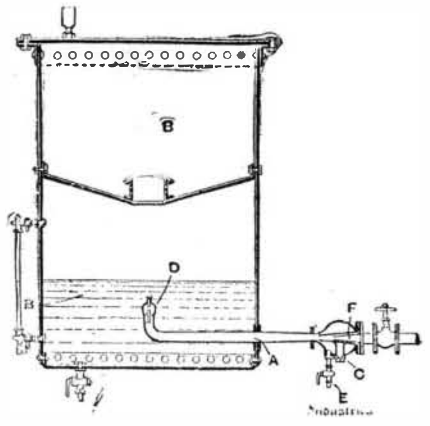
AIR COMPRESSOR.

A. Nosbaume, Antwerpen.

THE steam entering through F draws in air through C, and water through E. In the pipe, A, all the steam is condensed, so that only air and water are forced through the valve, D, into the chamber, B. B is fitted with a pressure gauge and a diaphragm, which separates the water from the air, so that the chamber above

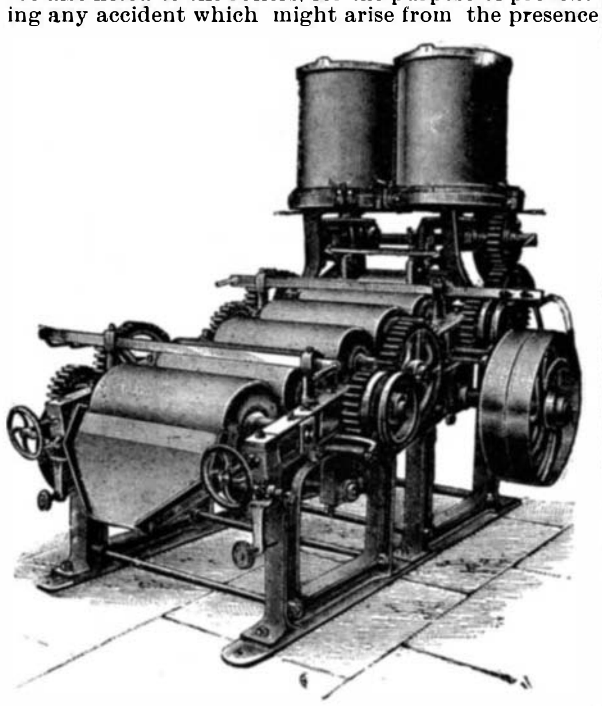


the diaphragm contains only compressed air. A blow-off cock and a water gauge are also provided.

IMPROVED PAINT GRINDING MILL.

THE accompanying engraving illustrates a new type of mill for grinding white lead, which has recently been introduced by Messrs. Follows & Bate, Limited, engineers, Gorton, Manchester. The machine is practically a combination of a pug mill and a double roller mill. Two pug mills are carried at one end of the machine for mixing the material before it approaches the rolls. While one of the pugs is feeding the rolls, the other is preparing the material; so that there is a constant supply and a consequent saving of time. The cylinders of the pug mills are 30 in. in diameter and 24 in. long, and are made of steel. The rolls are 30 in. long and 15 in. in diameter, and are made of granite mounted upon steel shafts. The rolls are in two sets of three, and the arrangements are such that the two sets may be worked either conjointly or separately. The two mills are secured together by means of wrought iron stays and lipped caps, which also afford a cover for some of the working parts.

Special adjusting wheels and scrapers have been designed for regulating the delivery and for keeping the rollers perfectly clean, and safety and adjusting springs are also fitted to the rollers, for the purpose of preventing any accident which might arise from the presence



IMPROVED PAINT GRINDING MILL.

of extraneous matter. An oscillating motion is imparted by a cam to the center roll of each set, so as to insure the perfect grinding of the material.—*Industries.*

WOODBURYTYPES.

THE late Mungo Ponton, of Bristol, in the days of the dawn of photography, discovered that bichromate of potash in contact with organic matter when exposed to light is acted upon thereby, so that a picture can be taken, an oxide of chromium being thrown down by the luminous action. Edmond Becquerel discovered the necessity for the presence of organic matter in such photographic action, but Mungo Ponton made the primary discovery at the root of so many present-day industrial photographic processes. Mr. Joseph W. Swan, of incandescent lamp celebrity, is also one who has done a great deal in devising photographic processes based upon the action of light upon the bichromates; but the one now to be described was discovered and worked out by the late Walter B. Woodbury.

A glassplate is first cleaned, talced, and collodionized in the usual way, in order that the resulting film may be stripped from its surface and printed upon from the back when placed under a negative. The plate is next coated with a mixture of gelatine, sugar, glycerine, Indian ink, and other pigments, and bichromate of ammonia, or potash; when dry, the film is stripped and exposed under a negative by the aid of an actinometer, no visible photograph to guide the operator being produced. After exposure it is attached to another glass plate coated with a thin India rubber film thrown down from a solution, and dried. The Woodbury film is laid down dry upon this surface, and "squeegeed" thereupon; it does not matter if it does not adhere perfectly at all points. The plate is then placed in a dish of hot water for some hours; the temperature is nearly that of the boiling point; this dissolves away the gelatinous pigment where it has not been attacked by light, and the light having acted upon it from the back, and penetrated it to different depths corresponding with the lights and shadows in the negative, the unaltered gelatine is dissolved off by the hot water to different depths. Thus an image in gelatine upon a tough collodion film is obtained in relief, and the ingredients are so proportioned and selected as to give as great relief as possible; the amount of coloring matter is small, to enable the light to deeply penetrate the film. By over-printing, light penetrates the whole film, and is reflected from the back surface, producing an indistinct picture. Notwithstanding the great relief of the film, there is no appreciable want of sharpness of definition in the resulting picture. The plate is next placed for two or three hours in a dish of methylated spirit to abstract the water quickly from the film, and is afterward left in a warm room for an hour or more, to dry thoroughly. When it is sufficiently dry to be removed from its glass support, it is in low relief, and exceedingly sharp; the film in the high lights is not quite transparent, but slightly opalescent if everything has been working properly.

In the Woodburytype process a vigorous negative is necessary. The thin ones somewhat frequently made in photographic studios in these days of gelatine dry plates will not give good results in the process now under notice. Such negatives should be "reproduced" in more vigorous form by copying and intensification, before employment for Woodburytype purposes. The Woodbury films have to be dried quickly, or they would deteriorate meanwhile; hence a good supply of air, dried by chloride of calcium or other special means, should be passed over them, at a temperature of about 80 deg. Fah., but not higher. In the development the temperature should be moderate at first, beginning at about 105 deg. Fah., and subsequently gradually raised. In stripping the film from the glass the India rubber comes off with it, and can be removed in little balls by laying the film on a flat surface, and rubbing with the finger. The film should then be kept for some hours before use in the hydraulic press.

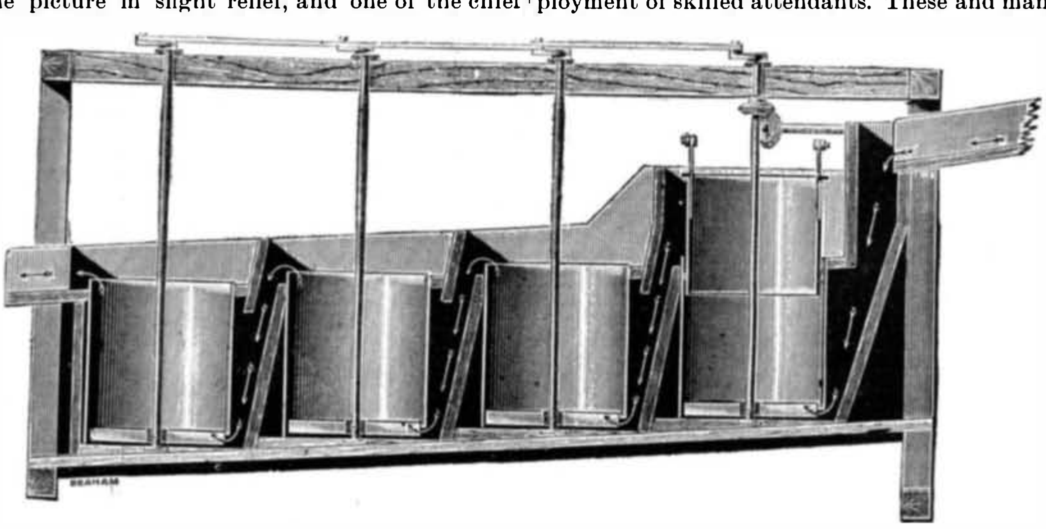
The mould to be used in the printing press has to be made from this thin skin of collodion carrying a dry gelatine picture in slight relief, and one of the chief discoveries made by Woodbury in this process was that under hydraulic pressure the image could reproduce itself in a plate of lead. The pressure is great—40 tons to the square inch being sometimes necessary; for a small picture a total pressure of 20 tons to the inch is enough. The lead is pure, and has a truly plane surface; when the pressure is applied the film lies upon a plate of polished steel, also with a truly plane surface; the steel plate is bordered by knife edges projecting a little above the surface, to prevent the lead from spreading. When the leaden mould is removed from the press, its edges are trimmed with a saw and plane, then it is ready for the press. These leaden moulds cannot be touched up by hand should they present any defects, with the exception that undue projections which sometimes appear here and there may be removed by a strip of glass manipulated by a skilled workman. Anything sticking up above the proper level of the surface of the lead can be thus removed.

These leaden moulds are embedded in a thick piece of gutta percha in the printing press, the tympan of which is of finely ground plate glass; the paper comes off the ground surface more easily that it would off polished glass. A lump of gutta percha two or three times as big as a cricket ball is rolled in the hands of a workman, then placed like a dumpling on the bed of the press, and when it cools to the right consistency the leaden plate is put upon it face upward, and the glass plate, wetted, is brought down upon it; the pressure upon the gutta percha is carefully regulated by means of screws, and the whole then left to get cold. The least bit of grit on the face of the gutta percha would be felt in working. The pressure upon the soft gutta percha and the plate is regulated according to the subject, for a picture presenting deep shadows requires greater pressure than one of the opposite kind. The ink used in the printing consists of a five per cent. warm solution of gelatine holding permanent pigments in suspension; Indian ink and carmine are the principal colors used, indigos and some of the madder browns are also employed when required; by mixing the various colors any desired tone can be obtained.

In producing Woodburytype prints Messrs. Waterlow use the finest Rive paper, weighing 10 kilogs. to the ream; this paper is, before use, specially prepared by being dipped sheet by sheet in a solution of shellac in borax, and allowed to dry; next it is rolled between steel plates in powerful presses. By these means a fine surface is obtained, and the paper is made less absorbent of aqueous liquids. In the printing a pool of the warm gelatinous ink is poured upon the mould from a bottle, pressure is then applied, and the surplus ink squeezes out over the edges of the picture; the pressure has to remain on the print for five minutes, hence six presses are mounted upon a revolving table, so that the operator without shifting his position can ink six lead plates in succession; when he has done the last one, the first has had its five minutes' pressure, and the print can be removed from the press. A moulded design, all hills and valleys like a relief map, is then upon the paper, which shows through of a pure white color in the deepest valleys. The prints are next dipped for ten minutes in a bath of common alum, strength about 10 grains to the ounce; the alum not alone renders the gelatine insoluble in hot water, but renders it less liable to decay by long exposure to atmospheric influences. The prints are then racked, face uppermost, upon canvas screens, until they are dry. Next they are trimmed and moulded by girls upon card or paper, like any other pictures which require mounting. When dry they have lost their relief appearance, and look as flat as any other pictures, the gelatine having shrunk to almost nothing, as the result of drying.—*The Engineer.*

IMPROVEMENTS IN ORE DRESSING MACHINERY.

IN no other branch of engineering has so much been attempted, and so little accomplished, as in that which deals with the preparation of metallic ores. The number of patents granted within the last twenty-five years is surprisingly great, if we group together all those which relate to inventions having for their object the more effective or more economical treatment of such ores. Yet very few of these new or improved machines are to be found in common use after they have been subjected to the test of two or three years' actual practice. The difficulties to be overcome in designing a machine of this character are very great, as there are numerous conflicting conditions to be fulfilled. The machine must be capable of performing the work required of it efficiently in all circumstances. To do this it must be simple in construction, strong, and easily repairable in case of wear and mishap. Nowhere certainly are these conditions so necessary of fulfillment as in the rough work of mining. The machines are legion which have failed to make good their claims because they were wanting in one of these points. Moreover, it is always desirable, and in most cases necessary, that the use of such machinery should not involve the employment of skilled attendants. These and many other



EDWARDS' ORE DRESSING MACHINE.

conditions which will at once suggest themselves to those who have had experience in the preparation of more than one kind or class of ores, are not to be easily satisfied. In this fact, which forces itself painfully upon the consciousness of every inventor before he has been long occupied with the problem of economically extracting metals from their ores, lies the explanation of the small success yet achieved in certain stages of the operation.

Bearing in mind these difficulties, and having been taught by a pretty wide experience in these matters to distrust appearances till they have been proved to be real by actual practice in different circumstances, we hesitate to describe Mr. Edwards' wet sizer and separator as a completely successful outcome of a bold attempt to solve a difficult problem by novel means. But we admit our inability to discover any weak points or shortcomings in the machine which was exhibited recently at the works of Messrs. Bateman & Co., of Greenwich. To all appearance, it fulfills in every particular the conditions to which a contrivance of that character is subject; and if this appearance be true, it constitutes a distinct advance in the practice of ore dressing.

Mr. Edwards' machine for the treatment of auriferous and other ores is, as its name implies, a "sizer" and separator of the crushed material as it comes from the stamps. The great advantages of "sizing" or separating, according to their dimensions or relative specific gravity, the particles of crushed ore, as a preparation for successful concentration, are known to all mining men; but in very many cases the operation is omitted, because the apparatus hitherto available for that purpose very often fails to give satisfactory results. That Edwards' machine will work effectively there is no doubt. That it will work rapidly is equally beyond question. In the course of the demonstration at Greenwich the other day, 2 cwt. of stuff was successfully treated in ten minutes—a rate of work that may be fairly estimated at 6 tons a day of twelve hours. Compared to this output, the machine is of remarkably small dimensions. It consists, as will be seen from the above illustration, essentially of three or more short vertical cylinders, set in line upon an inclined plane, and constructed to receive from below the water containing the mineral substances in suspension. The cylinders are provided with stirrers or agitators, to prevent a too rapid deposit of those substances. The agitator in the first cylinder, which retains the heaviest particles, revolves slowly; that in the second cylinder has no continuous rotary motion, but oscillates through a quarter circle, and that in the third cylinder oscillates through one-eighth of a circle. Thus the degree of agitation diminishes, like the dimensions of the particles of mineral in suspension, from cylinder to cylinder. The power required to give motion to these agitators is very small.

To understand the action of this machine, and the principle on which it proceeds, let us start with the assumption that all the cylinders in series are full of the water, bringing with it from a small chute or trough above the minerals to be sized and separated. As the water has passed from one to the other, each cylinder will contain different grades relatively to the rest, and in each, individually considered, there will be a gradation of the particles according to their size and specific gravity, the lighter particles being toward the top. As they have been in agitation a sufficient time to give a proper separation, it is now required to remove the upper portion of the water—to a depth of 12 in.—in each cylinder. That in the last of the series is to be discharged into the "tailings" receiver, while that in each of the other cylinders is to be passed on to the next. In this way the circulation is kept up, the discharges taking place about once a minute. As we have already said, the cylinders receive their water from below, so that the water which is discharged from the top of one is introduced through the bottom of the next in series. The transfer is effected very ingeniously, and the operation is brought about by the following very simple means.

In order to obtain a head of water wherewith to start the series of pulsations which effect the changes, the first cylinder has telescoping within it another cylinder, open at both ends, and capable of being raised by a hand lever to a height of 12 in. Expressed in another way, when this telescoping part is drawn out, the first cylinder of the set is made to be of greater capacity than the rest by increasing its height 12 in. When full, the sliding part is rapidly lowered, and the overflow passes away to the bottom of the second cylinder, from the upper part of which it displaces an equal quantity of water. This, flowing over the top, passes away in like manner to the third cylinder, and so on till the tailings receiver is reached. The loss of head due to friction causes the pulsation to decrease in violence from cylinder to cylinder, so that the action is strictly in accordance with the conditions prevailing in each cylinder. These sizing cylinders are each provided with a valve at the bottom for the discharge, at intervals, of the deposited minerals. In the trial made at Greenwich, Mr. Edwards exhibited a novel, and efficient form of buddle, set beneath the sizing and separating machine to receive conveniently the products of the latter.

THE INVENTORS OF PHOTOGRAPHY.

WHEN, in a science such as that of photography, a rapid progress is made, there is a tendency to walk ever onward and onward, without casting a glance backward, and to rush from discovery to discovery. We sometimes even forget the names of those who were the early pioneers, who entered an unknown path without the guidance of any previous labors, who obtained the first results, and who even foresaw the future consequences of the latter, but were unable to be lookers-on at the realization of their dreams.

As for us, who, through the labors of our ancestors, thanks to the heritage of facts and information that they have bequeathed to us, have been enabled to acquire results perhaps more important, but with more facility, let us not forget how great a share is their due. Let us stop a moment to admire them and then to study them.

In this century, which will be the age of steam, electricity, and photography, progress succeeds progress so rapidly that many facts, made known a long time back, remain ignored, although they might be put to profit. Impracticable or not utilizable at the epoch at which they were made, certain inventions are capable now of rendering the greatest service.

We are going to do some retrospective work as regards photography, and the reader will certainly be gratified to see, among early discoveries, those that have survived, those that have had but an ephemeral

FIG. 1.—MONUMENT TO NICEPHORE NIEPCE AT CHALONS-SUR-MARNE.

duration, and, finally, those that, after a period of rest, are to be developed anew as a consequence of the recent progress made.

As long ago as the sixteenth century, the property of silver salts of being influenced by light was pointed out by G. Fabricius. This alchemist had remarked that *luna cornea* (the name given at that epoch to chloride of silver) was blackened by light.

Scheele took up these experiments later on, and proved that the sensitiveness of this product was not the same under the action of the different rays of the solar spectrum.

Senebier, in 1782, Ritter, in 1801, and Berard, in 1812, studied this same question, and, after the labors of these men, it was possible to admit, with certainty, the existence of actinic and non-actinic rays.

This discovery is momentous, for it permits of manipulating sensitive preparations without danger

FIG. 2.—MONUMENT TO DAGUERRE AT CORMEILLES-EN-PARISIS.

by the use of a non-actinic light, but it shows one of the great defects of photography, and one to whose consequences we are always subservient.

Various objects, according to their color, will be absolutely different from the standpoint of actinism. While some will be produced with the greatest facility, others will not be, except at the cost of the most serious difficulty. If, as in a landscape (and this is the most ordinary case), they are mixed, we shall experience obstacles in the way of reproducing them in their relative value that are, so to speak, insurmountable. So we cannot too greatly encourage the studies of Vogel and Tailfer, the object of which is, by the introduction of certain substances into the photographic film, to render it equally sensitive to the various rays. The results already obtained in this direction seem to prove that the non-actinism of certain rays of the spectrum will not always be an obstacle in the way of their reproduction.

The first experiments in utilizing the properties of the salts of silver for the obtaining of images were made by the French physicist Charles, who, in 1780, in his lectures, reproduced silhouettes upon a sheet of paper impregnated with chloride of silver. The source of light employed was a fascicle of solar rays. Davy and Wedgwood continued these experiments in England, but we have to come up to 1844 to find the first image made in a camera. Joseph Nicephore Niepce busied himself with this important problem, and received the image upon a metallic plate covered with a thin layer of bitumen. The latter, in the high lights, becomes insoluble in its usual solvents, while it remains soluble and disappears in the other parts. The image that appears is formed partly by the exposed metal and partly by the bitumen rendered insoluble. This process was a very long one, and required no less than from ten to twelve hours' exposure in full sunlight. But it is undeniable that Niepce's experiments gave the first photographic image.

Niepce used the same reaction for obtaining plates by placing the bitumen-covered plate under an engraving or drawing rendered transparent. It will be remarked that Niepce's processes, greatly improved, are now in constant use in the art of printing.

Daguerre, too, occupied himself with the same problem, and he and Niepce were brought together through Charles Chevalier, a well known optician. In 1829, these two inventors worked their processes and made their researches conjointly. It is absolutely unknown what the result of this partnership was, which was abruptly terminated by the death of Niepce in 1833. Daguerre pursued his studies alone, and these resulted in the universally known process which bears his name—daguerreotype. It must not be forgotten, however, that Daguerre had had full communication with the labors of Niepce, and that the splendid discovery to which he gave his own name solely was at least inspired by Niepce's ideas. Nobody had any doubt of this, and it was with satisfaction that, upon the proposition of Arago, people saw a national recompense decreed to the inventors of photography—Daguerre and Isidore Niepce, son of Nicephore Niepce and heir to his rights.

The noise made about Daguerre's discovery caused the labors of a certain modest worker to be nearly forgotten—those of Mr. Bayard, who, previous to the discovery of the daguerreotype, had obtained and even exposed negatives formed directly in the camera. His process, however, is essentially different from Daguerre's, and, although he did not divulge it at an opportune time, it would be unjust not to mention it.

The same year, Talbot, who was following up the researches of Wedgwood and Davy, gave some methods founded upon the use of chloride of silver, showed how to fix negatives by iodide of potassium, and pointed out that other things than the vapor of mercury could render the image developable.

These are discoveries of the first order, but there are others which, although less important from a theoretical standpoint, have been followed by great practical consequences and must not be passed over in silence.

Thus, in 1839, Herschel pointed out the use of hyposulphite of soda for fixing images. This salt is still in daily use in photography, and there is nothing to make it foreseen that it will soon be replaced. In 1848, Niepce de Saint Victor, nephew of Nicephore Niepce, proposed glass as a substratum for the sensitized film.

As we have just seen, the efforts of researchers were especially directed at first to the obtaining of an image in the camera—Niepce, who obtained the first image; Bayard, whose original process obtained but little notoriety; Daguerre, who found the latent image and the daguerreotype; and, finally, Talbot, to whom we owe the first negative.

Among those who have occupied themselves with the production of the positive image obtained from the negative, we shall mention one whose name, little known outside of the world of photography, dominates all others through the importance of his labors and the prolific results that have been the consequence of them; we mean Poitevin. It is to him that we owe the complete study of the reaction of bichromated gelatine—a study whence have resulted the various processes of printing now so much employed, such as phototypy, photoglypty, photographic typography, etc. It is he, too, who indicated the use of gelatine as a substitute for collodion or albumen for the obtaining of sensitive films. No one ignores the fact that it is this substance which, in combination with bromide of silver, composes the gelatino-bromide plates whose truly wonderful rapidity has permitted of an unlooked for development in the application of photography to the various sciences.

France, with which no one can for an instant dispute the honor of the discovery of photography, has endowed the civilized world with it by purchasing from the first inventors processes that might have remained unknown to the public. But she has done still more: at the instance of eminent persons of the photographic world or learned societies, she has erected monuments to these makers and researchers in order to prepetuate their memory.

Now that we can more justly appreciate the importance of the results that have been the consequence of their discoveries, we shall express one regret, and that is that these monuments have not, all of them, the importance desirable. But, as we know, the discoveries of science are not those that make the most noise, and that are the best recompensed; the results are not always immediate, and the poor inventor is often already forgotten when we daily perceive the greater and greater results of his work.

We place before our readers reproductions of the monuments erected to our French compatriots. Let us hope that our neighbors across the channel, who are great admirers of photography, will not forget their countryman Talbot.

Let us now see what remains of these different discoveries. Niepce's process was not practical, and would not be any more so to-day, on account of its excessive slowness; but this inventor showed the possibility of reproducing the images of the camera. His tentatives in heliogravure were the starting point of very important processes (photogravure, zincography, etc.) which are now in daily use.

Daguerre's process no longer exists except as a historic curiosity, but what will remain imperishable is his discovery of the latent image. It has become possible to modify the processes for developing this, but all the present ones are based upon the production of such image.

Talbot, in addition to various processes of development of the latent image, gave us the negative image, which, upon the whole, is the base of photography. It is the great defect of the Daguerre process that there is but a single image and that is reversed; with the negative, the image can be multiplied to infinity, and is turned in the right direction.

As for Poitevin, whose special object was the production of an unalterable image, his work is now receiving full recognition. The various processes of which he is the father are continuously developing, and, thanks to

FIG. 3.—MONUMENT TO POITEVIN AT SAINT CALAIS.

them, photography is daily taking a more important place in the art of printing.

The use of glass, proposed by Niepce de Saint Victor, dethroned paper as a support, and up to recent years seemed to reign as master over it; but, aside from its planeness and exquisite transparency, it has two very