THE INDUSTRIAL PRODUCTION OF OXYGEN AND NITROGEN.

Since the times of Priestley and Lavoisier, chemists have ever been trying to find some industrial and cheap method of producing oxygen; and many persons, whose names we shall not mention, have vainly endeavored to extract this gas from the air, since this is the most abundant source of it that is naturally at the disposal of experimenters. We have passed in review the works of the best authorities, and have found therein no practical method of obtaining this gas regularly and in an industrial way. Mr. Boussingault, in his researches on the absorbing power of caustic barytes, declares, in a report made to the Academy of Sciences in 1850, that this substance loses all its properties, in its functions of absorption and production, at the end of eight or ten operations.

We likewise find in Mr. Wurtz's works a passage touching the operations and experiments of Mr. Gondolot. But neither Mr. Boussingault nor Mr. Gondolot appears to have been encouraged by the results that he obtained. We have seriously sought the causes of the want of success that has existed to our day, and have especially studied both the chemical and physical conditions of caustic barytes with respect to its use in the extraction of oxygen from the atmosphere.

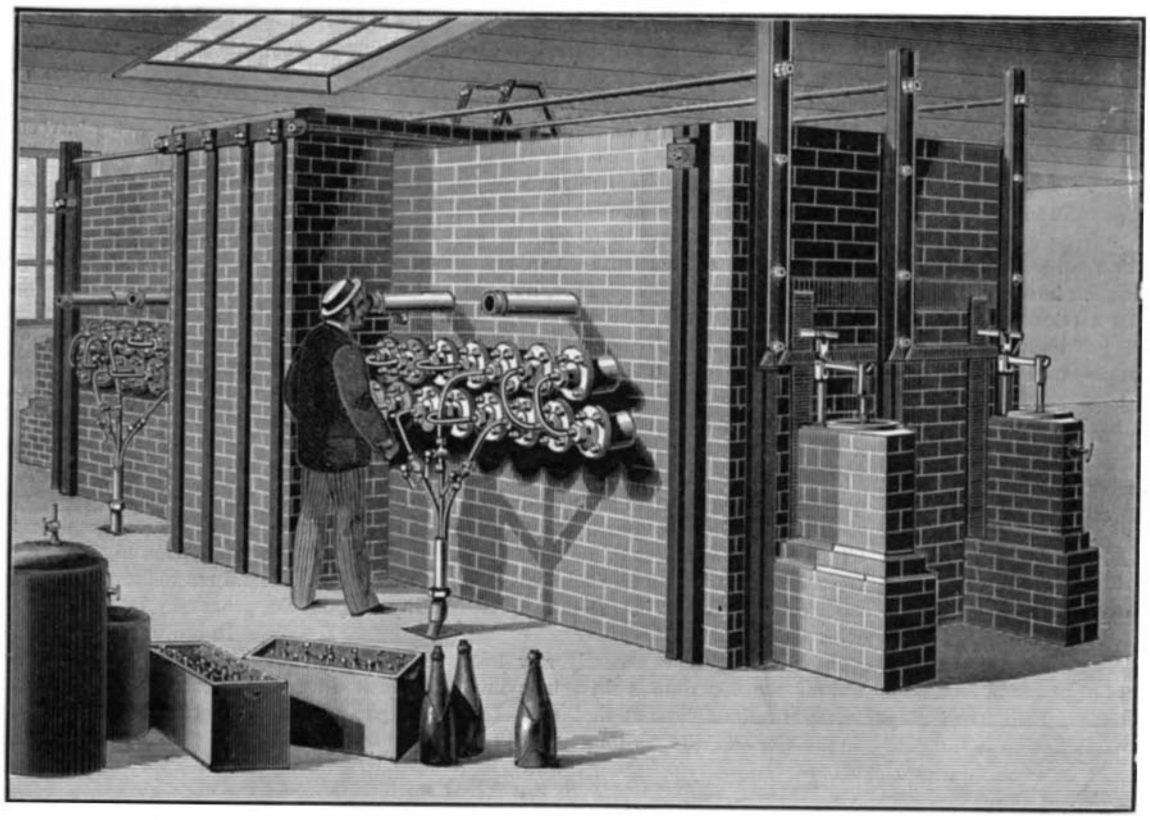

Fig. 1.—BRIN'S PLANT FOR THE PRODUCTION OF OXYGEN.

Our researches, and the multiple experiments that they necessitated, put us upon the real track of a product which we now possess, and which not only does not diminish in its powers of absorption and production, but has always given us proof to the contrary in the indefinite duration of its operation. For example: 1 kilogramme of caustic barytes made by our process will render at the first operation 25 liters of oxygen, and the production will increase from day to day, and, after eight days of continuous work, the yield of this same kilogramme will be 68 liters.

We assert, then, that a regular rate of production will permit of counting upon a yield of 50 liters of pure oxygen per kilogramme of caustic barytes, and per operation. We say 50 liters because it is not necessary to carry the deoxidation further.

We now come to the description of our process for separating the oxygen from the nitrogen in the atmospheric air.

The caustic barytes which we produce is placed in iron retorts arranged in horizontal series. These retorts have metallic friction joints at each extremity. For the perfect demonstration of our system we have constructed two coupled furnaces, each having 15 retorts 2·8 meters in length and 16 centimeters in internal diameter (Fig. 1). Two force and suction pumps are in communication with these series of retorts (Fig. 2). One of the pumps forces air into the retorts, where, in contact with the barytes, its gives up its oxygen. This is what we call p e r o x i d a t i o n. The other pump effects a vacuum in the retorts and sucks up the oxygen that has combined with the barytes. This is what we call deoxidation.

But the air, before entering the retorts, is freed from its carbonic acid by passing it through the chambers of an apparatus containing lime and caustic soda.

The coupling of these two furnaces has permitted us to transfer the peroxidation or deoxidation to either one of them at will through piping and cocks.

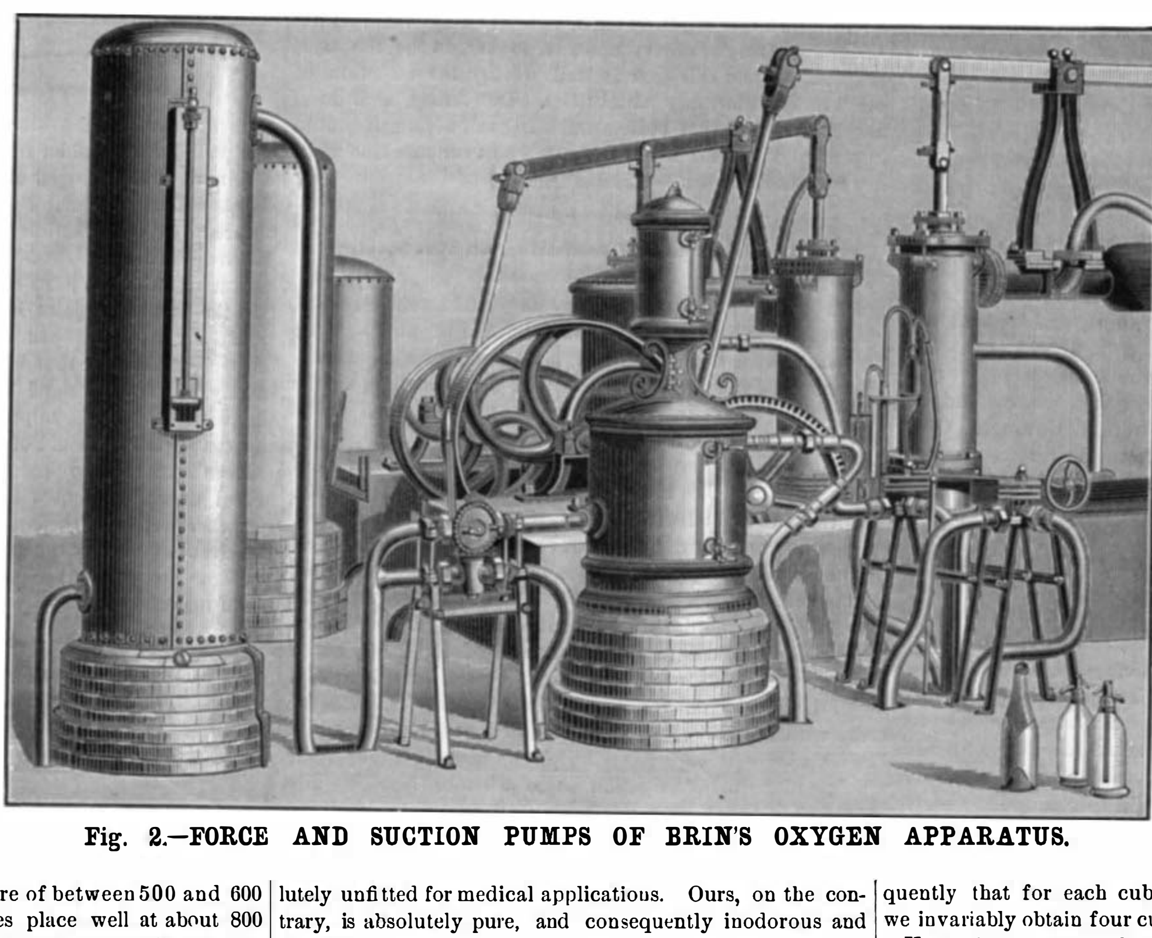

Fig. 2.—FORCE AND SUCTION PUMPS OF BRIN'S OXYGEN APPARATUS.

The peroxidation of the barytes is effected at a temperature of between 500 and 600 degrees, but the deoxidation takes place well at about 800 degrees. As it was necessary to regulate these differences in temperature absolutely and automatically, we devised pyrometric bars, which, through their expansion or contraction, allow us to obtain exactly the temperatures necessary for the peroxidation or deoxidation.

These bars are shown to the right of Fig. 1. The pyrometric bar receives at its extremity a lever which holds in balance a disk that is designed to accurately proportion the mixture of air and carbonic oxide that serves for heating. Now this bar, in expanding, causes the disk or air valve to rest upon the corresponding disk, and from this there at once results a lowering of the temperature to 500 degrees; then the bar that is regulated to permit of an elevation to 800 degrees contracts, and brings about an entrance of the air again, and consequently another rise in the temperature.

In this way we have obtained a regularity in the heating that guarantees a long duration of our material, and that also secures a perfect working without the needs of relying upon a personal surveillance. The running of our apparatus is therefore automatic and precise, since but one valve is to be closed in order to produce the peroxidation. This valve is opened for the deoxidation, and then the pyrometric bar is left free to play.

Our experimental plant is capable of producing 100 cubic meters of pure oxygen per day; and it is therefore not a *laboratory* matter that we are describing to our readers.

The oxygen that has been produced by all the processes known up to the present time has always cost so much that it has been impossible to deliver it for consumption, seeing that a sufficient production and reasonable price could not be guaranteed. Besides, the gas which is usually extracted from chlorate of potash remains, in spite of all modes of washing, charged with chlorine vapors that render it absolutely unfitted for medical applications. Ours, on the contrary, is absolutely pure, and consequently inodorous and tasteless.

We shall now speak of the applications of oxygen.

It occurred to us that by forcing pure oxygen under a high pressure into water we would obtain a solution of a certain quantity of the gas, that the volume in excess that could not dissolve would remain divided and confined in the water, and that we would then have a very light, tonic, and digestible gaseous beverage. The experiments that have just been made with this by several physicians are very conclusive. Carbonic acid, which for a long time has been daily consumed under the form of Seltzer water, is nevertheless placed among violent poisons, while our oxygen is an aliment which is indispensable to all organized beings.

Inhalations of oxygen are, by physicians, deemed necessary in certain diseases. One can therefore now count upon an absolutely pure gas for arresting all kinds of decompositions, since it is *the* antiseptic *par excellence.*

Acting as a combustive, it gives rise to a new metallurgy through the facility with which the highest temperatures may be obtained by its aid. There is no need of dwelling upon the economy that results from its use in the manufacture of all metallic oxides. The advantages of our system will be apparent, too, as regards the production of the Drummond light.

Finally, we must say a few words regarding the electrification of oxygen. Several chemists have given their attention to this subject, but have met with difficulties that proved insurmountable. In fact, before manufacturing ozone industrially and applying it economically, it was necessary to obtain oxygen in profusion. Ozone, moreover, is only the reduction of three volumes of oxygen to one—a reduction operated by electricity.

We shall submit a very simple and practical means of producing it. The oxygen is electrified in its passage against the sides of two test glasses, one within the other, and so arranged that the electric effluvia shall easily pass from one glass to the other. The interior glass holds a conducting liquid into which an electrode dips. The external vessel is surrounded with the same liquid, into which dips another electrode. These two electrodes are connected with the two poles of a Ruhmkorff coil actuated either by pile elements or a dynamo. As soon as the current passes, the characteristic odor of the ozone gas permits of at once knowing that the reduction is being effected. The energy of the ozone, then, depends upon the sum of electricity of which it is a carrier, and consequently upon its reduction. Ozone will soon be the subject of medical experiments, which we have left to some scientific men who have been specially requested to examine the question.

The industrial manufacture of oxygen by the reduction of peroxide of barium, followed by successive reoxidations and deoxidations, *ad infinitum*, can be just as well considered a production of nitrogen as of oxygen. In fact, the process is based upon the property possessed by barium of fixing the oxygen of the atmosphere and of setting nitrogen free, when a current of air is passed over barytes heated to a dull red. Now just as the transformations of the material alternate, so do the production of the gases likewise, that is to say, during deoxidation the retorts disengage oxygen, and, during peroxidation, nitrogen. A simple change of cock permits each of these gases being sent into its respective gasometer.

Nitrogen, then, is isolated just as well as oxygen during the operation of the plant. It may even be said that the production of the first-named gas is much greater than that of the second, since the atmospheric air contains about four volumes of nitrogen to one of oxygen, and consequently that for each cubic meter of the latter produced we invariably obtain four cubic meters of the former.

Up to the present we have confined ourselves to collecting only the oxygen, as being the more fertile in industrial applications and capable of more numerous and diverse combinations. Yet nitrogen, which is usually considered as merely the medium of oxygen, is likewise adapted to numerous special applications. For example, artificial fertilizers, most of them ammoniacal, are valued according to the proportion of nitrogen that they contain. The possibility of manufacturing ammonia by the immense source of nitrogen resulting from the production of oxygen is therefore one of the most valuable features of our plant. We need not be surprised that no one has as yet tried to perform such a synthesis of ammonia, that is to say, to bring about a direct combination of its elements, nitrogen and hydrogen, for the reason is very simple, and it is because it is first necessary to obtain these two elements. This obstacle disappears when we have at our disposal an absolutely gratuitous source of nitrogen, as is the case with us.

Without entering into a series of chemical considerations upon the reciprocal affinities of nitrogen and hydrogen, it will be seen that it is possible to create conditions that are sufficiently favorable to bring about a combination of these two elements.

The intermedium that we have chosen is an intimate mixture of carbon and caustic barytes. We place this mixture in retorts that are arranged either in a vertical or horizontal direction. A pipe leads the nitrogen into a quantity of water, which divides it, and it thus carries along a certain quantity of aqueous vapor. The gas thus charged with humidity is led into a retort heated to about 150°. Then the aqueous vapor decomposes on contact with the barytes and carbon, and the oxygen fixes itself upon these latter, while the hydrogen and nitrogen, alone remaining in presence, combine and form ammonia. The production of ammonia salts proceeds, then, from the easy combination of the ammonia gas and the acids into whose presence it is brought.—*Brin Brothers, in La Nature.*

The Maxim Machine Gun.

However opinions may differ as to the desirability of arming our troops individually with a quick fire or repeating rifle, so as to give each man a reserve of power to be used in the hour of need and when hotly pressed, there does not appear to have been from the first any question as to the practical value of that class of weapons known as machine guns. Hence they quickly found favor with the authorities, and have been introduced into both branches of the service. The essence of these guns is rapidity of fire, and a smart shower of bullets can be projected from them by the simple turning of a handle. The fire from these guns is exceedingly rapid, reaching some 150 to 200 rounds per minute, the operator turning a handle with one hand, and, for a traversing fire, imparting to his gun a horizontal reciprocating motion with the other. Remarkable as these results are, they are eclipsed by a machine gun which we have recently inspected in operation, and which by simply pulling a trigger once will feed itself and fire away continuously at the rate of 600 rounds per minute, if desired, the operator only having to impart the traversing motion to the gun as required. This remarkable gun is the invention of an American gentleman, Mr. Hiram S. Maxim, who is likewise the inventor of the system of electric lighting bearing his name, which was introduced into England about three years since. The gun has a single barrel, and is arranged in such a way that the force of the recoil from one round at the moment of firing is utilized and forms the motive power for loading and firing the next round, and so on round after round in succession. In fact, one recoil performs all the functions of bringing the next cartridge into position, forcing it into the barrel, cocking the hammer, pulling the trigger, extracting the empty shell, and ejecting it from the gun. To effect this the barrel is so mounted in its case that at the moment of firing, the recoil drives it backward about three-quarters of an inch, and it is this movement of the barrel alone that actuates the mechanism of the gun and enables it to keep up a continuous fire.

The gun we saw fired at Mr. Maxim's works, 57d, Hatton-garden, London, has a barrel of the ordinary service regulation caliber of 0·450 in. and weighs with its tripod stand 126 lb. It stands about 3 ft. high, and is about 4 ft. 9 in. long from muzzle to rear of firing mechanism. The training arrangements enable the gun to be elevated or depressed and set at any angle by adjusting screws, and traversed radially over any desired horizontal range. Or it may be instantaneously detached from the screws so as to be moved freely in every direction by hand. As the gun is self-firing, the operator can train it just as required while it is being discharged.

The cartridges are placed in a canvas belt in a manner somewhat similar to that in which they are carried in a sportsman's belt. The Maxim belt, however, is some seven yards long and holds 333 cartridges, and length can be attached to length as each becomes emptied, so that the fire can be maintained continuously. This belt is placed in a box immediately below the gun, and the leading end of it is inserted in the gun to start with. As the gun is fired the belt is drawn into it on one side, and one after another the cartridges are drawn out of the belt, forced into the barrel, fired, and the empty belt and cartridge cases ejected from the opposite side of the gun. By this arrangement the cartridges and the gunner are both below the level of the gun, and are only exposed to fire in a *minimum* degree. The external firing arrangement consists of a trigger or lever, which is placed against a graduated quadrant at the side of the gun, and the rapidity of firing is regulated by the distance to which this lever is pulled over. If this trigger be pulled over toward the gunner about an inch, and until the pointer indicates the figure 1 on the quadrant scale, the gun will then fire at the rate of one round per minute. By pulling the trigger over a little further the rate of fire is increased to about five rounds per minute, and the rate is gradually increased as the trigger is pulled further over until it reaches the rear end of the scale, when the fire is maintained at the unprecedented rate of 600 rounds per minute.

It is thus possible to fire either single shots, volleys of 10, 20, or 100, and to maintain a continuous fire either fast or slow. When the gun is once adjusted for a certain speed, it maintains the fire at that speed independently of human agency until all the cartridges have been discharged. Should the man working the gun be killed, the gun will still continue firing so long as any cartridges remain to be fired, provided no hitch occurs from a faulty cartridge. The great rapidity of fire in this gun is attributed to the following cause: In the ordinary machine gun it is stated that a very great speed is not possible with a single barrel, because a certain percentage of the cartridges hang fire—that is, they do not explode at the moment of being struck by the hammer, and therefore, if one of these guns be worked with too great rapidity, some of the cartridges will be drawn from the barrel before they explode. Hence, it is said that in all machine guns worked by hand it is necessary to have the movement sufficiently slow to give these comparatively slow cartridges time to explode before they are removed from the barrel. In fact, the action must be sufficiently slow to meet the requirements of the slowest cartridge of the series. With the Maxim automatic gun, however, a cartridge cannot be withdrawn from the barrel until after it has been exploded. It fires the quick-exploding cartridges rapidly, and if a slow one presents itself, it fires that particular one slowly. Should a cartridge hang fire for five minutes, it would not be withdrawn from the barrel until it had exploded; the gun, in fact, must and would wait for it. Hence great rapidity is possible with a single barrel.

Such is the gun we recently saw tried, and, although we did not see 600 rounds fired in a minute, we saw several series of rounds fired at that rate—that is, 10 per second. In practice and with continuous rapid firing the barrel would become heated, to counteract which it is surrounded by a water jacket. But besides the system of feeding the gun we have described, Mr. Maxim has another, in which the cartridges, to the number of 96, are placed in a flat brass drum on the top of the gun, and the movement of the barrel rotates the drum, draws the cartridges from it, and forces them into the barrel to be fired. When empty, the drum is removed and another one substituted for it without stopping the operation of the gun. A small reservoir attached to the gun furnishes the necessary supply of cartridges to keep the weapon in action during the brief interval of time required to remove an empty case and replace it by a charged one. The belt system of automatic firing has been applied by Mr. Maxim, not only to machine guns such as we have described, but also to rifles to be fired from the shoulder. In one instance he altered a Winchester rifle in such a way that the recoil performed all the necessary functions except pulling the trigger. An ordinary Martini-Henry rifle has been arranged by Mr. Maxim so that the recoil extracted the empty cartridge case and cocked the hammer, while the act of placing a new cartridge closed the breech action. Mr. Maxim has also made a third gun, in which all the functions are performed by means of a slight elongation of the cartridge case at the moment of firing, the case being corrugated to afford the required extension. The system first described by us, however, appears, so far, to be the most practicable, and this gun is well worthy the attention of our naval and military authorities. Delivering, as it does, such a perfect hail of bullets and being self-acting, it would appear to commend itself for use wherever machine guns are applicable in war.—*London Times.*

On the Influence of Punching on Soft Steel.*

BY W. BECK-GERHARD.

During the course of experiments made at the Poutiloff works at St. Petersburg, on the influence of punching on the strength of soft steel fish plates, the results, already well known, were arrived at, namely, that punching in the cold weakens perceptibly, and reduces the elongation of the steel; that steel annealed after cold punching, and when punched hot, is not injured; that annealing, when well done, even increases the tenacity of the punched specimen, and that the evil effects of cold punching are in a great measure removed by subsequent reamering out of the hole.

On bending samples of soft steel which had been punched in the cold through the holes, it was invariably found that the specimen would bend without cracking, if the punch side of the hole was on the convex side of the bend; but if the bar were bent in the opposite direction, that is to say, with the die side convex, the specimen broke. This was the case with all cast metal; while puddled or scrap iron could be bent without injury. This phenomenon led the author to institute an investigation as to whether there was any foundation for the very generally received opinion that the edges of a punched hole on the die side are injured by a ring of minute incipient radiating cracks. For this purpose a large number of specimens, 5 in. by 3 in. by ½ in., of all kinds of steel were prepared. The edges were planed, the surfaces polished, holes were pierced in various ways, and the metal surrounding them was carefully examined with a microscope, but no trace whatever of cracks could be found, though the nature of the steel ranged from 0·1 to 0·6 per cent of carbon.

Although the search for incipient cracks proved fruitless, Mr. Beck-Gerhard observed and has described, he believes for the first time, certain markings on the polished surfaces of the plates around the cold punched holes, which seem to possess very great interest. Visible to the naked eye, and surrounding the holes, were sheaves or bunches of lines starting tangentially to the holes, and curving slightly toward them. These lines branch out in opposite directions, and intersect with some degree of regularity. They do not appear in the vicinity of drilled holes, but are distinct in cold punched holes reamered out. In forged iron they did not appear, although they were most distinct in the softest steel, and vanished when the metal reached the hardness due to 0·6 per cent of carbon. An increase of thickness in the plate caused a corresponding increase in the number and clearness of the lines, upon which the shape of the hole was also found to have an effect. In all the 5 in. by 3 in. specimens the lines were distinctly sunk, while in two of the 10 in. by 10 in. specimens the lines were prominent, sinking gradually to the level of the plate toward their ends. At the points of intersection near the holes the continuity of the lines was interrupted; dots or nodes represented their course.

In the 3 in. specimens with planed edges the lines terminated abruptly at the edges, but in natural bars, such as fish plates, the more pronounced rays turned round the edges, and actually appeared on the opposite side. In all the samples the lines were less developed in the upper or punch side of the plate, and even at times degenerated into a mere frosted appearance. Heating the plates to redness did not obliterate the rays, though it rendered them less pronounced.

In order to determine how far the rays extended around a cold punched hole, a 10 in. square sample was cut out of a ⅝ in. steel plate, the surfaces were polished, and a 1 in. hole was punched in the center. The curved rays appeared very strongly marked on the die side, and less pronounced, but still very distinct, on the punch side. The surfaces of the plate were then washed with aqua regia, when the rays disappeared, but the surfaces became streaked with elongated bubbles and hair lines arranged in the direction in which the plate had last passed through the rolls. The sample was then cut into eight test pieces, four on each side of the central hole, and subjected to rupture by tension. The result was an average ultimate strength of about 27 tons per square inch, with an elongation of 20 per cent. All the fractures took place at one of the elongated bubbles, and the polished surfaces of the specimens developed ridges and indentations, which could not only be seen, but felt. On placing the specimens together in their original relative positions as a 10 in. square plate, it was at once seen that the markings on the strips formed together a system of curved rays around the central hole, precisely analogous to those which the solid plate had exhibited, only the rays extended much further over the surface. Test bars cut from a similar ⅝ in. plate 10 in. square, which had not been punched, exhibited none of the marks above described, hence it must be concluded that the effect or influence of the 1 in. cold punched hole had extended all over the 10 in. plate. The observations made so far, the author considers, are insufficient for the foundation of a theory, and regrets that his occupations do not admit of further investigation.

* Translated from *Gorni Journal*. St. Petersburg, March, 1884, and published in London *Iron Trade Exchange.*

Infringement of Combination Claims.

In the case of Schneider *vs.* Pountney, for infringement of a patent shade holder for lamps, Judge Nixon, of the U. S. Circuit Court, district of New Jersey, ruled as follows:

Where one party manufactures one portion of the device covered by a combination claim, and another party manufactures the other part of the combination, and it does not appear that the two parts are capable of separate use, *held* that the parties are joint infringers.

And the defendants cannot protect themselves by invoking the well-settled rule that where a patent is for a combination merely it is not infringed by one who uses one or more of the parts, but not all, to produce the same results, either by themselves or by the aid of other devices.

Even if there is no proof that the defendant had made an actual prearrangement with any particular person to supply the other portion of the combination, it will be inferred from the circumstances of the case that it is the intent of the defendants that such other portion shall be added to their article of manufacture.

The New Comet.

The new comet discovered by Dr. Wolf on the 17th inst has been observed by me. Its position at discovery was right ascension 21 hours 16 minutes; declination north, 22 degrees 23 minutes, which brings it near the western limit of the constellation Pegasus. As observed by me with the 9-inch reflecting telescope, it is an easy telescopic object in moderate moonlight. The coma is somewhat elongated in outline, and the nucleus is small but bright and star-like. The comet is moving southward at the rate of about half a degree daily along the western edge of the constellation Pegasus toward the star Epsilon. About the middle of October it will be in the head of Pegasus.

The comet may be readily picked up by telescopes of moderate aperture, as it is slowly growing brighter.

WILLIAM R. BROOKS.

Red House Observatory, Phelps, N. Y., Sept. 27, 1884.