Inventions.

THE NEW MALLETT SYSTEM OF CONTROLLED COMBUSTION.

For months past the ground floor of the building No. 500 East Eighteenth street furnished a growing mystery to the habitual passers-by. There seemed to be no special industry carried on there. It was a plain open space, with a forty-horse double flue boiler, and nothing more. Steam was generated but it was allowed to run to waste up the tall chimney stack at the rear end of the building, but singularly enough, and that soon became the chief point of the mystery, there was no smoke evolved. For six months the boiler, which had been an ordinary affair, such as may be purchased in any boiler shop of the city, made steam, burned up ton after ton of coal, wood and even tobacco, but did not belch forth the usual volumes of smoke. The greatest care was taken to keep off prying eyes. A burly watchman, who was not to be bullied or cajoled, guarded the premises night and day, and but very few were permitted to pass into the building. Those who were allowed to enter were engineering experts who were invited to witness the practical workings of a furnace which promises to work a revolution in the furnishing of power by steam. The experts came there critical and doubting; they went away convinced that it was the greatest discovery since the invention of the steam engine. Among those thus invited to see the experimental boiler were J. M. Blanchard, United States Examiner of Patents; Frank Wilder, superintendent of the motive power of the Erie Railway; W. W. Evans, superintendent of the Grant Locomotive Works; W. H. Culver, of the Dickson Locomotive Works; Professor Thurston, of the Stevens Institute of Technology, and Mr. Rider, of the Delamater Iron Works, who came provided with chemical and mechanical testing machines, and gave this initial boiler a most exhaustive test.

THE INVENTOR OF THE SYSTEM.

The new method of burning fuel was the invention of E. J. Mallett, Jr. He is the son of General E. J. Mallett, for many years United States Consul General at Florence, Italy. He was partially educated there and displayed a great taste for chemical research. Coming to New York he placed himself under the tuition of Professor Joy, of Columbia College. This was before the establishment of the present School of Mines in connection with the college. Going West into Colorado young Mallett was sought for as an expert on the most difficult metallurgical questions. He saw the great waste in the treatment of silver ores and set about the building of reverberatory furnaces in which bituminous Colorado coal could be used. With wood ores had been roasted, but not successfully with coal. The idea of drawing the air through the fire instead of forcing it in suggested itself to Mr. Mallett and was found to be a good one. More perfect combustion was the result, and the works in Canyon City, perfected in 1878, have since yielded their inventor a handsome income. Mr. Mallet was the first president of the School of Mines of Denver City, Colorado and ranks in the highest place as a chemist and physician.

It will be remembered that an account of his original researches on the use of original researches on the use of filamental carbon (antedating Edison's experiments) for electric lighting were first fully described by the *Herald*. The whole question of fuel, waste and controlled combustion then came under Mr. Mallett's attention. He was not only an educated engineer in theory, but he had seen and directed practical enterprises on a large scale. He took as a motto the apothegm of Bacon, "If experiments are not directed by theory they are blind; if theory is not sustained by practice, it is deceiving and uncertain." He took the common lamp as a text and model. When the smoke is seen issuing from the flame of an ill adjusted common lamp, the flame itself is dull and murky and the heat and light diminished in quantity. It would be impossible to burn that smoke when once produced, and all the "smoke consumers" were at once rejected by the young inventor, who turned him again to his Argand lamp and, having adjusted it, saw it burn without producing any smoke with a flame white and clear and the quantity of heat and light increased. The lamp had not burned its own smoke, but it had burned without smoke. The step from the lamp to the furnace was a simple one.

APPLICATION OF SCIENTIFIC PRINCIPLES.

Experts had known for years that, scientifically, carburetted hydrogen and the other compounds of carbon require certain quantities of atmospheric air to effect their combustion, yet practically no means were adopted for ascertaining what quantities are supplied, or they are treated as though no such proportions are necessary. Scientifically it is known that inflammable gases are combustible only in proportion to the degree of mixtures and union which is effected between them and the oxygen of the air. Yet practically engineers have never troubled their heads whether such a mixture is effected or not. The perfect control over the air supplied to the lamp Mr. Mallett sought to extend to the furnace. The inflammable gases generated by the application of heat to coal may be burned in a laboratory experiment with great nicety. But there are many other surroundings in a furnace. First, the quantities are large; second, the bodies to be consumed are partly gaseous, partly solid; third, the gases evolved from the coal are part combustible and part incombustible; fourth, they are forced into connection with a large and often overwhelming quantity of the products of combustion, chiefly carbonic acid gas; fifth, the very air introduced it itself deteriorated in passing through the bars and incandescent fuel on them, and thus deprived of much of its oxygen; sixth, and above all, instead of being allowed a suitable time, the whole is hurried away by the current or draught in large masses. From a ton of bituminous coal about 10,000 cubic feet of coal gas are produced, requiring about 100,000 cubic feet of air, adding to this the 240,000 cubic feet required for the combustion of the coke, or solid part of the coal, and a gross volume of 340,000 cubic feet of air is shown as the minimum quantity for a ton of coal, independently of the excess above that chemically required. When a fresh charge of coal is thrown upon the hot fire a great quantity of gas is at once generated, and it is just at this time that the passage of air is most restricted, and hence the great waste, though the appearance or non-appearance of visible smoke is no test either for or against the admission of air, as to quantity, since smoke may come from too much air as from too little. The first fuel loss comes from air entering the furnace and absorbing a much larger amount of heat than it gives back before it passes out of the chimney. A fire box of a furnace, in a measure, simulates a gas retort, producing volatile hydrogen, which passes up a big gaspipe, the chimney, and is lost in space unless air enough to enable it to burn is brought in contact with it. This division of the air for combustion was an important feature, one part going to the combustion of the solid fuel and the other part for the combustion of the gases, and at different stages of the combustion variations in the air supply and for the combustion of the gases a supply of hot air. Mr. Mallett soon arrived at certain definite points in what he termed his "controlled combustion," which included the admission of known and controllable amounts of air to burning fuel; the division of the air necessary for combustion into two volumes, one to burn the solid, the other to burn the volatile constituents of the fuel; the power of varying the relation of these two volumes of air so that while the sum total of air entering a furnace may remain the same, variable quantities may be admitted beneath the fuel and into the gas-combustion chamber; the supply of hot air to fuel gases to prevent the lowering of their temperature before they are ignited; the supply of hot air to the gas combustion chamber in subdivided currents or jets to assure a rapid mixing of the air and fuel gases; the separation of the furnace into two compartments, the firebox and the combustion chamber, such separation being effected by a brick septum wall, having apertures through which the fuel gases may enter the combustion chamber in a controllable manner to permit of their immediate incorporation with hot air; the utilization of that part of the heat contained in burnt fuel gases not conveyed to the boiler and which in the usual practice is required to produce draught; the substitution of mechanical aspiration for chimney draught.

THE SYSTEM GRAPHICALLY SHOWN.

All of these point are accomplished in the Mallett modification of the usual furnace. Fig. No. 1 shows a section of a furnace. In the firebox is seen the mass of burning coal resting upon the grate bars, which in this case are merely lengths of pipe, running from the boiler face to the rear of the septum wall, which is built of firebrick. When the charge of coal is first thrown in upon the live coke the supply of air is allowed to go through these open pipes, while the air by the usual en-

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