justified by the phenomena of polarisation. If we understand him correctly, it is this theory, hypothesis, or assumption, which Prof. Robinson combats, and he does the work in an able manner in a paper contributed to the March number of the *Journal* of the Franklin Institute.

He says definitely that the phenomena of polarisation of light, heretofore supposed due to transversal vibrations, can be explained on the basis of longitudinal vibrations alone, and he proceeds to show by hypothesis and experiment, that longitudinal vibrations, such as in sound-waves, can be polarised, and furthermore, that it is irrational and improbable to suppose that vibrations in extended media generally can be primarily otherwise than longitudinal. In other words, he attacks the transversal theory of light, and shows good reason for further inquiry. Light, it is well known, can be radiated, reflected, refracted, diffracted, and diffused, can be made to interfere, and can be polarised. With one exception, we can do the same with sound, but if Prof. Robinson is to be credited with a discovery, we can also polarise sound. In short, it is only necessary to polarise sound to make the theory of longitudinal vibrations universal—to make the theories of sound and light analogous on all points. Assent, says Prof. Robinson, will be the more readily given after noticing that in polarised light it is not necessary to suppose the vibrations transversal until after passing the polariser, and that the latter imparts an effect equivalent to a lateral impulse, as due to its one-sided action upon the ray transmitted, thus giving cause for rays which are more or less transversal. He points out that it is not to be assumed impossible for transversal vibrations to occur when sufficient cause exists; but it is assumed that the cause is insufficient when a material particle is made to vibrate from the action of a disturbance at a remote centre transmitted to the particle considered the centre—the transmission and the particle being supposed to belong to a homogeneous medium of indefinite extent. As regards the nature of the vibratory movements of particles of luminiferous ether, Prof. Robinson says, may we not justly ask that, if we can go through such a range of density as from platinum to hydrogen without a change, where, as we rise through the scale of ethereal tenuity, shall longitudinal vibrations end and transversal begin? Why should the luminiferous ether be supposed to have a peculiar form of vibration; and if ether undulations can be polarised, why not undulations generally? He thinks that if polarised light had never been discovered, probably the idea of transversal vibrations would never have been suggested, and he quotes M. Jamin as expressing a denial of any necessity for transversal vibration to account for the observed phenomena, except as regards polarisation, and even in that case raising the question as to the direction of vibration. From a consideration of the points involved, Professor Robinson arrives at the conclusion that transversal vibrations, at a considerable distance from a radiant, seem impossible, and he asks if light can be polarised, why not undulations generally? After some eight years' cogitation he has put the question to the test of experiment, and has obtained satisfactory results from his point of view. The method adopted for polarising the undulations of sound was the same in principle as that for polarising light by reflection. When the undulations representing sound pass from one medium into another whose velocity for sound differs, the sound is refracted; and recent investigations by Tyndall, Henry, and others have indicated that when the sound-waves encounter a change of density of medium, there is a reflection of sound, *e.g.*, as when passing from a clear atmosphere into a wall of fog. Altogether, says Professor Robinson, there seems no doubt but that sound acts like light in these respects, that is, on meeting a change of refractive power, it is both reflected and refracted, as light is at the surface of water or glass. The reflected light being polarised, the sound is supposed to be. Practically any two media whatever may be selected for the experiment; two gases, such as hydrogen and atmospheric air, two liquids, two solids, or a solid and a gas; but for convenience the experiments were made with coal gas and air. The respective velocities of sound propagation in those media are respectively 1,420 and 1,125, and applying the laws of Fresnel and Brewster we find that the index of refraction being equal to the ratio of the velocities of the waves in the media, it is for the case of air and coal-gas $n = 1{\cdot}26$, while the polarising angle of incidence comes out as tangent $i = n = 1{\cdot}26$, or $i = 51^\circ\ 45'$. To realize this incidence upon a surface of separation between the gas and air, the coal-gas was placed in L-shaped tubes, in which the two arms were not quite at right angles, but each arm made an angle of $51\frac{3}{4}^\circ$ with a normal to the elbow, which was cut away for about half the thickness of the tubes, and the hole closed with a delicate membrane. The tubes may, in short, be described as of very broad V-shape, with the point cut off, and the aperture closed by a membrane. They were 1 inch in diameter by three inches long, and were made of tin-plate, one end being slightly larger than another, so that any number could be joined together stove-pipe fashion. Being cylindrical, the plane of any one piece could be placed at any angle with the plane of the preceding piece. The ends of the combined tubes were capped with membrane, and the whole filled with coal-gas. It will be understood that the portions of the tube fitting easily to one another, any portion could be shifted so as to form almost any angle with the other portions. The actual construction employed for the experiments consisting of a varying number of L-pieces, as they are called, with larger pieces at one end and the centre, thus forming a simple zig-zag tube from end to end, so arranged that the polarising portion of the tube could be readily turned from cross to parallel, etc. The coal-gas was admitted at one end, and allowed to escape by a jet burner at the other, the length of the flame serving as a pressure indicator. A small mirror was attached to the membrane at one end of the tube, and an organ pipe was blown close against that at the other end, but subsequently pendulums consisting of small ivory balls and hollow glass beads were employed. These, suspended by a thread, were allowed to just touch the membrane when at rest, and when the ivory ball was allowed to swing against the membrane at one end, the glass head was impelled through a certain arc, measured on an adjacent scale. It is impossible, in the space at our disposal, to give the results of the very many experiments made, nor is it necessary in the present state of the hypothesis; suffice it to say that, when the tubes were filled with air instead of gas, there was little, if any, reflection, showing that the results obtained with gas in the tube were due to the surfaces of separation of gases differing in density. In repeated reflection from such surfaces the intensity of the final component varies with the relative positions of those surfaces, the same following the laws of polarisation in light, from which Professor Robinson oncludes that longitudinal undulations can be polarised. The conclusions deduced from his investigations are thus stated:—1. Vibrations in extended media, produced from the action of a remote single centre of disturbance, can only be longitudinal, even in light. 2. Vibration will be to some extent transversal when due to two or more centres of disturbance not in the same line, as when two or more independent co-existent systems of undulations combine into one, or when a simple system is modified by such lateral disturbance as a reflection or refraction. 3. That undulations, to be in a condition called polarised, must consist of vibrations which are transversal, and that no necessity exists for assuming vibrations transversal in front of a polariser. These experiments of Professor Robinson will doubtless be repeated in other forms by other experimenters, and another link in the chain which binds together light, heat, and sound will be forged. The new discovery, it will be seen, adds one more proof to the truth of the undulatory theory.

DR. SIEMENS' ELECTRICAL FURNACE.

At a recent meeting of the Society of Telegraphic Engineers, in London, Dr. Siemens gave the following description of his electrical furnace:

Among the means at our disposal for effecting the fusion of highly refractory metals, and other substances, none has been more fully recognized than the oxy-hydrogen blast. The ingenious modification of the same by M. H. Ste Claire Deville, known as the Deville furnace, has been developed and applied for the fusion of platinum in considerable quantities by Mr. George Matthey, F.R.S.

The Regenerative Gas Furnace furnishes, however, another means of attaining extremely high degrees of heat, and this furnace is now largely used in the arts—among other purposes, for the production of mild steel. By the application of the open hearth process, 10 to 15 tons of malleable iron, containing only traces of carbon or other substances alloyed with it, may be seen in a perfectly fluid condition upon the open hearth of the furnace, at a temperature probably not inferior to the melting-point of platinum. It may be here remarked that the only building material capable of resisting such heats is a brick composed of 9·85 per cent. of silica, and only 1·5 per cent. of alumina, iron and lime, to bind the silica together.

In the Deville furnace an extreme degree of heat is attained by the union of pure oxygen with a rich gaseous fuel under the influence of a blast, whereas in the Siemens' furnace it is due to slow combustion of a poor gas, potentiated, so to speak, by a process of accumulation through heat stores or regenerators.