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The action of the cell, it is suggested, is as follows :—

Starting with Zn, N H_4 Cl, S C
First Zn, Zn Cl_2, 2 N H_3, H_2 S C
Next Zn, Zn S, 2 H Cl, 2 N H_3, C
„ Zn, Zn S, 2 N H_4 Cl, C

So that the whole of the work of the cell is done at the expense of the sulphur.

The statements of the inventor with reference to the battery are, we must confess, somewhat startling and certainly require verification. That the substitution of a non-conductor like sulphur in the place of the conducting oxide of manganese should lower the resistance of the battery is hardly credible, but that the electromotive force should be lower is quite possible; it is most probably that of zinc and carbon.

THE INVENTION OF SYNCHRONOUS ROTATIONS BY MEANS OF PAUL LA COUR'S PHONIC WHEEL AS USED IN TELEGRAPHY.

I HAVE lately had occasion to investigate some points in connection with multiplex telegraphy, and the latest methods of obtaining synchronous rotation of two wheels at the two ends of a telegraph wire. I have thus, and through original documents, been brought face to face with certain facts which may not be generally known, and which I therefore propose to discuss through the columns of this paper.

It is well known that the British Post Office has adopted within the last couple of years a multiplex system of telegraphy called "Delany's." This system was described in the ELECTRICAL REVIEW of February 2nd, 1884, in an article headed "Delany's Synchronous Multiplex Telegraph System," and was also made the subject of an interesting and able paper read before the British Association last year by Mr. W. H. Preece, F.R.S. It may also be of interest to quote some passages from a "Report of the committee on science and the arts of the Franklin Institute, on the Delany's system of synchronous multiplex telegraphy" (*Journal of the Franklin Institute*, April, 1886, No. 4, p. 312—318.) On p. 313 this report says :—"Mr. Delany's system is based on the phonic wheel of Paul La Cour, of Copenhagen." On p. 314 it goes on to say :—"Mr. Delany inserted in the circuit of the magnet of the vibrating fork a resistance coil, which could be automatically cut out when the vibrations were too rapid, thereby strengthening the current of the magnet and making the wheel revolve slower." What I here especially wish to draw attention to is :—

First. A perfectly reliable and sure automatic synchronism, based upon the phonic wheel (the invention of Mr. La Cour) existed long before Mr. Delany published anything.

Secondly. The very same, but improved synchronism, as described in the *Journal of the Franklin Institute* and in the ELECTRICAL REVIEW as mentioned above, was invented and patented by Mr. La Cour, prior to Mr. Delany bringing his invention before the public.

Now, as regards the *first* point, I have in my possession a document, signed by the Director of the Danish Government Telegraphs, stating that a synchronism, based upon the phonic wheel, maintained a perfect, satisfactory, and reliable multiplex working from June 17th to July 10th, 1880, between the two telegraph offices of Fredericia and Nyborg. This same document further says that the synchronism was easy to manage and gave no trouble, but the method being somewhat different from the one now in question, I shall not dwell longer on it here.

As to the *second* point, Delany (Calahan and Delany) took out his patent in the United States on the 17th of July, 1883, and in Great Britain on the 9th of October, 1883, and that these gentlemen had not previous to these dates published anything concerning this matter is shown by the reference, in the beginning of their specification, to Mr. La Cour's original patent for the phonic wheel, and not to any earlier work of their own. The phonic wheel, which is the base of the electrical synchronous movements of the particular class used here, was invented by Mr. Paul La Cour, of Copenhagen, and patented by him in Great Britain on the 17th of May, 1878. A full description of this invention and its several applications was given by La Cour in his pamphlet, "La Roue Phonique," Copenhagen, 1878, and a short article on the same is also to be found in the TELEGRAPHIC JOURNAL, of December the 1st, 1878. An important improvement as to regulating the velocity of rotation of the phonic wheel, and as to its general application for synchronising purposes was patented in Great Britain by P. La Cour on the 7th of October, 1882, or about nine months before Delany's American, and twelve months before his English patent. In August and September, 1883, at the Vienna Electrical Exhibition, Mr. La Cour exhibited his improved apparatus and demonstrated his inventions in connection with multiplex telegraphy. His system was also fully described at the time in several scientific journals and periodicals, for instance in the ELECTRICAL REVIEW of September the 22nd, 1883.

In September, 1882, La Cour sold his American patent for the *phonic wheel* to a Mr. Jones, of New York, and undertook to supply him with all particulars as to further improvements he (La Cour) might make thereon. Accordingly, La Cour in a letter dated the 1st of October, 1882, sent Mr. Jones a copy of his latest patent specification (the one taken out in Great Britain on the 7th of October, 1882), together with some particulars to help him (Jones) to carry out the practical working. Mr. Jones duly received this letter, and acknowledged the same, on the 8th of November, 1882; and on the 17th of July, 1883, Messrs. Delany and Calahan, who were working in conjunction with Mr. Jones, took out a patent in the United States for a synchronous multiplex telegraph system. They also patented the same (electric synchronous telegraphic and other systems) in Great Britain on October the 9th, 1883.

So much for the priority of the invention of this kind of synchronous rotations. It now only remains to investigate whether La Cour and Delany's systems of synchronisms are identical, or whether the possible deviations are of any theoretical or practical importance.

In La Cour's patent of October the 7th, 1882, it is shown that the synchronism may be maintained by changing the period or rate of oscillation of the vibrating body, either by altering the space between the poles of the electro-magnets and the branches of the tuning-fork, or by regulating automatically the strength of the current that acts upon the tuning fork. Automatic and perfect synchronous rotation is obtained by keeping a tuning fork at each end of a telegraph wire in constant vibration by a local battery. At one end the current of the local battery is connected through the tongue of a relay in such a manner that when the tongue touches one side the current is stronger, and the oscillations of the fork thereby become slower than at the other end. When the tongue, on the other hand, touches the opposite side, the current is weaker, and the oscillations of the fork consequently become faster. The adjustment itself is effected by sending an impulse (or a double impulse, positive or negative), for each rotation of the sending phonic wheel; this impulse throws the tongue of the relay to the one side or the other, according as the receiving phonic wheel is a little in advance or a little behind.

This in itself simple principle is, with various unessential embellishments, to be found throughout Delany's patent of October the 9th, 1883.

Delany uses six contact pieces for the regulating impulses instead of two, which number La Cour had found quite sufficient for a reliable synchronism (*vide* the Certificate from the Scientific Committee of the International Electrical Exhibition at Vienna, 1883, and *La Lumière Electrique*, 1886, No. 10, page 435-441).

He also sends regulating currents in both directions, which, again, La Cour found quite unnecessary; and he further employs special instruments (sounders) to prove that the synchronism is perfect. This addition La Cour also considers superfluous, as the synchronism is established three to four minutes after the instruments are placed in position, and not again interrupted unless serious disturbances should occur on the line. The only thing which by comparison, perhaps, at the first glance, might appear novel and better in Delany's modifications may be this, that Delany varies the strength of the current in the circuits of the electromagnets of the vibrating fork by automatic insertion of a larger or smaller *resistance*, while La Cour, in his specification of the 7th of October, 1882, allows the tongue of the relay, as described above, alternately to make connection with two batteries of different *electromotive force*. La Cour expresses this principle in general by speaking of a "stronger or weaker current," which result, of course, can be attained in different ways. Practically, the one has given as good result as the other; but the use of resistance coils was also tried by La Cour prior to Delany's English patent specification, for in August, 1883, at the Vienna Exhibition, La Cour experimented with it publicly, and finally adopted a combination of both.

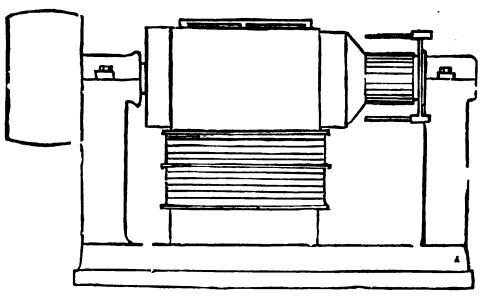
In conclusion, I may add that Mr. La Cour, not being in a position to support two patents in all countries (viz., that for the "phonic wheel," and that for "synchronous movements"), dropped the former after having disposed of the American one to Mr. Jones, whereas the latter is his property at the present moment.

P. CHR. DRESING, Mem. Soc. Tel. Eng.

THE ELECTRIC LIGHT AT "OLYMPIA."

THE permanent installation of electric light at this already popular place of amusement is now rapidly approaching completion, and is at present supplemented by a temporary installation of 60 arc lamps of the ordinary Brush type. Not only is this new installation of considerable magnitude, but it possesses features of peculiar interest on account of the area to be lighted and the difficulty of overcoming the effects of fog which, on account of the extent of the building, has no parallel anywhere so far as we are aware. "Olympia" at present consists of the great hall, which is 440 feet long and 250 feet wide, with a single span roof over 100 feet high in the centre. On the eastern end is a range of rooms consisting of general offices, board rooms, lecture room, dining rooms, and large refreshment and grill rooms; on the west end are two large ranges of buildings, now being used as the stables, fodder rooms, and harness rooms of the hippodrome. On the north-west side is another building of considerable importance, distinct from but communicating with the great hall. This is called the Minor Hall, having an assembly room, with large dining and supper rooms, retiring room and offices, &c., attached; this handsome building is 150 feet long and over 50 feet wide, and consists of three floors. Such is a brief sketch of the premises to be lighted by the installation we are about to describe. The generating electrical plant is underground between the two main buildings described, and consists of a dynamo room, 42 feet long by 30 feet wide, and a boiler room 32 feet long by 20 feet wide, communicating with the coal store, all under ground. The generating plant consists of four dynamos, each of 40 units; two compound steam engines, each of 200 H.P.; and three boilers, each of 200 H.P. As these boilers are of a type seldom used for electric light work, and have been designed and constructed with special care, some details may interest our readers. They are of the marine type and cylindrical, made of mild steel, manufactured by the Steel Company of Scotland by the Siemens-Martin process. The finished size of the shell of each boiler is 9 feet 6 inches diameter, and 8 feet 6 inches long, with two furnaces in each boiler. The furnace plate consists of a single plate, 10 feet 6 inches diameter, flanged to receive the double rivetted shells. The specified test actually applied to the plates of the boilers is a tensile strength of not less than 26 or more than 30 tons per square inch with a stretch of 20 per cent.; and, as a precaution against hardening in working, strips cut from the plates were required to stand the following test: to be heated to a cherry red and quenched in water at a temperature of 82° Fah., and afterwards to be capable of bending cold in a press to a curve, the inner radius of which is one-and-a-half times the thickness of the plate, without fracture. The stays for stiffening the end plates and tube plates to have an aggregate section of not less than one square inch for every 9,000 lbs., when the whole internal surface is pressed to 200 lbs. per square inch. The tubes are iron solid drawn of 3 inches external diameter.

The engines are of the compound horizontal type with a driving pulley 7 feet in diameter on each end of the crankshaft each pulley weighing 61½ cwt. with a surface speed of 2,200 feet. Each engine drives two dynamos direct by a double leather belt 12 inches wide without countershaft. The working speed of the engines is 100 revolutions per minute, and the steam pressure 100 lbs. per square inch. The engines and boilers are by Messrs. Davey, Paxman & Co., Colchester.



OUTLINE SKETCH OF A 40-UNIT SIEMENS DYNAMO.

The dynamos are compound direct current, each of 600 ampères, with an E.M.F. of 66 volts at the terminals, at a speed of 390 revolutions per minute, and were manufactured by Messrs. Siemens Bros. They are of a new type, remarkably compact and with a very high efficiency. This new type is to be known as Half H.B., which means half the field of the old form. In these particular machines the magnet coils are under the armature and the core and pole-piece solid wrought iron.

The work of wiring and fitting the whole of the lamps was done by the Anglo-American Brush Company, and comprises about 1,000 glow lamps of 17 C.P. actual at 60 volts, and 62 arc lamps of which four are to be used for lighting the approaches outside, and 58 for the Great Hall now fitted and used as the Hippodrome. The whole of the lamps, both arc and incandescent, work in single parallel. The arc lamps for the Great Hall are arranged in nine groups of six lamps, each of 12 ampères. They are at present fitted with ordinary globes, but are provided with a lantern 7 feet in diameter to take the whole group without globes, the lantern being in the shape of an inverted umbrella glazed with ground glass, and furnished with an opal shade or reflector of somewhat less diameter than the lantern. The groups are suspended from the main girders of the roof by cords of naked copper wire and counterbalanced so that the groups can readily be brought to the floor for trimming. Beside these groups there are to be four single lamps of 20 ampères each suspended in the same manner. The whole of