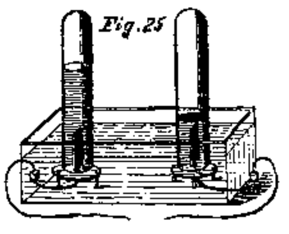
we can go on making from water a large bulk of *permanent gas*, as we call it, and then we can reconvert it into water in this way. [Mr. Anderson brought in another Leyden jar, which, however, from some cause, would not ignite the gas. It was therefore recharged, when the explosion took place in the desired manner.] How beautifully we get our results when we are right in our proceedings!—it is not that Nature is wrong when we make a mistake. Now I will lay this vessel, G, down by my right hand, and you can examine it by-and-bye: there is not very much water flowing down, but there is quite sufficient for you to see.

Another wonderful thing about this mode of changing the condition of the water is this: that we are able to get the separate parts of which it is composed at a distance the one from the other, and to examine them and see what they are like, and how many of them there are; and for this purpose I have here some more water in a slightly different apparatus to the former one (Fig. 25), and if I place this in connection with the

Fig. 25

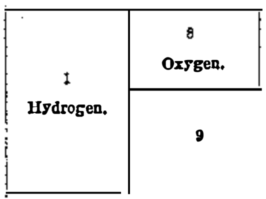


wires of the battery (at A B), I shall get a similar decomposition of the water at the two platinum plates. Now I will put this little tube, O, over there, and that will collect the gas together that comes from this side, A; and this tube, H, will collect the gas that comes from the other side, B, and I think we shall soon be able to see a difference. In this apparatus, the wires are a good way apart from each other, and it now seems that *each* of them is capable of drawing off particles from the water and sending them off, and you see that one set of particles, H, is coming off twice as fast as those collected in the other tube, O. Something is coming out of the water *there* (at H) which burns [setting fire to the gas]; but what comes out of the water *here* (at O), although it will not burn, will support combustion very vigorously. [The lecturer here placed a match with a glowing tip in the gas, when it immediately rekindled.

Here, then, we have two things, neither of them being water alone, but which we get out of the water. Water is therefore composed of two substances different to itself, which appear at separate places when it is made to submit to the force which I have in these wires; and if I take an inverted tube of water and collect this gas, H, you will see that it is by no means the same as the one we collected in the former apparatus (Fig. 24). That exploded with a loud noise when it was lighted, but this will burn quite noiselessly; it is called *hydrogen*, and the other we call *oxygen*—that gas which so beautifully brightens up all combustion but does not burn of itself. So now we see that water consists of two kinds of particles attracting each other in a very different manner to the attraction of gravitation or cohesion, and this new attraction we call *chemical affinity*, or the force of chemical action between different bodies; we are now no longer concerned with the attraction of iron for iron, water for water, wood for wood, or like bodies for each other, as we were when dealing with the force of cohesion; we are dealing with another kind of attraction—the attraction between particles of a *different* nature one to the other. Chemical affinity depends entirely upon the energy with which particles of different kinds attract each other. Oxygen and hydrogen are particles of different kinds, and it is their attraction to each other which makes them chemically combine and produce water.

I must now show you a little more at large what chemical affinity is. I can prepare these gases from other substances as well as from water; and we will now prepare some oxygen: here is another substance which contains oxygen—chlorate of potash; I will put some of it into this glass retort, and Mr. Anderson will apply heat to it: we have here different jars filled with water, and when, by the application of heat, the chlorate of potash is decomposed, we will displace the water and fill the jars with gas.

Now, when water is opened out in this way by means of the battery, which adds nothing to it materially, which takes nothing from it materially (I mean no *matter*; I am not speaking of *force*), which adds no *matter* to the water, it is changed in this way—the gas which you saw burning a little while ago, called "hydrogen," is evolved in large quantity, and the other gas (*oxygen*) is evolved in only half the quantity; so that these two areas represent water, and these are always the proportions between the two gases.



Oxygen.................. 88.9
Hydrogen................ 11.1

Water.................... 100.0

But oxygen is sixteen times the weight of the other—eight times as heavy as the particles of hydrogen in the water; and you therefore know that water is composed of nine parts by weight—one of hydrogen and eight of oxygen, thus:—

Hydrogen............	46.2 cubic inches	............equal to	1 grain.
Oxygen..............	23.1 "	.... "	8 grains.
Water (steam).......	69.3 "	.... "	9 grains.

Now Mr. Anderson has prepared some oxygen, and we will proceed to examine what is the character of this gas. First of all, you remember I told you that it does not burn, but that it affects the burning of other bodies. I will just set fire to the point of this little bit of wood, and then plunge it into the jar of oxygen, and you will see what this gas does in increasing the brilliancy of the combustion. It does not burn—it does not take fire as the hydrogen would—but how vividly the combustion of the match goes on. Again: if I were to take this wax taper and light it, and turn it upside down in the air, it would, in all probability, put itself out, owing to the wax running down into the wick. [The lecturer here turned the lighted taper upside down, when, in a few seconds, it went out.] Now that will not happen in oxygen gas; you will see how differently it acts (Fig. 26). [The taper was again lighted, turned upside down, and then introduced into a jar of oxy-

Fig. 26

gen.] Look at that!—see how the wax itself burns and falls down in a dazzling stream of fire, so powerfully does the oxygen support combustion. Again: here is another experiment which will serve to illustrate the force (if I may call it so) of oxygen. I have here a circular flame of spirit of wine, and with it I am about to show you the way in which iron burns, because it will serve very well as a comparison between the effect produced by air and oxygen. If I take this ring flame, I can shake, by means of a sieve, the fine particles of iron filings through it, and you will see the way in which they burn. [The lecturer here shook through the flame some iron filings, which took fire and fell through with beautiful scintillations.] But if I now hold the flame over a jar of oxygen [the experiment was repeated over a jar of oxygen, when the combustion of the filings as they fell into the oxygen became almost insupportably brilliant], you see how wonderfully different the effect is in the jar, because there we have oxygen instead of common air.

An interesting and curious application of the electric light has recently been made at Schaffhausen, on the Rhine. The famous cascade or waterfall at that place, ninety feet in hight, was illuminated by five electric lamps. The effect obtained was marvellously beautiful, especially when the light was transmitted through red or green glasses. This experiment was made at the instance of the Swiss Railway Company, who propose, if the attempt proves successful, to organise a series of night fêtes next summer, one of the most brilliant features of which will be this illuminated cascade.

CO-OPERATION OF WORKMEN.

One of the best plans yet tried by working men for advancing their interests, is the establishment of manufactories and trading stores by joint association, thus securing to themselves that large share of the wealth produced, which usually goes to the men who conduct enterprises. This has been done to a large extent in England, and we find, in a recent English paper, the following cheering account of the success of some of these associations:—

By far the most interesting portion of the reports of Mr. Alex. Redgrave and Sir John Kincaid relates to the development and extension of co-operative societies for the erection and working of mills in Lancashire, and also to some degree in Yorkshire. These co-operative societies, which have multiplied since the passing of the Limited Liability Act, are generally composed of operatives. Each society has a capital of £10,000 and upward, divided into shares of £5 and £10, with power to borrow in certain proportions to the capital subscribed, the money borrowed being made up of small loans by operatives and persons of the like class. In Bury, for instance, upward of £300,000 will be required to put the co-operative mills there built and building in a working order. In cotton spinning mills, the spinners and persons employed are frequently shareholders in the same mill, working for wages and receiving interest upon their shares. In cotton weaving sheds, the partners frequently hire and work looms. This is attractive to operatives, because no great capital is required to start them in their undertaking. They purchase the yarn ready for the loom, weave the cloth, and the factory operation is completed; or else they receive the yarn from some manufacturer who trades with them, and return to him the woven fabric. But this co-operative system is not confined to the spinning and weaving of cotton. It has extended to the trade on a variety of articles of consumption, such as flour, groceries, draperies, &c.

The following report, drawn up by Mr. Patrick, one of Sir John Kincaid's sub-inspectors, contains some valuable information in regard to the progress of this new system of mill-ownership, which, I am afraid, will be put to a severe test by the next industrial crisis:—

"May 16, 1860.

"There has been a co-operative company in existence at Rochdale, under the style of the 'New Bacup and Wardle Commercial Company,' for about twelve years. They are incorporated under the Joint Stock Companies Act, and unlimited. They commenced operations at Clough House Mill, Wardle, near Rochdale, with power to raise a capital of £100,000, in shares of £12 10s., £20,000 of which was paid up. They then increased to £30,000, and about five years ago built a large factory, Far Holme Mill, near Stackstead, of 100-horse power steam, in addition to Clough House Mill; and the half year ending October last, they paid a dividend at the rate of 44 per cent on the paid up capital (Mr. Patrick reports on the 11th June, that the New Bacup Mill and Wardle Commercial Company, 'Far Holme Mill, Bacup,' have just declared another dividend of 48 per cent on the paid up capital), and they have now increased their capital to the sum of £60,000, and have largely increased their Far Holme Mill, near Stackstead, in this neighborhood, requiring two more engines of 40-horse power each, which they are about to put down. The large majority of shareholders are operatives who work in the factory, but receive wages as workmen, and have no more to do with the management than to give their vote to the annual election of the Committee of Management. I have been through the Far Holme Mill this morning, and can report that, so far as the Factory Act is concerned, it is as well conducted as any in my division. I think, though I did not ask them the question, they have borrowed at 5 per cent interest.

"There has been another in existence in the neighborhood of Bacup about six years, trading under the firm of the 'Rossendale Industrial Association.'

"They built a factory; but, I am told, were not thriving, in consequence of the want of sufficient funds. This also was on the co-operative system. The firm has now been changed to 'The Rossendale Industrial Company,' and are incorporated under the Limited Liabilities Act, with power to raise a capital of £200,000. £40,000 has been taken in shares of £10 each, and they have borrowed about £4,000. This £4,000 has been borrowed from small capitalists, in sums from £150 down to £10, without any mortgages being given. When this co-operative company first started, every shareholder was an operative. In addition to the Wear mill—that referred to as having been built by the Rossendale Industrial Association—they have now bought of Messrs. B. Mum Bros., Irwell Mills, and are working the two.

"The prosperity and success of the New Bacup and Wardle Commercial Company seem to have given rise to the new companies that are now formed in my immediate vicinity, and preparing large factories to carry on their business. One is the 'New Church Cotton Spinning and Weaving Company,' under the Limited Liabilities Act, with power to raise £100,000 in £10 shares, £40,000 of which is already paid, and the company has borrowed £5,000 on mortgage at five per cent. This company has already started, having taken an unoccupied factory of 40-horse power, Vale Mill, New Church, and they are building the 'Victoria Works,' which will require an engine of 100-horse power. They calculate upon employing 450 people when complete, which they think will be in February next.

"Another is 'The Ravenstall Cotton Manufacturing Company,' also limited, with a nominal capital of £50,000, in £5 shares, with power to borrow to the extent of £10,000. About £20,000 is already paid up, and they are erecting at Hareholme a factory requiring an engine of 70-horse power. I am told that in both of these companies nine-tenths of the shareholders are of the operative class.

"There is another co-operative company which has sprung up within the last six months. 'The Old Clough Cotton Company,' which purchased from Messrs. B. & T. Mum two old mills, called Irwell Springs, and are on the same principle as the others, but not having been able to go there to-day I am not able to give all particulars about it. The power, however, has been returned as 13-horse and the number of hands employed 76, and I believe all the shareholders to be of the operative class.

"There are several who take part of a factory, one or two rooms, as the case may be, and in some instances even part of a room, but then these are masters of that part, although they work with and as their own workmen, hire and pay wages as any other manufacturer, without the workpeople employed having any interest in the business. There were many more of these at Bacup than there are now. Some have given it up, while others have succeeded, and either built mills for themselves or rent large premises. There are more of this sort at Rochdale than any other place in my division."

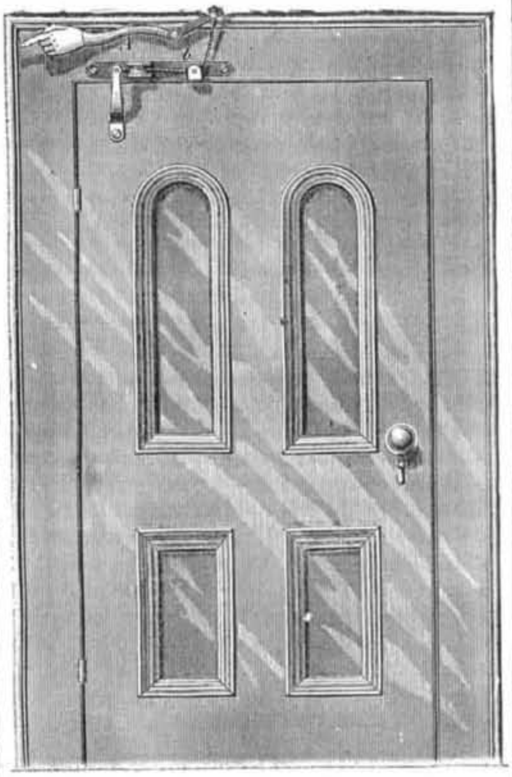
AMERICAN COOKING STOVES ABROAD.

We learn by the *Ironmonger*, a London periodical, that American cooking stoves have been introduced into that city, and have met with great favor by those who have used and examined them. It states that the patterns of these stoves were imported from America, and they are commended for beauty, comfort, cleanliness, and the saving of fuel. Our cotemporary observes that there is no country in the whole world where fuel is burned so extravagantly as in Great Britain; a circumstance, no doubt, owing partly to the abundance and consequent cheapness of mineral fuel, partly to the prejudice of English people in favor of a large open fire, and lastly, and possibly chiefly, to the fact that certain fashions, both in pattern and material, have got possession of the market, and are difficult to displace by those which are even far superior. Precisely in the same manner as the old school-books, which were in use in the infancy of our fathers, are still printed and employed by the hundreds of thousands, although they are despised by every person having the slightest acquaintance with the science of education, and consequently entirely superseded in all schools conducted on any system in advance of the most miserable routine. It is calculated that, at the lowest possible estimate, at least nine-tenths of the heat produced by the burning of coal in an ordinary grate passes uselessly up the chimney, and is entirely wasted. In other words, so defective are our ranges, that it takes ten pounds of coal to do the work of one. Others, and we fully agree with them, place the loss much higher. This extravagance in the use, or rather in the mis-use, of fuel is almost exclusively British. In the United States, where the coal fields are of infinitely vaster extent than those in Great Britain, much greater economy is practised; particularly in the construction of apparatus for cooking. Many of the American stoves are simple, valuable and ingenious.

STEWART'S IMPROVED APPARATUS FOR CLOSING DOORS.

After all the numerous devices which have been tried for closing doors, it is surprising to find still new ones coming forth for effecting so simple an operation. The one here illustrated is peculiar, and, in many places, will doubtless be found superior to any other.

The lever, A, attached by a fulcrum to the door frame, has its long arm weighted while its short arm is connected with the door by means of a cord which passes down vertically, and is turned by the pulley, *b*,



into a horizontal position, as shown. If the door is opened at right angles with its frame, the lever, A, is raised into a perpendicular position, so that it rests upon its fulcrum, and does not exert any power to close the door, thus allowing the door to remain open. A slight force, however, starts the door from its place of rest, and as the lever descends, its heavy end departs farther and farther from a line perpendicular to its fulcrum, thus drawing the door to its closed position with constantly increasing power, and finally holding it closed with its greatest force.

The patent for this door closer was granted to the inventor, Stephen Stewart, on the 11th of September, 1860, but an interest in it has been assigned to D. G. Chapman, to whom inquiries for further information in relation to it may be addressed, at No. 70 Dillwyn-street, below Noble, between Third and Fourth streets, Philadelphia, Pa.

STEEL SPRINGS.—For the last six months, Messrs. James Jeffries & Sons, the well-known spring manufacturers, of Philadelphia, have adopted a new mode of securing the leaves of their springs together. No hole is made through the leaves, nor is any bolt used. Two notches are made in each edge of the two top and two bottom leaves, these notches being made where they will be covered by the band which, when shrunk on, is indented, by means of a punch, into each notch. The band is thus indented at four points on each side, or at eight places in all, and has so firm a hold upon the leaves that loosening would be impossible. The top and bottom leaves being thus held firmly by the band, the intermediate leaves are held firmly in place by the studs, punched in the ordinary manner, at their ends. The metal taken out of the top and bottom leaves in making the notches is not one half that which would be removed for a bolt hole, while the intermediate leaves are left of the full width and strength. Springs thus secured together can never work loose, and there is no extra part which, like a bolt, can break or come off.

ACTUAL YIELD OF CROPS PER ACRE.

Any one much acquainted with farmers must be aware of their general disposition to overestimate their crops; but we suspect that those most familiar with this trait of human nature will be surprised at the actual yield of the leading staples in the fertile State of Ohio, as shown by the following statistics from the office of the Auditor of the State, which we find in a recent number of the *State Journal*:—

Wheat.—Number of acres sown, 1,790,627; bushels produced, 13,345,844; average per acre, 7½ bushels.

Corn.—Acres sown, 2,339,204; bushels produced, 69,372,343; average per acre, 30 bushels.

Oats.—Acres sown, 644,954; bushels pr duced, 15,055,059; average per acre, 23½ bushels.

Rye.—Acres sown, 98,011; bushels produced, 561,-065; average per acre, 5¾ bushels.

Barley.—Acres sown, 102,729; bushels produced, 1,639,388; average per acre, 16 bushels.

Buckwheat.—Acres sown, 149,645; bushels produced, 2,222,083; average per acre, 15 bushels.

Meadow.—Acres, 1,340,566; tuns of hay produced, 1,365,888; average per acre, 1 tun.

Wheat Crop.—Smallest average per acre: Trumbull county, ½ bushel; Mahoning, ½ bushel; Columbiana, 1 bushel; Stark, 1 bushel. Largest average per acre: Ottawa county, 17 bushels; Erie, 16 bushels; Sandusky, 16 bushels; Lucas, 16 bushels. Smallest crop in one county: Trumbull, 2,084 bushels; Mahoning, 6,510; Portage, 10,373 bushels; Geauga, 11,078 bushels. Largest crop in one county: Butler, 589,076 bushels; Seneca, 502,500 bushels; Montgomery, 461,214; Highland, 399,005 bushels.

Corn Crop.—Smallest average per acre: Carroll county, 15½ bushels; Geauga, 20½; Stark, 21; Vinton, 22½. Largest average per acre: Lucas county, 42 bushels; Lake, 37; Preble, 38; Butler, 37; Ross, 37; Pickaway, 37; Warren, 37. Smallest crop in one county: Paulding, 127,593 bushels; Geauga, 154,319; Carroll, 211,596; Van Wert, 282,018. Largest crop in one county: Ross, 2,895,097; Pickaway, 2,722,153; Butler, 2,089,463; Franklin, 1,883,209.

Butler county produced the largest crop of barley, 339,935 bushels; Coshocten, the largest crop of rye, 26,541 bushels; Columbiana, the largest crop of buckwheat, 123,233 bushels; Wayne, the largest crop of oats, 529,370 bushels; Trumbull, the larges crop of hay, 47,998 tuns.

AMONG the numerous useful applications of which photography is capable, there is one both novel and amusing which deserves to be recorded. Urgent private affairs detaining a certain prince at Palermo, he could not as usual, pay his annual visit to Paris this summer. But the prince's wardrobe required replenishing, and with a new Neapolitan dynasty came new fashions; the prince was in a state of sartorial despair, till the happy thought occurred to him to be photographed, on the scale of one inch to the foot, and to send the proof to an eminent Parisian *tailleur* The artist took his measures accordingly; the suit was duly made and forwarded to Palermo. The prince, on receipt of his garments, sent a letter to the tailor, in which he proclaims the fit to be admirable. He is delighted, and so is the tailor. The prince sent another photograph representing him in his new suit. It is easy to see that it is a perfect fit.

WATER IN LONDON.—In a careful and elaborate report to the New River Water Company, Pr fessor Spencer, in speaking of the corrosion of iron mains and the effect of gas leakage, states that it is computed that there are 4,000 miles of gas mains laid under the roadways of London, from which 600,000,000 feet of gas are annually absorbed into the earth, the far larger proportion of which could be saved by improved conduits. As a matter of economy, its results would pay a dividend of five per cent on the gross capital of the London companies. It is a question for photographers how far the extraordinary excess of carbureted hydrogen with its other impurities, contaminating their water at times, may account for exceptional and unexplainable phenomena and puzzling failure.

Two telegraph operators can carry on a silent conversation together by making the dots and lines of the Morse alphabet on each other's hands with their fingers.