the modified medium-sized dynamo-machine, capable of producing 36 webers of current with an expenditure of 4 horse-power, and which, if used for illuminating purposes, produces a light equal to 6000 candles, I find that a crucible of about 20 centimetres in depth, immersed in a non-conductive material, is raised up to white heat in less than a quarter of an hour, and the fusion of one kilometre of steel is effected within, say, another quarter of an hour, successive fusions being made in somewhat diminishing intervals of time. It is quite feasible to carry on this process upon a still larger scale by increasing the power of the dynamo-elec ric machine and the size of the crucibles.

By the use of a pole of dense carbon, the otherwise purely chemical reaction intended to be carried into effect may be interfered with through the detachment of particles of carbon from the same; and although the consumption of the negative pole in a neutral atmosphere is exceedingly slow, it may become necessary to substitute for the same a negative pole so constituted as not to yield any substance to the arc. I have used for this purpose (as also in the construction of electric lamps) a water pole or tube of copper, through which a cooling current of water is made to circulate. It consists simply of a stout copper cylinder closed at the lower end, having an inner tube penetrating to near the bottom for the passage of a current of water into the cylinder, which water enters and is discharged by means of flexible indiarubber tubing. This tubing being of non-conductive material, and of small sectional area, the escape of current from the pole to the reservoir is so slight that it may be entirely neglected. On the other hand, some loss of heat is incurred through conduction in the use of the water pole, but this loss diminishes with the increasing heat of the furnace, inasmuch as the arc becomes longer, and the pole is retired more and more into the crucible cover.

To melt a gram of steel in the electric furnace takes, it is calculated, 8100 heat units, which is within a fraction the heat actually contained in a gram of pure carbon. It results from this calculation that, through the use of the dynamo-electric machine, worked by a steam engine, when considered theoretically, 1 lb. of coal is capable of melting nearly 1 lb. of mild steel. To melt a ton of steel in crucibles in the ordinary air furnace used at Sheffield, from 2½ to 3 tons of best Durham coke are consumed; the same effect is produced with 1 ton of coal when the crucibles are heated in the Regenerative Gas Furnace, whilst to produce mild steel in large masses on the open hearth of this furnace, 12 cwts. of coal suffice to produce 1 ton of steel. The electric furnace may be therefore considered as being more economical than the ordinary air furnace, and would, barring some incidental losses not included in the calculation, be as regards economy of fuel nearly equal to the Regenerative Gas Furnace.

It has, however, the following advantages in its favor: 1st. That the degree of temperature attainable is theoretically unlimited. 2d. That fusion is effected in a perfectly neutral atmosphere. 3d. That the operation can be carried on in a laboratory without much preparation, and under the eye of the operator. 4th. That the limit of heat practically attainable with the use of ordinary refractory materials is very high, because in the electric furnace the fusing material is at a higher temperature than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it.

Without wishing to pretend that the electric furnace here represented is in a condition to supersede other furnaces for ordinary purposes, the advantages above indicated will make it a useful agent, I believe, for carrying on chemical reactions of various kinds at temperatures and under conditions which it has hitherto been impossible to secure.

DESILVERIZATION OF LEAD BY THE ZINC PROCESS.*

By J. E. Stoddart.

The treatment of argentiferous leads with zinc, for the purpose of extracting the silver and refining the lead, is by no means a novel process. About twenty years ago a metallurgist named Parks took out patents for desilverizing rich leads by means of zinc, and a manufacturing firm adopted his process. They were, however, subsequently obliged to abandon it, in consequence of the difficulty experienced in the separation of the zinc from the concentrated silver, to admit of the cupellation of the latter metal. A German chemist named Flach afterwards took up the subject, and by running the alloy of zinc, silver, and lead along with iron slag, through a peculiarly constructed blast-furnace, was enabled to free the concentrated silver-lead from zinc. He also proposed the use of this furnace for removing of traces of zinc from the desilverized lead, but this was abandoned in favor of the ordinary improving or calcining pan. The operation with the blast-furnace was found to be very troublesome, and as the greater portion of the zinc was entirely lost, was by no means economical. M. Manes, of Messrs. Guillem & Co., Marseilles, who were the first to work Flach's process, found out and patented a simple means of treating the alloy, and recovering the zinc by distillation. This is the process now in use and known as the Flach-Guillem process, and which is carried on in the following manner:—About 18 tons of "rich lead," containing generally from 60 to 70 ounces of silver per ton, are melted in a large cast-iron pot, to which 1 per cent. by weight of zinc is added, and the whole well stirred for twenty minutes. The fires are drawn, and the contents allowed to settle and cool until the zinc rises to the surface, and forms a solid ring or crust containing the silver and other foreign metals. This alloy is removed to a small pot at hand, where part of the lead is sweated out, and the alloy thoroughly dried. The large pot with the lead now partially desilverized is again heated up, and treated in the same way as before, but with the addition of only a half per cent. of zinc, which when it has risen to the top is removed as before, and dried. A third addition of a quarter of per cent. of zinc is found necessary to take out the remainder of the silver, care being taken, on the cooling of this zincing, that all the crystals are cleanly skimmed off. The lead in the large pot is assayed, and found almost always to contain less than 5 dwts. of silver to the ton of lead; if it should happen to contain more, it is due to carelessness on the part of the workmen. The pot is now tapped, and the lead run down into an improving pan, where it is kept at a high heat for nearly eight hours, for the purpose of oxidising or burning off the small percentage of zinc which is left in it from the zincing process; after seven or eight hours' firing in this pan it should contain no trace of zinc. It is then tapped and run into moulds for market lead, or for the manufacture of lead products. The old improving pans were made of cast-iron, placed on a bed of sand, with a groove in the upper sides, which groove was filled with bone-ash to prevent the action of oxide of lead on the iron. These pans, from the giving way of the bone-ash, and the great wear and tear on the iron from the high heats necessary, were found to be both troublesome and expensive; they were very often under repair, and seldom lasted more than six or eight months. They have been superseded by an improving pan of cast-iron lined with brick inside. This pan, instead of being placed on a bed of sand, as was the case with the old improving pan, is hung on brick walls, and is quite open both below and round the outside. This new pan has been working in the patentee's' works, Marseilles, for some years without any break down. It burns no more coal, and can be as economically worked in every way as the old pans. The zinc and silver alloy, after being dried, is melted in a plumbago crucible, covered on the top, well luted with fire clay, connected with a small cast iron receiver by means of a plumbago pipe, and fired up with coke. The zinc, distils over, and is condensed in the iron receiver. After all the zinc has been distilled, the pipe is disconnected, the cover removed, and the lead and silver, left in

* Read before the Philosophical Society of Glasgow, Nov. 8, 1880.

the crucible, is ladled out into moulds. Thence it is taken to the refinery, where it is cuppelled in the usual way. The block of metallic zinc recovered in the condenser is removed, and used over again in the first part of the process. All the oxide of lead and dross formed in the different processes are taken to the reducing-furnace, mixed with coal-dross, and reduced to the metallic state. The refuse from this furnace still contains some lead, and is put through the slag hearth, a blast furnace fired with coke, the fumes of lead oxides from which are condensed in what is known as Johnson's patent condenser, and are all recovered. The lead from the slag hearth, containing a number of impurities, as copper, antimony, iron, or sulphur, is taken to the improving furnace—a furnace built in exactly the same way as the dezincifying pan. About 20 tons of this lead are heated for a period generally from four or five days, but the time varies according to the amount of impurities present. The oxidised impurities, as they are formed, float to the surface, and are skimmed off by the workman, who is made to keep the lead perfectly clean, so as to have a fresh surface always exposed to the action of the flame. The dross skimmed off is first of a black color, but gradually becomes lighter as the operation goes on, until it shows nothing but yellow oxide of lead. When this appearance is noted the pan is tapped into moulds, or into the desilverizing pot, where it is treated with zinc, and the silver extracted as in the manner before described. By this process the lead can be desilverized and turned out in the shape of market lead in thirty hours from the time it is put in process ; the loss in working being not more than 1¼ per cent., and the amount of oxide of lead formed is very much less than that formed in any of the other processes, thereby effecting a very considerable saving in the working expenses. It makes an excellent quality of sheets, pipes, red-lead, and litharge, and has even been used for the manufacture of white-lead. There is, however, one product it cannot be used for by itself, and that is the manufacture of chemical lead. Your President gave us a very interesting paper on this subject last session, showing that the reason of its not being suitable for this was on account of its extreme purity. I understand that Mr. James Napier, Jr., of this Society, has made a number of experiments in the same direction, and found that by adding to it a small percentage of copper or antimony, or both, a good chemical lead can be obtained. That all the silver is thoroughly taken out may be seen from the fact that there is an excess of silver obtained on the large scale to the extent of nearly 2 per cent. over the assays. An analysis of the market lead gave—Antimony, 0.0015, and silver 0.0004 per cent., a trace of copper, but no iron or zinc ; from which it will be seen that the lead refined by the zinc process is almost chemically pure, and to this is due the finer quality of the products manufactured from it.

THE TERRESTRIAL PROGRESSION OF THE BRAZILIAN "CAMBOTA," *CALLICHTHYS ASPER.*

To the Editor of SCIENCE :—

Letters from Mr. John C. Branner, who was engaged upon the geological survey of Brazil under the late Prof. C. F. Hartt of Cornell University, contain extracts from letters to him from Mr. Joseph Mawson, Bahia, describing some habits of the siluroid fish, *Callichthys Asper*, there known as "*Cambota*." These habits have probably been observed and described already, but as they are not referred to in Günther's Catalogue of the Fishes in the British Museum the account of a recent observer may be interesting to the readers of "SCIENCE."

"During the rainy season the fish live in fresh water pools. When the pools dry up in the dry season, they bury themselves in the mud and remain there until the rains return the following year. They are noted for overland excursions. It is said that they are often met with going from one pool to another.

I have had six of the fish in a narrow-necked tin of water, with some sand and mandioca meal at the bottom, for five days, and they continue active and vigorous, especially the smaller ones. These examples measure from 5 to 10 cm. in length, and I have seen them much larger. I have had them out in the garden several times. I find that they move best on smooth damp ground, and are embarrased by sticks or other inequalities. They can jump a little vertically, but their progress on land is effected entirely by a quick wriggling motion of the body which is nearly flat upon the ground. The paired fins (pectorals and ventrals) are extended laterally, and seem to bear little if any weight; but they move slightly, and appear to serve to steady the body.

Last night I heard a peculiar sound, and on looking around I saw one of the fish travelling about the room. He had escaped from the tin which was in my bed-room, had fallen from the table to the floor, and travelled along the corridor, about 12 meters (about 40 feet) to the *sala*. I watched him travelling for two hours, during which time I estimate that he moved at least 90 meters. Toward the end of the two hours he seemed to flag a little, but in the earlier part his method and speed were fairly seen. He seemed to start with a sudden movement of the head or the barbels, then wriggled briskly for 5 to 10 seconds, advancing about a meter. Then he would rest for about 10 seconds, and start as before. This was kept up during the whole two hours, and I left him still moving. This morning, five hours later, I found him dead. While he was moving I spilled some water on the floor, but he crossed it ; hence I concluded that it was mud rather than water of which he was in search. The fish are eaten and considered good food."

It may be added that some examples of these fish were brought me by Mr. Branner, and found to be the *Callichthys asper*. The species of the genus are easily recognized from the fact that the trunk is covered by only two rows of large scales, a dorsal and a ventral series.

The ability of *Callichthys* to withstand a somewhat protracted deprivation of water, which it shares with other fishes of South America and India, with the North American Ganoids *Amia* and *Lepidosteus*, and with some other Ganoids and Dipnoans, is probably accounted for by the observations of Prof. Jobert of Rio Janeiro, published in the *Annales des Sciences Naturelles*, sixth series, V. and VII.

ITHACA, Dec. 21, 1880. BURT G. WILDER.

ASTRONOMY.

A PROBABLE VARIABLE STAR.—On Nov. 25, Swift's Comet was compared with the star No. 4339 of Lalande, by Mr. Talmage at Mr. Barclay's Observatory, Leyton, the magnitude of the star being estimated 8, as it was also by Lalande. Argelander in the *Durchmusterung* gives it 6.4 and Heis made it a naked eye star 6.7, but erroneously identifies it with Lalande 4359. It escaped observation in the Bonn Zones and may be worth occasional examination as likely to prove an addition to our variable star list.—*Nature.*

WINNECKE suggests that Hartwig's Comet is identical with the comets of 1382, 1444, 1506, 1569 and that it therefore has a period of 62⅓ years.

THE asteroid picked up by Peters on Oct. 10, is identical with that discovered by Palisa on Sept. 30.

M. TRIPIER is expected to take charge of the Observatory of Algiers in April, 1881.

DR. COPELAND at Dunecht, using Prof. Pickering's device of a prism introduced between the eyepiece and