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Contents:

(Illustrated articles are marked with an asterisk.)

NAVAL ARCHITECTURE AND ENGINEERING.

A cotemporary remarks that "the loss of the British iron-clad *Captain* is an event that cannot fail to exert an important influence on naval architecture in the future," and there is no doubt of the truth of the remark. Within the last ten years there has been something almost constantly turning up or going down, to modify naval architecture.

This is not to be wondered at. The transition from wood to iron, as the material for the construction of war vessels, could scarcely have been accomplished without some failures and disasters. To suppose that it could, would be to suppose engineers incapable of error, iron incapable of penetration by shot, and the power of invention to devise means of attack, to be inferior to the same talent in devising means of defense.

There have, therefore, naturally been many mistakes made, as well as modifications necessitated by the continued improvement in the methods and instruments of attack.

The *Captain* seems to have been one of these mistakes. Her enormous weight of armor appears to have rendered her unfit to endure heavy weather. The query now arises whether such enormous weight of metal can be made by any modification of model compatible with good sea-going qualities in a ship. We do not believe any one is yet prepared to give a satisfactory answer to this question. There is no end of theorizing, and plenty of men will be found to take the affirmative, as well as the negative side in the debate, but experience with heavy iron-clad vessels has been such as to rather emphatically point to the negative as the ultimate decision of engineers. The advances secured in the weight and penetrating power of artillery seem to necessitate even as great or greater weight than that of the *Captain* in order to withstand the now well-nigh irresistible force of projectiles.

One serious difficulty in practical experiments with such vessels, is the enormous expense attending them. The *Captain* must have cost the British Government nearly or quite as much as a fleet of wooden war vessels. It is impossible, therefore, that in the race for naval supremacy such rapid progress can be made as some seem to expect. Some of the blunders committed, however, seem certainly too gross for the present state of knowledge on this subject.

For instance the French naval squadron, especially designed for service in the Baltic, has been found to draw too much water for that service, and has been withdrawn from it.

The Prussians have employed well known means to render difficult the navigation of the shallow waters on the south Baltic coast. The usual lights have been extinguished, and false lights substituted, and the inlets and entrances to rivers filled with torpedoes, and protected by light-draft gunboats which can run where the French ships are totally unable to follow them. Think of ships drawing from twenty to thirty feet of water sent upon such a service.

Of all the blunders committed by the French in the initiation and conduct of the present war, scarcely anything can exceed this. France has expended vast sums in experiment and in construction to produce a formidable navy that is at most worthless to her in her present crisis.

England made a similar blunder in the Crimean war. She also sent to the Baltic a fleet of heavy-draft vessels, which proved of no use, yet with this lesson of history so recently learned and written, France has followed the example of England with the same results. How long is it to be before naval constructors will learn that only light-draft vessels are fit for such service.

But then here comes in the difficulty. To make formidable iron-clads of light-draft seems almost an impossible problem.

A NEW ARTIFICIAL LIGHT.

One of the arguments employed in our works on chemistry to prove that the atmosphere is a chemical mixture and not a true compound is derived from an experiment upon the solubility of air in water. Roscoe says, in his admirable treatise:

"When air is shaken up with a small quantity of water, some of the air is dissolved by the water; this dissolved air is easily expelled again from the water by boiling, and on analysis this expelled air is found to consist of oxygen and nitrogen in the relative proportions of 1 and 1·87. Had the air been a chemical compound, it would be impossible to decompose it by simply shaking it up with water; the compound would then have dissolved as a whole, and, on examination of the air expelled by boiling, it would have been found to consist of oxygen and nitrogen in the same proportions as in the original air, viz., as 1 to 4. This experiment shows, therefore, that the air is only a mixture, a larger proportion of the oxygen being dissolved than corresponds to that contained in the atmosphere, owing to this gas being *more soluble in water than nitrogen*."

It is somewhat remarkable that no practical application of this experiment has been attempted until recently. The principle above enunciated is now applied to the manufacture of oxygen from the air. By compressing atmospheric air into receivers filled with water, more than the usual quantity of oxygen will be dissolved, and the dissolved air can be forced into a second and third receiver, becoming each time more and more rich in oxygen, until an atmosphere is finally obtained that consists of 90 per cent of that gas. Some use for the nitrogen may be invented, but at present it is of little value. It is probable that this method will eventually prove the cheapest for the manufacture of oxygen. Experiments have established the fact that an atmosphere containing 50 per cent of oxygen yields results nearly equal to what can be obtained from pure oxygen. Thus far the chief investigations have been made in this direction of furnishing a new and cheap artificial light. As soon as we can feed an air to our lamps containing 30 or 40 per cent more than the usual proportion of oxygen contained in the atmosphere, the brilliancy of the light will be greatly increased and it will afford a much healthier light than is now given by our gas. A lamp has been invented in Cologne, called the Phillips Carbo-oxygen lamp where the oil is some cheap hydrocarbon, the wick of non-combustible material, probably asbestos, and oxygen is supplied from a reservoir by a peculiarly constructed apparatus. The flame is made to assume the form of a star, and any heating of the wick holder is prevented by the manner in which the oxygen jet is permitted to feed it. It is said that the lamp needs no special attention beyond that of filling it with the patented hydrocarbon liquid. The wick requires no trimming, and explosions are impossible, as the oxygen does not in any way mix with the gases that might be produced by the heat of the combustion. The light of a lamp consuming five and a half cubic feet of gas per hour is equal to 90 or 100 candles, or ten times that of an ordinary gas jet. In diffusive power it would, however, probably not equal a less brilliant light. For lighthouses, fog signals, and photographic purposes, and for studies for the microscope, such a lamp would be of great value. The usefulness of this method of obtaining oxygen would not be confined to the production of light. There are other important applications for that gas, and the moment that we can obtain it cheaply it will enter into metallurgical operations, into compound blow-pipes, into laboratory and pharmaceutical uses, and, in fact, be applied in a thousand ways. It is possible that we may find some other liquid than water that has great solvent power for oxygen with none for nitrogen. The receivers once filled with such a liquid need not be filled a second time, but an indefinite quantity of air could be absorbed and expelled from the same apparatus, and it is possible that this operation could be carried on by clock-work or some other mechanical means. We are manifestly on the eve of the discovery of an easy and cheap method for the manufacture of oxygen for artificial light and other purposes, and the source of the gas appears likely to be the atmosphere.

AFFAIRS IN PARIS.

In consequence of the hostilities at Paris, the office of the Scientific American Patent Agency has been temporarily removed to Fécamp, Seine-Inférieure, No. 22 Rue des Cordieries. Fécamp is not likely to be bombarded by the Prussians, and may be conveniently reached by our clients via Bordeaux or Marseilles.

A Paris correspondent of the New York *Tribune*, who lately went to call on some of his friends, says: "I found everyone engaged in measuring the distance from the hostile batteries to his particular house. One friend I found seated in a cellar, with a quantity of mattresses over it to make it bomb-proof. He emerged from his subterraneous "Patmos" to talk to me and after ordering his servant to pile on a few more mattresses, retreated again. Anything so dull as existence it is difficult to imagine."

Communication between Paris and the interior of France is now maintained by means of balloons and carrier pigeons. M. Durnorf, the aeronaut, lately carried a large mail from the beleaguered city. He left the Place St. Pierre, Montmartre, Paris, at eight o'clock in the morning. A strong east wind was blowing. He rose three thousand yards, and with a telescope saw the Prussians pointing cannon at him. The infantry also tried their rifles, but he was out of range. He descended near Evreup, and thence by rail to Tours.

The roar of cannon is now continuous at Paris, as the contending armies are constantly at work, harassing and destroying each other.

The French, judging from their own accounts, have devised an ingenious system of night attacks, by which they deprive the Prussians of rest, and frequently obtain important advantages over them by capturing prisoners. In these attacks the French use the electric light to blind the eyes of the enemy. Preparations have been made to light the city with petroleum if it becomes necessary to cut off all the gas.

THE SIEGE OF PARIS.

As London is the chief European center of commerce, Paris is the center of fashion and gaiety for the entire world. In time of peace its hotels are always crowded with people of every country and race, who bring to it and leave with it vast sums of money annually. The first Napoleon having in view the brilliant future of this modern Babylon, ravished every city which fell into his hands for works of art to decorate the streets, parks, and palaces of the French capital; thereby rendering it, in connection with its more modern improvements, undoubtedly the most attractive and splendid city the world has ever seen in any age.

One shudders at the probable condition of this beautiful city and its inhabitants at the present moment. The Palace of the Tuileries, the Palace of the Luxembourg, the Grand Hotel, and other public buildings are turned into hospitals and lazar houses, as shown by the yellow flags displayed upon them, and the city is crowded with probably fifteen hundred thousand non-combatants. The long list of disasters to the French arms has been crowned with news of the fall of Strasbourg which must strike to the hearts of the Parisians like the final death-blow to all hope of success for their cause. Their parks are dismantled, their beautiful groves destroyed, and their rich bronzes melted down as material for artillery. They are cut off from external intercourse with the world, and can only get such news of external affairs as the Prussians permit to pass their lines. They are consequently well posted as to their disasters, but anything calculated to raise hope could only, if it existed, reach them by devious and doubtful means. To crown all, it is reported that riots rage in the streets, and that firing can be both seen and heard from a distance between unknown factions, which must, whatever their character, add to the confusion and dismay of the populace.

It is hard for those who have not visited and sojourned in Paris to form any adequate idea of her former beauty, and what must be the aspect she now presents in her distress. Even though familiar with her splendid hotels, theaters, and churches, her boulevards, parks, and gardens, our imagination finds it impossible to picture the reality of the death and misery which now fill them all with cries of desolation and despair; and though we have felt that this war originated entirely with the French, and was begun on the most flimsy and insufficient pretext, we cannot withhold a sentiment of keenest pity and sorrow for the helpless misery of the—with all their faults—most refined, cultivated, and pleasant people the world has ever produced, nor help regretting the too probable fate of this unrivaled city.

THE CHEAP PRODUCTION OF POTASH.

In Vol. XXII., page 399, SCIENTIFIC AMERICAN, we gave the various methods employed for obtaining potash from feldspar, published in foreign journals, but failed to do credit to a distinguished American scientist who was one of the first to propose a practicable method for the resolution of minerals containing this alkali. The subject is of sufficient importance to recur to it once more.

At the meeting of the American Association for the Advancement of Science, held in New Haven in August, 1850, Professor Henry Wurtz, read a paper on green sand, which was afterwards published in *Silliman's Journal*, Vol. X., page 329, from which we quote the following:

"The pulverized and ignited marl (green sand) was mixed with a sufficient quantity of chloride of calcium to form upon the fusion of the latter a pasty mass. The decomposition of the green sand takes place in this case, at a low temperature, and is so complete that I have founded upon this circumstance a method of decomposing minerals in the process of analysis, which I have had the honor of presenting to the Association before. The mass, after fusion, falls to pieces in water, yielding to this solvent, in most cases, all the potash which was contained in the green sand employed in the form of chloride of potassium."

In the previous communication alluded to above, the process is given of fusing feldspar, hornblende, scapolite, etc., with chloride of calcium and chloride of barium. Subsequently to Professor Wurtz's valuable paper, to wit, in 1853, Prof. J. Lawrence Smith published in *Silliman's Journal* a process for "determining alkalies in minerals," which was essentially the one proposed by Dr. Wurtz, with the slight modification of the substitution for chloride of calcium of an equivalent mixture of carbonate of lime and sal ammoniac convertible by heat into carbonate of ammonia which passes off, and chloride of calcium which remains and accomplishes the decomposition. Professor Wurtz has found that his original plan, while less complex, is preferable on many accounts to Dr. Smith's modification. Dr. Smith's modification of Prof. Wurtz's method for the resolution of minerals by the "lime process," has become quite celebrated, and is given in all its details by Prof. S. W. Johnson, in his admirable edition of "Fresenius' Quantitative Analysis." Either of the methods accomplishes the object and appears preferable to any hitherto proposed.

In August, 1864, Professor Wurtz published in the *American Gas Light Journal and Mining Reporter*, an article entitled: "A Neglected Source of Wealth," in which he called attention to the importance of economizing the alkali of the green sand marl. He says, "it may be assumed that the average of potash in washed green sand of a good quality will be at least seven per cent. This is equivalent to 157 lbs. of anhydrous potash, or 188 lbs. of pure hydrate of potash per tun of 2,240 lbs. Now the very best qualities of American potashes, worth at the present (1864) market rates $14 per cwt., contain not more than seventy per cent of pure hydrate; so that a simple calculation shows that one tun of washed green sand marl, which should be delivered in New York for probably $7 or $8, contains $37·60 worth of potash. The green sand could also be employed for making alum by heating it red hot, then acting upon it with dilute sulphuric acid, crystallizing the solution, adding to the mother liquors a small quantity of chloride of potassium, obtained by another method from the green sand itself, which converts the iron alum formed into common alum and crystallizing again. If only five of the seven per cent of potash present were thus obtained in the form of alum, the quantity of alum from a tun would be 1,120 lbs.; only ten per cent of the crystallized alum being potash."

The treatment of green sand and all feldspathetic rocks proposed by Professor Wurz does indeed contain the germ of neglected wealth. In view of the great amount of potash now accessible from the Stassfurt mines, it would hardly pay from a commercial point of view to work feldspar or green sand for that alkali, but there is another direction in which great benefit can be derived by the application of the method to the resolution of granitic rocks, greenstone, feldspar, basalt, green sand, hornblende, mica, scapolite, and other rocks and minerals for enriching our farming lands. It would hardly require any thing more complicated than a lime kiln for the fusion and subsequent leaching of these minerals. Many farmers already understand how to grind up bones and treat them with sulphuric acid to manufacture superphosphate. It would be just as simple an operation to heat the broken rocks and while still hot to project them into dilute sulphuric acid, and thus to disintegrate them or to fuse them, according to Dr. Wurtz's plan, with chloride of calcium or with carbonate of lime and sal ammoniac, after Dr. Lawrence Smith's method, or wanting all these substances, to heat the rocks red hot, then plunge them suddenly in cold water to render them friable, then grind them and mix with lime, and heat in a kiln, and afterwards leach out with water.

A practicable and simple method for economizing the potash of our common rocks would be a great boon to the country, and the solution of this question ought to command the attention of our men of science. An acre of ordinary wheat soil, ten inches deep, will weigh somewhere in the neighborhood of 1,000 tuns, and according to the estimate of skilled chemists, contains at any one time, of potash soluble in water, about seventy pounds. Two crops of wheat and hay would remove the whole of this, and the soil would be utterly exhausted unless some provision was made for supplying the waste. The natural source from which this waste is supplied is found in the rocks and minerals contained in the soil, and we have recently pointed out the newly discovered property of humic acid to dissolve silica, and thus help to decompose the rocks. Plowing, tilling, draining, all have their share in asserting the necessary decomposition, but these are at best but slow operations, and it would greatly facilitate matters to have a cheap supply of potash and phosphoric acid to add to the soil, in proportion to the removal of these substances by the crops.

Our works on agricultural chemistry contain full tables of the amount of mineral matter taken from the ground by every variety of crop. The wheat grains, the straw, the husks, the corn, everything has been analyzed, and the precise figures are given, so that a debit and credit account can be kept by the farmer with every field, and as the cattle are fed with food, so ought the ground to have returned to it all that it is deprived of by the crops, in this way an equilibrium can be established, and the farm can never be exhausted. In most instances the air, the water, and the rocks will furnish us all that we need if we only know how to manipulate them and make them do our bidding.

The saying of Benjamin Franklin is still true: "Every man has a gold mine on his own farm, and that lies only plow deep."

Common-Sense Chairs.

The above quaint expression is used in the heading of a circular before us, advertising a class of old-fashioned easy chairs, manufactured on a large scale, by F. A. Sinclair, at Mottville, Onondaga Co., N. Y.

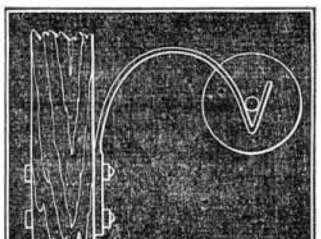
As applied, the title is most appropriate, for we have not seen, since the days of our grandmother, chairs combining so much strength and comfort as the articles to which it refers. The seats are composed of woven splints of ash, and the frames are made of hard wood, firmly secured together. A variety of patterns are made and sold under appropriate names, "Union Arm Chair," "Old Puritan," "Grandmothers' Rockers," etc. The largest size contains nearly as much timber as we have seen used by some speculators in constructing small houses in the vicinity of this city.

For watering-place hotels and piazzas in the country, we know of nothing so comfortable and appropriate as these chairs, but as to office use, for which the manufacturer recommends them, we disagree with him—they are too comfortable for business purposes.

Send to Mr. Sinclair as above for illustrated circulars, or call and see the articles, at 199 Fulton street, New York.

BALANCING CYLINDERS.

Our answer to C. E. M., of N. Y., on page 106, current volume, has called out a most valuable correspondence on the subject of balancing cylinders, of which we propose to give a summary in the present article. Our readers will recollect a letter from W. O. Jacobi, published on page 148, in which he stated that cylinders could be tested while running so as to balance them intelligently and perfectly. We expressed in a remark appended to that letter some doubt that this could be done. Since the appearance of the letter referred to we have been favored by a call from Mr. Jacobi, who has convinced us that cylinders can be tested as he proposes; and his method is so simple and ingenious that we gladly lay it before our readers.



The accompanying diagram shows the apparatus employed: A bent steel spring bar, having a V-shaped bearing, in which one of the journals of the cylinder to be balanced rests; the other end rests in a bearing adjustable vertically, so that the cylinder may be brought into a horizontal position. This being accomplished, the cylinder is set revolving at moderate speed by a belt and pulley on the end opposite the spring bar, and a piece of chalk is held so as to just touch it at the end resting in the bearing of the spring bar. If the end of the cylinder is out of balance it revolves around a center, which is not the center of the cylinder, and the chalk mark, clearly points out the place to add the counterpoising weight.

Mr. Jacobi states that in his establishment he has employed this method with perfect success in balancing the "fancys" in carding machines, these cylinders being long in proportion to diameter, and more difficult to balance than those short in proportion to diameter.

Mr. John Mitchell prefers balancing on pivots to using steel bars. He first balances the heads separately on the shaft, then marks the centers of the horizontal bars or "lags," suspends the cylinder on pivot centers, and balances by chipping or drilling. We tried this method in all its essential features some years since, but could never get so nice a balance as when we used steel bars. With the latter we never failed, but the cylinders we operated upon were very strong, and short in proportion to diameter. Mr. Mitchell would have added to the value of his communication by stating the character of the cylinders he has balanced in the method described, their size, and the speed at which they are run.

Another correspondent, who does not give his name, loosens the boxes allowing the cylinder room to jump, and marks with the sharp point of a file in the way prescribed by Mr. Jacobi with the chalk, operating on one bearing at a time. It seems impossible to reach the nicest adjustment in this way, and we should much prefer Mr. Jacobi's plan, the elasticity of the spring bar permitting motion from the slightest inaccuracy in balance.

This correspondent remarks that a crank shaft cannot be perfectly balanced, because the weight cannot be applied opposite the crank pin; but by suspending the bearings so as to allow the crank wheel to find its center of gravity, he has succeeded on a 20-pound crank wheel in balancing a 4-pound pitman rod, having a 5-inch stroke, running at a speed of 4,000 revolutions per minute.

Mr. G. Westinghener, of Schenectady, N. Y., balances cylinders from two to three feet in length, designed to run 1,500 revolutions per minute, as follows: The cylinders weigh about 200 pounds, and have a shell of wood. He uses small pointed pieces of iron rod, about an inch and one half in length as weights driving them partially in, so that they will not fly out when the cylinder is rapidly revolved. They are inserted one at each end, directly opposite each other. The cylinder is then set in motion to see whether it is more or less out of balance than before the insertion of the spikes, the positions of which are changed until the cylinder runs without shaking. He says this sometimes involves a number of experiments, but he always succeeds in getting them to run steady, and this he does on a bench that can be shaken easily by the hand

We have no doubt a cylinder can be balanced in this way, but it seems a very slow and unmechanical method. The revolving of the cylinder to see whether it has lost or gained in balance cannot be called a very scientific method of test, if indeed it deserves the name of test at all. Mr. Jacobi's method, on the contrary, not only determines that the cylinder is out of balance, but at once indicates the point to add weight in order to correct the inaccuracy, in accordance with scientific principles. The one is mere "cut and try," the other proceeds directly to the object in view.

Mr. Phillip Strickler, who claims to have had a long experience in balancing cylinders and runner millstones, uses the steel bars for balancing cylinders, balancing successively each head as it is put on the shaft. Then if it is to be lagged with staves of wood or metal, he centers each on the edges, and balances them endwise separately on pivot centers. Then he places them on the heads in exactly the order they are to remain, and balances the whole on the steel bars, distributing the counterpoising weight along the light side, not concentrating it at a single point.

We know this method will secure a good balance, but it is positively essential that everything should be complete before balancing, and no alteration made afterward. Mr. Strickler's method of balancing runner millstones will be found with diagrams in our next issue. We also publish another letter on the subject of balancing in our correspondence columns this week.

The subject is one of the highest practical importance, and its full discussion is very desirable.

FAIR OF THE AMERICAN INSTITUTE.

We found, at our last visit, that notwithstanding the Fair has been now opened three weeks, still active preparations for the opening were still in progress. The shafting is not all running, and there is not steam power enough furnished by the boilers to run such machinery as is ready to run at any proper degree of speed. We, however, give this week brief notices of such machines as were present, and of which we were able to get some information. There are only three inclosures of

MACHINISTS' TOOLS.

Lucius W. Pond, of 98 Liberty street, New York, shows a fine collection, consisting of one 22-inch lathe with compound rest and cross feed, very strong and powerful; one 32-inch planer—a four-tun machine; one 22-inch planer—1½-tun machine, and one upright drill press. Mr. Pond has, within the last two years, completely re-organized his establishment, and now uses entirely new patterns, which give greater power and simplicity to the well-known and highly-appreciated tools of his manufacture. The old Jersey City Locomotive Works have recently been re-fitted and supplied throughout with Mr. Pond's tools made after these new patterns. The patterns of his lathes have been changed so as to give increased size to the parts which receive strain, and they are in all respects excellent tools. The 32-inch planer is very heavy and powerful, and both it and the smaller one alluded to, run with great smoothness of action. By using a simple train of cut gears and racks to drive the tables of his planers, Mr. Pond does away with stud gears ordinarily used with single belts, and is enabled to increase backing speed at pleasure. This collection of tools will not fail to please all mechanics who examine them.

The New York Steam Engine Company, 126 and 128 Chambers street, New York, exhibit one 20-in. planer, one 32-in. lathe, two drill presses, one car wheel boring machine, a machine for turning nuts, one shaping machine, one slotting machine, and a punching press. These are all fine tools, but the punching press shown is perhaps the most noticeable feature of the collection.

George W. Moore, of Worcester, Mass., shows in connection with the tools in this inclosure, a simple and useful gage to turn bevels of gears to agree with the drawing.

The Union Vise Company, 80 Milk street, Boston, Mass., exhibit two beautiful milling machines of different sizes, evidently both excellent tools. They also show a universal head for milling machine or planer by which spur and bevel gears can be cut, or work held upon an arbor or chuck can be milled at any angle, and in almost any position. They also show a machine for cutting spirals, either straight or conical, right or left hand, and of almost any pitch, the changes being made by the ordinary gears of an engine lathe. They show lastly the James Ross Steam Permeator or oil and tallow cup for lubricating the valves and cylinders of steam engines. They are beautifully designed and finished, and rank among the best of this class of devices.

Cowin & Johnson, of Lambertville, N. J., exhibit a universal lathe chuck, of peculiar construction, in which a socket wrench applied to one end of a worm shaft causes the jaws to simultaneously and firmly grasp the work. The working parts of this chuck are all covered, so as to be out of the reach of dirt, chips, etc., which often interfere with the action of chucks of this class.

PUMPS AND BLOWERS.

Knowles & Sibley, of 126 Liberty street, New York, exhibit various sizes of the Knowles Patent Steam Pump. This pump has neither cranks nor fly wheels. The main steam valve of the pump is not a rotary valve, but is an ordinary flat slide valve. The slight rotary motion given the valve rod simply puts the valve in a position to be driven horizontally on its seat. The steam cylinders are fitted with spring ring packing, with screws and springs, for proper adjustment. The water cylinders are fitted with composition heads and rings, adjustable by screws, or with leather rings or a patent fibrous head, according to the nature of the work required. All the joints are ground to fit, and require no packing. The glands and piston rods are solid composition. The valve seats are composition, and the valves, either rubber or metal, are very durable, and are placed in the pump so as to be easily accessible, and in the larger sizes, for fire or marine purposes, are got at immediately without removing any nuts or bolts.

J. H. A. Gerricke, 169 Broadway, New York, exhibits a turbinate force pump. It consists of a wheel case containing a turbinate wheel secured to shaft, and having vanes or paddles of different lengths at its curved periphery, which are bent at their discharge ends, closely fitting the space between it and the case, within which it revolves without touching. In the end of the wheel is an anti-friction pin (used in the vertical pumps) which revolves in a female step, secured in the case. An upper chamber contains anti-friction partitions and a bottom plate which withholds the weight of the water from the wheel.