fecting the theory of the motion of the moon, it is necessary that a considerable number of auxiliary observations should be made. These, it is proposed, should be made at the Natal observatory with the greater facility, as all the lengthy mathematical analysis necessary for their reduction has already been executed by Mr. Neison himself. The principal subjects already taken up at the observatory are the following: —

1°. The determination of the exact amount of the parallactic inequality in the motion of the moon by means of observations of the position of a crater near the centre of the lunar surface.

2°. The determination of the exact diameter of the moon by observations of pairs of points near the limb.

3°. The effect of irradiation and its variations upon the apparent semi-diameter of the moon.

4°. The systematic variation in the apparent place of the moon produced by the irregularities on its limb.

5°. The real libration of the moon by a method independent of the errors caused by abnormal variations in the apparent semi-diameter of the moon.

The first investigation is in continuation of the one already commenced at the Arkley observatory, England, and will be carried out with the additional co-operation of the observatory of Strasburg, Germany. Arrangements are being made to obtain the co-operation of the Cape and other observatories in the investigation of other of the above subjects.

ECONOMY OF FUEL IN IRON-MANUFACTURE.

As the price of iron falls, every item in the cost of its production is more and more carefully scrutinized, — the quality of the ore, the cost of transportation, the labor used at the various steps in the process, the accessories and mechanical appliances, the rapidity of working, the quantity of fuel to the ton of pig-iron produced, and the cost of the fuel. Of all these, the cost and quantity of fuel used are, perhaps, receiving the largest share of attention from the iron-men just at present.

One coal-saving device is the Gjers soaking-pit. Formerly the huge ingots of steel from the Bessemer converter were allowed to cool, and were again heated before rolling them into steel rails. The efforts to roll them while still hot failed, owing to the fact that the core might still remain fluid while the outside shell of the ingot was cooling even below the rolling-heat. The Gjers soaking-pit is a hole in the ground, walled with bricks, in which the ingot of steel is placed until it has uniformly cooled to the rolling-heat, thus saving the reheating-furnace. It is claimed that the Gjers soaking-pit saves sixty-seven tons of coal to a hundred tons of rails. Again: at the South Chicago works the pig-iron is run directly from the blast-furnace into the Bessemer converter; while the usual practice in most works has been, and still is, to allow the pig-iron to cool, and to melt it again in a special furnace for the Bessemer converter.

The above processes save in the *quantity* of fuel; while, on the other hand, a large saving in the cost of fuel is looked for in the improved methods of coking and in the recovery of the valuable by-products. It seems quite generally admitted, that a good system of coking, which will save the tar-oils and the ammonia, will pay all the coking-expenses.

The great national economy will be better understood from figures. In the year 1880, in the United States, 2,752,000 tons of coke were produced from 4,360,000 tons of coal by the old-fashioned beehive oven. Two years ago the figures for Great Britain were 7,000,000 to 8,000,000 tons of coke from nearly 13,000,000 tons of coal by beehive ovens. This quantity of coke could have been produced by the Simon-Carvès system of coke-ovens from 10,000,000 tons of coal; effecting a saving of 3,000,000 tons, and also a saving of the coal-tar and ammonia by-products.

The beehive oven, which takes its name from its form, is a low, square chamber with dome-shaped top; has an opening for escape of gases at the top, and a door in the side through which to admit the air, to charge the coal, and to discharge the coke. The burning is regulated by opening and closing the side-door, and all the gases go to waste at the top. The Simon-Carvès system of ovens consists of a row of chambers side by side, with combustion-flues in the parting-walls and under the floors. The waste-gases are burnt in these flues, and liberate heat enough to distil the gases of the coal. These gases, before entering the combustion-flues, are passed through condensing-apparatus, where the tar and ammonia by-products are saved. The two ovens, therefore, work upon totally different principles. The beehive cokes by slow combustion, sacrificing a portion of the coal by the door, as well as the by-products: the Carvès simply distils. The beehive saves 60% to 65% of the coal as coke: the Carvès saves 75%. The beehive oven produces a very fine coke, in long, columnar, hard, silvery, porous masses: the Carvès gives a dark, dense, heavy coke. And it is here that the iron-master hesitates; for he likes the silvery, porous beehive coke for making iron, and does not yet accept the dense, heavy coke of the Carvès oven.

Jameson has invented an oven which is known by his name, and which is essentially a beehive oven, with a suction-pipe entering at the bottom instead of the roof-outlet for gases. The products of combustion are drawn by an artificial draught through the pipe; and, after being carried through apparatus for the condensation of the by-products, this gas is available for any purpose. The actual yield from a ton of coal has been estimated to be: sulphate of ammonia, 10 pounds; oils, 8 gallons; gas, 12,000 cubic feet; coke, 67% to 69%. The tar from this oven is lighter than water (specific gravity, .960), and consists mostly of oils, boiling between 250° and 300° C., of little value as burning-oils, and of secondary value as lubricants. Paraffine is present, and both toluine and xyline in small quantities, but no benzine. A portion of the oils breaks up into phenols, which, so far as investigated, give colors of little stability. Neither naphthaline nor anthracine is present, both valuable as sources of coal-tar colors; and, while this tar presents an attractive field for research, it is not of great value at present. On the other hand, the tar from the Simon-Carvès has a specific gravity of 1.20, is black and thick, rich in naphthaline and anthracine, contains benzine, toluine, xyline, and carbolic acid, and is free from paraffines. A good deal of benzol is supposed to be carried off and burned. Now, Mellor has recently patented a process for extracting benzol from gas by passing it up through an earthenware tower filled with broken glass moistened with nitric acid. Davis has also a process for refrigerating gases. Either of these processes, added to the present plant of the Simon-Carvès, would save valuable products for coal-tar colors.

It is generally the fate of new improvements, that some unforeseen difficulty stands in the way of immediate adoption. In this case the dilemma seems to be, that the iron-men say, give us beehive or Jameson coke and Simon-Carvès by-products, and we will embrace the improvement at once. But, while the Jameson coke is good, the by-products are not as yet of much value; and, while the Carvès by-products are valuable, the coke is not yet satisfactory. Improvements often are adopted partially, or in some modified form. So it appears to be in this case.

The furnaces at Gartscherrie, near Glasgow, Scotland, have for years been smelting with raw coal, allowing it to coke itself at the top of the furnace, thus losing all the by-products, and some of the coal itself. They have recently tried closing in the top of two of these furnaces, and conducting the furnace-gases through condensing-apparatus on the way to the boilers, hot-blast stoves, etc. They have been so much pleased with the result of the experiment, that they propose to apply the same improvement to the other eight furnaces. This arrangement will probably yield a much heavier oil than the Jameson oven, but perhaps not so heavy as the Simon-Carvès; and, as the coke is made within the furnace itself, it is hard to say just what its quality may be.

Report says that modified plans are being tried in still another way, and that the highly bituminous coals of Colorado are treated by a process of coking; and the derived gas is injected into the blast-furnace, and thus re-enforces the heat of the coke, which is mixed with the ore, as usual, and has thereby effected a reduction of 75% in the cost of the smelting.

R. H. RICHARDS.

THE FLORA OF LABRADOR.

THE list of the plants of Labrador published in the Proceedings of the U. S. national museum, vol. vi. pp. 126–137, is interesting as showing some facts of geographical distribution. Though the list makes no pretensions to being complete, still it may be considered that it represents the flora in a sufficiently complete form to allow inferences to be drawn from it.

There are enumerated, altogether, a hundred and sixty-one species and varieties. Of these, two, Ranunculus acris and Capsella bursa-pastoris, have been introduced from Europe. Of the hundred and fifty-nine left, a hundred, or nearly sixty-three per cent, are natives of Europe as well as of Labrador. Out of these hundred species, there are some having a more northern distribution than Labrador, and a few extend even to the Arctic circle. Many of them are marsh or swamp plants, or else live along the seacoast. The flora, as a whole, is most decidedly northern in its character.

Of the fifty-nine species not known to Europe, it is found that thirty-eight have a range to the northward of the 49th parallel, and that only about four (viz., Fragaria Virginiana, Kalmia latifolia, K. angustifolia, and Alnus serrulata) can be considered as southern forms. Of these, the first is 'rather rare,' the two Kalmias are found in 'ravines and near ponds in the interior,' while the last is found 'in ravines' and along the seacoast. The northern aspect of the flora is further illustrated by the following facts: —

The Ericaceae, an order most abundant in cold climates, has seventeen species; Rosaceae has eighteen species, ten of them belonging to the northern genera Potentilla and Rubus; Caryophyllaceae has eleven species and varieties; while the Labiatae has not a single one, the Borraginaceae has only one, Scropulariaceae but two, and Compositae is sparsely represented by four.

This last seems an especially striking fact, and is in accordance with what we might expect. We know that the order is largely a tropical one, and that probably the heat of the summer months in Labrador is not sufficient, and not long enough continued, to enable the plants to flower and fruit. Of the Leguminosae, there are only five species, four of them being European also; and this order may be regarded as being in the same category as the Compositae.

In a former article (Indigenous plants common to Europe and the United States, *Journ. Cinc. soc. nat. hist.*, iv. p. 51), I have endeavored to show that we must look to the north as the place of origin of many of our plants; and when we find that sixty-three per cent of Labrador plants are also European, and twenty-three per cent have a high northern range, some extending to Alaska and Greenland, we see further reason for the assertion. That many of these plants were at one time distributed all around the Arctic circle, there can be no doubt; and that they have been driven from their first homes by the excessive cold, and found suitable abiding-places at the south, must also be considered as an established fact. The agent in this pushing-southward of northern forms may be regarded as the glacial period, when the presence of the immense mass of ice on the continent caused the flora to continue to retire farther and farther south as the cold became more and more intense: when it mitigated, many of the plants returned north, and established themselves as near as they could to their original homes.

JOS. F. JAMES.