THE GAUMONT SPEAKING KINEMATOGRAPH FILMS.[1]

JOHANNES MULLER, one of the greatest physiologists of last century, when considering the time factor in nervous processes, was so impressed with the inherent difficulties of the question, that he said, "We shall probably never attain the power of measuring the velocity of nervous action, for we have no opportunity of comparing its propagation through immense space as we have in the case of light." As is often the case, when the forecast is darkest light is near. As it has in the case of determining the velocity of a nervous impulse by Helmholtz, so it has in the synchronisation of the kinematograph and phonograph. The question of synchronisation of a camera and a talking machine is a problem that attracted the attention of Edison himself from the time of his invention of the kinetoscope, an instrument, however, in which only one person at a time could see the moving picture.

It is not enough to have a perfect synchronism between the phonograph and the kinematograph—between the talking machine and the camera. The vocal sounds of one or more speakers must be registered at a distance of several yards from the phonograph. To do this without altering the purity and intensity of the sounds emitted is no easy problem.

Obviously the phonograph and kinematograph must be placed in the same electrical circuit. Experience has shown that the phonograph must control the action of both instruments. In July, 1901, the Gaumont Company obtained the first patent for such an arrangement.

The problem is how to obtain *at the same time* records from a kinematograph and from a phonograph, gramophone, or talking machine, and, having obtained these, how can they be reproduced and presented *simultaneously*, the one record to the eye and the other to the ear, so that a large audience—even six thousand in number—shall be able to see and hear that all marches in unison and produces an illusion so complete as almost to represent real life.

In the ordinary speaking and moving pictures which have been presented hitherto, the actor or singer has just to speak or sing into a phonograph placed close to his mouth, whereby a record is obtained. This is reproduced on an appropriate machine, and when he hears the sounds he makes as best he can the appropriate sounds, movements, and gestures while the kinematograph records. There is no question of *simultaneous recording and reproduction* of the double record. Consequently, the result is not satisfactory. By means of the combination of a camera, a talking machine, and a megaphone, the combination being termed by M. Gaumont the chronophone, large scenes as well as the effects of a full chorus are obtained at one and the same operation.

At first sight it might seem as if the problem of producing *simultaneously* combined pictorial and audible records was a comparatively simple one. It is, however, far from being so. We may lay down the following conditions:—

(1) Absolute synchronism between the phonograph and the kinematograph both in recording and reproducing the result.

(2) Registration of sound by the phonograph at a sufficient distance at the same time as the registration of the pictures on the moving film, without the phonograph being in the field of the kinematograph.

(3) The amplification of the sound so that a large audience can hear the sound and observe the exact correlation between the movements of the speakers, or actors, or singers, and the audible sounds as regards pitch, loudness, and quality of the vocal or other sounds.

It has been calculated that in a record on an ordinary 12-in. disc of a gramophone the length of its sinusoidal sound line or spiral groove—counting 100 grooves to the inch from the centre to the circumference of the disc—is about 240 yards, or 720 ft. If, however, the ripples made by the vibrating stylus as the disc revolves under it at the rate of 32 in. per second be added, it brings up the total length of the sound line—in the reproduction of a sound record lasting from three to four minutes—to, it may be, 500 yards, or 1500 ft. The disc makes about 76 revolutions per minute, or an average rate of each revolution in 0·8 second.

In order to produce what M. Gaumont has called "filmparlants," or speaking kinematograph films, two motors of identical pattern actuated from the same source, and of approximately the same power, are used for driving the phonograph and the kinematograph. A rheostat introduced into the circuit enables the operator to vary at will the velocity of the motors, even when they are in action.

Experience has shown that the best results are obtained by first setting in action the dynamos and the phonograph. The kinematograph is not engaged until a given moment. This can be arranged by placing a clutch between the kinematograph and its motor. The automatic engagement apparatus is controlled by a lever connected with the armature of an electromagnet, which is actuated at a given moment which corresponds with a definitely determined position of the needle in one of the grooves of the disc of the phonograph, which is of the gramophone type.

If, however, by any chance there is a discord, however small, even a fraction of a second, between the emission of the sound by the talking machine and the movement of the lips of the speaker, there is a special arrangement, called the "differential," by means of which any want of accord between the phonograph and camera can be immediately rectified. The differential gearing, which is placed on the shaft between the kinematograph and its motor, and is actuated by means of a special small motor, is provided with a reversing commutator which enables the operator to control the speed of the kinematograph, either hastening or slowing its movements. The speed of the phonograph remains constant, so that all correction in speed, in order to synchronise the two machines, is done by accelerating or retarding the speed of projection by means of the kinematograph. By means of the differential any accidental displacement of the phonograph needle during the projection can instantly be rectified.

In order that the operator may be in close proximity to the phonograph, and to enable him to make sure that everything works well and to regulate the apparatus, he has before him a rectangular box called "Chef d'Orchestre," but which is practically a "control board," fitted with a voltmeter which acts as a speed indicator, a frequency meter which gives exactly the angular velocity at each instant of the phonograph, a starting gear with a series of resistances, whereby the phonograph is set in motion, and a two-way commutator in connection with the differential motor.

The following coloured speaking films, amongst others, were demonstrated by means of the "chronophone" by way of showing its applicability to the reproduction of all kinds of vocal sounds:—(1) A Gallic cock placed on a pedestal, where he crows right lustily, so that the whole audience could hear the

[1] Abstract of a discourse delivered at the Royal Institution on Friday, May 10, by Prof. William Stirling.

loud-sounding efforts of Chanticleer, and observe the characteristic movements that accompany his vocalisation. (2) A den of lions with their trainer. The growling of the animals, the dull thud of the iron bar on the floor of the cage, are reproduced with startling realism. (3) The reproduction of speech and accompanying gestures by a person who is seen speaking through a telephone. (4) A musician playing on a banjo, exhibiting the movements of the fingers over the strings, and the fidelity with which musical sounds elicited by the vibrations of strings can be reproduced. (5) A festive gathering of Frenchmen, one of whom gives the toast of "The King," and the company unite in singing "God Save the King." (6) A sailor reproduces in stentorian tones Kipling's "Ballad of the Clampherdown."

THE AMERICAN PHILOSOPHICAL SOCIETY.

THE annual general meeting of the American Philosophical Society was held in Philadelphia on April 18–21 inclusive, when numerous papers embodying the results of original investigations were presented.

The evening of April 18 was devoted to a celebration of the centenary of the introduction of gas as an illuminant, under the auspices of the American Philosophical Society, the Franklin Institute, the American Chemical Society, and the American Gas Institute. Dr. William W. Keen, the president, was in the chair, and a paper on by-products in gas manufacture was read by Prof. C. E. Munroe, of George Washington University, Washington.

The total number of papers read and discussed at the various sessions was very large, and it is possible here to refer only to a few of wide interest or importance. In a paper entitled "Illustrations of Remarkable Cambrian Fossils from British Columbia," Dr. Charles D. Walcott, secretary of the Smithsonian Institution, described a remarkable and ancient fauna that he found in connection with geological explorations in the higher Rocky Mountains of British Columbia. From a camp at 7000 ft. elevation, he climbed a thousand feet to a ledge of rocks where the ancient Cambrian fossils are so perfectly preserved that the internal anatomy of many of the forms may now be reproduced by photography. The bay in which the mud was deposited which now forms the rocks containing the fossils was connected with the open ocean, and at the spot where the fossils were found the waters must have swarmed with the invertebrate life of the time. No fishes or other vertebrates were found to have existed at this ancient epoch. The marine worms are so perfectly preserved that they show not only the exterior form, but the interior intestine and the long proboscis which the worms thrust out through the mouth to secure food and to aid in drawing themselves through the mud. The crabs show the intestinal canal, liver, and a beautiful series of legs, gills, and claws connected with the appendages about the mouth. Specimens of Medusæ, or jelly-fish, are beautifully preserved, even to the details of the thread-like swimming muscles.

During the evening of April 19 Prof. R. W. Wood, of Johns Hopkins University, delivered a lecture before the society and guests at the College of Physicians on "The Study of Nature by Invisible Light, with especial Reference to Astronomy and Physics." The following morning an executive session was held in the hall of the society, at which candidates for membership were balloted for, when the following foreign men of science were elected members:—Dr. George F. J. A. Auwers, of Berlin; Dr. Wilhelm Ostwald, of Leipzig; and Prof. Magnus G. Retzius, of Stockholm.

Afterwards Dr. Frank W. Clarke, of the U.S. Geological Survey, contributed a paper on some geochemical statistics. He first treated of the average composition of the igneous rocks, and then compared them with the rocks of sedimentary origin. From the amount of soda lost by the decomposition of the igneous rocks, and the amounts retained by the sedimentaries or transferred to the ocean, he showed that about 78,000,000 cubic miles of the primitive crust of the earth had been decomposed, forming a mass of rock consisting of about 80 per cent. shales, 15 per cent. sandstones, and 5 per cent. limestones. He next compared the rate at which river waters transport dissolved salts to the ocean, with the composition of the ocean itself, and from these data computed the probable age of the earth since the continents assumed their present form at something near 83,000,000 years. The saline matter of the ocean alone amounts to about 5,000,000 cubic miles, or enough to cover the entire surface of the United States with a solid mass a mile and three-quarters thick. The rate at which sediments are being deposited in the ocean was also determined, and found to be about 0·000027 of an inch annually.

Prof. H. C. Jones, of Johns Hopkins University, read a communication on absorption spectra and the solvate theory of solution. A large number of lines of evidence have been brought to light, he said, in the laboratory of Johns Hopkins University all pointing to the conclusion that a dissolved substance combines with more or less of the solvent in which it dissolves; about 7000 solutions have now been studied with respect to their power to absorb light. It has been found that a given coloured compound dissolved in different colourless solvents absorbs light very differently in the different solvents. This is interpreted as being due to a combination of the different solvents with the dissolved substance, forming the different compounds which absorb light differently. The bearing of this work on the nature of solution is important. Matter in the pure homogeneous condition does not enter into chemical reaction. It becomes active chemically only when dissolved. Chemistry, biology, and geology owe their existence to matter in the dissolved state, and any light thrown on the nature of solution is of importance for the natural sciences in general. The theory of solution hitherto held has been found to be insufficient. In dealing with solutions we must always take into account the part of the solvent combined with the dissolved substance.

In a paper on the thermal relations of solutions, Prof. W. F. Magie, of Princeton University, pointed out that the heat capacity of electrolytes dissolved in water is related to the temperature change of the heat of dilution. Experiments to demonstrate this were described, and it was pointed out that the heat of dilution is a difference between two quantities of heat, one evolved in an amount proportional to the absolute temperature, the other absorbed in an amount independent of the temperature. One of these quantities is proportional to the dissociation which occurs on dilution, and measures the energy lost by the solute as its ions combine with water. The other involves as a part of its value the heat absorbed by the dissociation. The special significance of these relations lies in the strong support which they give to the theory that the molecules and ions of a salt in solution are associated or combined with the molecules of water.

The results of an important research on an exact