## THE KNOWLES STEAM PUMPS.

During the closing days of the Industrial Exposition recently held in Pittsburgh, Pa., a very interesting competitive trial was made of the various steam pumps exhibited. The tests were of a purely practical nature, no facilities being afforded for scientific determinations; but the results are, nevertheless, valuable to engineers, as showing quite clearly the relative efficiency of the machines under conditions of actual use. The details of one of the last competitions, between the victor in the previous contests and the other dumps below named as entered, sum up, in general terms, the result reached. The Knowles pump had already proved its superiority as a fire pump, and had also come off best as against the Blake, Niagara, and Hutchinson machines, in the latter trial being tested at slow running, at working against a pressure of 60 lbs., at regular working speed (piston speed 160 feet per minute) against the same pressure and also being subjected to critical comparative examination by well known experts as regards advantages of construction, facility of repairs, and similar points. The decisive contest below mentioned was the result of a claim for the premium by the exhibitors of a machine constructed on the pulsometer principle, on the alleged ground that the latter was a direct-acting steam pump and would throw more water with the same amount of fuel than any other apparatus. The conditions of the trial were to throw a stream through a three quarter inch nozzle, to a given hight, and hold it at the same point for three quarters of an hour. The start was to be made with two gages of water and 100 lbs. of steam pressure. The Knowles pump was selected by the judges as the competitor under this challenge, but subsequently exhibitors of other pumps were allowed to enter their machines in the same trial. We are informed by Messrs. Bailey, Farrell & Co., of Pittsburgh, who exhibited the Knowles pump, that the results were as follows: The pulsometer consumed 103 lbs. of coal, and failed at times during the test to keep the stream up to the required hight. The Knowles pump consumed 52¼ lbs. of coal, and kept the stream above the given point during the entire test. The other pumps also maintained the streams, but used greater quantities of coal than the Knowles, as follows: The Cooper (fly wheel) pump, 63 lbs.; the Niagara, 72 lbs.; the Blake, 62 lbs.; and the Hutchinson, 60½ lbs.: the Knowles, therefore, winning the contest.

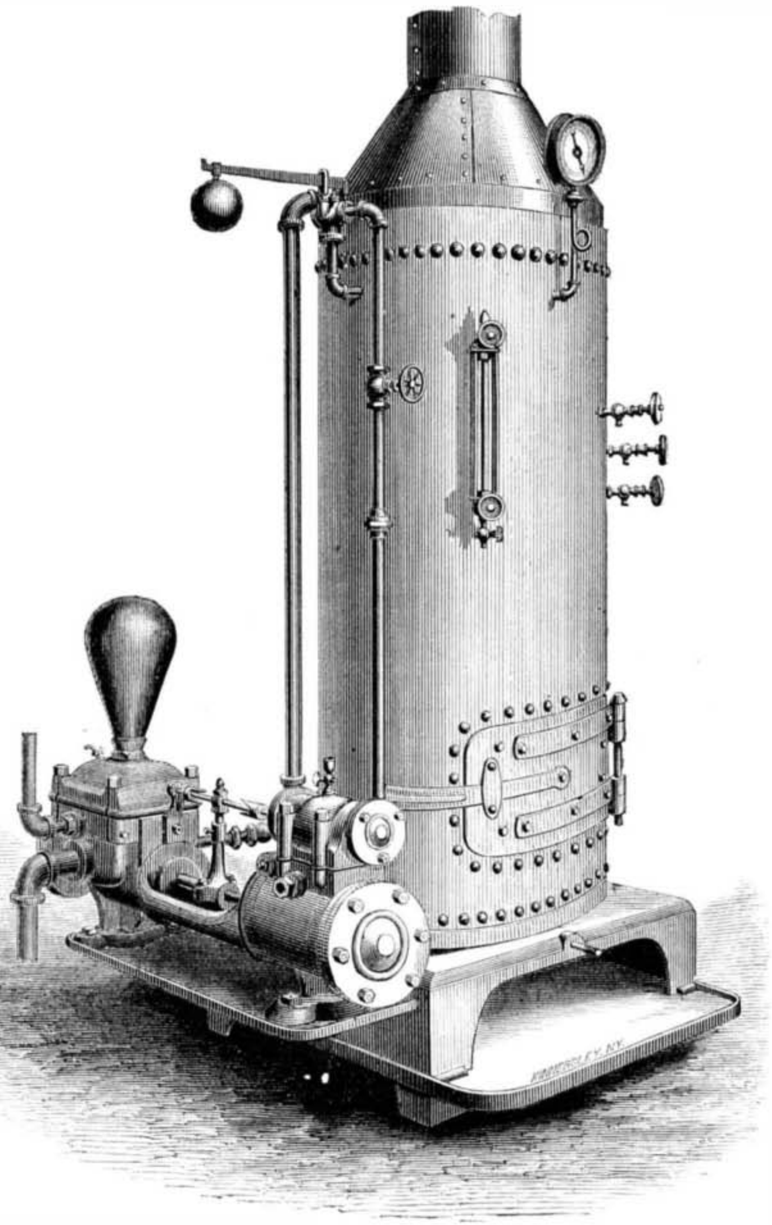


Fig. 1.—STEAM PUMP WITH BOILER.

We have obtained from Mr. Knowles the following information relative to some of the best and newest forms of pump, engravings of which are given herewith. Fig. 1 represents the No. 3 pump complete, with boiler. This machine is adapted to general purposes, especially for supplying buildings and railway tanks with water. It is of very simple construction, and includes an improvement in swinging bolts, and a removable hand attachment, as represented in Fig. 2. The last mentioned device is useful for filling boilers when steam is down, washing decks, and for similar purposes. It is easily removed and applied.

Fig. 3 represents the pump arranged as an independent stationary steam fire engine. The capacity is only limited by the size of the machine, and it is claimed that steam can be raised and a stream of water thrown upon adjacent buildings in less than seven minutes from the time of lighting the fire under the boiler. In Fig. 4 a form of the pump especially adapted to fire purposes, and known as No. D D is shown.

The protection of large edifices, and especially factories

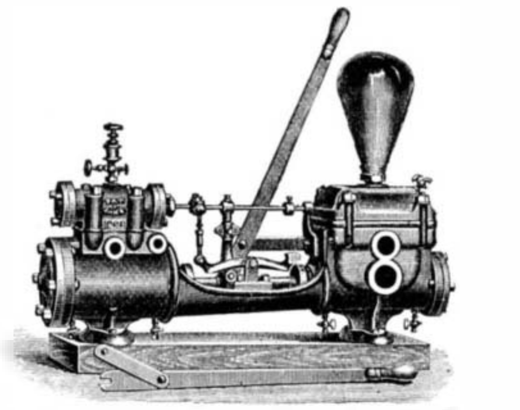


Fig. 2.—STEAM PUMP WITH HAND ATTACHMENT.

by steam pumping apparatus has been found by actual experience to be one of the best measures of safety. Where

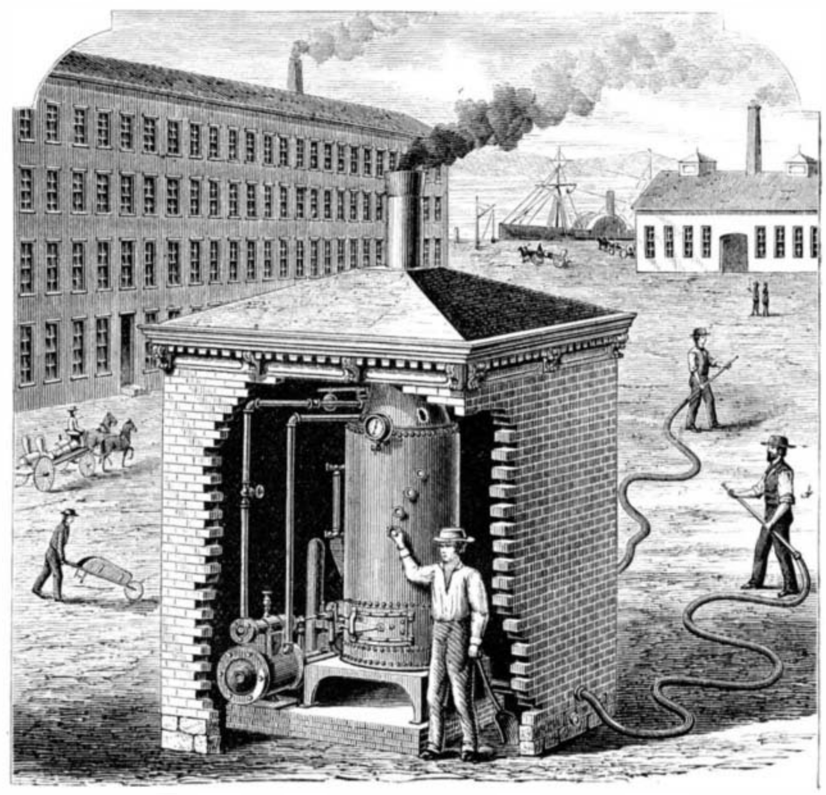


Fig. 3.—STATIONARY STEAM FIRE ENGINE.

the pump has its own boiler, as above noted, and is isolated from the main structure, it is out of the reach of danger, and is always ready for immediate operation. Pipes may be laid from it, underground, to various parts of the works; or a single powerful machine, connecting with hydrants, reservoirs, ponds, or running streams, and capable of throwing from one to fourteen streams to distances of two hundred feet, might be employed to protect an entire village or town. The manufacturer informs us that the pump under examination will be guaranteed to project the above number of streams to the distance named, from hydrants or other sources situated a mile away.

The Knowles pump finds one of its most important applications in mines, and two different forms, used for deep mining, are represented in Figs. 5 and 6. Fig. 5 is a double-acting plunger pump, arranged with hand holes for affording immediate and easy access to the valves. The valve plates are entirely separate from any other part of the pump, and all the stuffing boxes are on the outside. The water passages are large, and the general construction heavy and strong Fig. 6 is also a double-acting plunger pump with accessible parts. Its principal feature is the absence of joints in the water end, and the novel arrangement of valves by which not only the valve but also the valve seat is instant y removable by simply unscrewing the cap nut. These pumps are now working on lifts equal to 1,600 feet vertical column, without causing shocks or pounds of any description.

The first pump made by Mr. L. J. Knowles was produced in 1855, and patented at that time through the Scientific American Patent Agency; and two years later the manufacture

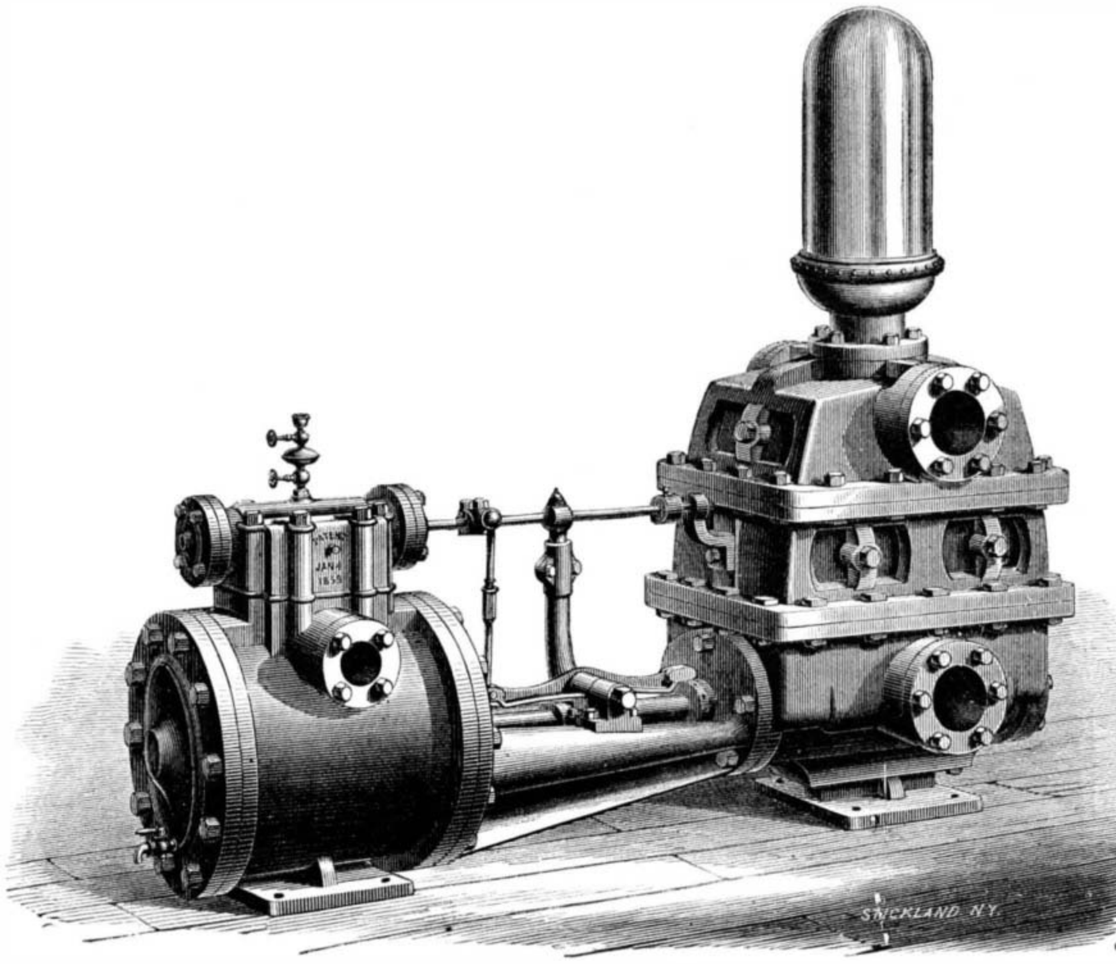


Fig. 4.—FIRE PUMP.

was regularly begun. The manufactory of these celebrated pumps is located in Warren, Mass., and was established in 1862, since which time it has been gradually enlarged until it now covers two acres of ground. The principal warerooms are at 92 and 94 Liberty street, in this city, and at 14 and 16 Federal street, Boston, with branch houses in Chicago and San Francisco. Upwards of five hundred different patterns of pumps are now made, ranging from the smallest sizes to pumping engines weighing from ten to forty tuns each, and possessing a capacity, as demonstrated by actual tests, of supplying several millions of gallons of water daily, and of forcing the same to hights of hundreds of feet.

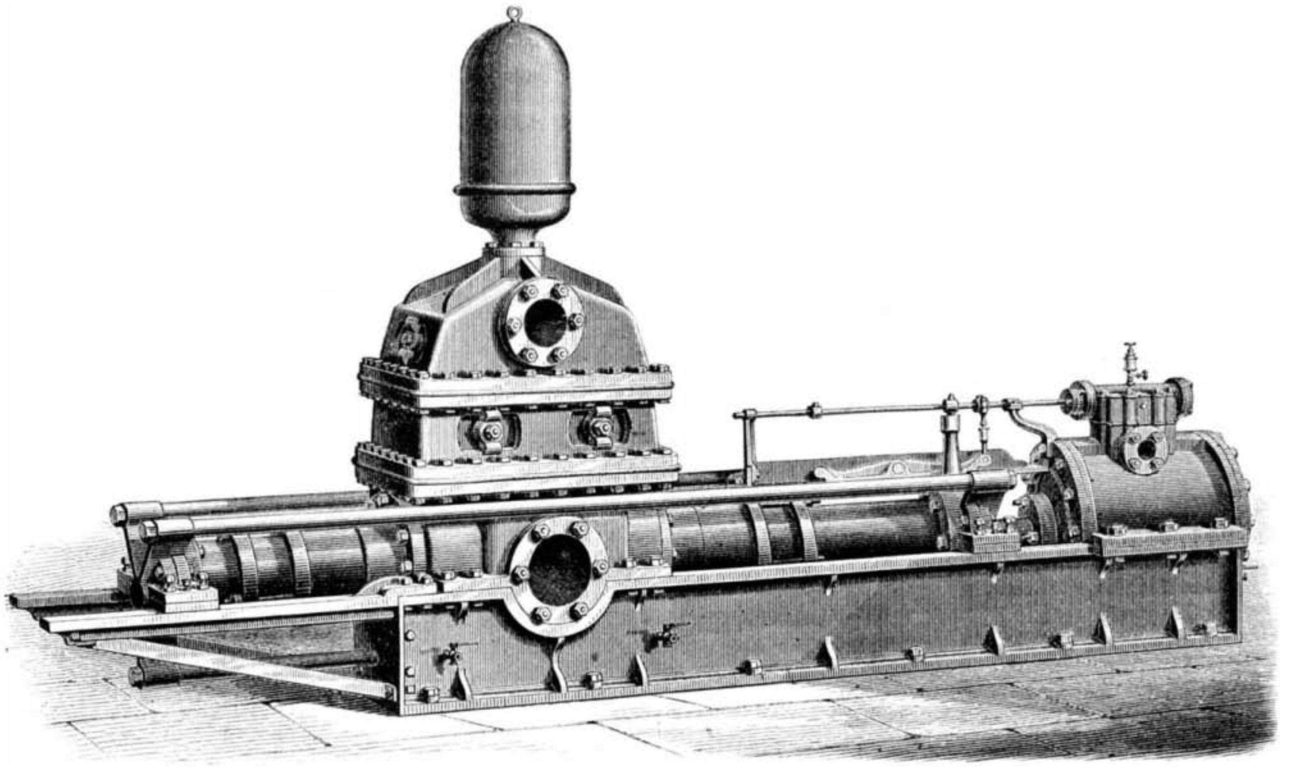


Fig. 5.—HORIZONTAL MINING PUMP.

### The New Force.

The new force claimed to have been discovered by T. A. Edison may be demonstrated in the following manner:

Upon an insulated table place an ordinary Morse key and an elec tro magnet, the coils of which are so wound that no magnetism is produced in its cores by the passage of an electric current. Use for an armature a piece of the metal cadmium, to one of which fasten a flat spring. The other end of the spring attach rigidly to a standard fixed on the table. Adjust the armature a short distance away from the core of the magnet. The standard is to be connected by wire to one end of a glass rod or tube, say two feet long. The other end of the tube connects by wire with a graphite point (a lead pencil will answer). Another graphite point is connected by wire to a gas pipe or other suitable mass of metal, not in contact with the apparatus; and the two points, in position similar to the arrangement for producing the electric light, may be placed in a box from which light is excluded, but with a hole in the top for observation. Place 10 or 15 Bunsen cells in circuit with the key and the coils in the usual manner. Now, if the key be closed, a spark of considerable brilliancy will be evolved from the graphite points, but possessing no continuity. If, however (the battery circuit remaining closed), any part of the connection between the gas pipe and the cadmium is broken, and contacts be made either slowly or rapidly between the disconnected points, the spark re-appears at each contact. It is here that the phenomena are surprising, and apparently unexplainable. The graphite is not in the battery circuit, nor in any other. Moreover it is separated from the rest of the ap paratus by the glass tube. This alone would seem to prove that the force is not electrical, at least as the term is generally understood; and when supplemented by the fact that the most delicate galvanometer and the chemicals most sensitive to the electric current fail to note its presence, this conclusion must be accepted. Many experiments have been made with a view of obtaining some definite knowledge, but nothing has been developed beyond the facts above stated, and in addition that, like electricity, the new force passes through or over some substances better than it does over others, and also that, as the resistance of one of its best known conductors is increased by length, the spark decreases in brilliancy.

The occurrence of this spark has frequently been observed by electricians while conducting experiments, but heretofore no attempt has been made to discover the cause or effect. Any theory upon the subject is, of course, at present only speculative, but it is not improbable that the phenomena are in some degree the physical manifestation of that mysterious magnetic power which is not obstructed by material obstacles, and is weakened only by separation. This view is supported by the analogy existing between two demonstrated facts. First: When the new force is conducted through the human body from points attached to both sides of the neck, the spark is of a certain strength. When the connection is through the trunk, from hand to hand, the strength is greatly diminished.

Second: Substances which act as dielectrics offer no obstruction to the passage of magnetic power. The action of a magnet upon a needle is the same when separated by a thickness of glass or porcelain, as when separated only by a distance of air equal to the thickness of the dielectric, and is diminished only by wider separation.—*Journal of the Telegraph.*

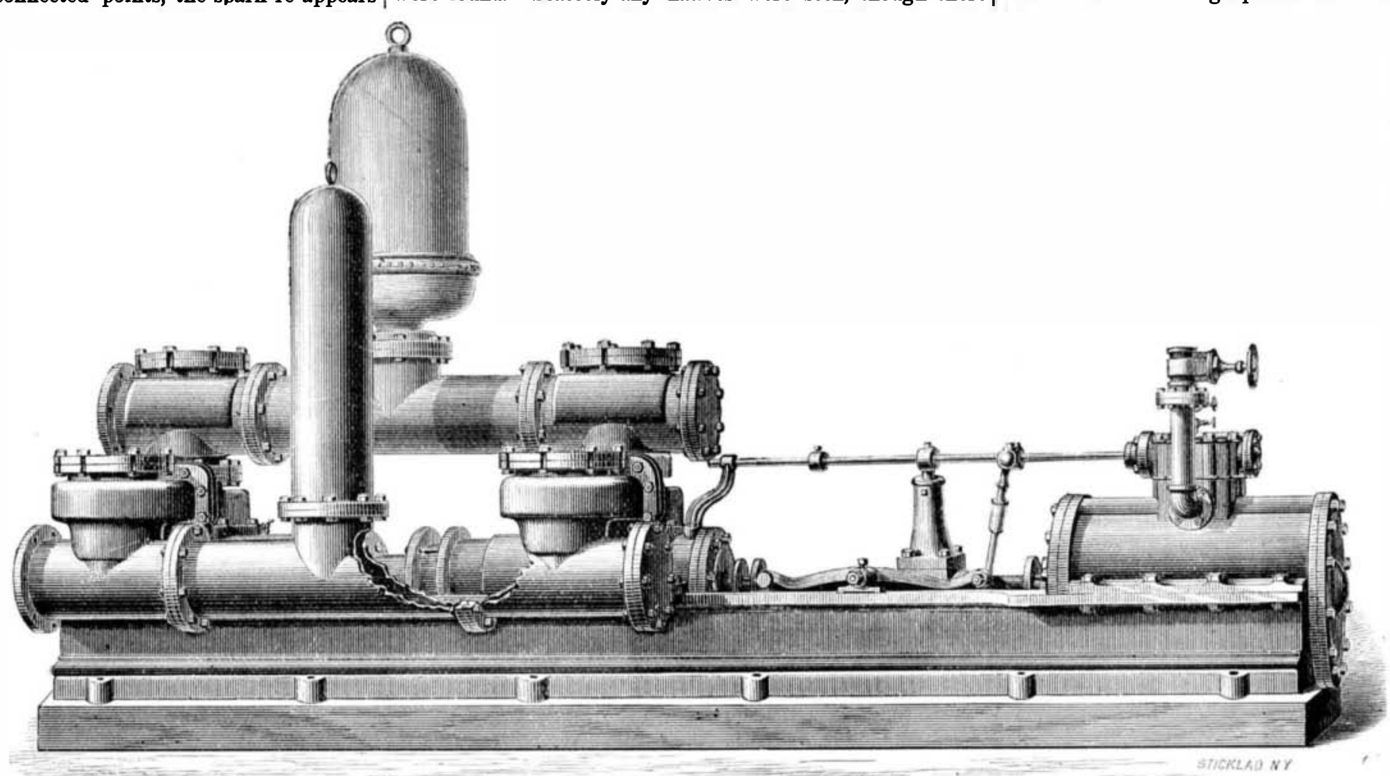


Fig. 6.—HORIZONTAL MINING PUMP.

### Remarkable Bird.

The London *Daily News* publishes an interesting letter from Mr. Smithurst, the engineer of the steamer which made the voyage up the newly discovered Baxter River, New Guinea. The river seems to be a magnificent one, and could evidently, says *Nature*, be made navigable to a considerable distance inland. The exploring party found the banks to consist mainly of mangrove swamps, though, near the end of the journey, high clay banks with *eucalyptus globulus* were found. Scarcely any natives were seen, though there were frequent signs of their being about. Mr. Smithurst refers to a very remarkable bird, which, so far as we know, has not hitherto been described. The natives state that it can fly away with a dugong, a kangaroo, or a large turtle. Mr. Smithurst states he saw and shot at a specimen of this wonderful animal, and that "the noise caused by the flapping of wings resembled the sound of a locomotive pulling a long train very slowly." He states that "it appeared to be about sixteen or eighteen feet across the wings as it flew, the body dark brown, the breast white, neck long, and beak long and straight." In the stiff clay of the river bank, Mr. Smithurst states that he saw the footprints of some large animal, which he "took to be a buffalo or wild ox," but he saw no other traces of the animal. These statements are very wonderful, and before giving credence to them we had better await the publication of the official account of the voyage.

### Pneumatic Telegraphy.

Pneumatic telegraphy has become quite an institution of the age. Scarcely a capital in Europe has failed to avail itself of its facilities to complete its telegraphic system. When stations lie together, close and thick, it is manifestly advantageous to connect them by mechanical means, so as to save, by the transport of the actual telegrams themselves, the multiplication of wires, apparatus, and clerks; and especially so when this can be done with a rapidity equal to that of telegraphy itself. Messages cannot be manipulated or written out at a greater rapidity than forty words per minute; so that, if it is possible to transport a telegram itself from one place to another in a minute, not only is speed of transmission obtained, but all sources of error are eliminated. In fact, the average initial delay occupied by messages on the shortest lines is about five minutes, so that tubes which can convey the messages bodily within this limit are economical and beneficial. The essential element of telegraphy is speed of transmission, and it is evident that, when currents of air can produce greater dispatch than currents of electricity, pneumatic tubes are preferable to wires. But apart from the question of speed of transmission, tubes are essentially economical in the employment of staff, for their use reduces the number of clerks required to a minimum. But of course there is a limit to their useful employment, and a point is reached when, from telegraphic and economical grounds, wires surpass tubes in efficiency and durability. The limit of length is about two miles, for at this distance telegrams exceed the five minutes interval allowed for their average transmission. Of course, where rapidity is of no consequence, this distance can be much exceeded; but, fortunately for the British public, the one criterion which its telegraphists have always endeavored to attain, especially since the transfer of its telegraphs to the State, has been swiftness of transmission, and it is to swiftness more than to any reduction in price that the marvelous increase of business is due. In five years telegrams in England have increased from six millions to twenty millions.

The first germ of pneumatic telegraphy was sown in the year 1810, when Mr. George Medhurst (who, because he lived in Denmark street, Soho, has always been called a Danish engineer) proposed and patented "a new method of conveying letters and goods with great certainty and rapidity by air." His proposal is so clear and interesting that it deserves extracting:

"If a light and hollow vessel is so formed as to fill the area of a tube, and to move freely through it, carrying papers not exceeding three ounces in weight, it will be driven through the tube with the velocity of 150 feet in a second by the pressure of nine ounces per square inch.

"And therefore a tube of uniform dimensions, being laid upon or under ground, from one place to another, without any sudden curvature, will form the means of conveying packets of letters with the velocity of 100 miles per hour, by forcing the air through the tube with a pressure of three ounces per square inch for every ounce weight in motion.

"And if there are two tubes of the same dimensions laid ing from one place to another, packets of letters may be conveyed each way, at the same time, without a possibility of their clashing against each other; and many packets may be conveyed the same way, in the same tube, which can never approach each other, but will all proceed with an uniform motion and equal rapidity to their destination, where, the tube entering an airtight room, the packets will be deposited, and may be delivered or forwarded to the next stage through their proper tubes, commencing in the same room, and their progress can never be impeded by the seasons or the elements."

This proposal did not take practical form until 1854, when Mr. Latimer Clark laid down a 1½ inch lead pipe between the Electric Telegraph Company's Central Station, Lothbury (LY), and the Stock Exchange. An engine exhausted a receiver at LY, and carriers containing the messages were sucked through from the Stock Exchange. The traffic was only required to flow in one direction. In 1858, the system was extended to Mincing lane, and about 1860 Mr. Varley introduced the use of compressed air, so that messages were drawn in one direction by a vacuum, and propelled in the other direction by a plenum. Mr. Clark had previously used a vacuum to work in both directions, a receiver at Mincing lane having been exhausted by the engine at LY, by means of a special pipe laid down in the same trench with the carrier tube.

In 1865 the system was introduced in Paris. Considerable modifications were made in its mode of working. Compressed air was used entirely, and the necessary pressure was obtained by admitting water from the mains into large air reservoirs. This tube served several stations, which were worked intermediately, like a line of railway, or a telegraph current, each station having its own store of power to propel or forward the carrier on to the next place. This mode of obtaining power was found wasteful and expensive, and it has been nearly entirely abandoned in favor of steam working at one end of the circuit.

About the same period (1865) a system was introduced in Berlin by Messrs. Siemens, who used two pipes, laid in the same trench, between the telegraph station and the Bourse, arranged in a circuit, through which a continuous current of air was always kept flowing in the same direction by a double-acting air pump, worked by a steam engine. This last mode of working was tried in London, but it has not proved successful, and it has been abandoned.

It will be seen how closely this system of Siemens' resembles that of Medhurst, and how curiously history works in a circle, for the vision of 1810 has become the stern fact of 1875. In all the places named the pneumatic telegraph has received considerable extension, and it has also been largely introduced in Vienna, where the Parisian system has been adopted.—*Telegraphic Journal.*

## ASTRONOMICAL NOTES.

OBSERVATORY OF VASSAR COLLEGE.

The computations and some of the observations in the following notes are from students in the astronomical department. The times of risings and settings of planets are approximate, but sufficiently accurate to enable an ordinary observer to find the objects mentioned. M. M.

### Position of the Planets for January, 1875.

#### Mercury.

Mercury should be looked for after the middle of the month in the southwest, farther north than the point at which the sun is seen to set. It will be in the best position on the 28th, and can be recognized by its white light and by its nearness to Saturn. At this time, Mercury, Saturn, Venus, and Mars can all be seen in the evening.

#### Venus.

On the 1st of January, Venus rises at 9h. 8m. A. M., and sets at 6h. 32m. P. M. On the 31st, Venus rises at 8h. 45m. A. M., and sets at 7h. 47m. P. M.

Venus will be well seen all through the month, and will be very near Saturn on the 16th, and in conjunction with the moon on the 28th, at which time the planets mentioned above can also be seen.

#### Mars.

On the 1st of January, Mars will rise at 10h. 55m. A. M., and set at 10h. 21m. P. M. On the 31st, Mars will rise at 10h. 13m. A. M., and set at 9h. 43m. P. M. The moon will be near Mars (apparently) on the 2d of January, and again on the 30th.

#### Jupiter.

Jupiter is still unfavorably situated for evening observers. On the 1st it rises about 4 in the morning, and sets at 1h. 39m. P. M. On the 31st it rises at 2h. 18m. A. M., and sets at 11h. 56m. A. M.

#### Saturn.

Saturn rises on the 1st at 9h. 56m. A. M., and sets at 8h. 5m. P. M. On the 31st, Saturn rises at 8h. 7m. A. M., and sets at 6h. 25m. P. M.

Venus and Saturn will have nearly the same apparent position on the 16th, but will be nearer the horizon, and therefore not so conspicuous as were Mars and Saturn in November.

#### Uranus.

Uranus is in good position, and can be seen with an ordinary telescope. It is among the small stars of *Leo*, rising on the 1st at 7h. 48m. P. M., and on the 31st at 5h. 41m. P.M. On the 31st it comes to the meridian at 12h. 40m. (20m. before one in the morning) and is then 9½° west of Regulus, and 3½° above that star.

#### Neptune.

Neptune rises at 0h. 35m. P. M. on the 1st, and sets at 1h. 47m. the next morning. On the 31st it rises at 10h. 38m. A. M., and sets at 11h. 50m. P. M. It cannot be seen without a powerful telescope.

#### Sun Spots.

The report is from November 17 to December 17 inclusive. From November 5 to November 18 no spots were seen. The photograph of November 18 showed two going off; but before the next picture, November 22, they had disappeared. In the photograph of November 23 there appeared a group of spots on the western limb, a group on the eastern limb, followed by a single one, and, near the center, two very small ones. Clouds prevented photographing on November 23. The pictures of November 24 and November 25 showed only a regular motion of the spots seen on November 22. In the photograph of November 27 there appeared but one large spot on the western limb: the two single ones first observed, near the center, November 22, could no longer be found, and the group which had been seen on the western limb had passed off. The picture of November 29 show the large spot going off, surrounded by faculæ.

Photographing was much interrupted by clouds from November 29 to December 12; but when openings in the clouds allowed observations with the telescope, the sun's disk was seen to be free from spots until December 12, when a small one was seen coming on, but after that date it could not be found. On December 14 a large spot was observed on the very edge. In the photograph of December 17, this spot appeared to be divided into two, and, near the center of the disk, a group of four very small spots was seen, which had not been found before.

## Correspondence.

### Electricity a Mode of Motion.

*To the Editor of the Scientific American:*

I take pleasure in briefly meeting the objections of Mr. R. B. West, of Guilford, Conn., to my theory that electricity is nothing more nor less than a motion of the atomic particles of matter. As Mr. West, in his communication, clearly sets forth what may prove a stumbling block to other inquirers, permit me to quote it in full:

"In No. 23, Volume XXXIII, a correspondent advances the theory, if I rightly understand, that electricity is nothing more than motion in the form of an impact or repulsion, communicated from atom to atom, and decreasing in force with the increase in distance from the starting point. This would seem very probable if electricity were capable of being communicated only by direct metallic contact; but on the contrary, it will pass, with comparatively little resistance, through a space made practically devoid of matter; and an inductive disturbance is produced when there could be no possible communication of force. Electricity may possibly be something like an allotropic form of motion, but the definition of an atomic impact alone can scarcely be used.'

Instead of entering upon a criticism of Mr. West's statement of facts, namely, that electricity will pass with comparatively little resistance through a (so-called) vacuum, I prefer, for the sake of the argument, to admit that he is correct.

The difficulty seems to consist in a lack of appreciation of matter itself. Mr. West seems to forget that it is impossible to render a space void of matter. What he conceives to be practically *nil*, as perfect a vacuum as can be formed, is really complete materiality, in which the atomic particles of what he conceives to be *nil* are in direct connection with the atomic particles of the metallic conductor, and therefore capable, in greater or less degree, of transmitting a force existing in the metallic conductor. I agree with Mr. West that there could be no transmission of electricity through a space devoid of matter; but it seems to me that, in raising his objection, he should have offered some proof of fact that he has discovered a space void of matter; or, failing to do so, he should have advanced some argument to show that a void is possible, and that, being possible, it is possible to transmit a force through it; otherwise, he is clearly not warranted in denying a material connection between one so-called conductor and another.

The concluding suggestion of Mr. West, that "electricity may possibly be something like an allotropic form of motion," I confess, puts me a long distance at sea. I am quite at a loss, for instance, to conceive of setting something in motion, and then, taking something away, having motion continue on its own account. I would like very much to witness a practical demonstration of that thing; or if that is impossible, to have somebody advance an argument showing that motion may exist independent of matter. It has always seemed to me a requisite of motion that something material shall move. W. E. SAWYER.

New York city.

### The Rattlesnake's Poison.

*To the Editor of the Scientific American:*

My attention has been attracted by a statement made in your issue of December 4, 1875, page 353. After showing the fallacy of certain stories which have been widely circulated in print, and by word of mouth, which have gained credence, regarding the toxic effect of the spittle of man when administered to venomous reptiles, and relating the incident of the boot, which contained a serpent's fang and was credited with so fatal a record, you state that the inventor of this story did not know that the rattlesnake poison is only active when freshly injected from the poison bag.

The story, is of course, improbable; but the error of your statement is very clearly shown by the following experiments by Mitchell with the venom of that reptile. He says that "it is difficult to conceive of the singular energy of the venom of the rattlesnake without carefully conducted experimental research, or of the tenacity with which its powers are preserved in the presence of violent chemical reagents and extremes of heat and cold. The dried venom retained its potency after two years of climatic changes; nor was its action in any degree changed by strong sulphuric and hydrochloric acids, ammonia, chlorine water, soda, or potassa. Freezing or prolonged boiling in no way impaired its deadly qualities." He used the venom after five years' keeping, and found it uninjured.

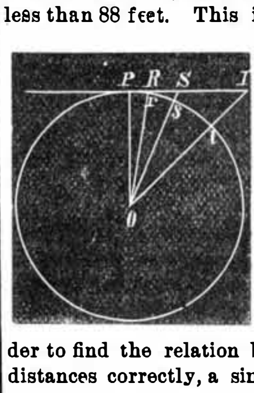
Dr. Weir Mitchell's reports of his exhaustive researches with this virulent body are richly worth perusal, showing as he does the precise manner in which it is so swiftly and fatally transmitted through the serous tissues, and conclusively settling the fact that the serpent cannot inoculate itself, a point which was for a long time disputed. His reports on this subject may be found in the *Smithsonian Contributions*, 1860, and the New York *Medical Journal*, January, 1868.

New York city. HENRY S. WELCOME.

[For the Scientific American.]

### SEEING DISTANT OBJECTS FROM ELEVATIONS.

A correspondent mentions that it is proposed to build, ni Fairmount Park, Philadelphia, adjacent to the Centennial buildings, a tower 750 feet high, and asks if it is true that, from the top of this tower, New York city, 90 miles distant, can be seen. According to the rule that the horizon dips 8 feet for every mile, which, for 90 miles, would be a dip of 8×90, or 720 feet, a tower of 750 feet high would be taller than necessary. He does, however, doubt if this rule is correct, and this doubt is well founded. If the rule were correct, we could see from the top of Mount Washington, 6,400 feet, to a distance of 800 miles, and from the highest mountain plateau on earth, 24,000 feet high, to a distance of 3,000 miles, almost one eighth of the circumference of the globe. Inversely, the tops of such mountains could be seen from similar distances, and every one knows that this is by no means the case. The fact is that the dip is only about 8 inches for the first mile; but for 2 miles it is nearly 2 feet, for 8 miles 4 feet, for 7 miles 30 feet, and for 11 miles not less than 88 feet. This is clearly shown in the engraving,




wherein the circle represents a section of the earth through its center, O. PI is the horizon of the point, P, and Rr, Ss, and Ii are hights from which the point, P, can be seen at different distances, Pr, Ps, and Pi. Without going into any mathematical demonstration, it is clear that the hights Rr, Ss, and Ii increase in a far greater ratio than the distances, Pr, Ps, and Pi; but in order to find the relation between the respective hights and distances correctly, a simple trigonometrical calculation is required, without which the solution of the problem is impossible.

ORP, OSP, and OIP are rectangular triangles, in which the angles at R, S, and I are the complements of those at O. Let the distance, PS, be 70 miles, about 1°; then the angle, PSO, will be 89°; and as the sides, PO and SO, of the triangle, PSO, are to one another in ratio as the radius to the sine of the angle, PSO, we will have: SO : PO = *rad.* : *sin.* 89°. As PO is the radius of the earth, 20,691,914 feet, we will have: SO : 20,691,914 = 1 : 0·9998477, from which SO = 20,694,954. From this we subtract the earth's radius, Os, leaving 3,040 feet for Ss, the hight required to see the point, P, at a distance of 70 miles.

In the same way, other distances may be calculated, and we have condensed some items of these calulations into the following table:

TABLE OF THE RELATION BETWEEN HIGHTS AND DISTANCES, SEEN ON THE EARTH'S SURFACE.

| | | | | | |
|---|---|---|---|---|---|
| For | 1', nearly | 1 mile, | the hight is | 8 | inches. |
| " | 2', " | 2 " | " | 2 | feet. |
| " | 3', " | 3 " | " | 4 | " |
| " | 6', " | 7 " | " | 30 | " |
| " | 10', " | 11 " | " | 88 | " |
| " | 20', " | 23 " | " | 338 | " |
| " | 30', " | 35 " | " | 760 | " |
| " | 35', " | 41 " | " | 1,036 | " |
| " | 50', " | 58 " | " | 2,116 | " |
| " | 60', " | 70 " | " | 3,040 | " |
| " | 80', " | 93 " | " | 5,430 | " |

These results are proved by experiment to be correct, as we shall find when traveling in mountainous districts and noting how far we can see. At the highest tops of the Highlands, on the Hudson river, near West Point, which do not reach 2,000 feet, we can, on a clear day, just get a glimpse of the highest buildings in New York city, using a telescope. The distance is only fifty miles; but at a hight of 1,600 feet, objects 50 miles off are invisible. In order to see to a distance of 90 miles, the hight necessary is about 5,000 feet; and if the Philadelphia tower is built to a hight of 760 feet, objects at a distance of 35 miles only, less than half way to New York, may be seen. If, however, two towers were built, one in New York and the other in Philadelphia, each 1,200 feet high, from each a circle of 45 miles radius would be visible, and the top of the one would be just perceptible from the top of the other, by means of a telescope, if the atmosphere were exceptionally clear. X.

To prevent water freezing in the gas meter add glycerin. The proper proportion is one pint of glycerin to a gallon of water.