ELECTRICAL CURRENT IN THE HUMAN BODY.

When ordinary precautions are observed, says Alfred M. Hayes, in The Electrical Engineer, supply at 250 volts presents practically no danger, and the possibility of such even at 500 volts may be overestimated. It will not be exceeding the bounds of ascertained knowledge to assert that volts alone can neither injure nor kill, and also that amperage alone is in no sense dangerous. In order that injury may result it is necessary that the conditions be such that a certain number of watts of electrical energy are expended in overcoming the resistance of the human body, the action of passing through and overcoming the resistance of the tissues causing the sensation usually described as shock.

In order to remove any misconception with regard to the writer's meaning in making the above statement, and to prove that high voltage alone presents no element of danger, let us take a Wimshurst or other similar statical machine, and having put this into operation until the main collectors become so highly charged that they commence to discharge themselves into the atmosphere (which will mean, in all probability, that they are at a potential some millions of volts above earth), let us place one hand upon a suitable earth connection, say a wire connected to a water pipe, and then bring the other hand into contact with the highly charged collector in question. The result will be that an infinitesimal current, as regards amperage, but at some millions of volts, will pass through the tissues of the body and go to earth, the current being so small that the wattage expended is not sufficient to cause the slightest inconvenience, in fact, practically no sensation will be felt.

Perhaps the machine which presents the most directly opposite characteristic to the above is that most useful article of commerce, the plating dynamo. Here we have a machine producing, say, 2,000 amperes at a potential of six volts, but, notwithstanding the enormous electrical current produced, the possibilities of obtaining the slightest shock are even more remote than in the previous instance. The reason for this is clearly that the voltage of the machine is insufficient to force the number of watts through the tissues which are requisite in order to produce a sensation either unpleasant or dangerous. The exact number of watts which must be expended in the human frame before fatal results ensue will vary in the case of different individuals, and will be largely governed by the physical condition of the subject.

At as low a voltage as 110 volts, the danger of shock is very remote, and the charged conductors may be handled with perfect impunity in any part of the building. If the conductors are touched by the hand, the state of the skin at the moment of making contact will largely govern the quantity of current which will pass, a hand moist with perspiration offering the most favorable conditions for increasing the severity of the shock, a dry condition of the skin having just the opposite effect. Should accidental contact be made with one hand with a conductor at this potential by a person standing in a damp basement the resulting shock will be very slight, even should the person be wearing a pair of wet or imperfect boots. Thus, we see that the resistance of the human body is so great that, when interposed in the path of conductors having a difference of potential amounting to 110 volts, it will limit the current passing, and consequently the watts expended in the tissues to such a small value that no serious results can accrue.

All other things being equal, the watts expended in the body, should contact be made with a conductor charged with 220 volts, will be exactly four times the amount in the first instance, and the shock will be consequently increased in severity. A case was recently reported in which a person met instant death by grasping a conductor charged at this potential —namely, 220 volts above earth—but the writer's experience justifies him in saying that the circumstances surrounding this occurrence must have been altogether abnormal.

Reaching the question of power supply at 500 volts, we shall find that an element of danger really exists, but one which merely demands a few extra precautions in order to reduce the possibility of mishap to a remote contingency. Contact between a conductor carrying current at a pressure of 500 volts and the bare flesh will under some conditions result in a severe and possibly fatal shock to the system, the nature and severity, however, entirely depending upon the details mentioned above. One may, again, with perfect safety make such a contact when standing in a dry workshop upon a boarded floor, but given a damp situation or an earth connection with some other part of the body at the same moment, the result may be extremely serious, as at such a voltage the combined resistance will be insufficient to cut the current down to a safe limit.

It will be noted that in the foregoing remarks the voltages have been definitely stated, and the writer thinks it will be understood that the current available was in each case practically unlimited, as this article deals with conductors charged from the supply mains, the point being that it is possible to have a potential difference of 500 volts or any other value, but with such a small amperage available that practically no physical effects are obtainable, taking, for instance, the case of the statical machine mentioned, or a set of small batteries having the requisite voltage, but merely a trifling capacity. It has been stated as a somewhat remarkable fact that a person has grasped the 500-volt trolley line whilst standing upon the top of a tramcar without the slightest inconvenience resulting. Really there is nothing at all remarkable in this, as it simply, again, resolves itself into a question of Ohm's law, the electromotive force being 500 volts and the resistance being represented by that of the person's body, plus the resistance to earth through the dry woodwork of the car, the total being so high that the current passing was reduced to a safe limit.

POWER REQUIRED FOR MACHINE TOOLS.

The following tests were made at the locomotive shops of the Buffalo, Rochester & Pittsburg Railway at DuBois, Pa., with the purpose of ascertaining the amount of power used by various machine tools when operating in regular, routine work, and at the same time the power lost in shafting and belting in a group-driven system. If all the machines in a group were thrown on and driven at their highest capacity at one time, they would probably require the full power of the motors as installed in this plant; but in actual operation, this never happens. Some of the tools are always either standing idle or working lightly, and the amount of power demanded hardly ever reaches half of the possible maximum total.

The plant consists of five buildings, viz., the power house, a building containing the locomotive erecting, boiler and machine shops, the round house, the blacksmith house, and the storehouse and offices. These buildings are located on a plot of ground 32 acres in extent, and the equipment is intended to handle the repairs of about 150 locomotives, with provision for an increase of 75 engines, which is expected to cover about five years, making an estimated ultimate total of 17 engines per month. The machine, boiler and tank shops are under one roof, covering an area of 134 by 524 feet. The blacksmith shop is 80 by 140 feet, the power house 63 by 93 feet, the office and store-house 60 by 120 feet; and in addition to these there is an oil house 30 by 60 feet, a 16-stall round house, and a 26 by 140 feet coal, coke and iron storage building.

The power plant is designed for the transmission of power by electricity and compressed air, and furnishes all power needed for driving the machinery, lighting the shops, grounds, a large car-building plant, and neighboring stations, and the further supply of steam for heating the buildings. All pipes and wires pass from the power-house to the several buildings through underground galleries. The boiler equipment comprises four 200-h.p. water-tube boilers, the furnaces of which are hand fired. The engine room contains the following machinery of Westinghouse make: A 200-h.p., compound engine, direct connected to a Westinghouse, 125-k.w., D.C., E.T., compound-wound generator, operating at 250 volts and 280 R.P.M. This generator carries the day load and supplies power for machine tools, cranes, lighting, etc. A 100-h.p.,