THREE STARS WITH LARGE PROPER MOTIONS.—M. A. Verschaffel communicates to No. 3824 of the *Astronomische Nachrichten* the positions of the stars B.D. $+24°\cdot2439$, $24\cdot2733^1$ and $24\cdot2733^2$, as recently observed by him at Abbadia, and compares them with the positions given in the catalogue A.G. Berlin B. and brought to 1900 by the corrections for precession and secular variation given in the catalogue, thereby demonstrating the existence of a large amount of proper motion for each star.

THE PYRAMID SPOT ON JUPITER.—Herr Leo Brenner, in writing to *The Observatory* (No. 324), explains the great discrepancies which have appeared between the positions, and velocity, of the "pyramid" spot as determined by himself and as determined by the English observers Messrs. Denning and Phillips.

He found that the centre of the formation travelled, during a year, at the mean velocity of 0°·5 per day, and then Messrs. Denning and Phillips recorded that, according to observations made on June 28, it had moved at a mean velocity of nearly 7°·0 per day for a period of nine days. This great change of velocity seemed impossible, but Herr Brenner has found a solution to the difficulty in the observed fact that it is not *one* spot that is being observed, but a series of three or four spots, and of these, some are new formations of which Messrs. Denning and Phillips had measured the position as though they were portions of the original spot, thus obtaining the great differences in position noted above.

Herr Brenner has arrived at the conclusion that neither the markings seen by him during August and September, nor those seen by the English observers on June 28, can be identical with the "pyramid" spot of last year, and these conclusions are strengthened by the observations of Señor Comas Solá, which were published lately in the *Bulletin de la Société Astronomique de France*.

EPHEMERIS FOR COMET TEMPEL$_3$-SWIFT.—In continuation of the ephemeris given in *Astronomische Nachrichten*, No. 3811, M. J. Bossert now publishes the following ephemeris for this comet.

12h. M.T. Paris.

1902.	R.A. h. m. s.	Decl. ° ′	log *r*.	log Δ.
Nov. 10	20 3 45	−16 6·2	0·1697	0·1596
,, 15	20 14 42	−15 26·6	0·1591	0·1603
,, 20	20 26 19	−14 42·2	0·1486	0·1606
,, 25	20 38 35	−13 52·6	0·1383	0·1603
,, 30	20 51 29	−12 57·5	0·1282	0·1595
Dec. 5	21 4 57	−11 56·3	0·1184	0·1584
,, 10	21 19 0	−10 49·5	0·1089	0·1566
,, 15	21 33 38	− 9 36·7	0·1000	0·1546
,, 20	21 48 51	− 8 17·4	0·0917	0·1525
,, 25	22 4 35	− 6 52·0	0·0843	0·1502
,, 30	22 20 51	− 5 21·0	0·0776	0·1479

Kiel Circular, No. 53.

THE AUTOMATIC TELEPHONE EXCHANGE.

THE object of the automatic telephone exchange is to dispense with the assistance of a third party in making connection between two subscribers. Those who are at all familiar with the complexity of the connections and of the numerous devices needed in a modern exchange having a large number of subscribers will realise that to work out a system in which the telephone girl is replaced by an automatic arrangement is a matter requiring no little ingenuity, and will, perhaps, not be surprised that the problem has apparently only been attacked successfully on the other side of the Atlantic. The American technical papers have shown that, during the past few years, the construction of automatic exchanges has received considerable attention and that several different systems have been worked out. Some attempts have been made to introduce these into this country, but not with much success; in fact, until the last year or so England did not afford a promising field for the introduction of automatic telephones unless for small private exchanges. In America, however, matters are different, and, as we have said, descriptions of two or three different systems in actual or experimental use have been published. One of these, recently described in the *Scientific American*, is noteworthy for the fact that the automatic apparatus at the exchange is operated mechanically so far as possible, the electrical control being reduced to a minimum. Greater trustworthiness, it is said, is obtained by this means, though we should be inclined to think that the wear and tear would also be greater. We do not know whether this, the Faller, system has had any extensive trial as yet. Another system, which we propose to describe briefly, has been in operation in some parts of America for three or four years, and as it is being installed now in several large American towns, and is also being introduced into Germany and England, we may judge that it has proved both trustworthy and economical. In Chicago, an exchange on this system is being constructed with an ultimate capacity of 100,000 subscribers.

This system is known as the "Strowger" system. We have had an opportunity of inspecting a small model installation representing part of an exchange suitable for 10,000 subscribers, and were struck by the ease and simplicity of its working and its great convenience from the subscriber's point of view. Of course, working a small portion of an exchange under exhibition conditions is one thing and running the complete system continuously, with all the subscribers connected, is another; but there was little to lead one to suppose that the working under the more arduous conditions of actual service would be any less satisfactory, and indeed the success which has attended the operation of three or four large exchanges in America is direct evidence to the contrary. One of these, at Fall River, Mass., has been in operation for two years and, with an ultimate capacity of 10,000 subscribers, already has 4000 connected. Apart from the clerical staff, only five people are required to look after this exchange, and these are said to spend most of their time connecting up new subscribers; at night and on Sundays the exchange is left to take care of itself.

We may first of all consider the subscriber's instrument; this takes no more room than, and looks very much like, an ordinary wall set. There is, however, no magneto ringer, and on the front of the box is a circular metal disc having ten holes on the right-hand side numbered from 0 to 9; below this is a ringing-up push. Suppose a subscriber wishes to call up No. 5683; he takes his receiver off the hook in the usual manner and, putting his finger in the hole marked 5, rotates the disc until his finger comes against a stop; he then allows the disc to return to its normal position and repeats the operation with the holes marked 6, 8 and 3 in succession. He is now connected through, and if No. 5683 is engaged, will hear a buzzing in his receiver; if not, he has only to press the ringing-up push and wait until his call is answered. When he puts back his receiver on the hook, all the connections are restored to their original condition. The time taken to get connected through—or to find out that the number you require is engaged—is considerably less than with the ordinary system, even when the exchange girl replies to your call and connects you up immediately, which, as telephone users know, happens but rarely.

The apparatus at the exchange consists of a number of automatic switches known as "first" and "second selectors" and "connecting switches." The construction of all these is very similar, but is too complicated to describe in detail; we can only indicate the principle upon which they work. The switch consists of a semi-cylinder, along the axis of which is the switch-arm. This arm can be raised or lowered in ten steps and also rotated so that its contact can be brought up to any of the contacts on the inside of the semi-cylinder; these are arranged in ten rows of ten contacts each. We may best understand the operation of these switches by following out what happens on ringing up, say, No. 5683. Each subscriber has a "first selector" switch of his own at the exchange, and the first movement of the dial on his instrument operates this switch. As he draws down the hole 5 to the stop, a succession of five current impulses are sent along the line, and these raise the central switch-arm to the fifth row up on his switch. This picks out all the subscribers whose numbers begin with 5000, by connecting the caller to the group of "second selectors" corresponding thereto; there are ten connecting or "trunk" lines leading from the first selectors to the second, and the switch-arm, when it has risen to the fifth row, rotates until it picks out a disengaged trunk, passing over any which are in use by other subscribers. The second movement of the dial operates the second selector in precisely the same way, raising its arm to the sixth row of contacts and causing it to rotate over that row until it picks out a disengaged trunk line leading to the group of subscribers with numbers beginning with 5600. The remaining two movements operate the selector switch and are slightly different; the first raises the arm to the eighth row of contacts and the second rotates it to the third contact in that row. The subscriber is now connected to No. 5683 and can ring him up if he is not engaged; the signal that he is engaged is given through another set of contacts on the connector switch, an interrupted current being sent along the caller's line and causing his receiver to hum. When the conversation is finished and the caller hangs up his receiver, all the switches which he has been using return to their normal position of rest.

The exchange is run on the central-battery system and metallic circuits are used throughout. It will be noticed that the subscriber's connections are duplicated at the exchange, one pair of wires running to the first selector and one to the contacts corresponding to his number on the connectors. It is also obvious that the number of connections in one group of hundreds or thousands which can be made at once is limited by the number of trunk lines; ten of these per hundred subscribers have been found to be practically sufficient, but the number could, of course, be increased without limit if it was found desirable. Once two subscribers are connected through, their conversation cannot be interrupted, since any attempt to call either up results merely in the caller receiving the busy signal, and any calling up between other subscribers does not affect the lines they are using. This alone is a very great convenience from the user's point of view; in addition, the gain in time in getting connected up, the impossibility of getting on to a wrong number except by the subscriber's own fault and the secrecy of the system must be reckoned to its advantage. So far as the exchange is concerned, the chief advantage lies in doing away with the exchange girl; the cost of maintenance is said to be no more than in a manually operated system, the floor space required for connections and switches about the same; there is, therefore, a slight saving in room, since none of the resting rooms which the strain upon the operators now renders necessary is required. M. S.

INSTANTANEOUS CHEMICAL REACTIONS AND THE THEORY OF ELECTROLYTIC DISSOCIATION.[1]

IT is generally held that instantaneous chemical reaction, if not all chemical action, is dependent upon ions; in other words, that such reactions take place between electrolytes. In order to test this point, the author has attempted precipitation by double decomposition (like the reaction between silver nitrate and hydrochloric acid) in solutions that are excellent insulators. As a solvent benzene was chosen, though it seems that petroleum ether or toluene would have been equally good. The benzene used was the best that is made by Kahlbaum, free from thiophen. It was allowed to stand for days over phosphorus pentoxide, from which it was distilled, and was finally kept standing over metallic sodium. The conductivity was tested by comparison with that of air. For this purpose an Arrhenius resistance cell, with plates less than a millimetre apart, was placed in series with a sensitive galvanometer, and a dynamo giving a pressure of 110 volts. When the cell contained air a slight movement of the needle could be seen on closing the circuit, and on replacing the air by benzene the deflection was somewhat less. The insulating properties were therefore good.

Some difficulty was found in obtaining suitable solutes owing to the general insolubility of salts in hydrocarbons. Certain oleates, however, are soluble, and those of copper, nickel and cobalt were used. These were prepared by heating pure oleic acid with the calculated quantity of standard solution of sodium hydroxide and then adding to this sodium oleate solution a slight excess of the sulphate of the heavy metal. The precipitate was thoroughly washed with water and finally dried at 110°. The salts so obtained were analysed by reduction in hydrogen.

These oleates are readily soluable in benzene, even in the cold, and give colours similar to those of salts of the corresponding metals in aqueous solutions. On heating the dark red solution of cobalt oleate in toluene it turns blue, and on cooling it again becomes red, in the same way as cobaltous salts change colour in aqueous solutions. It was found that 5 per cent. solutions did not conduct any better than pure benzene. Metallic sodium does not cause any precipitation, and was, in fact, used as a desiccating reagent; the only change that ever took place was the usual slight pinkish coloration that freshly cut surfaces always assume after a time. Magnesium, aluminium and zinc have been kept in a copper oleate solution for weeks without in the least changing their appearance and lustre. It is therefore abundantly proved that these oleates in benzene are not ionised. Cryoscopic determination of the molecular weight of copper oleate in benzene gave figures about 2400 and the boiling-point method about 2650, whereas the theoretical figure is 625·6, so that, according to the usual idea, the copper oleate would appear to be polymerised.

A solution of dry hydrochloric acid gas in benzene was next prepared. The gas was obtained by dropping the aqueous solution into concentrated sulphuric acid and further drying by sulphuric acid and phosphoric anhydride. The conductivity of this solution was no higher than that of the benzene itself. It does not attack the carbonates of sodium, calcium and barium, or bright magnesium ribbon. Zinc, however, is attacked, whether amalgamated or not, but platinum in contact with it makes no difference, the hydrogen being evolved from the zinc alone. Thus voltaic action is absent. A dilute aqueous solution of the acid seemed to act rather less readily on amalgamated zinc than did the solution in benzene. Similarly, contact with platinum or other metals does not cause magnesium to be acted on by the acid. Iron, nickel, cobalt, copper and cadmium are not attacked; tin and aluminium are slightly acted upon, and lead very slightly. This is so whether the metals are by themselves or in contact with others. Metallic sodium is fairly rapidly attacked. The chlorides of the metals acted upon are practically insoluble in benzene.

In all the experiments, great precautions were taken against moisture, the generators and other apparatus being connected to suitable drying trains. The flask containing the benzene and substance to be tested was fitted with a doubly perforated rubber stopper, and was connected with the drying train of the hydrochloric acid generator and also to a large tower filled with pumice and phosphoric anhydride. Before introducing the benzene and substance, the flask, stopper and connecting tubes were heated to drive off moisture, and while still hot, the benzene and substance to be tested were quickly introduced and the whole at once connected with the train. The air was then displaced with dry hydrogen, which passed through the hydrochloric acid generator, and finally the acid was slowly evolved until the train was saturated.

When dry hydrochloric acid gas is passed into a solution of copper oleate in benzene, there is formed instantly a heavy brown precipitate which is cupric chloride. We have here, then, a case of instantaneous precipitation by double decomposition which is perfectly comparable with that of the formation of silver chloride in aqueous solutions, when silver nitrate solution is treated with hydrochloric acid. Yet the benzene solutions conduct no better than benzene itself, nor is there the least perceptible increase of conductivity at the instant of the formation of the precipitate. The oleates of nickel and cobalt, when treated in benzene solutions with dry hydrochloric acid, react in a perfectly analogous manner. Analysis showed the precipitation to be complete.

It was found that the conductivity of two samples of anhydrous stannic chloride is no better than that of air. This salt mixes with benzene in all proportions, giving mixtures which are equally non-conductors. Yet when such a solution is poured into a benzene solution of copper oleate, there forms *instantly* a heavy brown precipitate which is principally anhydrous cupric chloride. The precipitate takes down some of the stannic oleate which is formed with it and is difficult to manipulate, but analysis shows that the reaction is in the main a simple double decomposition.

Anhydrous phosphorus trichloride, arsenic trichloride and silicon tetrachloride are miscible in all proportions with benzene and give solutions which are insulators, like the solution of stannic chloride. In each case, when a solution of copper oleate in benzene is treated with a solution of PCl_3, $AsCl_3$ or $SiCl_4$ in the same solvent, copper is precipitated as a dark brown precipitate. This is essentially cupric chloride, but is in each case contaminated with some of the oleate.

We see, then, that HCl, $SnCl_4$, PCl_3, $AsCl_3$ and $SiCl_4$ each precipitate cupric chloride from benzene solutions of copper oleate. There is, then, apparently double decomposition by means of ions, and yet the solutions are non-conductors, showing that ions are not present.

[1] Abstract of a paper in the *Journal of Physical Chemistry*, vol. vi. pp. 1–14, 1902, by L. Kahlenberg.