energy of the fire under such boiler, will cause the water in said boiler to pass with great rapidity to the other boiler, as described by him. As to any regular intervals between such changes, I think his remedy, of opening the furnace and connecting doors of the empty boiler to lessen the generation of steam and pressure therein, indicates the cause and cure, and is the direct result of uneven firing or generation of steam; and consequently regular intervals between the changes could not well occur.

The small steam space in his boilers, together with the too small, interrupted, and contracted steam outlets, would cause the pressure within either boiler to rise or fall several pounds to the square inch almost instantly, with even slight changes in the generation of steam.

As the pressure of a column of water one foot in hight is only half a pound to the square inch, it follows that an excess, of so little as half a pound in pressure to the square inch of steam in one boiler over the other, would be sufficient to force the water from it to the other until the water level would stand one foot lower in the hotter boiler than in the other; while an excess of one pound pressure would make a difference of two feet in the water level in the two boilers.

REMEDY.—All water feed pipes to boilers should have a check valve as near the entrance to the boiler as possible.

When two or more boilers are to be fed from one source or pump and from the same pipe leading therefrom, each boiler should have its branch from such pipe, and a stop cock, in addition to the check valve in such branch. This effectually controls the flow of the water to each separate boiler and prevents the return from it.

The steam connections from the boilers should be of at least double the capacity for such sized boilers. When two or more such boilers are used together, their steam pipes should conduct the steam to a drum at least equivalent to three or four cubic feet capacity for each such boiler. The steam to be taken from the upper side of such drum to the engine, etc., by a pipe larger than or of a capacity equal to that of all the pipes leading to the said drum combined.

Safety valves as well as pressure gages should be attached directly to each separate boiler, and never to the steam drum nor to pipes conveying steam from the boilers.

With these precautions and directions adopted by your correspondent, all further trouble will be avoided in his own case as well with the other houses alluded to by him.

Albany, N. Y. HORACE L. EMERY.

Ants in Sugar.

To the Editor of the Scientific American:

More than the usual quantity of sugar was recently purchased for my family; and the surplus, above what the wooden box used to keep it in would hold, was put into a paper one, and placed by its side on the same shelf. Black and brown ants had always troubled us, but none of them entered the paper box, which they could have done if so disposed. I sought for but found no reason. Finally, I tried the experiment of keeping it all in paper boxes or bags, and for three years have had no trouble, as formerly, with ants in the sugar boxes, I do not claim to give or know any reason; but such are the facts.

Northampton, Mass. M. L. KIDDER.

[For the Scientific American.]

REMARKABLE RELATION BETWEEN THE SPECIFIC HEAT AND THE ATOMIC WEIGHT.

BY P. H. VANDER WEYDE.

Dulong and Petit were the first who, in 1819, pointed out the curious fact that, when the numbers representing the specific heat of elementary substances were multiplied with those representing their atomic weights or chemical equivalents, products are obtained, which are equal to within a small fraction. So taking the specific heat of the substances mentioned, and multiplying it with their atomic weights, we obtain the following table:

Elementary substance.	Specific heat.	Atomic weight.	Product of number of the two former columns.
Mercury	0·033	100	3·3
Gold	0·032	98	3·13
Silver	0·057	54	3·07
Copper	0·095	32	3·04
Iron	0·11	28	3·08
Sulphur	0·2	16	3.2

If the value of atomic weights of many substances are doubled, as for good reasons is done at the present day, the products are of course also double that given in this table and all approximately =6, in place of nearly =3, as is here found to be the case.

A similar relation to that which Dulong and Petit discovered for the elementary substances was found by Neuman in 1831 for compounds; for instance, in case of sulphates and carbonates, he found for the following minerals:

Mineralogical name.	Chemical name.	Specific heat.	Atomic weight.	Product.
Anhydrite	Sulphate of Lime	0·185	68	12·6
Celestin	" Strontia	0·135	92	12·4
Heavy spar	" Baryta	0·108	116	12·5
Lead vitriol	" Lead	0·085	151	12·8
Iceland Spar	Carbonate of Lime	0·204	50	10·2
Iron spar	" Iron	0·182	58	10·5
Zinc spar	" Zinc	0·171	62·6	10·7
Witherite	" Baryta	0·107	98·5	10·5
White lead ore	" Lead	0·081	133·5	10·8
Strontianite	" Strontia	0·144	73·8	10·6

Two questions suggest themselves from the above details in every philosophically inclined mind. First: Are these coincidences merely accidental? Secondly: If not accidental, what do they mean? Is there some natural law at the bottom of these remarkable relations?

In regard to the first question, it must be remarked that the law appears quite general, and the exceptions very few, therefore accident is out of the question; besides, the small differences in the products are easily accounted for by the fact that the specific heats differ at different temperatures, and for different physical conditions of the substances under investigation; while it is very significant that, in proportion as the experiments were made more carefully, the numbers calculated became more and more equal, as Regnault has pointed out.

In regard to the second question, as to the cause of this peculiarity, we have only to recall the numbers given on page 372, which show that 30 lb. mercury, 17 silver, 10·5 copper, 8·75 iron and 5 sulphur possess at the same temperature the same amounts of heat; and to remark that these numbers are very nearly in proportion to one another as the respective atomic weights of the substances, 100, 54, 32, 28, and 16. As now these numbers express the combining equivalents, so that, for instance, 100 lb. of mercury will combine with 16 of sulphur and form vermillion, and as we have reason to suppose that, in this case, like in others, each atom of mercury combines with an atom of sulphur, it is more than probable that 100 lb. of mercury contains as many atoms as 16 lb. of sulphur. If the number of atoms in these two quantities of mercury and sulphur is the same, and the amounts of specific heat the same, it is clear *that all atoms must possess the same specific heat.* This, now, is the law which lies at the foundation of the remarkable property explained.

When applying the modern theory, that heat is only a mode of motion, to the fact that all single atoms possess the same specific heat, it follows that it takes the same motion producing force, to increase the atomic oscillation (that means, raise the temperature) of every atom, be it mercury, sulphur, iron or any other substance of this series of elementary substances; and that it takes a greater force (more heat) to increase the oscillation of the compound atom of a carbonate, and still more of a sulphate, etc.

"When these bodies lose their heat," means, in the modern language of the conservation of force, nothing but that they communicate their atomic motion (oscillating or otherwise) to the atoms of the surrounding bodies, and put them in the same motion as they possess themselves, losing an equal amount of their own motion. Or conditions may be so arranged that this atomic motion (heat) is changed into motion of masses, commonly called force; of this arrangement, the steam engine is the great type and example for further development.

Compound Engines in the Navy.

Mr. J. W. King, Chief of the Bureau of Steam Engineering United States Navy, recommends in his report that "all naval engines now in store be sold, and that all our naval vessels be supplied with compound engines." Almost every engineer has his preferences in favor of some particular engine. Isherwood had his, and so had Dickerson and Ericsson. Of course, the hobby each one happens to be riding is considered the best horse, and so a series of costly experiments and changes and repairs are undertaken, for which the country pay and the service is but little, if any better off. Our navy wants the best engines and also the most economical, since frigates cannot tow a coal yard around with them. But changes should only be made after a series of successful experiments demonstrates the fallacy of the rule that "the old way is the safest." Commenting on Mr. King's remarks, the *National Gazette* says: "Until something more definite and satisfactory is known in relation to this type of engine, we think it would be a false economy to introduce them by wholesale into our naval vessels. We see no objection to having one or two experimental sets of compound engines built for the navy, but to make such a sweeping change as recommended by Mr. King is impolitic and unwise. The truth is that compound engines are by no means as economical as their admirers would have us believe. An engineer who is running one of them at the present time, in a large transatlantic steamer, informs us that he would like to have the difference of the price of coal said to be consumed each voyage and what is actually paid for and consumed. Compound engines were given a fair test on our lakes and rivers a quarter of a century ago, and did not prove a success."

Heath's Improved Steam Engines.

This invention relates to an improved arrangement of steam chests, ports, and valves, having for its object to balance the valve as evenly as possible, shorten the steam passages, enlarge the area of the ports without correspondingly enlarging the waste of steam in the ports, and to provide for jacketing the cylinder more readily than can now be done. The steam chest surrounds the cylinder, and annular valves work, between the cylinder and the steam chest, on ports at each end of the cylinder, admitting the steam from the space between the rings or valves, and exhausting into the jacket behind the rings or between the rings and the end of the jacket.

The outer surface of the steam cylinder and the inner surface of the steam chest are turned up truly for the pistons to fit between them steam tight, and the pistons are fitted with metal packing rings. The pistons are composed of a solid ring, preferably made in two parts, and bolted together tightly, so that steam cannot pass from one face to another, both the outer and the inner faces being recessed to provide space for the packing rings. As the steam might force the packing rings in the inner face of the piston backward to the bottom of the recess when passing over the ports, at which time there is a direct pressure on the rings, holes are made in the rings to admit steam behind them and balance their pressure. This arrangement of the engine admits of the application of a jacket more easily and better than when a square steam jacket is arranged on the side of the cylinder, which greatly interferes with the fitting of the jacket. The steam chest cylinder and the steam cylinder may be formed in one casting, proper stays being formed to connect them together between the parts where the valves work; or they may be cast separately and connected by the heads, if preferred.

But little steam is lost by the amount contained in the ports so as not be effective, for the steam cylinder ports are very short, being only equal to the thickness of the cylinder, which need not be thick, as it is constantly exposed to steam pressure at the outside.

Arden A. Heath, of Mercer, Pa., is the inventor of this improvement.

Ice Houses.

This being the season for storing ice, we would call attention to what is known as the "Stevens plan" for erecting a cheap house and storing ice, from *Hall's Journal of Health* for December:

"For one family, make a house twelve feet each way, by setting twelve posts in the ground, three on a side; board it up, eight feet high, on the inside, so that the weight of the ice shall not press the boards outward; dig out the dirt inside, six inches deep, and lay down twelve inches of sawdust; pack the ice in a pile nine feet each way, filling the space of eighteen inches between the ice and the boards with sawdust or tan bark, with the same thickness on top; make an old fashioned board roof, leaving the space above the ice open for ventilation. Have a small entrance on the north side of the roof.

"If the ice house can be located on the north side of a hill, and a small stream of water introduced slowly through the roof, on a very cold day, so as to make its way between the pieces of ice, the whole mass will freeze solid; or a pile of snow could thus be made into solid ice, and would last from one winter to another."

The Effect of a Grain of Strychnine.

A man in Harrisburgh recently attempted to commit suicide by taking a grain of strychnine. The skill of his physician having saved his life, he narrates his experience for the benefit of science. He says:

"In the course of five minutes I began to feel slight cramps in the calves of my legs. The cramps increased in intensity and extended to the feet and thighs, causing the most intense pain. I attempted to rise from the chair, but fell to the floor with convulsions in the lower extremities. Unsuccessful attempts were made to bathe my feet in hot water, each effort to raise me bringing on violent paroxysms, in the last one of which I thought my jaws had become unhinged. I was now perfectly paralyzed from the hips down, and suffering the most excruciating pains, which began to extend upwards; the muscles of the shoulders and neck were soon considerably convulsed, the forearms still being free from pain.

"I now prepared for the final struggle, which I knew must be near at hand, as I had become rigid from the neck down, save the forearms. The convulsions of the muscles were becoming fearful, and the torture awful to endure. My hands were drawn in to my sides, with the fingers drawn apart, and slightly bowed, and the jaws became rigid. I felt myself raised as if by some mighty power, and fixed immovably, with only my feet and head touching anything. I became unconscious of everything except my own agony, which was now beyond all description. I could feel my heart fluttering, and my brain beating and throbbing with an irregular motion, as though at every beat it would burst from its confinement. Every joint was locked, and every drop of blood seemed stagnated. I remember thinking it could not long be thus, when I must have lost consciousness.

"I remember nothing more until I felt a sensation of relief, as though the garments of death, which had been drawn over me, were being drawn back. Those terrible cramps seemed to be descending towards my lower limbs. A feeling of relief stole over me, and I began to be again conscious.

"From that time I resumed consciousness, when I was entirely free from cramps, with the exception of a little in the feet. I had but one attack of cramps afterwards, which was immediately relieved by a dose administered by my wife—the doctor having left for a short time—and when he returned, I felt that the poison was completely neutralized."

Snakes and Tigers in India.

We need not wonder at the eagerness, says the *Chemist and Druggist*, with which physicians and authorities in India examine every new remedy put forth as an antidote to the poison of a snake bite, when we learn that in British India, including British Burmah, the deaths from snake bite during the past three years amount to 25,664. This statement appears in an official report published in the *Gazette of India*. From that report, we also learn that during the same period the deaths resulting from the attacks of all kinds of wild beasts in the same area numbered 12,554. The snakes killed more than twice as many as were slain by the tigers and all the other fierce forest rangers put together. Truly the serpent is still "more subtle than the beasts of the field."

WHAT sunshine is to flowers, smiles are to humanity. They are but trifles, to be sure, but, scattered along life's pathway, the good they do is inconceivable. A smile, accompanied by a kind word, has been known to reclaim a poor outcast, and change the whole current of a human life. Of all life's blessings none are cheaper, or more easily dispensed, than smiles. Then let us not be too chary of them, but scatter them freely as we go; for life is too short to be frowned away.

Improved Steam Heating Apparatus.

The accompanying engraving represents the steam heating apparatus, patented July 18, 1871, by F. H. Pulsifer and Wm. C. Wheeler, of Baltimore, Md.

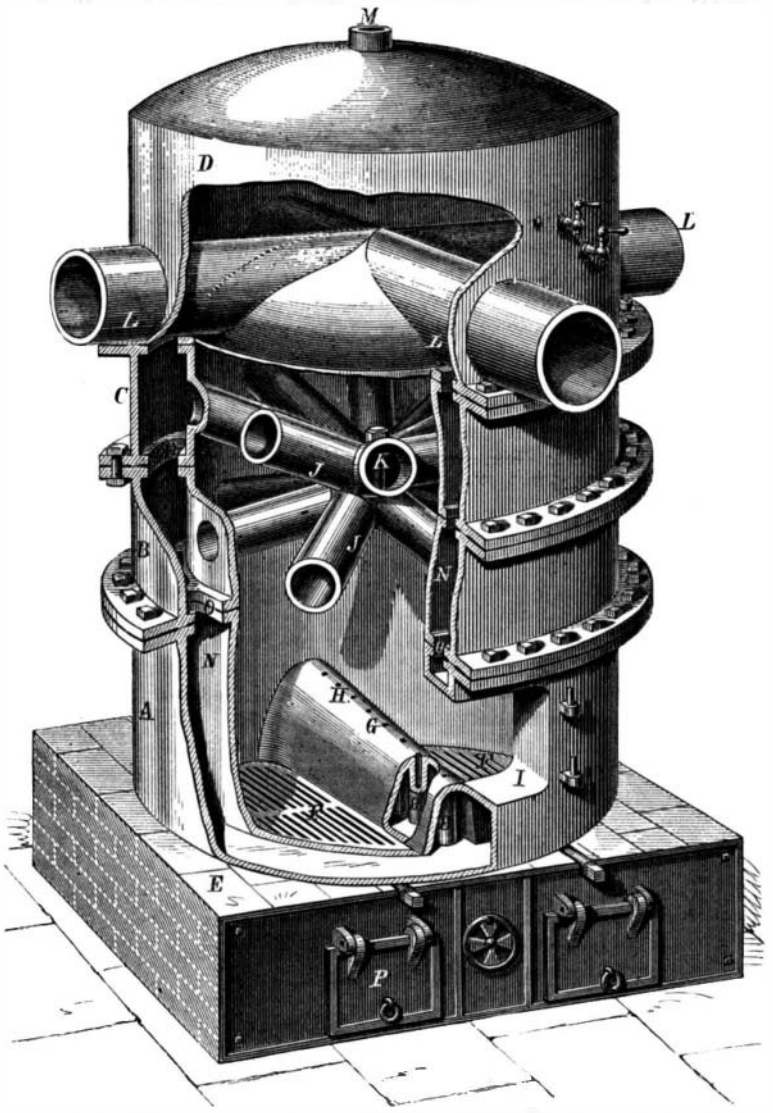
A B C D represents the outer shell, made in four sections and bolted together. The lower section, A, rests upon the brick ash pit, E, and is provided with a grate, F, separated by the hollow partition, G, inclined as shown. Through this partition is cast a number of tubes, H, for the passage of air to the fires, thereby producing a more perfect combustion of the fuel. By means of this partition two separate fires may be made, and, if preferred, only one grate or side may be used, thereby saving one half the amount of fuel. In this section is arranged the furnace door, I, which is of the ordinary construction. The sections, B and C, are provided with eight pipes or tubes, J (through which the water circulates), inclining and joining in the center, and bolted together through the center by the bolt, K. A water space is thus left all around the tubes.

In the engraving two of the sections, with flues or tubes, are shown; but for a larger boiler, as many sections as desired can be used. The pipes, J, in each section, may be set around or advanced, as shown in the engraving, thereby obtaining a greater heating surface.

In the top section, D, forming the dome or steam drum, are arranged four flues or pipes, L, running at right angles to each other, thereby obviating the necessity of elbows as heretofore used. M is the steam pipe connection. The sections are all connected between the inner and outer shell, forming the water space, N, by the openings, O. The front of the ash pit is of cast iron, and is fitted with ash pit doors, P. The advantages claimed for this apparatus over others heretofore used are, that a better circulation of the water is obtained, as well as a greater amount of heating surface; the water, being in the hollow partition in close proximity with the fire, is sooner heated, and, if desired, only one of the fires may be lighted, thereby saving one half of the fuel. A more perfect combustion of the fuel is also claimed; the outlets or escape flues having no elbows, the smoke is sooner got rid of; by bolting the pipes together in the center, greater strength is given the boiler. And it is claimed that, by including the tubes, they are not so liable to be cracked or broken in contraction or expansion, nor to hold the sediment contained in the water. And by arranging the tubes or pipes, as shown in the engraving, all the heat passing from the furnace or fire must come in contact with some portion of the heating surface, before passing out to the chimney.

The boiler is designed not only for heating but for other purposes.

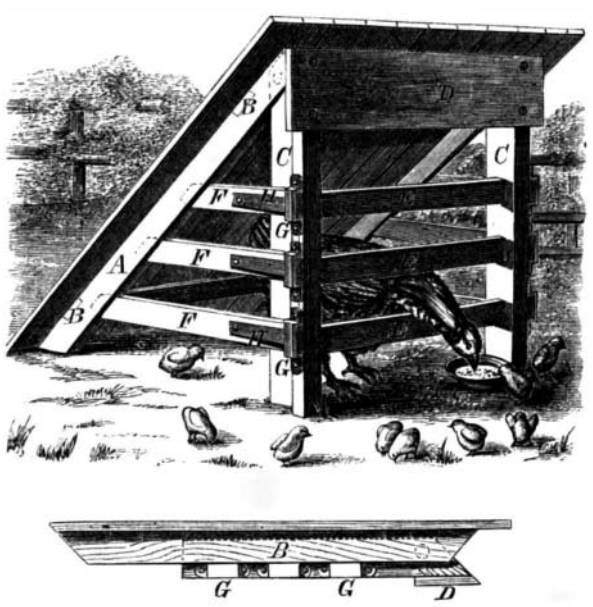
For further information or for purchase of State rights, address Frank H. Pulsifer, Milwaukee, Wis., or Wm. C. Wheeler, 679 Lexington street, Baltimore, Md.



PULSIFER & WHEELER'S STEAM HEATING APPARATUS.

WILCOX'S FOLDING HENCOOP.

To raisers of poultry and farmers in general, the invention we herewith illustrate will possess interest. It is a folding chicken coop, which may be closed together in small space for storage or transportation, and is constructed as follows:



The inclined bars, A, are held parallel to each other by crossbars, B, which, with the inclined bars, support the roof. To the upper ends of the bars, A, are pivoted the uprights, C. The latter are rabbeted on the outside, so that when the coop is folded they partly overlap the bars, A, as shown in detail at the bottom of the engraving. To the outer sides of the upper ends of the bars, C, is attached a board, D, the ends of which project and rest against the ends of the bars, A, as shown.

The edge of the board, E, and the ends of the bars, C, as also the edges of the shoulders of the bars, C, are beveled off so that the coop may stand firmly when set up.

To the bars, C, and at a proper distance from each other, are attached crossbars, E. The side bars, F, are slid in through keepers, G, and are held in place by spring catches, I, which engage the keepers, as shown. The inner ends of the bars, G, enter mortices in A, as shown in dotted outline.

When taken down and folded, the parts assume the position shown in detail at the bottom of the engraving.

The invention was patented through the Scientific American Patent Agency, Nov. 14, 1871, by Edward J. Wilcox, of Ivy Mills, Pa., who may be addressed for further information.

ANTS AS ENGINEERS.—It appears that the ants in Panama are not merely mining engineers—they build tubular bridges. A corresponding member of the Glasgow Natural History Society, who has been lately in that country, describes the curious covered ways constructed by these ingenious insects. In tracing one of these covered ways, he found it led over a pretty wide fracture in the rocks and was carried across in the air in the form of a tubular bridge of half an inch in diameter. It was a scene of busy traffic. There was nearly a foot of unsupported tube from one edge of the cliff to the other.

Toothache, Earache, Etc.

The little work noticed in another column, entitled "First Help in Accidents," speaks of these complaints, so prevalent at this season of the year, as follows:

"It is a bad practice to put cotton wool, soaked in laudanum or chloroform, into the ear for the relief of toothache. It is true that it may sometimes prove effectual, and procure a night's rest, for the connection between the teeth and the ear is very close. But let it be borne in mind that the ear is far too delicate and valuable an organ to be used as a medium for the application of strong remedies for disorders of the teeth, and that both laudanum and chloroform, more especially the latter, are powerful irritants, and that such applications are always accompanied with risk. The teeth should be looked after for themselves, by some competent dentist; and if toothache spreads to the ear, this is another reason why they should be attended to at once; for prolonged pain in the head, arising from the teeth, may itself injure the hearing. In earache everything should be done to soothe it, and all strong irritating applications should be avoided. Pieces of hot fig or onion should on no account be put in; but warm flannels should be applied, with poppy fomentation externally, if the pain does not soon subside."

Clark's Locomotive Engine.

John Clark, M. E., of 44 Finsbury Circus, in the city of London, England, has recently patented, through the Scientific American Patent Agency, an improvement in locomotive engines, the object of which is to radiate the leading and trailing axles of locomotive engines, or of engine and tender combined, to enable them to pass round sharp curves more freely.

He constructs the leading and trailing axles hollow, inside of which he fits a central spindle, to which are fitted, at each end, cranks in connection with the driving gear. The hollow axles may be called the carrying axles, and the central spindles, the driving axles. The centre part of the spindles may be square or hexagonal, to fit freely a bush fixed at the center of the hollow axle, so that it may slide therein. Thus, when the spindle is driven, the carrying or hollow axle will be driven with it.

The radial movement of the hollow axles is effected by links fixed to the framing. The spindles are carried in bearings in the framing, and are held in a parallel plane with the other axles of the engine by horizontal rocking shafts. The engine may have eight, ten, or even twelve wheels coupled and propelled by one pair of cylinders, either outside or inside.

One purpose effected in the design is to make the load moderate on all the wheels—say not to exceed nine tuns per pair—and to include all the weight for adhesion. In the eight wheeled engine, the four wheels in the centre form a fixed or parallel wheel base from seven to ten feet centers.

The leading and trailing axles radiate freely to pass curves of three chains radius. In the ten wheeled engine the six wheels in the centre form a fixed or parallel wheel base, the middle pair being without the flange. In the twelve wheeled engine the six wheels, situated immediately behind the leading axle, form a fixed or parallel wheel base from nine to twelve feet centres, and the leading and two trailing axles are fitted with the radial arrangement.

The load carried by the radial axle is entirely borne by a transverse spring or springs from a pin in the center buckle, supporting slings from a bracket fixed to the framing or boiler. Either wheel of the leading and trailing axles is free to rise or fall about an inch and a half, to suit the "cant" or inequalities of the rail, without imparting any cross twist to the framing, thereby securing the advantages of the American bogie as applied to engines. The said supporting slings have a double fulcrum pin, where they are joined to the supporting brackets, to secure a certain amount of righting to make the engine run smooth and steady on a straight road.

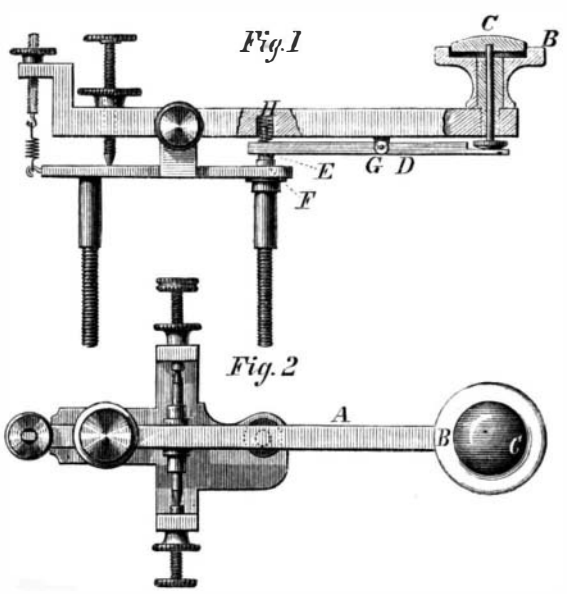
The details of Mr. Clark's invention cannot well be explained without drawings, but the general description given will enable engineers to comprehend in some measure the nature of the improvement.

SELF-CLOSING TELEGRAPH KEY.

This telegraph key, which was patented through the Scientific American Patent Agency, Nov. 7, 1871, by Jeremiah F. O'Sullivan and Philip W. O'Sullivan, of Jackson, Miss., is so constructed as to hold the circuit constantly closed, in order that it may not be accidentally left open by careless and inexperienced operators.

To this end there is applied to the ordinary key bar, A (see engraving) a secondary button, C, in addition to the ordinary one, B, in connection with the lever, D, and spring, H, the latter holding the lever in constant contact with the conductor, unless it is lifted off by pressure on the secondary button.

The second button, C, is fitted upon a pin or shank, which passes through the button, B. The lever, D, is pivoted to the under side of the bar, A, at G. The spiral spring, H, holds the pin or hammer, E, in contact with the anvil, F, thereby closing the circuit.



The instrument can be worked perfectly, without grasping the button with thumb and fingers, by operators who do not use the thumb in writing. The improvement can be adapted to all keys at very little expense, and new keys can be made as cheap as the old.

The key is very convenient to inexperienced operators. Accidents that would open a common key will have no effect on this. The spring, so sensitive to the touch which closes the circuit, would require a nicely balanced weight to keep it open without bearing down the key bar and connecting the platina points on the hammer and anvil.

For further particulars, address O'Sullivan & Brother, Jackson, Miss.