formed severe muscular exercise. During eight hours of each of the 3 days he was engaged in raising and lowering a heavy weight which was suspended by a cord passing over a pulley at the top of the chamber. The work in this case was so severe that he was thoroughly exhausted.

The result showed that the subject during the periods of rest gained about half an ounce of protein and lost not far from the same quantity of fat daily. The diet which was roughly calculated in advance to be very nearly sufficient for the needs of the organism when no considerable amount of work was done proved to have a slight excess of protein and not quite enough fats and carbohydrates. With the severe mental work the results were almost exactly the same. During the 3 days of hard study the organism consumed about the same quantities of nutrients as when it was at rest. Whether this would prove true for a longer period is not certain.

During the period of hard muscular work the results were quite different. As was to be expected, the food did not suffice for the demands of the body. Instead of gaining one-half an ounce, the organism lost about one-sixth of an ounce of protein per day, while the loss of fat reached 6.9 ounces. The fuel value of the materials consumed in the body during the periods of rest and of mental work ranged from 2,600 to 2,700 calories per day, but in the period of muscular work it rose to 4,325 calories. In this case, therefore, the severe muscular work increased the consumption of protein by over half an ounce and the consumption of fats by more than seven ounces per day. The experimenters have estimated the changes which would have been needed in the daily food to make it equal to the demands of the body during the period of muscular work. They calculate, for instance, that if the daily food had been increased by doubling the butter and sugar and adding half a pound of bacon it would have been sufficient.

The chief interest of these experiments, from the practical standpoint is the light they throw upon the ways the food is used in the body and the kinds and amounts that are appropriate for people of different occupations and under different circumstances. Physicians tell us that disease is largely due to errors in diet. It is only by such researches that the exact knowledge can be acquired which is needed to show how our diet can be fitted to the demands of health and strength as well as purse. In addition, the experiments have great scientific interest.

A number of experiments of this kind have been made in Europe, but these are the first in the United States. These investigations are being continued by the Department of Agriculture, and further reports may be expected from time to time.

Thus far we have described only those features of these investigations which included the measurement of the income and outgo of matter and the determination of the fuel value of the food. The fuel value of excretory products was also determined, as well as the energy manifested by the body in the form of heat or external muscular work. For the measurement of the body's energy delicate and elaborate apparatus was devised. Highly interesting results have already been obtained, but so many improvements in the methods and apparatus have suggested themselves during the progress of the work that it has not been deemed advisable to publish the details of this part of the investigation at present.

AN INDUCTION-COIL METHOD FOR X-RAYS.

SINCE sending a note of a new method of operating an induction coil by the discharge of a condenser we have used it for operating X-ray tubes, and find it gives us a much more powerful means of driving than any method we had heretofore tried. An exposure of one second gives an excellent negative of such common test objects as coins in a purse, and an exposure of five seconds is sufficient to give a negative showing clearly all the bony structure of the hand and wrist, a negative sufficient for the purposes of a surgeon. The best negative of the hand is to be obtained in about 20 seconds, and 45 seconds gives a marked over-exposure. Not only the bones, but the outlines of the cartilaginous and fatty tissues, and the tendons, are shown in a negative from a 25-seconds exposure. We have not had any opportunity to take any photographs through the body, but judging from results given by the flourscope this method gives a far greater penetration of the rays and a much sharper outline of the shadows than any other we have used. The fluorescence is absolutely steady; the pulsations of the heart can be seen with startling clearness, and the outline of the liver and lungs may be sharply distinguished. The details of the bony structure of the trunk are also clearly shown. The ribs appear as tubes rather than solid rods, owing perhaps to the outer portion being more dense than the inner. The processes on the spinal column are well marked. The hand of the observer may be held between the patient under examination and the tube, and a clear image of its bones may be seen even through the most dense portions of the trunk.

The tunstate of calcium crystals glow so brightly as to make the screen have a distinctly granular appearance. Each crystal seems to be separately illuminated like the grains of sand on a piece of coarse sand paper placed in the bright sunlight.

The effect of prolonged running on the tubes is very similar to that of a static machine, only more pronounced. The resistance of a tube may be increased by running with closed spark-gap, making the concave electrode cathode as usual. If the tube be reversed the resistance will be lowered. It is very often found that a tube which has been run hard for some time when allowed to cool will increase in resistance, so as to be beyond the range of the coil. By running such a tube, making the concave electrode anode on the coil a few minutes, the resistance will be lowered. Slight warming will facilitate matters. Again reversing the tube and running with closed spark-gap, the tube may be brought back to its maximum efficiency in a very few minutes. We have repeated this operation five or six times on some of our tubes with good results. It is needless to say that the above applies only to focus tubes with a platinum anode.

The part played by the spark-gap is not yet clear to us, but we have noted the following observations: A spark-gap between spheres is better than one between points. Some tubes will run without a spark-gap, but when the gap is used it should be on the cathode end of the tube. The proper adjustment of a spark-gap may increase the intensity of radiation several hundred per cent.

The platinum anode in the focus tubes which we use becomes red hot, and the whole tube feels warm to the hand. This is true of tubes which do not heat when driven by a 12-plate, 26-inch Wimshurst machine.

As stated in our note of February 17th, we are operating our induction coil by discharging through its primary a condenser which has previously been charged at 220 volts from the lighting mains. This charging and discharging we now accomplish 250 times a second by means of a five-part commutator on the shaft of a small motor. Since the condenser is disconnected from the mains only when it has risen to their voltage, there is no spark ing when it is disconnected; and since the discharge of the condenser is exceedingly rapid, it has entirely passed before the commutator segment has left the brush leading to the primary. In other words, the condenser brush leaves its commutator segment when both are at 220 volts, and the coil brush leaves its commutator segment when both are at zero. Hence no sparking need occur on the commutator except the slight spark of making circuit.

The great increase in voltage at the terminals of the secondary over that given by the same coil when operated in the ordinary manner is probably due to the exceeding rapidity of discharge of the condenser, and hence the rapid change in the number of lines of force enclosed by the secondary. For each discharge of the condenser there must be a rise and fall of the current in the primary of the induction coil; but, since we get a uni-direction discharge at the secondary, one of these alone, either the rise or fall, must be effective. The reaction of the secondary of the coil tends to increase the rapidity of rise of current in the primary, but tends to retard the fall, moreover, at the instant the condenser is connected to the coil we have 220 v., the potential of the condenser, applied to a circuit of exceedingly low resistance and very small induction, and from this we must get an extremely rapid rise of current. From these considerations alone it appears probable that the secondary discharge is due to rise rather than to the fall of current in the primary.

The volume of the discharge is so great that the ends of the secondary bristle with brush discharges, even when the terminals are within sparking distance of one another, and great care must be taken in insulating the primary from the secondary. There seems, moreover, to be a continual brush discharge from turn to turn of the primary, the nature of which we are unable to determine. If the iron wire of the core be put in a glass tube, and the primary be wound in a single layer about it, and the whole inclosed in a second larger tube, and the space between the tubes be filled with oil, the needed insulation is given.

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NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION, II.

[*Continued from p. 468.*]

WEDNESDAY evening was devoted to the Earth Sciences. Dr. Frank M. McMurry, of the Buffalo School of Pedagogy, read the following paper, written by Professor Ralph S. Tarr, of Cornell.

Place of the Earth Sciences in the Secondary Schools.

The question is raised again and again, shall the earth sciences (geology and physical geography with their subdivisions) have a place in the curriculum of the secondary school? and this has been variously answered. Many schools have properly omitted them from the course, and others are thinking of doing so. I say properly, because, as the subjects have been taught in the majority of cases, it is better to omit than to continue them.

Then again, when the question is under consideration, which of the natural sciences shall have a place in the schools, we very often find the earth sciences excluded, though this was certainly not the case in the report of the Committee of Ten. The reasons given for the exclusion of these subjects from the proposed curriculum are usually two: first, that they are not disciplinary subjects; and second, that for their proper understanding they need too much knowledge of other sciences. The first grows out of a failure to appreciate that there has been progress in the methods of teaching the earth sciences, a progress