nitrogen and oxygen have never been recognized by spectral analysis of the sun or the stars, the existence of the former gas has been determined to be probable in the nebulæ,and the latter is found in meteoric stones which are almost entirely composed of terrous oxides. Hydrogen is present everywhere; carbon has not been found by spectrum analysis, but is readily recognized in the carbonaceous meteorites. Calcium, and hence lime, is largely disseminated; iron is everywhere,while Janssen's curious absorption spectrum indicates the vapor of water in the atmospheres of many celestial bodies. Closer investigation, however, shows that these chemical conditions are confined within narrow bounds,that the formation of planets at the expense of the central mass is governed by mechanical causes quite independent of such conditions, so that it cannot be concluded a *priori* that the planets necessarily possess the required atmospheres. While, on one hand, the analysis of meteorites appears to show that these bodies are formed in a medium slightly rich in oxygen: on the other, it is evident that free oxygen cannot result but from an excess of the gas over the hydrogen absorbed in the formation of water. Atmospheres of other worlds then are formed poor in oxygen or else totally free from it, and, like those of Jupiter, Saturn, and Uranus, as proved by the spectroscope, are composed of vapors or gases which exercise an absorption unknown to our world.

The further progress we make into the domain of natural science, as applied to the heavenly bodies, the further away from us the apparent probabilities of life existing thereon seem to recede. The recent discoveries of the spectroscope only prove the necessary conditions encompassed by still closer limits; and so far from being able to admit that they are naturally everywhere realized, we are barely able to cite two planets of our system,other than our earth, where such conditions have any shadow of probability of existing; while on the only globe of which we can speak with certainty, the moon, we know them to be utterly absent.

IMPROVEMENTS IN SUGAR MAKING.

The methods of purification employed in the sugar industry depend almost entirely upon the action of lime and the elimination of that alkali by carbonic acid. These processes leave,remaining in the saccharine products,a certain proportion of organic matters and mineral salts which oppose to a certain degree the crystalization of the sugar, while also causing the formation of molasses and the mingling of the sugar with the residue. M. P. Lagrange has recently devised a method which is based on the elimination by the joint action of baryta and phosphate of ammonia of the organic salts of lime,of certain vegetable acids combined with potash and soda, and of the alkaline sulphates existing in the sugar products. By this process, without the aid of lime or salts of lime, and while causing the eliminations as above noted, M. Lagrange believes that he is enabled to produce the products, and to secure the best conditions of alkalinity, without forming glucose at the expense of crystalizable sugar. In factories,therefore,devoted to the manufacture of cane sugar, it would seem that this improvement is of considerable importance as doing away with the serious difficulties and large losses due to the glucose formation and the lime salts.

The purifying process generally in sugar manufactories is applied to sirups of 20° Baumé, which have already been submitted to the calco-carbonic treatment. The products being led into a serpentine or double bottomed boiler, phosphate of ammonia is introduced in proportion to the lime, of which the quantity has been determined by hydrometric analysis, so as to leave in the sirup but a thousandth part of lime absorbable by the black; then the baryta is added, in such proportion to the sulphates and organic matters that the sirups will eventually contain but one one-hundredth part of matters still precipitable by that substance. The whole is then boiled,filtered, and carried to the coarse black, leaving in the receptacles a residue which constitutes a most valuable fertilizer.

In refineries where the purification is made in the boiler where the crude sugar is melted, dissolved phosphate of ammonia is substituted for fine black and blood in such proportion to the lime as to leave a hundredth part of the alkali,which the black totally absorbs: the baryta solutionis next added, in such proportion to the alkaline sulphates and organic matters contained as that but the quantity of alkali necessary for the easy maintenance of the alkalinity up to the molasses will remain. To obtain the best results, experience has proved that,for a sample of sugar indicating 88°, the proportion of phosphate of ammonia crystalized per 2,200 lbs. of sugar is 1·6 lbs., and that of the baryta, per same weight of sugar, is 6·6 lbs., using the hydrate of 10 equivalents of water.

The mixture after melting is boiled, when the precipitate swells,and a clarification ensues,comparable to that obtained with blood albumen. The sirup is then treated as in the instance already cited, and the residue from the filters is also applicable for fertilizing purposes. The products of establishments using the process are said to be largely increased.

In connection with the subject of sugar manufacture may be noted an important invention recently patented by M. Marguerite (represented in this country by Mr. Edmund Ratisbonne, 48 Broad street, New York city), through this office, for obtaining sugar from molasses by the addition to the latter of certain salts which provoke crystalization. The processis said to beespecially valuable in treating third qualitysirups as well as molasses. The operation consists in adding to the spent molasses(containing,say, fifty per cent of sugar, fifteen per cent of salts, and twenty per cent of water) crystalized sulphate of magnesia in the proportion of twenty per cent by weight, together with a little water to make a solution of the sulphate marking 100° Baumé. The whole is then subjected to centrifugal action in a machine having either perforated sides or very fine wire cloth. The sulphates of lime and potash precipitated are retained and the liquor is then filtered through charcoal and boiled *in vacuo*. After cooling, a certain quantity of pounded sugar is added to form nuclei and the sirup is lastly subjected to the ordinary temperature of fillings, the heat being alternately raised and lowered.

After a few days,crystalization becomes exceedingly abundant and continues to increase for some time, after which the hydro-extractor is employed. Other salts, such as sulphate of soda, sulphate and chloride of magnesium, chloride of manganese, sulphate of iron and zinc and their chlorides, and also the acetates, nitrates, and ammonia salts, though these are not so desirable, may all be used instead of the sulphate of magnesia, the proportions of which vary according to the nature of the molasses and the results of expense.

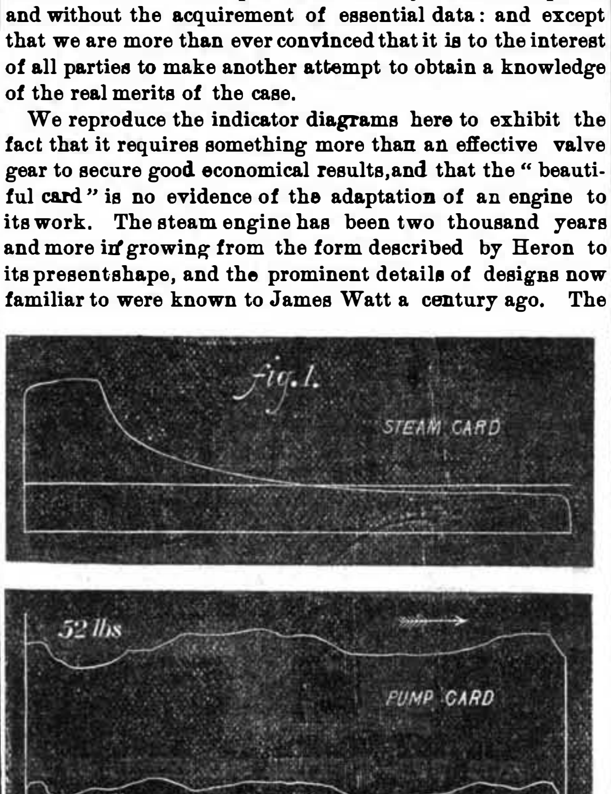
The crystalization of the sugar results from elimination of the potash, the salts of which are prejudicial, its place being taken by the magnesia, whose salts are favorable thereto. This invention we believe to be one of considerable importance in an economical point of view, and hence perhaps worthy of the closer examination of sugar manufacturers generally.

PUMPING ENGINE ECONOMY.

A *soi-disant* "practical friend" writes us a note, referring to an editorial of March 2 (page 176 of our current volume) commenting upon that "Remarkable Report about Remarkable Pumping Engines," in which he informs us that the Providence pumping engines "were overhauled and boilers cleaned just previous to the two million gallon test," that indicator cards were taken, that the coal was screened, and that a maximum duty test could not be made "owing to causes still unexplained." He thinks that a different method of testing might have given a more satisfactory result; "but that there are many points, not embodied in the report," which influenced the decision of the board of experts. He encloses several of the indicator cards taken, a set of which we here reproduce as illustrating the peculiarities of the two styles of engine, the one being the representative of the standard drop cut-off single cylinder engine and the other being a good representative of rather conservative practice in the construction of "compound" engines.

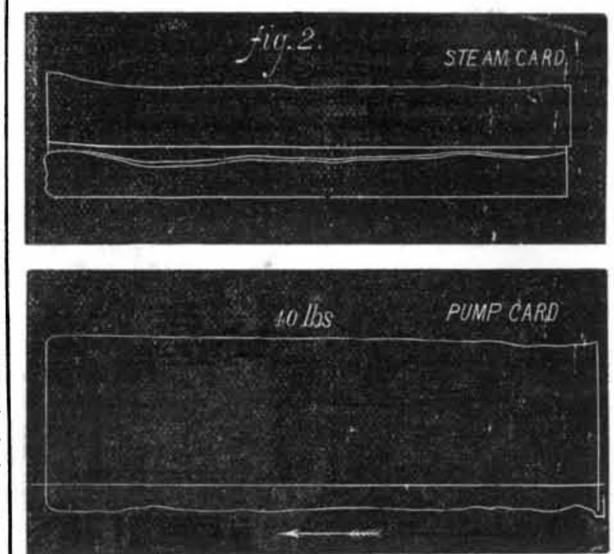
We based our remarks and strictures upon the report of the board, which we found published in the Providence *Journal* of March 2, in which the statements occur that: "The coal was not selected for any supposed superior quality, and was consumed just as it came from the yard without screening, picking or other special preparation," and "the engines and boilers, in both cases, were taken just as they were found, without any cleaning or other preparation." No mention, as we have already remarked, was made of indicators being applied to determine the cause of the low duty obtained. We have no reason to change our views as already expressed, views which we find expressed quite as strongly in the editorial columns of the *Engineering and Mining Journal* of subsequent issue and contemporary date. We have nothing to add: except that we are pleased to know that the examination was more complete than we had been led to suppose, and regret that the board should have rendered a report apparently inconsistent with the results, and that they should have allowed themselves to report at all before "circumstances permitted" a duty trial at full power and without the acquirement of essential data: and except that we are more than ever convinced that it is to the interest of all parties to make another attempt to obtain a knowledge of the real merits of the case.

We reproduce the indicator diagrams here to exhibit the fact that it requires something more than an effective valve gear to secure good economical results,and that the "beautiful card" is no evidence of the adaptation of an engine to its work. The steam engine has been two thousand years and more in growing from the form described by Heron to its presentshape, and the prominent details of designs now familiar to were known to James Watt a century ago. The



problem of designing a good engine for any special purpose is still the most important and most difficult presented to the engineer; and we doubt if one in a hundred of those who attempt it are capable of doing creditable work. Indeed we believe that the number of engineers who are really familiar with the essential conditions of success might almost be counted on the fingers, and we are always distrustful of those who are most confident of their own powers as designers of steam engines.

In Fig. 1, we have copied the steam cylinder and pump cards of the Corliss, and in Fig. 2, those of the Worthington engine.



In the Corliss engine, steam is expanded from about one eighth stroke. In the Worthington there is no expansion by cut-off,but the ratio of expansion is the ratio of piston areas, —about three to one,—while the latter exceeded the former, on the two duty tests, by ratios of nearly two to one and four to one, respectively. The Corliss card is an exceedingly fine one, as exhibiting the action of the valve gear, but it gives no clue to the real value of the engine. The Corliss machine consists of five similar pairs of steam engines and pumps, coupled to one crank shaft; the Worthington was a single pair of cylinders, yet the pump card of the latter is beautifully smooth and far superior to that of the former. The vacuum on the steam card of the compound engine is better than on that of the single cylinder engine, as given by gage; but the difference seems less on the card. It is, however, sufficient to account for a part of the difference of duty.

The great causes of loss with the Corliss, we presume to be a short cut-off with low steam, large exposed surfaces in and outside the steam cylinders, and a boiler surface immensely disproportionate to the work done. This is shown to be the fact, also, by the evident tendency to equalization of efficiency at the higher duty test, and we are probably fully sustained in our demand for a careful test at full duty. We cannot understand yet why this was not made, and hope that we may be given good reasons for the neglect, if any exist.

The lesson taught by the affair,as it now stands,may be repeated in a few lines. It is as important for a designing engineer to know when expansion causes loss as to know when it may be expected to produce economy. It is important that the designer should understand the serious effect of external losses by conduction and radiation,and still more important that he should comprehend the nature and extent of losses by internal condensation and rëevaporation. It is important that an engineer should comprehend the necessity of making his boiler power just right, and that great losses will be incurred by error in making it either too large or too small for the work for which it is designed.

It is important that a constructing engineer should know that a loss of an inch or two of vacuum, a too tightly packed pump, or a leaky piston or valve, may destroy a hardly earned reputation.

It is important for the engine driver to understand these last points, and also that careless firing, an air hole or two, dead coals in the corners, or irregularity elsewhere, may mean a loss of very serious extent.

It is important that experts should understand all this, and many other matters not much less essential, and that they should: First, see what are the conditions under which the trial is to be made; secondly, see for themselves that everything is in order before commencing their test; thirdly, conduct the trial in such a way as shall reveal every defect and bring out every excellence of the apparatus tested; and finally, make a report that shall not only express their conclusions, but that shall enable all parties interested to see plainly the reasons thereof, and to judge for themselves whether the experts are experts, and whether their judgment is well sustained by facts,and is not warped by charity or prejudice.

A NEW disease to afflict horses and trouble their owners has appeared in New York and Brooklyn. It is called "pink eye," and appears to be a variation of the old epizoötic. The discharge in the epizoötic was from the nose; in "pink eye" it comes from the eyes, and for a time the horse becomes quite blind. It also causes a stiffness and swelling of the legs. The disease is not necessarily fatal,but minor diseases are superinduced by it. It is thought that the malady has been induced by the severe changes in the weather during the winter.

ALTHOUGH platinum is one of the heaviest of metals, yet its ductility is so great that Wollaston succeeded in drawing it into wire having a diameter of only one thirty thousandth part of an inch, a size so small that a mile length of the wire would weigh only one grain.

Car Axles and Bearings.

The *National Car Builder* states that, at a recent meeting of the Car Builders' Association, discussions took place in regard to Mundy's friction roller journal box. In this device the roller, six inches in diameter, turns on a solid spindle, the bearing of the roller being the whole length of the spindle. It was claimed that this was better than the ordinary plan of making the spindle and roller in one piece. The improved arrangement, it was claimed, provides a larger bearing, and prevents the escape of oil therefrom.

Mr. Garey described the following experimental tests which he had made of the power required to move cars with different sized journals: A passenger car with 3¼ inch journals, and weighing 44,674 pounds, required a force of 800 pounds, as shown by a dynamometer, to move it along a level track as slowly as the engine could be made to move. The car was in good running condition and the journals well fitted. Another passenger car, which was new and had run only 90 miles, weighing 46,770 pounds, and with 3⅞ inch journals, required just 700 pounds, as indicated by the same instrument, to move it on the same track and in the same way as the other; thus showing that 100 pounds less force was required to move the heaviest car with the large journals. Specimens of the Ainsworth friction metal bearings were shown, one of which was stated to have run 40,363 miles under a Pullman car without heating. The metal is claimed to be 25 per cent cheaper than brass, three times more durable, and requires 50 per cent less oil.

Mr. D. A. Hopkins called attention to the advantages of lead-lined bearings. They had been tried under heavy palace cars, and had run 58,000 miles without heating or wearing out. The lead should not be more than 1-16th of an inch in thickness; it then accommodates itself to the journal, and gives a true bearing; but if thicker, will be pressed out at the sides and ends.

Mr. Garey remarked that in the course of his experience he had heard much of the antifriction metals, but had rarely or never seen any. He did remember making a trial of one specimen, which, it was claimed, would run without any oil at all, and not get hot. And it did so for a considerable time, and then he had to throw it away. It was like the horse that undertook to live without eating; as soon as he got well under way, he died.

We understand that the metaline bearings, lately illustrated in the SCIENTIFIC AMERICAN, are to be tested on the cars of the Greenwich street elevated railway, in this city. This bearing, it will be remembered, is composed of compressed graphite and other substances, and runs without oil. In fact, oil is its worst enemy, for its presence quickly injures the metaline.

Improvement in the Manufacture of Beer.

The liability of beer to turn sour, ropy, etc., is due to the presence of special ferments derived from the air, and from the materials used. By boiling the infusion of malt and hops, cooling out of contact with air and fermenting with pure yeast in vessels to which only carbonic acid or pure air is admitted, a beer is produced of superior quality, which may be preserved without trouble for any time. Even a partial adoption of these precautions is attended with valuable results. In preparing pure yeast to start with, the author makes use of the fact that oxygen favors the growth of true yeast but hinders the propagation of the other ferments. Pure yeast being obtained, the beer is afterwards fermented in an atmosphere nearly destitute of oxygen, as its quality is thereby improved. Pure yeast when kept in pure air undergoes no change, even at summer temperatures. The *mycoderma vini* does not, as the author once thought, become changed in beer yeast on submersion in a nutritive fluid; under these circumstances it acts as an alcoholic ferment, but does not propagate itself.—*L. Pasteur.*

THE more machinery a nation has in operation, the more fully and profitably is its labor employed, the more rapid its material progress, and the more developed its civilization.

THE SEPARATION OF TAR AND THE MANUFACTURE OF SULPHATE OF AMMONIA FROM WASTE PRODUCTS.

The distillation of coal in closed receptacles, for the manufacture of illuminating gas, produces, beside the coke remaining in the retorts, tar and ammoniacal waters, which are collected in special apparatus, known as refrigerators and condensers. Large establishments have recently been erected in France for the purpose of obtaining these products in separate condition, in order that the coal tar may be utilized in the many ways now known to the arts, and the ammoniacal liquor chemically treated so as to yield merchantable sulphate of ammonia. Our engravings represent the principal portion of the extensive plant of the works, showing the apparatus for separating the substances and for subsequently extracting the salt above mentioned from the waters. The latter, when received from the gas house, are conducted into huge cisterns of masonry, A, in Fig. 1, situated as shown underground. Thence, by means of the pumps, B, actuated by the engine, C, the liquor is elevated to a series of large reservoirs, D F G, located in the upper story of the building. Reservoir D is subdivided by a partition into two compartments, into each of which the water successively passes. As indicated by the proportion of shaded lines in Fig. 1, the major part of the tar is deposited in this first reservoir; the water conducted by a surface pipe then enters the reservoir, F, leaving more of its tar, and is finally decanted into G in almost a pure state, whence it is drawn off by the pipe, L, into suitable vessels of a certain measured capacity. The tar that is deposited is removed from the bottoms of the reservoirs by the pipes, H I and K, the last two communicating with the pipe, H, which extends outside the building so as to deliver the tar into the vehicles designed to transport it to the factory where it is to be utilized. The total area of all the reservoirs, D F and G, is about 107 square feet.

In Figs. 2, 3, and 4, are represented end and sectional views of the distilling apparatus, which is composed of a double set of boilers and mechanism. G is the vessel which receives the decanted liquor from the reservoirs through the cock, *a*. A part of the water is thence directly conducted to the vessels, E, in which a quantity of lime is previously introduced, and in which is machinery for agitating the contents. Receptacle E is connected by tubes, M (Fig. 3), near the bottom,

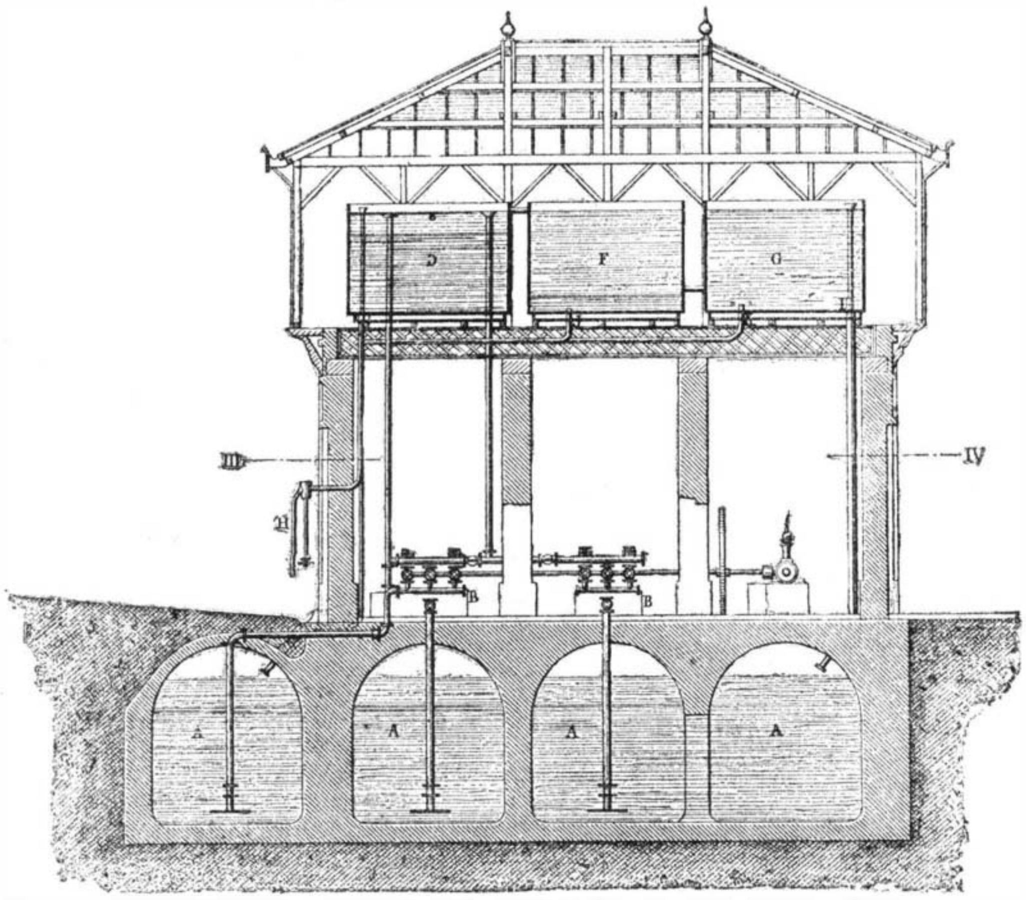


Fig. 1.—APPARATUS FOR DECANTING AMMONIACAL LIQUOR FROM COAL TAR.

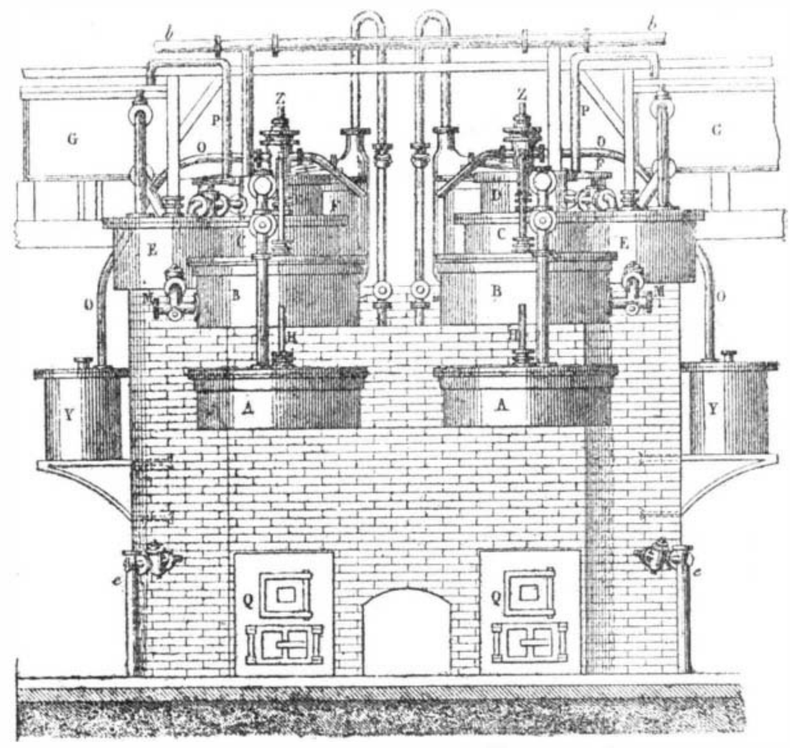


Fig. 2.—DISTILLER—END VIEW.

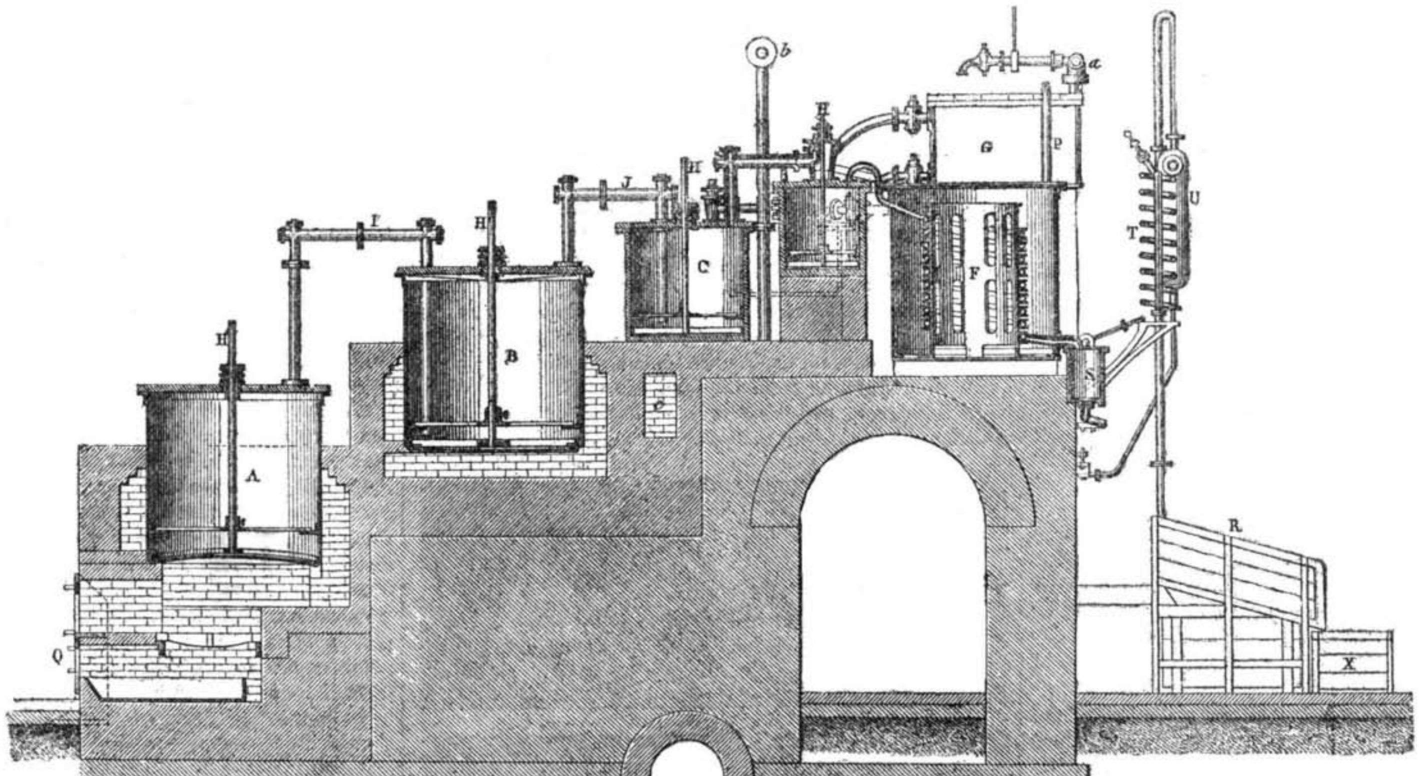


Fig. 3.—APPARATUS FOR MAKING SULPHATE OF AMMONIA