passing through the whole three to give a shadow of the bones of the hand on another screen. I have advantageously employed a large screen, therefore, in which the crystals are even coarser than those previously used, and the thickness very much increased. By this means I have now no difficulty in seeing many of the deep structures of the body in movement.

Different Conditions of the Tube may be utilised for Different Effects.

Lately I have been trying to follow up Prof. J. J. Thomson's suggestion about there being different kinds of X-rays, in order to discover, if possible, whether a particular set of rays might be utilised for different tissues. Whether it be a matter of difference or intensity or difference in quality (as Prof. Thomson suggests), there can be no doubt with the tube in a certain condition the bones of the hand appear jet black on the fluorescent screen, while the soft tissues are scarcely visible. On the other hand, in a different condition of the tube the soft tissues are much more prominent and the bones faint. Following up this inquiry, I made a series of experiments by way of placing metal rings near the kathode, some of them earthed and all adjustable. I am quite aware others have placed rings of metal near the kathode, and described alterations in the tube which they have attributed to different causes. The sole object in my experiments was to afford an indication of alteration in a given condition of the tube. These experiments were so far successful, but I found much the same results could be obtained by using the discharge rods of the coil. The method adopted was, first, to heat the tube by means of a Bunsen burner until I got the exact condition required. The discharge rods were approximated until they cut out the focus tube, and then one was very slightly withdrawn until the tube again became fluorescent. The slightest alteration in the vacuum afterwards was immediately indicated by sparking across the gap. It need hardly be pointed out that an arrangement like Mr. Campbell Swinton's for correcting the vacuum by means of a magnet instead of heat would be an advantage if it could be applied to the ordinary focus tube. Once having selected the particular condition required, a small Bunsen burner below the tube may be so regulated as to give the necessary heat. By these means a particular condition of the tube may be kept up for a very long period without trouble. I have had it going on constantly in some instances for half-an-hour at a time with little or no apparent change in the appearance of the shadow of the tissues, and consequently had no difficulty in focusing the fluorescent screen on the ground glass of the camera, nor in photographing the screen with shadows of objects thereon.

Action upon Tissues and Fluorescent Screens.

Actions upon the tissues of the body have been recorded from several sources, and severe loss of skin and hair as a direct result of the application of the rays has been noted. Although I worked for months, it was only within the last few weeks that, having to place my hand near the tube, between it and the fluorescent screen, for long periods and several nights in succession, evidence of a dermatitis ensued. The hand looked as if it had been sunburned, and became red and swollen; there was afterwards shedding of epidermis and loss of hair. The severer effects remained for over a fortnight.

Another curious action on the tissues was noticed while photographing a fish. The apparatus used was the old form of German tube, and an induction coil with Tesla. After half-an-hour's exposure the back of the fish was covered with patches of phosphorescence, which remained for some hours afterwards.

It is usually considered that the action of the rays upon the potassium or barium screen is of very short duration. I have several times tried to see if the luminescence remained for any length of time after the current had been turned off, but could never record anything definite in this way. For reasons which need not be here entered upon, I had been experimenting with a view of putting the fluorescent screen into a particular condition for a period of time, and some metal objects were hung over the back of the screen to serve as a shadow. It was exposed to the effects of the rays for a quarter of an hour, and afterwards set aside where it was not acted upon by the daylight. The following evening I resumed my experiments, and found an image of the metal ring which had been used the previous night. The bluish colour was different inside and outside of the ring from that part of the screen which had been protected by the metal. The screen was immediately put past and examined for four nights in succession; each time, though less distinct, I could see the image, and it did not completely disappear for a week, during which time the screen was kept in the dark.

With regard to the action upon the tissues, I think it right to point out that there are at least two other forces at work—heat and electricity—and that while the former might not have much to do with the action on the skin, the latter might. In any case, however, the above-mentioned results were obtained after, and seem to have been the direct result of exposure to the action of forces in the region of the focus tube.

JOHN MACINTYRE.

JUMPING COCOONS.

THE curious movements of jumping beans have lately attracted some attention, though to style the spasmodic jerks of the beans jumps is to court disappointment. Some "jumping cocoons," described by Dr. D. Sharp in the *Entomologist*, were however, remarkably good athletes, for they could spring out of a small vessel, such as a tumbler, in which they were placed. These cocoons were from South Africa, but in spite of their exceptional gymnastic efficiency, Dr. Sharp hardened his heart and sacrificed them upon the altar of science, in the hope of discovering something unusual that would explain the powers of jumping. The cocoons looked like a piece of oval pottery, about five millimetres long, and having a rough surface. In each of the two investigated a pupa was found; the two were similar in every respect, and they no doubt belonged to the larvæ that made the cocoons. "This little pupa," says Dr. Sharp, "is shut up in a remarkably hard thick cocoon, and it has to get out. Nature has not provided it with caustic potash for the purpose, but has endowed it with a mechanism of complex perfection to accomplish this little object. On the front of the head it has a sharp chisel edge, and with this it has to cut through the pottery; contracting itself to the utmost in the posterior part of the cocoon, and retaining itself in this position by the hooks on the mobile part of the body, it is in a condition of elastic tension in consequence of the other side of the body being so differently formed and immobile; therefore, releasing the hold of the hooks, the pupa is discharged forwards, and the chisel piece strikes the front part of the cocoon; repeating this an enormous number of times a circle may be gradually inscribed on the inside of the far end of the cocoon, which gives way when sufficiently weakened, and the insect becomes free. In both the specimens the inside of the cocoon is about half-cut through; either this is done as the result of a prolonged series of wriggles, or of shocks such as I have described. It is by no means improbable that the early part of the performance is carving the groove by wriggling, the later part knocking it off by jumping against it." The pupa is thus a most interesting one to entomologists. The order of insects to which it belongs appears to be somewhat uncertain, but Dr. Sharp thinks it will prove to be an anomalous lepidopterous insect allied to Trichoptera, and possibly somewhere near to *Adela*.

MECHANICAL CONCEPTIONS OF ELECTRICAL PHENOMENA.[1]

MATTER AND MOTION.

UNTIL the middle of the present century the reigning physical philosophy held to the existence of what were called imponderables. The phenomena of heat were explained as due to an imponderable substance called "caloric," which ordinary matter could absorb and emit. A hot body was one which had absorbed an imponderable substance. It was, therefore, no heavier than before, but it possessed ability to do work proportional to the amount absorbed. Carnot's ideal engine was described by him in terms that imply the materiality of heat. Light was another imponderable substance maintained by Sir David Brewster as long as he lived. Electricity and magnetism were imponderable fluids, which, when allied with ordinary matter, endowed the latter with their peculiar qualities.

During the fifty years, from about 1820 to 1870, a somewhat different kind of explanation of physical events grew up. The

[1] Abridged from a lecture delivered before the Franklin Institute by Prof. A. E. Dolbear.