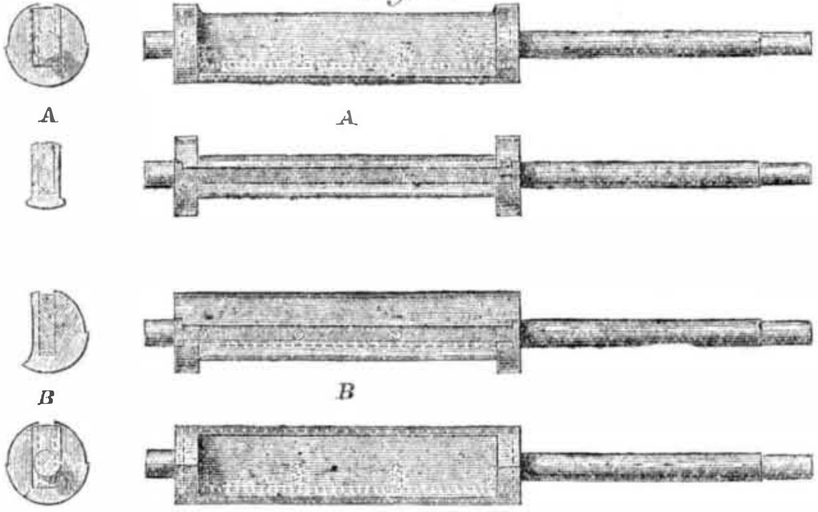
point of adjustment but also to perform the labor of moving the valve to a certain degree; and it has to perform this duty after reaching through steam-tight packing or stuffing boxes. The packing in these stuffing boxes by use becomes hard, when new packing becomes necessary; or it leaks and it is necessary to screw up a little tighter; all of which must be done by hand, thereby putting the regulator under subjection or friction, variable, according to the judgment of the engineer. There is also the friction on the regulator in the auxiliary valve arrangement necessary to overcome the power required to move such valve through all its bearings, stuffing boxes, guides, etc., and under the pressure of steam. These distributing elements do not exist in the Corliss engine valve gear.

The governor is therefore extremely sensitive, as it is not saddled with two duties, *actuation* as well as regulation. A stop motion is provided for the purpose of preventing accidents should the regulator at any time, and from any cause, cease to perform its functions or become inoperative. This mechanism does not allow the steam valves to hook on, and therefore they cannot open. The result is that the engine is stopped by this mechanism *alone*, although the screw valve may be wide open.

Fig. 3.



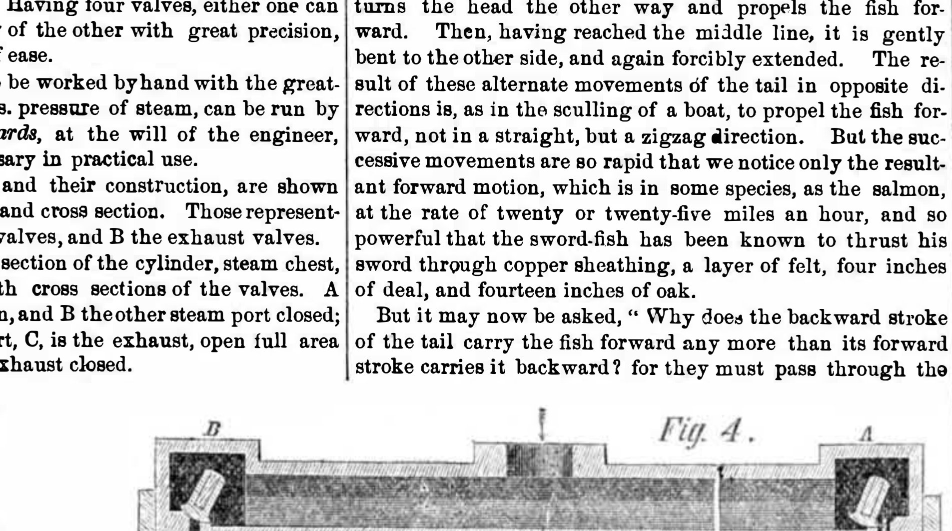
The valves are circular slides, motion being imparted to them by levers keyed to valve stems. These stems have a flat blade the length of the valve in the steam chest, and they oscillate on centers or fixed bearings in the front and back bonnets. The valves are fitted to these blades in a manner that admits of their adjusting themselves to their seats as the valve and seat from time to time become worn. The construction of the valve and stem is such that a valve can, it is claimed, be taken out in a shorter space of time than in any other engine, by taking out four bolts to remove the back bonnet, and drawing one key where keyed to the valve lever. Having four valves, either one can be adjusted independently of the other with great precision, and with the greatest of ease.

The valve gear can also be worked by hand with the greatest ease, and with 80 lbs. pressure of steam, can be run by hand, *backwards* or *forwards*, at the will of the engineer, which oftentimes is necessary in practical use.

The valves and blades, and their construction, are shown in Fig. 3, in longitudinal and cross section. Those represented by A show the steam valves, and B the exhaust valves.

Fig. 4 is a longitudinal section of the cylinder, steam chest, and exhaust passage, with cross sections of the valves. A shows one steam port open, and B the other steam port closed; the valves lapping the port, C, is the exhaust, open full area of port, and D the other exhaust closed.

Fig. 4.



It will be noticed also that the circumference of the exhaust valves, C and D, is partially cut away, thus reducing friction and allowing the acting portion of the valve to seat itself as it gradually wears. These devices are observed in the transverse sections of Fig. 3 as well as in the longitudinal section, Fig. 4. It will also be observed in the longitudinal section, Fig. 4, that the piston has traveled a very small part of the stroke, while the steam valve, A, and exhaust valve, C, have been opening the full area of their ports. The quick opening and closing of the steam and exhaust valves, and at the proper time (see Tredgold), with a positive mechanism for closing the same, has been a subject that has received the greatest amount of attention and thought from our most scientific engineers, and it is one of the principal subjects of the Corliss patent.

The workmanship of the engine is exquisite; that of the engine exhibited at the National Fair of the American Institute, which elicited commendation from every person competent to judge, was, as we are told by the builder, the same as that given to every engine before it leaves his works.

In style, as seen by the engravings, the engine must satisfy the most exacting taste.

Orders for machines, or requests for descriptive pamphlets, or for further information, should be addressed to W. A. Harris, corner of Park street and Promenade avenue, Providence, R. I., or at 49 Murray street, New York. [See advertisement on another page.]

How a Fish Swims.

Now, how does it swim? We have found that the successive or simultaneous removal of the dorsal, anal, pectoral, and ventral fins, only renders the fish's position unsteady; but he could swim as well as before. But if the end of the caudal fin be snipped off, its speed is diminished; if the entire fin is removed, it moves still slower, and with evident exertion, but bravely keeps it up until the tail itself has been cut off up to or beyond the anal fin; then at last the poor victim to science succumbs, rolls over and over like a log upon the water, gasps convulsively, makes a few desperate but ineffectual struggles with its abbreviated tail—and dies.

The sight appears more cruel than it is, for the successive cuts seem to disturb the fish very little; and as the whole is over much sooner than the dying struggles of a hooked fish, we may claim the right to make the sacrifice for our intellectual dinner—especially as it occurs by no means every Friday.

We have learned that a fish cannot swim without its tail. Let us now inquire how it swims with it. Very much as you scull a boat with an oar; but with the difference that in this case the oar is a part of the boat, and is flexible both in its length and in its hight.

Let us suppose our fish floating at rest in the water. Its tail is extended straight behind the body; suddenly it is bent to one side; this of course turns the head towards the same side, and perhaps carries the fish a little backward; but now comes a more forcible backward stroke of the tail, which turns the head the other way and propels the fish forward. Then, having reached the middle line, it is gently bent to the other side, and again forcibly extended. The result of these alternate movements of the tail in opposite directions is, as in the sculling of a boat, to propel the fish forward, not in a straight, but a zigzag direction. But the successive movements are so rapid that we notice only the resultant forward motion, which is in some species, as the salmon, at the rate of twenty or twenty-five miles an hour, and so powerful that the sword-fish has been known to thrust his sword through copper sheathing, a layer of felt, four inches of deal, and fourteen inches of oak.

But it may now be asked, "Why does the backward stroke of the tail carry the fish forward any more than its forward stroke carries it backward? for they must pass through the same space." There are four different reasons: First. The forward stroke is much less forcible and rapid than the backward. Second. The water is already moving; for the previous backward stroke of the tail from the other side to the middle line has forced the water in all directions out of its way, so that the further stroke forward meets comparatively little resistance; but the backward stroke meets all the more and is therefore the more effective in sending the fish forward. Third. This and the fourth reason depend upon the form of the tail, or upon the will of the fish.

There are some tails, such as those of the sharks and of the sea-snakes, which are long and narrow and stiff from edge to edge; and these are "feathered" like an oar. But the tail or an ordinary fish is not only much wider, but flexible in every direction, and capable of being spread out or narrowed by the action of little muscles attached to the bony rays which support it. Now such a tail may be feathered, and probably is, when the fish is moving slowly; but for more rapid movements it is probable that the whole tail is spread out and hollowed backward for the backward stroke; but that upon reaching the middle line it is narrowed and made convex for the forward stroke, so as to offer the least resistance to the water.

Those fishes which have scales overlapping each other are aided in still a fifth way; for in the forward stroke the scales upon that side of the tail would be flattened closely together so as to present a plane surface; but in the backward stroke the edges of the scales would be raised a little from the bending of the tail, and would offer a roughened surface to the water.—*From "Beast, Bird, and Fish," by Burt G. Wilder, in Harper's Magazine for December.*

PROFESSOR MORSE'S OFFICIAL REPORT UPON THE TELEGRAPHY OF THE FRENCH EXPOSITION.

COMPARATIVE SPEED OF INSTRUMENTS.

In the comparison of the speed of transmission by the different telegraphic systems now in use, the anxiety of Prof. Morse to properly set forth the merits of his own invention in this report has led him to some conclusions which we cannot but regard as inaccurate. He states, that in France and Prussia the Morse instrument is officially rated at twenty to thirty messages per hour, and the Hughes printer at fifty messages per hour, each message being calculated as equivalent to twenty words; but, in the table given of the results reached by American operators in special trials, the minimum rate is 1,600 words per hour, which is equivalent to eighty messages of twenty words each; therefore, Prof. Morse claims that the speed of his own instrument has been greatly underrated in the official European reports, and that it is actually the most rapid system in use. It should be borne in mind, however, that the actual discrepancy between the skill of American and European operators, though very considerable, is much less than would, at first sight, appear from the above showing. The rate given in the official reports represents the average speed of good operators under favorable circumstances, while that of the American operators is the result of special trials of selected experts, which as might be expected, give a very high average. A much nearer approximation to the true rate is that given by taking the average of a week's regular work in the New York office. This was done about two years since, and the result, as far as "through wires," or principal circuits are concerned, was as follows:

The Morse instrument transmitted, in a day of ten hours, an average of 300 messages of twenty words each, or thirty messages per hour.

The combination (improved Hughes) printer transmitted, per day of ten hours, an average of 325 messages of 20 words each, together with 4,000 words of press news, the whole being equivalent to 52 messages per hour. If the American lines were kept in as good working condition as those of Europe, these averages would undoubtedly be much higher, as may be proved by comparing the maximum speed per hour which has actually been obtained and officially verified:

The Morse apparatus in England, 1,476 words.
" " " " America, 2,704 "

The combination instrument, in the hands of an expert operator, has transmitted 2,700 words per hour through a circuit of 240 miles, a distance fairly representing the average length of circuits in the country. The Morse apparatus, as constructed and used in America, cannot be made to record, with certainty, over $1,800 words per hour, and this we consider to be about the average rate attainable in continuous work by the best American operator, under favorable conditions of the wires, while the rate of the combination printer, under similar conditions, is 25 or 30 per cent higher. Singularly enough, Prof. Morse makes no allusion whatever to the latter instrument in his report, although it is, practically, the most rapid one in use at the present day.

NUMBER OF MORSE INSTRUMENTS IN USE.

A mass of valuable statistics is brought together in the latter part of the report, which want of space prevents us from quoting as fully as we could wish. From reports received from official sources, in reply to questions propounded by Prof. Morse, and addressed to the telegraphic administrations of foreign countries, it appears that the Morse instrument has almost entirely superseded every other one throughout the civilized world—as might be expected from its simplicity, economy, and effectiveness. The Hughes printer is considerably employed in Europe on important through lines, as the combination is in America, and for this class of work it possesses incontestable advantages. From the returns, it appears that about 200 of the Hughes instruments were in use in Europe in 1867, the majority of these being in France. A careful estimate, based mostly upon official reports, puts the whole number of Morse instruments, employed in Europe, Asia, Africa, and Australia, in 1867, at nearly 12,000. In America, the Western Union Company report that they employ 4,000, and the various other lines cannot have less than 2,000 in daily use, including the railway lines and those of competing companies, as well as a large number in Canada, making a grand total of about 18,000 instruments of this kind in use at the present time.

MORSE'S TELEGRAPHIC INVENTIONS.

Now that the long and bitter controversy, as to the credit which is really due to Prof. Morse for his various inventions and improvements, has almost entirely died away with the expiration of his patents and the consolidation of rival telegraphic interests, it may be well to impartially examine the claims of Prof. Morse, as set forth in this report, as well as in the little pamphlet published by himself in Paris, in 1867. The inventions or discoveries here claimed as his own, by Prof. Morse, may be briefly summed up as follows:

1. The recording or generic telegraph, operated either electro-magnetically or electro-chemically.

2. The telegraphic relay circuit, or the opening and closing of a secondary circuit by means of a primary circuit.

3. The dot and line alphabet.

4. The use of sounds as a medium of receiving telegraphic communications.

5. The system of automatic transmission by the use of metallic type, or of the embossed paper strip from the register, as a means of opening and closing the circuit.

6. The use of a printing wheel and ink as a mode of recording, generally known as the "ink writer."

It must be admitted by the unprejudiced reader that, in the report under consideration, Prof. Morse has, in most cases, brought forward sufficient and satisfactory evidence of his having been the inventor of the apparatus and devices above named. In regard to the electro-chemical system of recording and the mode of transmission by the embossed paper strip from the register, although very probably first suggested by Prof. Morse, they do not appear, by the evidence, ever to have been put in practical form, and this fact, therefore, in our opinion, does not detract from the credit due to Bain, who made the electro-chemical system a practical reality, or from that of Edison and Westbrook, who, at a more recent date, independently invented and put in operation, unknown to each other, modes for transmitting, by the embossed paper strip, which, although upon the same general principle, differ widely in the details of their construction.

The line of argument which has been adopted by some writers upon this subject—that of resolving the invention into its elementary parts, and showing that each detail was before known, and that, therefore, no credit was due to the man who combined them in such a manner as to produce a new result—is an exceedingly unfair one. Almost every great invention is a combination of devices previously well known, and, indeed, it is almost impossible that it should be otherwise.—*The Telegrapher*.

For the Scientific American.

ON MANGANESE AND SOME OF ITS COMPOUNDS.

BY PROFESSOR CHARLES A. JOY.

It is difficult to trace the origin of the word manganese, the ores containing it were variously styled female magnets, black magnesia, alabandicus, from the City of Alabanda; mangadesum by the glass makers, and later manganesium, and finally manganese. But notwithstanding the antiquity of the name, it is safe to say that even at the present time very little is known about the properties of the metal, and it is for this reason that we have chosen to speak of it, in order to put together for convenience of reference, the various methods of its preparation, and the properties of the metal as accepted by the best authorities.

For a long time iron and manganese were confounded together, but after the Swedish chemist, Gahn, proved the existence of a new substance in the mineral pyrolusite, the analogy between the new metal, manganese, and the old metal, iron, at once suggested that the former could be reduced in the same way as the latter.

The oxide of manganese was heated with charcoal, and a complete reduction followed. The heat required was the same as that for the reduction of iron. The metal obtained in this way, like pig iron, was found to contain considerable silicium and carbon, and to be very brittle. Whether it could be made malleable by burning off the carbon and squeezing out the silicium in a puddling furnace has never been ascertained, as no one has ever manufactured sufficient metallic manganese to make the trial. If the first chemist who reduced an ounce of iron from the oxide by means of charcoal could see to what uses the brittle, easily rusting, unmalleable metal as described by him, is now applied, he would be slightly surprised, for in small quantities or in the form of powder, every chemist would be forced to say that iron would have to be kept hermetically sealed, or protected by naphtha from the action of the air. It may be that manganese in larger quantities and properly refined, purified, and annealed, would be capable of being hammered into thin foil or drawn into fine wire, but at present we have no positive knowledge on the subject.

Another method for the reduction of manganese is to fuse the chloride with an equal weight of fluor spar, and one fifth its weight of metallic sodium. When obtained in this way it has the color of cast iron; is very brittle and very hard. It will take a fine polish, cannot be scratched by a file, cuts glass easily, does not change in moist air, is not attracted by a magnet, and has no effect upon the magnetic needle; it cannot be wrought, but can be cast the same as iron, and its specific gravity when prepared in this way is 7·16.

This method has been severely criticised by our best chemists, and it has been objected that the metal obtained was in no way pure, and ought not to be accepted as disclosing the true properties of manganese.

Deville fused the metal to a crystalline mass, the powder of which decomposed water rapidly; its color very much resembled that of bismuth. The fluoride of manganese has been reduced by metallic sodium, and we have ourselves reduced the amalgam of manganese to a fine powder, but were unsuccessful in fusing it to a button.

Some authorities say that metallic manganese decomposes water at ordinary temperature; that its color is reddish white; that it oxidizes in the air, and must therefore be kept under naphtha the same as potassium and sodium; that it is slightly magnetic, and that it readily combines with silicium and carbon, and that its specific gravity is 8.

The metal is said to be easily attacked by acids. In reference to the alloys of manganese, not so much is known as could be desired. Its effect upon iron is, however, becoming more familiar, and has been made the basis of several patents. In this country, especially, the use of franklinite iron, containing a large proportion of manganese, is well understood, and the iron produced is valuable for many purposes. In England there are thirty-six patents involving the use of manganese in iron and steel, the earliest of which was taken out in 1799.

Dr. Prieger, of Bonn, has prepared alloys of manganese and iron, and manganese and copper. An intimate mixture of black oxid of manganese, powdered charcoal, and iron filings or turnings, is made in a black lead crucible holding thirty to fifty pounds. A covering is made of charcoal, fluor spar, and common salt, and the contents of the crucible exposed for several hours to a white heat. On breaking the crucible, the alloy of manganese and iron will be found as a perfectly homogeneous button. Two equivalents of manganese and one equivalent of iron, afford an alloy containing thirty-six per cent of manganese; four of manganese and one of iron, give about eighty per cent of manganese. Both alloys are harder than the hardest steel; they are capable of a high polish, fuse at a red heat, do not oxidize in the air, and only partially so in water; their color is between that of steel and silver. These alloys could be used for journal boxes or bearings of machinery, and would be useful in affording a method for the introduction of manganese to iron or steel castings.

The alloy of manganese and copper is prepared in a similar way, and is very hard. Its properties have not been sufficiently studied by our workers in metal, and it would seem to offer a good field for investigation. It will thus be seen that our knowledge of manganese is very limited. The specimen of the metal in the cabinet at Columbia College is very hard and brittle, and has a distinctly red color. It has been kept in a loosely stoppered bottle for several years without any signs of oxidation or absorption of moisture. It probably contains some carbon and silicium.

In reference to the applications of the compounds of manganese to the arts, it may be well to mention a few of them in this connection.

VIOLET COLORS.

A very rich violet color is prepared by fusing finely pulverized pyrolusite and phosphoric acid in proper proportions, digesting in ammonia, filtering, evaporating to dryness, and treating with water; a violet powder remains, called Nuremberg violet.

GREEN COLOR.

Manganese green is the manganate of baryta, and can be represented by the formula $3\,BaO, 2MnO_3$. It possesses a fine green color, and is much safer than arsenic pigments.

PERMANGANATE OF POTASH.

This valuable salt can be prepared by passing chlorine gas through a solution of the simple manganate. This is said to be a more economical way for its manufacture than the old methods.

PERMANGANATE OF SODA.

This salt is made on a large scale, by heating together 12 parts anhydrous caustic soda, 36 parts soda lye of 1·337 sp. gr., 10 parts chlorate of potash, and 18 parts finely pulverized pyrolusite. This, and the preceding salt are of great value in chemistry, on account of the fact that they contain oxygen gas in a condition suited to the rapid oxidation of substances; a property that renders them available as disinfectants to destroy all bad odors, to be substituted for ozone in bleaching, and, in general, to be employed as powerful oxidizing agents. The salts are also valuable for the preparation of perfectly pure oxygen.

IN GLASS.

The use of manganese compounds in glass manufacture is one of the earliest applications of this element; but the fact that glass which has been bleached by it afterwards undergoes a marked change, and in the course of a few months has entirely different optical properties, is not generally known. The oxide of manganese is put in to counteract the effect of oxides of iron, but, in course of time, the oxide is acted upon by the light and air, and colors the glass red. Many a photographer has been puzzled to know why the glass of his skylight no longer lets light through so as to give him good pictures, and many a gardener has been troubled by the parched appearance of the grape vines in his conservatory, and by the decrease in the yield of grapes; both of these phenomena are due to the fact of the presence of manganese in the glass and the consequent red color. Red glass will not permit any chemical rays to pass, and hence the photographer can take no pictures. The same color will let heat through to parch and dry the vines, but the life-giving rays are cut off. Thus as our knowledge increases, we must order our glass to be made according to the laws of light as well as of chemistry.

SULPHURIC ACID.

When water impregnated with sulphurous acid is treated with sulphate of maganese, the sulphurous acid is changed to sulphuric acid. Here is a use of the oxidizing property of a compound of manganese that may offer a way to important manufactures. It works on a small scale, and probably would on a large one, if any one would try it.

OXYGEN.

The mineral pyrolusite, or black oxide of manganese, has long been employed to make oxygen, but the recent method of converting it into manganate of soda, and afterwards expelling the oxygen by heat, is less familiar to us. A better method than the manganate of soda is said to be the employment of the corresponding lime salt. By heating lime and binoxide of manganese in a current of air, the manganate of lime is formed, which is less likely to fuse than the soda salt, and hence is more readily made. If the air be passed over the lime for a considerable time, the permanganate of lime will form, and this bids fair to afford us the permanganates in a ready and cheap way, and also offers a method for isolating pure permanganic acid by decomposing the lime salt with sulphuric acid.

By mixing the permanganate with the binoxide of barium, we shall be able to prepare oxygen gas in the cold, by simply pouring an acid upon the salts in a flask, just as we make hydrogen by means of zinc and sulphuric acid.

We have gone far enough in our sketch to show that the applications of manganese are very numerous, and we may recur to the subject again at some future time, particularly as we have said nothing about its most important use in the manufacture of chlorine.

Improvements in Salt Making.

The old and usual mode of taking salt, when made, out of the pans is by a man standing on what is called a "hurdle" up each side of the pans, and with a long shaft, having a rake at the end, drawing the salt to the side of the pan, and then with a perforated spade lifting the salt out and putting it on to a bench, into carts, or into the stove-house. For the men to be able to do this work, the place being very hot from the steam and heat of the brine, they have to work nearly in a nude state, and to render the place a little colder they have to burn down the fires from under the pans for several hours before and during the time this work is going on; and when the quantity of salt has been taken out there has to be put into the pan a large amount of cold brine, which then renders it necessary to push the fires very much to get up the heat again. This causes a loss of time in making salt, and is very destructive to both pans and the brickwork surrounding the fires. Salt having to stay so long a time in the pans between the times of emptying them, and being a substance so naturally inclined to fasten itself to anything that is hot, a scale, from two to four inches in thickness, will form in a fortnight on the bottom of the pans, and requires to be hammered to break it. This scale often adheres so fast on the plates of the pans that they are twisted into all shapes and forms, causing breakages. They are also often burned into large holes, the leakages from which allow the brine to run into the fires and flues, and injure and destroy the brickwork so much that the repairs often amount to one-fifth of the value of the salt made. The work being so very unpleasant for the men and the repairs such a serious item of expense, Messrs. Hamer and Davies, having set up extensive new salt works at Wincham, England, determined to find out means to obviate these defects as far as possible, and they have, it is thought, succeeded, and have taken out letters patent for their improvements. They have now three pans at full work so successfully as to quite equal all their expectations. The salt is taken out of the pans by steam power instead of by men, and continued night and day alike. The salt being taken out so regularly prevents the formation of the scales, so that the pans need no hammering, and, therefore, no twisting of the plates, and also obviates the leakage and consequent destruction of the brickwork and filling up of the flues, as in the old method. All these improvements combined, more salt is made from the same quantity of fuel, and in less time, from the same dimensions of pans.

The mode in which this work is performed is by having a railway up each side of the pan, or by making the pan slide into a railway, and having a carriage across the pan, constructed with a shaft through the center, to which rakes are attached by one end; the other end of the rakes travel on the bottom of the pan. The carriage has a flanged pulley or wheel on each end, the same as a railway carriage, and travels from front to back of the pan, with the rakes that cover the whole width of the pan. The machinery is so arranged that the carriage is drawn backwark and forward by wire ropes. When the rakes are at the front end of the pan, and begin to be drawn towards the back, they take the salt as it is made with them at the rate of about 20 ft. per minute until they arrive at the foot of an incline upon which the rakes travel, and on arriving at the top the salt drops into carts standing to receive it. The travel of the rakes at the foot of the incline changes, the speed being reduced to about two feet per minute while ascending the incline, so that the brine runs from the salt down into the pan, instead of in the old way on to the hurdles, and wasted, and it is quite hot when it gets into the pan again. The rakes having dropped the salt into the carts, the machinery is so arranged that the carriage is raised on one side, lifting the rakes up, and being held up by a leg or catch on each end of the carriage; a return motion takes place and the carriage and rakes go back to the front of the pan, at which place the catches or legs are set at liberty, and the rakes go down into the pan and commence another journey. Each double journey is made in nine minutes on a pan of 70 feet long and 26 feet wide. By this process the salt made is put into the carts every nine minutes, and when these are filled the stages on which they stand are so arranged that one man can take all the salt away from three pans and put it either into railway wagons, boats, or into the store-house, as may be required.

At this time the salt being made is the butter salt of the finest quality, and the advantages of the machinery employed in its production over the old plan are the following: The color is much better than that of the salt made in the usual way; there is very little scale formed on the pan bottoms, therefore the repairs needed are much less. In addition, it would appear that more effective control can be obtained over the flues, so that the smoke consuming principle can be much more effectively applied than previously.

IT is said that a new description of lava is being thrown from the crater of Vesuvius since the last eruption, consisting of crystallized salt. This beautiful phenomenon has hitherto been unknown in volcanic natural history.

AVOID bathing in cold water or in a cold room, unless there is a full and quick reaction. Chillness after a bath is a sure indication that it was not properly taken.