss may be, 1st, those affecting the internal work of the machine; 2d, those affecting the external work; and 3d, the relations between the internal and external work.

The mechanical energy employed to give motion to a dynamo-electric machine is expended in two ways, viz., 1st, in overcoming friction and the resistance of the air; and 2d, in moving the armature of the machine through the magnetic field, the latter, of course, constituting solely the energy available for producing electrical current. The greatest amount of power expended in the first way was noticed to be about 17 per cent. of the total power employed. This expenditure was clearly traceable to the high speed required by the machine. The speed, therefore, required to properly operate a machine is an important factor in ascertaining its efficiency.

The above percentage of loss may not appear great, but when it is compared with the total work done in the arc, as heat, constituting as it did in this particular instance over 50 per cent. of the latter, and about 33 per cent. of the total work of the circuit, its influence is not to be disregarded. In another instance the work consumed as friction was equal to about 80 per cent. of that appearing in the arc as heat, while in the Gramme machine experimented with this percentage fell to 20 per cent. of that which appeared in the arc as heat, and was only about 7 per cent. of the total power consumed in driving the machine.

In regard to the second way in which mechanical energy is consumed, viz., in overcoming the resistance necessary to move the armature through the magnetic field, or, in other words, to produce electrical current, it must not be supposed that all this electrical work appears in the circuit of the machine, since a considerable portion is expended in producing what we term the local action of the machine, that is, local circuits in the conducting masses of metal, other than the wire, composing the machine.

The following instances of the relation between the actual work of the circuit, and that expended in local action, will show that this latter is in no wise to be neglected. In one instance an amount of power somewhat more than double the total work of the circuit was thus expended. In this instance also it constituted more than five times the total amount of power utilized in the arc for the production of light. In another instance it constituted less than one-third the total work of the circuit, and somewhat more than one-half the work in the arc.

Of course, work expended in local action is simply thrown away, since it adds only to the heating of the machine. And since the latter increases its electrical resistance, it is doubly injurious.

The local action of dynamo-electric machines is analogous to the local action of a battery, and is equally injurious in its effects upon the available current.

Again, in regard to the internal work of a machine, since all this is eventually reduced to heat in the machine, the temperature during running must continually rise, until the loss by radiation and convection into the surrounding air equal the production, and thus the machine will acquire a constant temperature. This temperature, however, will differ in different machines according to their construction and to the power expended in producing the internal work, being, of course, higher when the power expended in producing the internal work is proportionally high.

If, therefore, a machine during running acquires a high temperature when a proper external resistance is employed, its efficiency will be low. But it should not be supposed that because a machine, when run without external resistance, that is, on short circuit, heats rapidly, inefficiency is shown thereby. On the contrary, should a machine remain comparatively cool when a proper external resistance is employed, and heat greatly when put on short circuit, these conditions should be regarded as a proof of its efficiency.

As a rule the internal resistance of dynamo-electric machines is so low, that to replace them by a battery, the latter, to possess an equal internal resistance, would have to be made of very large dimensions, so that the efficiency of dynamo-electric machines cannot be stated in terms of battery cells as ordinarily constructed.

In regard to the second division, viz., the external work of the machine, this may be applied in the production of light, heat, electrolysis, magnetism, etc.

Where it is desired to produce light, the external resistance is generally that of an arc formed between two carbon electrodes; the resistance of the arc is, therefore, an important factor in determining the efficiency. To realize the greatest economy, the resistance of the arc should be low, but, nevertheless, should constitute the greater part of the entire circuit resistance.

In some of our measurements the resistance of the arc was surprisingly low, being in one instance ·54 ohm, and in another, ·79 ohm. It was, however, in some instances, as high as 3·18 ohms.

It may be noted as an interesting fact that, where the greatest current was flowing, the resistance of the arc thereby produced was low. This is undoubtedly due to higher temperature and increased vaporization from the carbons. In this latter case also the greatest amount of light was produced.

The amount of work appearing in the arc, as measured by the number of foot pounds equivalent thereto, is not necessarily an index of the lighting power. In two instances of measurement the amount of energy thus appearing in the arc was equal, while the lighting powers were proportionately as three to four. This apparent anomaly is explained by considering the resistance of the arc, it being much less in the case in which the greater light was produced. The heat in this case being evolved in less space, the temperature of the carbons, and, therefore, their light-giving powers, was considerably increased.

A few remarks on the economical production of light from electrical current may not be out of place. The light emitted by an incandescent solid will increase as its temperature is increased. In the voltaic arc the limit to increase of temperature is in the too rapid vaporization of the carbon. Before this point is reached, however, the temperature is such that the light emitted is exceedingly intense. No reliable method of measuring the temperature of the arc has as yet been found.

A well known method of obtaining light from electrical currents is by constructing a resistance of some material, such as platinum, having a high fusing point, and heated to incandescence by the passage of a current. When platinum is employed, the limit to its increase of temperature is the fusing point of the platinum, which is unquestionably but a fraction of the temperature required to vaporize carbon. Were the falling off in the amount of light emitted merely proportional to the decrease in temperature, the method last described might be economical. Unfortunately, however, for this method, many facts show that the decrease in the light emitted is far greater than the decrease of the temperature. Most solids may be heated to 1,000° F. without practically emitting light. At 2,000° F. the light emitted is such that the body is said to be a bright red. At 4,000° F. the amount of light will have increased more than twice, probably as much as four times, that emitted at 2,000° F. It is reasonable to suppose that, with a further increase of temperature, the same ratio of increase will be observed, the proportionate increase in luminous intensity far exceeding the increase in temperature.

It would, therefore, appear that the employment of a resistance of platinum or other similar substance, whose temperature of alteration of state as compared with carbon is low, must be far less economical than the employment of the arc itself, which, as now produced, has been estimated as about two or three times less expensive than gas.

Indeed, it would seem that future improvements in obtaining light from electrical currents will rather be by the use of a sufficient resistance in the most limited space practicable, thereby obtaining in such space the highest possible temperature.

Perhaps the highest estimate that can be given of the efficiency of dynamo-electric machines, as ordinarily used, is not over 50 per cent.; our measurements have not given more than 38 per cent. Future improvements may increase this proportion. Since the efficiency of an ordinary steam engine and boiler in utilizing the heat of the fuel is probably overestimated at 20 per cent., the apparent maximum percentage of heat that could be recovered from the current developed in a dynamo-electric machine would be overestimated at 10 per cent. The economical heating of buildings by means of electricity may, therefore, be regarded as totally impracticable.

Attention has long ago been directed to the use of dynamo-electric machines for the conveyance of power. Their employment for this purpose would, indeed, seem to be quite promising. Since in this case one machine is employed to produce electrical currents, to be reconverted into mechanical force by another machine, the question of economy rests in the perfection of the machines and in their relative resistances.

In respect to the relations that should exist between the external and internal work of dynamo-electric machines, it will be found that the greatest efficiency will, of course, exist where the external work is much greater than the internal work, and this will be proportionately greater as the external resistance is greater. Our measurements gave in one instance the relation of ·82 ohm of the arc to ·49 ohm of the machine, a condition which indicates economy in working. The other extreme was found in an instance where the resistance of the arc was 1·93 ohm, while that of the machine was 4·60 ohms, a condition indicating wastefulness of power.

* Read before the American Philosophical Society, Nov. 1, 1878.

RADIOMETER PRESSURE.

IN some recent experiments Crookes has employed the torsion balance in order to estimate the molecular pressure within the radiometer. He finds that it varies between 7 ten-millionths and 9 four-millionths of an atmosphere.—*Comptes Rendus.*

DU FAY'S THEORY.

THE difference in the electric action of excited smooth glass by dry silk, and that of scaling wax, etc., by fur, woolen cloth, etc., was discovered by M. Du Fay, intendant of the French king's gardens, about the year 1733, who, in consequence, introduced the terms *vitreous* and *resinous* electricity. After describing some other of his discoveries, Du Fay proceeds to describe the one in question in the following manner: "Chance has thrown in my way another principle, more universal and remarkable than the preceding one, and which casts a new light upon the subject of electricity. The principle is that there are *two kinds* of electricity, very different from one another, one of which I call *vitreous* and the other *resinous* electricity. The first is that of glass, rock crystal, precious stones, hairs of animals, wool, and many other bodies. The second is that of amber, copal, gum lac, silk, thread, paper, and a vast number of other substances. The characteristics of these two electricities are that they repel themselves, and attract each other. Thus a body of the vitreous electricity repels all other bodies possessed of the vitreous; and, on the contrary, attracts all those of the resinous electricity. The resinous also repels the resinous, and attracts the vitreous. From this principle one may easily deduce the explanation of a great number of the phenomena, and it is probable that this truth will lead us to the discovery of many other things."

SPECTROMETRIC MEASUREMENT OF HIGH TEMPERATURES.

By A. CROVA.

THE spectrometric study of the luminous radiations emitted by incandescent bodies has led the author to the discovery of a new method of determining elevated temperatures by the analysis of the light which they emit. If we take, in the continuous spectra of light emitted by two incandescent sources, the one of known temperature, T, and the other of unknown temperature, x, two simple radiations of very different wave-lengths, λ and λ', to which we may refer all our measurements, and determine by means of a spectro-photometer the ratios—

$$\frac{I}{I'} \text{ and } \frac{i}{i'}$$

of the intensity of the two rays λ and λ' in the two spectra. The quotient of these two ratios represents the ratio of the intensities of the ray λ', in the two spectra when the more intense has been lowered so as to give the same intensity to the ray λ in the two spectra.

PHYSICAL SOCIETY, LONDON.

On a Condenser of Variable Capacity.—Professor Guthrie read a note by Mr. C. Boys. This condenser was designed for use in connection with the Holtz electrical machine to show the effect of condensation on the length of the spark. It consists of a test tube coated externally with tin-foil to form the inner armature, and a glass tube inclosing the test tube, and having its outer surface covered with tin-foil for the outer armature. The inner tube can be slid out or in along the length of the external tube, and the capacity thereby varied. Professor Guthrie showed that a spark from the Holtz machine could by its means be gradually reduced.

Professor Macdonnel stated that he had for some years used a similar apparatus, the inner coating, however, being strong sulphuric acid.

Differential Thermometer.—Dr. O. J. Lodge exhibited a differential thermometer in which saturated water vapor takes the place of air or other gas. This application is based on the fact that the pressure of a saturated vapor in contact with its liquid depends only on the temperature. An ordinary cryophorus answers the purpose when held so that the water occupies part of one bulb and a part of the stem next it; the greater the length of the water column in the latter, that is, the more horizontal the cryophorus is held, the greater the sensitiveness of the instrument. When both bulbs are at one temperature the water in tube and bulb is at one level. If, now, there be a difference of temperature between the two bulbs, there will be a difference of pressure in the vapor in their interiors, and the level of the water will change until the pressure is equilibrated. Unlike