Thus we see that there is considerable influence exerted by the gaseous products of distillation on the composition of the gases produced by combustion.

(To be Continued.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

The Anthracite Iron Manufacture of the United States. Its improvement proposed.—BY H. FAIRBAIRN.

Often as the iron manufacture has been transferred from one nation to another, and frequent as these changes have become since the adoption of the principles of a scientific economy in the general manufacturing system of modern times—yet in no instance has so rapid a revolution taken place as that by which Scotland has become a country of first rate rank in the manufacturing of iron—and this by the mere invention of working iron furnaces with the heated blast of air. By this discovery, so simple in its principle, but so powerful in its consequences, has Scotland become the country in which one-quarter of all the iron consumed by all the nations, was manufactured in the late year of 1848—from the comparatively small quantity of 44,000 tons in the year 1836, the manufacture having advanced to 650,000 tons in the short period of eleven years, since the invention of Mr. Neilson has overcome the disadvantage of the inferior qualities of the coals of the region of the Clyde, and thus forced upon the knowledge of foreign nations that Lanarkshire which was once known only in the Rob Roy of the romantic pages of Sir Walter Scott—but now amongst the best known in the pages of the ledgers of the merchants of Boston and New York—and as sending out iron to be sold almost at the doors of the iron manufacturers of the United States.

But this instance of a conquest of difficulties by a scientific economy of materials, ought not to discourage, but, on the other hand, to animate the American iron manufacturer, in the contest for the possession of this first of all occupations for the realization of individual and of national wealth. Nature has done little for Scotland, but science has improved that little in a very memorable manner during the last few years; and nature, on the other hand, has done every thing for the United States, whilst science would appear to have been almost standing idle amidst an iron manufacture, fast sinking under the competition of the pig iron of Scotland, and the bar iron of South Wales.

And yet Wales is also an inferior country in a geological point of view, possessing only a stubborn siliceous carbonate of iron, and making bar iron deficient in the leading quality of malleability, unless with the addition of hematite ores from the extreme north of England, imported to Merthyr Twydfwell at a cost which is fatal to all profit in these times of extreme depression of trade. So great is the disadvantage of Wales in the poverty of the iron ores of the country, that the importation of hematite ores has sometimes been attempted even from Pennsylvania; and there is a gentleman residing at Barren Hill, about thirteen miles from Philadelphia, who has been concerned in the shipment of very numerous

cargoes of iron ore from that locality to the Dowlais iron works, which are the most extensive in South Wales.

Neither in Wales nor in Scotland is there any other advantage than in an economical management of the fuel required in the iron manufacture, by which, iron though inferior in its quality, can be sold at considerably lower terms than iron produced from the superior hematite ores of the United States.

For the known cost of producing a ton of pig iron, at the best situated iron works in Scotland, is £2 10s. sterling—free on board in the Clyde—and the cost of a ton of iron in bars is £5 15s. 6d.—free on board at Cardiff, which is the shipping port of the iron districts of South Wales. These are the prices at which a profit can be obtained, either in Scotland or in Wales, and they are about thirty per cent. below the prices at which iron can be manufactured in the average of the United States.

But some knowledge of the iron manufacture of Great Britain, with recent opportunities of comparison with the manufacture in Pennsylvania, causes the present writer to suppose that the disadvantages of the American iron manufacturer may be removed with less difficulty than is usually perceived amidst the exaggerated estimates which are so general in this country, of the manufacturing advantages of Scotland and of Wales.

For certain it is that the first of the requirements of a profitable iron manufacture, is iron ore of the best quality and the largest yield; and here immeasurable are the advantages of the iron regions of the United States. Science may do much against the deficiency and the dearness of fuel and of limestone, but inferior iron ores render a country peculiarly liable to the loss of the iron manufacture in modern times. The importance of the quality of the ores is seen in the compulsory importation of the iron of Sweden for the manufacture of steel in England, metallurgical skill having yet been unable to use British iron for the manufacture of steel of a satisfactory quality—whilst all the feudal poverty and darkness of Sweden have not prevented the sale, at enormous prices, of the iron produced from the calcareous and magnetic iron ores of the Dannemora mines. The same calcareous iron ores exist in Pennsylvania as in Sweden; hematite ores in every variety of argillaceous composition there are in the original mountains of Pennsylvania, and these mountains are at convenient distances from the coal fields in the centre of the State. One of these mountains the writer has visited recently, at Cornwall, in Lebanon county, where the extent, the variety and the richness of the hematite ores formed a scene of the highest interest to those who have been accustomed to the iron ores of the other parts of the world. And this is only one of the numerous similar inexhaustible accumulations of iron ore, which belong to the geology of the mountains of Pennsylvania, and which have been described in the various reports which have appeared from the Geologist to the State.

But the advantages arising from these rich deposits of iron ore, have been hitherto more than counterbalanced by the high prices of fuel in the iron manufacture of Pennsylvania—this being the principal cause of the inability of the American iron master to compete with the iron manufacturers of Scotland and of Wales.

The fuel of Pennsylvania is almost exclusively anthracite coal, for the

purposes of the iron trade; for though charcoal furnaces still remain in existence, they are now few and far between. Pennsylvania resembles any European country in the disappearance of the natural woods, and the expense of raising timber for fuel, can no more be borne in Pennsylvania than in any of the countries to which the iron manufacture has been lost by the exhaustion of the woods, and the deficiency of the substitute for charcoal in any of the varieties of coal.

In the incombustibility of anthracite coal, or in the comparative incompleteness of the combustion which has yet been obtained in the use of this variety of fuel, is the marked and undoubted disadvantage remaining to be overcome by the iron manufacturers of the United States. Iron manufactured from this fuel, is manufactured at four times the cost of the fuel in the form of coke, in Scotland and Wales.

But here it may be well to compare generally the cost of the materials of the iron manufacture in Wales, and in the United States.

In the published evidence taken before a committee of the House of Commons in England, the details of the manufacture at Merther Tydwel are given by Mr. Anthony Hill, of the Plymouth iron works, a gentleman of great eminence in the iron trade of Wales.

After describing his production of pig iron at 27,000 tons per year, the witness is asked to state the quantities of ironstone, coal and limestone required for the production of a ton of iron in bars, and answers:

"The proportion of ironstone is about $3\frac{1}{2}$ tons; coal about $2\frac{1}{2}$ or 3 tons, and of limestone about 15 cwt."

Next Mr. Hill is asked the general price of ironstone? Answer:

"It varies in different situations—from 10s. to 11s. per ton."

"What is the price of coal?"

"About 3s. per ton."

"What is the price of limestone?"

"About 2s. per ton."

These are the proportions and the cost of the materials in Wales, and estimating the known corresponding proportions and costs in Staffordshire and Scotland, they form a true average for Great Britain at large.

The similar estimates for Pennsylvania are about an average of $2\frac{1}{4}$ tons of iron ore at \$2.25 per ton; 2 to $2\frac{1}{2}$ tons of anthracite coal at \$3 per ton, and 1 ton of limestone at 75 cts. to \$1 per ton. These proportions and prices being taken for the best situated works at this time in the United States.

There is, consequently, an advantage to Pennsylvania of about \$3 in the expenses of the iron ore, but a disadvantage of \$7 in the value of the coals; whilst the limestone, though dearer in money, is better in quality in Pennsylvania than in Wales—and this material may be taken as of the same value in both countries—leaving the principal disadvantage of the American iron manufacturer most distinctly apparent in the higher price of the anthracite coals, than of the bituminous coals of Wales.

Some difference there is in favor of Great Britain in the expenses of the labor about the furnace; but labor may be yet largely saved in the iron manufacture of Pennsylvania, where the labor-saving spirit of the country has not yet been in the same operation as in the cotton and other important manufactures of the United States. But with the difference of \$7 in the

cost of fuel, which is 30 per cent. on a ton of pig iron against it, there can exist no probability of a profitable iron manufacture in the United States.

And the same disadvantage has followed the manufacture of iron in the country of its commencement with anthracite coal—which is South Wales—where the hot blast was invented and patented for this purpose by Mr. George Crane.

But Mr. Crane is dead, and this worthiest of men, and personal friend of the writer of these observations, died unrewarded in any manner with the anticipated wealth to be derived from a patent which formed the subject of so much interest in the manufacturing world of a few years since. Nor has the anthracite iron manufacture been generally profitable to any of those enterprising capitalists who hurried into the trade on the announcement of the successful application of the hot blast at the Ynishedwen iron works in Wales.

Of 23 blast furnaces which were in operation in 1847, none could be made to produce more than 50 tons of pig iron per week, with the same steam-power, labor and other expenses, with which 90 tons could be produced by the use of the ordinary coal which Mr. Anthony Hill uses at the Plymouth iron works—which is the same as the bituminous coal of the great seam at Merther Tywydwell—or the coal of the western side of the northern coal field of Pennsylvania, as analysed by Professor Walter R. Johnson, and as described in his celebrated report to Congress on the various coal fields of the United States. The intractability of anthracite coal has been too insufficiently overcome by the use of the hot blast, and though in the years 1846 and 1847, when the railway mania in England caused iron to advance to excessive prices, and excessive prices to follow in the United States as the usual consequence of the high prices in England, iron, however expensively manufactured, was every where profitable in that period of speculation in the trade, yet in the subsequent and the still existing state of prices, fallen to the lowest point of production, there is found to be no more vitality in the anthracite iron manufacture of Wales, than in that of the United States.

The question then arises in this state of the iron manufacture—can this difficulty be overcome, of the incombustibility of anthracite coal—and as the hot blast has not reduced the quantity of anthracite sufficiently to allow of a profitable iron manufacture, can chemistry do anything further in the use of a fuel which alone is available for the production of iron in the United States?

This can apparently be done with great ease. The completion of the combustion of anthracite coal can be managed by still simpler means than even the hot blast of air—by the alteration, only, of the manner of filling the iron furnaces with anthracite coal.

The existing mode of filling iron furnaces, even with coke or with charcoal, is sufficiently rude and unimproved amidst the chemistry of the time; but still iron can be produced, although tons of material are thrown into the fire in a confusion which wastes the power of the steam engine in forcing air through solid masses of materials which ought to be more regularly given to the action of the blast; whilst coke and charcoal are, moreover, very much more penetrable than anthracite coal—for anthracite coal is charcoal in another and a harder state—it is the same substance, but of a

greater specific gravity, both charcoal and anthracite being pure carbon, with the exception only of the foreign and earthy matters which they may chance to contain, or as they are in a pure or an impure state. The best quality of anthracite is the purest of all the varieties of fuel, vegetable or mineral; it ranks next to the diamond in the mineralogical order of carbonaceous substances, and in the collection of minerals in the British Museum in London, in the diamond case, there is one piece of coal on which is labelled "Anthracite from Pennsylvania;"—this specimen of diamond anthracite bearing the appearance of being from the centre of the vein of the southern coal field of the state. It therefore surpasses charcoal, and very greatly surpasses that other description of charcoal, which coke may also be termed, but always with large additions of sulphurous and other impurities—and as a material of fire, anthracite has no equal where its heat can be brought fully into use.

But to bring anthracite into full use, it must be fully brought into contact with the blast of the iron furnace, and therefore with the oxygen contained in the air; and this process is entirely reversed in the mode in which anthracite is thrown into the iron furnaces of the present time.

The old and rude mode of filling in the charges—which is in barrow loads of about 6 cwt. of mine, and 6 cwt. of coal—is that which is universal at the anthracite iron furnaces, with limestone in quantities excessive beyond all knowledge of any practice in making iron in any other part of the world.

Here 6 cwt. of anthracite coal is thrown upon the furnace in a single mass, and the coal is always in its original form, unbroken, and as coming direct from the mines. The largest coal is universally preferred by the anthracite iron manufacturers, on the fatally erroneous supposition that the longer "it stands the blast," the more heat it must be giving out; whereas it is clear that the object to be attained in all smelting is to bring out the heat in the shortest time, and by the smallest expenditure of steam power for the blast, and of furnace room and labor for the process; and in proportion as the combustion is rapid, the greater quantity of metal will be made.

It is therefore proposed to reverse this practice of filling furnaces with anthracite in its largest form, and to fill the fuel in the form of broken coals, as stove, egg, nut or pea coal, or even with anthracite ground into the size of coarse gunpowder—there being no limit to the intention in view in the proposal for its reduction and disintegration, other than the mere mechanical difficulty in its fineness being such as that the dust would be rejected by the blast.

The reasoning on this proposal is, that anthracite is less easy of combustion than its equivalent in charcoal, only because it is a harder substance—the difference being mechanical only—the fibrous texture and less degree of compactness of charcoal, admitting the entrance of the fire to its contents more readily than will the amorphous texture and greater degree of consolidation possessed by anthracite coal. Hence, to procure the admission of the fire equally to the intercal substance of charcoal and of anthracite coal, is to render their combustion equally easy and equally rapid, and to bring out the same quantity of heat from equal weights of charcoal and of anthracite coal.

But as used at the present time, four times the quantity of anthracite is required, in weight, to produce the effect of charcoal in an iron furnace—and 10 cwt. of charcoal will make the same number of tons of pig iron for which two tons or more are required in the form of anthracite coal, although in theoretical chemistry their heating powers are the same, in equivalents of weight.

The difference in practical production of heat is clearly to be found in the easy combustion of charcoal, as a soft substance, which is never thrown into the fire in large masses, and is therefore more readily surrounded, attacked, and consumed by the fire; and by reason of its smaller volume, is in more direct contact and interminglement with the ironstone and the limestone—which therefore receive the heat more rapidly and more completely than by the same process as now conducted with anthracite coal in lumps of a ten-fold size, as compared to the dimensions of the pieces of charcoal generally in use.

The 10 cwt. of charcoal is manifestly thus consumed for the full purpose of giving out its heat to the other materials, iron ore and limestone—and this could be still better accomplished were even the charcoal reduced to smaller dimensions, and the feeding of the furnace managed for the production of a still closer intermingling of the various materials in the flames.

But 6 cwt. of anthracite coal is now thrown upon the same furnace in the largest blocks—or much of it in that state—and it is always thrown in at once, and forms a layer of material of an impenetrability which accounts sufficiently for its slower combustion than charcoal, and for the less effect in the quantity of metal which it can be made to produce. For an examination of the cinder heap of any anthracite furnace, will show that nearly one-quarter of all the coal has passed through the furnace entirely unconsumed beyond a slight incineration of its external surface—on fracture, this waste anthracite disclosing its interior entirely untouched by the fire. It is estimated that one-fourth or one-fifth of all the anthracite is lost in the lumps which are thus lying around the furnaces in the cinder heaps and waste of the works.

Another large portion of the anthracite is lost to all but its least effect in the furnace, by falling down against the walls of the furnace, and being there consumed in the least degree of contact with the iron ore and lime, this being a double source of loss in the coal which is burned against the walls, and in the rapid destruction of the brick work from that cause. This is the only reason why anthracite furnaces are so much more rapidly burnt out than those in which charcoal or coke is in use—the best of the anthracite being misdirected from that mere mechanical cause of the weight of the blocks causing it to roll down against the walls.

Since to this crude and chance medley filling of the anthracite is principally owing the waste of so large a portion of the fuel, in the contrary practice of filling the coal in a broken form, and more in juxtaposition with the iron ore and limestone, must the remedy be found for this extensive waste of the fuel of the anthracite iron furnaces of the United States.

As the machine called the coal breaker was invented for the preparation of anthracite for stoves and domestic use, so it is only required to extend its use and operation to the preparation of the same fuel for the iron

works of the country, there being no more reason for the use of large masses of coal in iron furnaces than in ordinary fire places, the furnace being only a fire place on a greater scale.

The burning of anthracite in the reduced form, allows of its combustion being equally rapid and complete with that of charcoal; for the substance and atoms of the anthracite can be thus exposed to the fullest action of the blast; in proportion to the smallness of the particles of coal will be the admission of the air and oxygen to its surface in the greatest number of directions—and anthracite may, even as dust, be rendered still more combustible than charcoal, which is not in a state of equally minute disintegration, for in dust, anthracite may be rendered capable of a combustion which shall be instantaneous, and instantaneously complete.

There is then no difference between anthracite coal and charcoal when the carbon of each can be brought into equal degrees of contact with the flame, and this is only a mechanical difference, which is effected by the reduction of the harder anthracite coal.

But the anthracite could not be used in the smallest form if filled in with barrows and in the great weights at once, which is the existing practice in the trade. For a mass of 6 cwt. of small coal would fill up the interstices of the furnace, and prevent the admission of the blast, thus “gobbing the furnace,” in the phraseology of the people of South Wales.

Therefore the furnace is proposed to be filled in small, regular, and unvarying quantities—the use of the barrow system of filling being supposed to be abandoned, and the coal to be thrown into the furnace by shovels, the filling to be continuous, and the distribution of the coals equal over all the surface of the fire; or if shovels be not preferred, a hopper, slide, or shute to be used for carrying down the coals into the furnace, a plan which is already not unknown at some few of the iron works of Scotland and Wales.

The most complete mode of filling an iron furnace would undoubtedly be by inserting all the materials down hoppers or shutes, for the purpose of producing the most complete intermingling of the coals, iron ores and limestone; and therefore the most rapid and complete giving out of the heat of the coals to the interlying other materials, all the materials being broken to the smallest state. By three several hoppers meeting in one, or by the previous intermingling of the materials for a single hopper or shute, would the combustion of the fuel be completed the most fully for the purpose of giving out its heat and melting effect to the surrounding iron ore and lime. The fall of the materials might be managed to be continuous, from a receiver to the hopper or hoppers, and to resemble the falling of sand through an hour glass, the quantities to be increased, diminished, or suspended by the simple means of a slide or stopper which applies to machinery of such a kind.

By such a mode of filling furnaces, the utmost economy of materials would be effected; the most complete combustion would be ensured; the escape of the carbonic acid gas would be facilitated; the utmost uniformity would be procured in the working of the furnace, and the greater part of the labor of filling would be saved by the machinery, which would do that labor in a manner so much more economical, and so much more complete.

Hence three quarters of the anthracite would be saved were this mode of bringing out the carbon of the coal successful in practice, as it is theoretically probable of such a result; and against the saving of so large a portion of the cost of manufacturing iron, there would only be the trifling difference of about 25 cents per ton as the higher prices of broken anthracite, than of the coal as in use at the present time.

And then follows the equally extensive saving of steam power, furnace room, labor, and other general expenses now wasted in producing little more than one-half of the quantity of iron, as by coke or semi-bituminous coal. For if only one-quarter of the quantity of anthracite were thrown into the furnace, and that quantity were consumed in one-quarter of the time, it might follow that a three-fold quantity of iron would be made in the same time.

Such and so extensive may be the results of so simple a proposal as the use of broken anthracite coal in the manufacture of iron—that which has been commenced by the heating of the air, being hoped to be completed by the breaking of the coals.

Were the full heating powers of anthracite in this or in any other manner produced in our iron furnaces, it follows that the principal difficulty would be overcome in Pennsylvania, and that a flourishing iron manufacture would be established by the reversal of the expenses of fuel—which being now adverse by 30 per cent. would become favorable in the same proportion, and this would alone render the United States at once independent of further supplies of iron from any other part of the world. And with the further saving of furnace room, steam power and labor, it is probable that the increased make of iron would create a further saving, which would render the total difference an average of nine or ten dollars per ton, or one-half of all the expense of making iron at the present time in the United States.

After these considerations of the iron ores and the fuel respectively of Great Britain and of the United States, it is proposed to compare further the remaining ingredient of the manufacture—the limestone—in its qualities and the proportions of its use in the trade.

Here another very extensive saving would appear to be practicable in the iron manufacture of the United States.

What is the purpose for which limestone is thrown into an iron furnace? is a question which may be asked from many iron manufacturers, who will only reply that limestone is a hot substance—that Mr. Perry always said that you never could use too great a quantity of it in an anthracite iron furnace, and that too much limestone is always an error on the right side.

But the true and only purpose of limestone in the manufacture of iron, is to carry out of the furnace the argillaceous or other earthy remains of the process of melting, which float upon the surface of the metal, which has been precipitated into the hearth by its weight being greater than that of the earth from which it has been disengaged. Argillaceous matters are found to flow with difficulty from an iron furnace, but when mingled with lime a compound is formed which flows with facility in the form of marl—and the true cinders of an iron furnace ought to display on fracture the appearance which belongs to marl when cut by the spade. There is no other reason for the use of limestone in an iron furnace, and

the quantity to be used must be determined by the quantity of argillaceous matters with which it is required to combine—and therefore by the quantity and the quality of the iron ore in use.

And it was shown before in the evidence of Mr. Anthony Hill before the English Parliamentary committee, which we know to be true of other iron works in Great Britain, that the quantity of limestone there in use is 15 cwt. to $3\frac{1}{2}$ tons of the iron ore of Wales.

But at the anthracite iron furnaces of Pennsylvania the proportions are an average of 1 ton of limestone to $2\frac{1}{2}$ tons of hematite iron ore; at some iron works the limestone being used in even greater than that proportion of 1 to $2\frac{1}{2}$ of hematite ore.

The ores of Wales produce an average of 30 per cent. of iron, and 50 per cent. of argillaceous matters, the remainder being the carbon, water, and other matters which may be drawn off at the tunnel head. On $3\frac{1}{2}$ tons of iron ore, the argillaceous remains are therefore $1\frac{3}{4}$ tons—and for the taking up and carrying away of this quantity of earth, 15 cwt. of limestone is all that is used in Great Britain, and there the limestone is never so pure in quality as in the hematite regions of the United States.

The ores of Pennsylvania contain 50 per cent. of iron, and 30 per cent. of argillaceous matters, the remainder being the oxygen and water which are dispersed on combustion at the tunnel head. Therefore, in $2\frac{1}{2}$ tons of iron ore, the earthy remains are only 16 cwt. as compared to $1\frac{3}{4}$ tons in Wales.

Thus there is an excess of one-quarter of limestone used in Pennsylvania, to take up only one-third part of earthy remains—and three-quarters of the limestone is therefore wasted at the anthracite iron works of the United States.

An examination of the cinder embankments of the various anthracite furnaces, will show this result, in the color of the cinder, three-quarters of which will be found to display no argillaceous matters in combination; it is the same substance as when thrown into the furnace at the tunnel head; and it has been in the fire for no other purpose than to be run out again, after wasting coals, furnace room, steam power and labor, in order that it may now be encumbering the ground around the works. In the remaining quarter of the cinder the true marl will be discovered on fracture, and by this quantity the operation has been solely performed of bringing away the argillaceous contents of the ore.

And considering that the limestone of Pennsylvania is usually of almost perfect purity, whilst the limestone of Great Britain is usually of considerable impurity, and therefore that the capacity of the American is greater than the British for combining with the argillaceous matters of the iron ore, it is probable that the quantity required in Pennsylvania could be reduced fully three-quarters from the quantity now in use. When the cost of the limestone, the loss of the furnace room, steam power, labor, and haulage of the cinders are estimated in this manner, it is probable that about \$3 per ton of pig iron could be saved in the limestone thus wasted in the anthracite iron furnaces of the United States.

Such and so vast may be the savings in the iron manufacture, should practice confirm theoretical suggestions respecting the materials which form the principal expense of the trade. Many other considerations there are occurring to a stranger in Pennsylvania, but certain it would appear

to be, that an independent and most extensive and profitable iron manufacture can be established in the republic, notwithstanding the present declining state of the trade by reason of the opposition of Scotland and of Wales. Though iron be now made in Scotland at 30 per cent. less money than in Pennsylvania, it may come to pass that Pennsylvania may make iron at 30 per cent. below the prices now paid in Scotland or in Wales.

And this will be the better event for the world at large. The iron manufacture is the foundation of all the arts of civilized existence. All nations should be able to furnish iron for themselves, for this metal is so indispensable that Sir Thomas Moore does not say too much in ranking iron as second only to the water that men must drink, or to the air that we must breathe; and a monopoly of iron by one nation is only less to the enslavement of the others, than though one alone possessed water to be sold to the remainder of the world. This is seen in the overwhelming wealth of England and the excessive poverty of Ireland, which is only produced by the coals and iron of England, and by the unfortunate deficiency of Ireland in coal fields worthy of the name. Ireland being therefore possessed of no iron furnace, and no one important manufacturing town, and thence its unemployed population, and the violence and desolation of that most miserable of lands. But when such inventions as the hot blast have produced consequences so extensive and so rapid in Scotland, it is not certain that the iron ores of Ireland may not be brought into profitable use in the early progress of the economical science of the present time. Equality of nations, as equality of individuals, is for the benefit of all; and though it is not desirable, and is not probable, that even all the superior advantages of the central State of the American Union, should enable iron to be sent to Scotland or to Wales, or do more than exchange the malleable bars of the Juniata for the hard railway iron of Wales, or for the fluid pig iron of the Clyde—yet are all the materials of the foundry and the forge to be seen by the eye of the traveler in the utmost profusion, for future generations, who shall live amongst the dark blue outline of the mountains of Lebanon and the Juniata; and the neighboring carboniferous mountains of the Schuylkill, and the counties in that fortunate quarter of the republic of the United States.

March 7th, 1849.

Note upon some phenomena of Binocular Vision. BY MM. FOUCAULT AND J. REGNAULT.

Translated for the Journal of the Franklin Institute.

MM. Foucault and J. Regnault have presented to the Academy of Sciences of Paris an account of some ingenious and beautiful experiments made by them, for the purpose of determining whether when the two fields of sight, or the corresponding portions of the two retinae, were simultaneously impressed by light of different colors, a sensation of the compound color was produced. Mr. Wheatstone had affirmed that it was not—the general impression among observers appeared to be that it was. The instrument employed in this experiment was Mr. Wheatstone's stereoscope,