

duced electricity to escape into the ground. If when in this

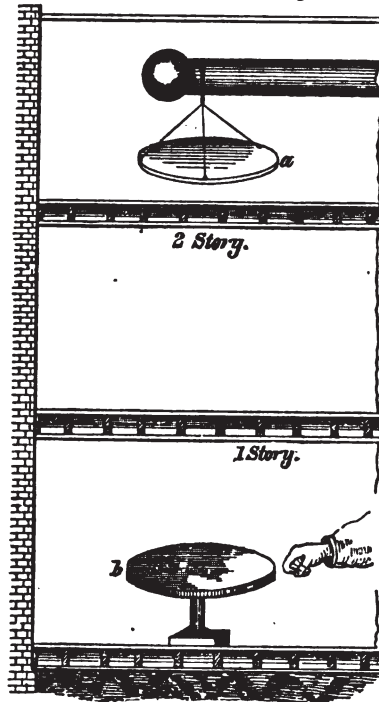


FIG. 9.

charged cloud is passing over the building, all conducting bodies in it, by this inductive action at a distance, have their natural electrical equilibrium disturbed; the upper part of each body becoming negatively electrified, and the lower part positively; and if the cloud continue in this position for a few minutes, the free electricity of the lower part of the conductor will be gradually driven into the earth, through the imperfect insulation of the floor. If in this case the lower part of the cloud is suddenly discharged, sparks of electricity may be perceived, and perhaps shocks experienced, by the inmates of the dwelling, produced by the sudden restoration of the equilibrium, due to the removal of the repulsive force of the cloud on the natural electricity of the bodies below.

The inductive action of the electrical discharge at a dis-

condition the knuckle was held near the lower disc and the upper one suddenly discharged by a spark received on a ball attached to the end of a wire connected with the earth, a spark was seen to pass between the knuckle and the lower disk. A similar effect was produced when the upper plate was suddenly charged by powerful sparks from the machine, though the intensity in this case was somewhat less.

In this experiment, the upper disk may represent a charged thunder-cloud, and the lower one the ground, or any conducting body within a house. While the

tance is still more surprisingly exhibited, by an arrangement shown in Figure 10, which the writer adopted about the same time during his electrical investigations at Princeton.

The roof of the house which he occupied in the college campus was covered with tinned iron, and this covering was therefore in the condition of an insulated plate, on account of the imperfect conduction of the wood and brick-work which intervened between it and the ground. To one of the lower edges of this covering was soldered a copper wire, which was continued downward to the first story, passed through a gimlet-hole in the window-frame into



FIG. 10.

the interior of the author's study, and then passed out of the lower side of the same window, and thence into a well, in which it terminated in a metallic plate below the surface of the water. Within the study, the wire was cut and the two ends thus formed were joined by a spiral of finer wire *a* covered with silk thread. Into the axis of this spiral a large sized sewing-needle *d* was inserted, the point having been previously attached to a cork, which served as a handle for removing it. With this arrangement, the needle was found to become magnetic whenever a flash of lightning was perceived, though it might be at the distance of several miles. The intensity of magnetism and the direction of the current were ascertained by presenting the end of the needle to a small compass represented by *c*. In several instances the inductive action took place at such a distance, that after seeing the flash the needle was removed its magnetic con-

dition observed and another needle put in its place, before the noise of the thunder reached the ear. In this experiment the inductive action of the electrical discharge in the heavens was exerted on the natural electricity of the tinned roof, (a surface of 1,600 square feet,) and a considerable portion of this passed down through the wire into the well. The arrangement served to indicate an action which would otherwise have been too feeble to produce a sensible impression.

It must be observed that the effect here described was not produced by the actual transfer of any electricity from the cloud, but was simply the result of induction at a distance and would probably have been nearly the same had the intervening space been filled with glass or any other solid non-conducting substance. We say probably very nearly the same, because Professor Faraday has shown that the inductive effect at a distance is modified by a change in the intervening medium.

It is also proper to mention here, (although we cannot stop to give the full explanation of the means by which the result was obtained,) that the electricity passing along the wire was not that due to a single discharge into the well, but to a series of oscillations up and down in alternate directions until the equilibrium was restored.

*Electricity in Motion.*—The phenomena we have thus far described relate principally to electricity at rest. Those which relate to ordinary or frictional electricity in motion have not been so minutely investigated as the other class, and present much more difficulty in ascertaining the laws to which they are subjected. The discharge of electricity from the clouds or from an ordinary electrical machine is so instantaneous that we are principally confined in our investigations to the effects which remain along its path after its transfer.

The electricity however which is developed by chemical action in a galvanic battery is of sufficient quantity to produce a continuous stream, or at least a series of impulses in such rapid succession that they may be considered continuous. By employing electricity of this kind, it has been supposed