meteors it is true, and of these it is hoped the real paths may be computed; but on the nights of August 10 and 11 observers were somewhat disappointed with the character of their results. The effect of the full moon's influence in practically obliterating a meteoric shower may not, however, have been given sufficient weight. The best night appears to have been August 12, when shooting stars were tolerably frequent considering the circumstances.

But if moonlight presented an obstacle to success in the second week of August, there was no such impediment early in the month and during the last fortnight of July. The earlier stages of the shower were therefore well observed. In fact, it is questionable whether the Perseids have ever been more successfully observed in the month of July. Among those who participated in the observations were Prof. A. S. Herschel, Messrs. J. R. Bridger, W. E. Besley, A. King, and many others. At Cambridge a large number of meteors were recorded. The results show that the first Perseids were noticed on about July 16, and gradually increased in numbers until the date of maximum. The radiant showed the usual E.N.E. motion in a most decided manner.

At Bristol, between July 15–30, in 17¼ hours of observation, 177 meteors were seen, including about 24 Aquarids (radiant 338° − 10°) and 20 Perseids. But the only night on which a sufficient number of Perseids were registered to indicate a good radiant was July 30, when the position was at 31° + 54° from 10 paths. Several of the most prominent of the minor showers of the epoch were observed, and their radiants accurately determined as follows:—

24° + 43°, 7 meteors	305° − 12°, 8 meteors
291° + 59°, 6 ,,	315° + 47°, 9 ,,
292° + 52°, 7 ,,	335° + 73°, 5 ,,

Other showers were indicated at 53° + 63°, 245° + 72°, 333° + 28°.

Mr. W. E. Besley, at Clapham Common, London, registered the paths of 110 meteors between July 14 and 24, and the great majority of these were seen on the 23rd (30 meteors) and 24th (51 meteors). His results are important, for on the former date he found the radiant point of the Perseids at 23° + 51°, and on the latter date at 25° + 52½°, from 5 and 7 meteors respectively.

Prof. A. S. Herschel, at Slough, during a series of short watches between July 17 and August 1, recorded 53 meteors, including some very interesting early Perseids and several Aquarids. The position of the latter radiant was placed at 339° − 12°, from about 7 paths.

Some of the meteors seen by Prof. Herschel were also noted by the writer at Bristol. The earliest Perseid of which duple observations were secured appeared on July 19, at 11h. 49m., and it was a fine object, estimated to equal Jupiter by the Bristol observer. The radiant from the combined paths was at 17° + 50°, and the height of the meteor varied during its descent from 81 to 54 miles. Another Perseid was seen at Slough and Bristol on July 23, 12h. 12m., of 1st magnitude. Its radiant was at 24° + 52°, and height 84 to 55 miles. These radiants, together with those determined by Mr. Besley on July 23 and 24, and that by the writer at Bristol on July 30, agree very satisfactorily with the ephemeris place of the radiant given by the writer in *Ast. Nach.*, 3546, and *Memoirs* R.A.S., vol. liii. p. 210.

Fairly bright Aquarids were recorded at Slough and Bristol on July 28 and 30, with heights from 65 to 44 miles and 56 to 40 miles respectively. These meteors are usually lower in the atmosphere than the Perseids, and move much slower. If we take the radiant of the former shower in 1900 as 339° − 11°, we shall probably have a position which is certainly within 1° of probable error.

On July 15, at 10h. 13m., a Capricornid fireball was seen at Bristol and four other places. It was a splendid object, about three times brighter than Venus, in the northern part of England. It fell from heights of 51 to 21 miles, along a path of 78 miles; velocity, 16 miles per second.

On July 17, at 8h. 47m., a magnificent fireball appeared over the northern part of England and Scotland. Though the sun had not long set, the brilliancy of the meteor was described as very dazzling, and the nucleus left a streak which remained visible for three-quarters of an hour. The meteor was directed from a radiant at 249° − 20° in Scorpio, and fell from a height of 58 to 15 miles, along a path of about 175 miles.

On July 24 another fireball appeared, and was rated at about three times the brightness of Venus. It was seen at Bristol and at several stations in the eastern counties. It fell from 68 to 27 miles, along a path of 103 miles; velocity, 19 miles per second, and was directed from a well-known July radiant at 280° − 15°.

But the number of brilliant meteors which have recently appeared is so large that the objects cannot be alluded to in detail. Many ordinary shooting stars have also been doubly observed, and these will be tabulated and published at a later period. Among these there was an interesting θ Perseid on July 23, 11h. 13m., with heights of 83 to 59 miles, and a radiant at 30° + 47°, quite distinct from the true Perseids.

On about August 10–12 the radiant of the Perseids was found far east of its place in July. On August 12, Mr. King, at Leicester, determined the position as 48½° + 58° from 16 Perseids, and Mr. Besley derived it at 47° + 56½° on the same night from 4 meteors. On August 16 the writer at Bristol saw 5 Perseids from a radiant at 54° + 58°.

Though the shower was partially obliterated by moonlight just at the important time, it has this year furnished some interesting materials for discussion as regards its earlier and later stages. W. F. DENNING.

WHAT PRESSURE IS DANGEROUS ON ELECTRIC RAILWAYS WITH OVERHEAD TROLLEY WIRES.[1]

THE following investigations were set on foot on account of a dissension between the firm of Messrs. Brown, Boveri and Co., Switzerland (Baden), and the authorities regarding the proper pressure for two different electric railways to be worked by three-phase alternating current, namely, the lines Stansstad-Engelberg and Fermatt-Garnergratt, which lines it was proposed to work at a pressure of 750 volts. But this pressure being regarded as dangerous, the authorities refused to allow one exceeding 500 volts to be actually employed.

In these circumstances the firm communicated with Prof. H. F. Weber, of the Zürich Polytechnic, asking him to express his opinion on this matter. In view, however, of his own want of experience on this particular point, Prof. Weber commenced a long series of investigations of the physiological effects of the electric current on the human body, and he used himself as the measuring instrument, thus exposing himself to great danger.

The experiments were made with reference to the special circumstances of the above railways, where the current was supposed to be supplied through two overhead leads, the rails being used as the third conductor of the three-phase system.

Two series of experiments were made corresponding with the cases—

(*a*) A person seizes the two bare leads with both hands simultaneously, or both of the leads fall on a bare part of the human body.

(*b*) A bare part of a person standing on the railway or on a car comes into contact with one of the leads.

The apparatus used in the case of experiments (*a*) consisted of an iron ring wound with 630 turns of wire, through which was sent an alternating current, the frequency of which was 50 per second. The voltage between the first and the last turn was kept at 210 volts. To every thirtieth turn was soldered a copper wire of 10 cm. length, and 6 mm. diameter, and consequently the pressure between the first and the second wire was 10 volts, that between the first and third 20 volts, and so on, up to 210 volts.

Prof. Weber tried these pressures successively on himself, constantly holding with one hand the first wire and seizing with the other hand each of the other wires in succession. The experiments were made three times, his hands being each time wetted to begin with, and afterwards being used dry. The results of each of the three series so obtained were consistent with one another.

When experimenting with *wet hands* he obtained the following results:—

P.D.	Effect.
10 volts.	Very feeble trembling of the muscles of the fingers; the current from hand to hand was measured and found to be 0·001 ampere.
20 volts.	Very considerable trembling of the hands, wrists and forearms; the hands and the arms were able to be moved freely, and the wires could be

[1] By William Rung, C.E., of the firm of Brown, Boveri and Co., Switzerland. Translated from the Danish *Civilengeneer* by F. Lehmann, M. F. Danish C.E.

released easily. The current was from 0·0020 to 0·0027 ampere.

30 volts. The fingers, hands, wrists, the forearms and upper arms nearly paralysed; the fingers or hand could scarcely be moved; serious pains in the fingers, hands and arms, and the experiment not endurable for more than 10 seconds. The wires could, however, be released, but only by using the greatest determination. Current, 0·015 ampere.

40 volts. The fingers, hands and arms were instantaneously paralysed, and the pain was almost unbearable. The wires could hardly in any case be released. The pain could not be endured longer than 5 seconds.

50 volts. Again instantaneous paralysis of all the muscles of the fingers, hands and arms; the wires could not be released; the state endurable for 2 seconds at most, whence it was impossible to measure the current.

Having obtained the above results, the experimenter did not find it advisable to let the pressure exceed the 50 volts; the fact that when the hands were wet, it was impossible on 50 volts pressure to release the wires, seemed to prove to him that serious danger was just beginning at this point.

With *dry hands* he formed the following results :—

P.D.	Effect.
40 volts.	The fingers only tingle slightly; the current too feeble for measurement.
	The effects gradually increasing and extending to the arms up to the shoulders, until at
80 volts.	The fingers, hands and arms were almost cramped and aching in every part; great effort was required to release the wires; current from 0·009 to 0·011 ampere.
90 volts.	At the same moment in which the wire is seized, the hands are absolutely paralysed and the wire cannot be released again. The pains in the hands and arms were so violent that they caused the experimenter to call out involuntarily; the effects could not be endured for more than 1–2 seconds.
	The experimenter now went back to 80 volts, and the difference was so great that the effects of this pressure seemed to be extremely feeble relatively to the effects at 90 volts pressure; this fact prevented him from trying the effects of pressure higher still

From these experiments Prof. Weber draws the following conclusions :—

"A simultaneous touching of both of the poles of an alternating current circuit is dangerous as soon as the pressure exceeds 100 volts; and since it is impossible to set one's self free, the case must be regarded as fatal whenever immediate help is not at hand."

These results are consistent with several disasters which have happened in practical life.

In 1896, in Horgen (Switzerland), a man, to prevent his falling down from a ladder, seized with both his hands two non-insulated leads with a P.D. of 240 volts between them, and was immediately killed.

In a mine in Silesia a workman seized in the same manner some non-insulated leads and was killed on account of his being unable to release them, the P.D. being 300 volts.

In the Electric Central Station in Olten a workman, desirous of proving to his companions that a pressure of 500 volts was quite safe, seized both of the leads and was killed instantly.

From this it is obvious that the general opinion of a pressure of 500 volts not being dangerous does not hold good, the limit being much lower. In spite of the great number of disasters which have already happened, the danger does not seem to have been generally appreciated, and workmen and erectors are often seen to deal with leads and apparatus of relatively high pressures in the most careless manner. That disasters have not taken place far more often may be due to the fact that in most cases help has been at hand instantly.

Entirely differing from these are the results of the other series of experiments (*b*). In this case the person is supposed to stand at one of the poles itself, namely, the earth, from which he is, however, rather well insulated by means of his shoes; and, as it will be evident from the results, the danger is in this case very small even at high pressures.

The arrangement used for this series of experiments consisted of twenty glow-lamps, each for 100 volts pressure, connected in series and all well insulated, the total alternating pressure between the first and the last lamp being 2000 volts. The free terminal of the first lamp was earthed, and between every two consecutive lamps a 6 mm. copper wire was soldered to the main connecting the lamps. Between the earth and the first, second, third to the twentieth of the 6 mm. wires, the pressure was consequently 100, 200, 300, . . . 2000 volts.

Standing on the ground, Prof. Weber touched the different wires—firstly, merely by a slight touch; secondly, by firmly gripping them in his hand. The experiments were made under two conditions, the experimenter standing firstly on moist gravel soil, and afterwards on clay covered by a thin layer of coal-dust.

Standing *on moist gravel soil*, he obtained the following results :—

P. D.	Effect when the wire was Slightly touched.	Firmly gripped.
800 volts.	Feeble stinging of the skin.	No effect.
	Gradually increasing until at	
2000 volts.	Violent stinging of the skin.	Intense trembling of the fingers.

Standing on clay covered with coal-dust, he obtained the following results :—

P. D.	Effect when the wire was Slightly touched.	Firmly gripped.
200 volts.	Scarcely sensible stinging of the skin.	No effect whatever.
500 ,, 700 ,,	Gradually increasing.	The fingers begin to tingle feebly. Intense trembling of the fingers, hands, arms and ankle-joints.
1000 ,,	Stinging like burning by a flame.	The effects in the fingers, hands, arms and feet not endurable longer than 1 to 2 seconds; difficulty in releasing the wire.
1300 ,,	Same effect.	The fingers, hands, and the arms are entirely paralysed, and the wire cannot be released.

From the last series of experiments it will be obvious that to touch one of the poles is not dangerous as long as the pressure does not exceed about 1000 volts; the intense stinging which appears at the first slight touching serves as a protection against the danger, for the hand is instinctively drawn back rapidly.

The main result of these experiments is, then, that all pressures between 100 and 1000 volts must be regarded as equally dangerous, and consequently there is no reason for not using the higher pressures between 500 and 1000 volts, especially as they lead to greater economy in the working of the electric railway. Further, there is only a very little chance of the passengers or other persons coming into contact with both of the leads. To this danger the employés only are exposed, and being generally people with some electric training, they are acquainted with the danger and may be supposed to be sufficiently careful.

Finally, it is to be remarked that the authorities after these investigations allowed the use of a working pressure of 750 volts as originally proposed.

SEA COAST DESTRUCTION AND LITTORAL DRIFT.

THE increasing number of seaside resorts that are constantly being established all round the coast of this country, and the necessity of protecting the sea front from the devastation of the waves, has led recently to greater interest being shown in the protection of the shores and cliffs.

The means taken to preserve our coasts are as diverse as many of them are ineffectual; and in many cases are designed without any proper consideration being given to the way in which the waves act, or to the physical conditions which have to be dealt with in the management of the littoral drift; while