ceiving the steam on its circumference, acting as a motor, and the other, receiving the water at its center, acting by centrifugal force. To feed a hundred horse power boiler it took an apparatus of only 10 centimeters diameter, weighing 3 kilogrammes.

The little feed apparatus was very simple and ran with regularity. Orders began to come in in numbers, and Mr. Flaud was full of confidence in the industrial success of it; but there was another inventor who held a valuable patent for a turbine whose arrangements resembled those adopted by Giffard. This patentee, Girard, a distinguished hydraulic engineer, had never thought of the combination invented by Giffard, or even of the feeding of boilers. He was a very positive person, a man who had suffered much, and in the new application devised by another he hoped to find something to make up for his numerous troubles; and he, therefore, was desirous of working up, to his own exclusive profit, what many manufacturers would necessarily have seconded. In the face of a claim that was presented with some irony, and under the threats of a lawsuit that he was not in a position to defend, in view of his financial position at the time, Giffard betook himself to his calculations of 1850.

It was May 8, 1858, about one month after abandoning the centrifugal apparatus, that he took out his patent in France for the feed apparatus that bears his name—the first realization of those new scientific doctrines the knowledge of which to-day is the basis of classic teaching.

The annexed cut (Fig. 2) shows, at Nos. 1 and 2, the figures of the patent which represent the injector as seen in sectional elevation.

The perfection of this apparatus, in which no part was in motion, made nil the project of working up the first centrifugal motion apparatus that Mr. Girard had seen fit to seize upon.

For four or five months the injector, constructed as shown in the cut, worked in the shop in Rue Jean Goujon, and was visited by the most prominent engineers, who could scarcely believe what they saw until they had an opportunity of experimenting for themselves.

Before the injector, the only feed apparatus employed for steam engines were four in number, viz.:

1. The *pulsometer*, which consisted of a large and strong vessel that was emptied and filled alternately by maneuvering cocks and valves, and which could be employed for locomotives and steamboats.

2. The *pump*, actuated by the engine, and the vagaries in the operation of which were numerous, since nothing more was necessary to stop the play of the valves than the presence of the smallest foreign body, or even of sour water. Moreover, the working of the pump required a certain amount of force from the motor that diminished its power; and, in addition, freezing and frequent repairs were to be apprehended.

3. The *donkey engine*, or pump actuated by a special engine, a costly apparatus that consumed much steam and took up considerable room, on locomotives for example.

4. The *reservoir*, which allowed water to enter the boiler through the action of gravity, thus necessitating its being placed at a great height.

During the year that followed the obtaining of the patent, numerous practical improvements brought the injector to a state of perfection in working, and the certificate of addition in which I embodied all these improvements bears date of May 7, 1859.

Fig. 2, No. 3, shows the drawing that was annexed to the certificate of addition of 1859, and represents in section the improved and final arrangements of the feed apparatus of Giffard's invention.

I have said that mechanical builders and engineers had considered that it was impossible for the injector to work; so, when the first application of it was made on the locomotives of the Railway of the East, care was taken to leave the feed pumps in place so as to be able to use them if there should be need. But it was not found necessary to have recourse to them; for it was ascertained by experiment that the action of the injector was easy and sure, and, at the end of a fortnight, the feed pumps were removed. Fig. 1 represents portion of a locomotive engine with its injector.

It will be still remembered at the present time what surprise and astonishment followed the first applications made by M. Dupuy de Lôme, the director-general of naval constructions, who was one of the first, in 1858, to negotiate for the introduction of the injector into the navy.

Communications were received by scientific societies from distinguished men whom they had charged with the duty of making in their behalf an attentive study of this apparatus, which was attracting the attention of all competent men by its originality and the novelty of the scientific principles that it brought in play.

In a report made to the Société d'Encouragement, and which was published in its number for June, 1859, Mr. Ch. Combes, of the Institute, after saying that the injector contained no solid movable piece, added that it was founded upon the principle of the lateral communication of the motion of fluids, and that it utilized "the jet of steam from a boiler for feeding this boiler itself," realizing an industrial application in which "the heat contained in the jet carried along by the steam played the principal role."

In one part of this important paper, Mr. Combes expressed himself thus: "Considered as a feed apparatus for steam boilers, Mr. Giffard's apparatus is, undeniably, the best of all that have been or can be employed, as it is the simplest and most ingenious of them. If we suppose, in fact, that conformably to ideas hitherto held, the quantity of steam contained in bodies is preserved in its entirety through the changes in volume that these undergo, independently of the quantities of motive or resistant power that are the consequence of such changes, it is clear that the operation of Mr. Giffard's apparatus will give rise to no loss of heat except that due to radiation or to contact of the boiler and its appendages with the surrounding medium. The supply will take place gratuitously. If, conformably to the more rational principles of the new dynamic theory of heat, we admit that heat is converted into motive power, and reciprocally, so that all motive or resistant power, all the live force developed or destroyed in the changes of volume or state of the bodies, be accompanied by a disappearance or a production of equivalent heat, the quantity of heat expended in the operation of the Giffard apparatus will be (setting aside losses through radiation or contact with the surrounding medium) precisely equivalent to the motive power that corresponds to the elevation of the quantity of feed water from the reservoir that holds it, and to the forcing of it into the boiler under the pressure that exists therein. We are, then, justified in saying that the Giffard injector is a feed apparatus which is theoretically perfect for steam boilers. The inventor has proved that the dimensions can be so arranged that it will work under material conditions that nearly reach such theoretic perfection."

Testimonials in regard to the importance of this invention are numerous from all sources, but it will suffice to mention that the mechanical prize (Montyon prize) was awarded Giffard by the Academie des Sciences at the competition of 1859, without his having taken any steps to obtain it or even made any communication.

I shall not, at present at least, speak of the difficulties that the invention met with later on, for I desire to remain faithful to the title of this article and limit myself to the history of the invention.

Reduced to its simplest terms, the invention of the injector is based upon the idea that the steam boiler should furnish directly the power necessary to supply itself with water.

To realize such an idea, a section in the boiler causes a jet of steam to issue, which passes into a conical tube that leads it in such a way as to suddenly come in contact with the sucked up liquid, in order to bring about by a sudden condensation the transformation of the live force.

As a consequence of the conversion of velocity into pressure, the water is carried to a valve in another section of the boiler, and the dimensions of which are smaller than those of the aperture that allows the steam to escape. A system of two cones, one convergent and the other divergent, permits of regulating through the former the convergence of the fluid jet, the form of which is so modified by the divergent cone as to facilitate its re-entrance into the boiler in spite of the pressure existing therein.

Such is the apparatus as arranged on all locomotives to feed their boilers.

Fig. 3 shows in longitudinal section an injector in position; and this, with the description appended to this article, will be sufficient to allow the working of the apparatus to be understood.

And now we may sum up the new scientific principles, four in number, that are combined and brought into play in this remarkable invention, along with principles and mechanical methods already known:

1. On contact with the water the steam condenses and communicates to it its velocity.

2. Condensation can only take place if the water is notably colder than the steam; and it is therefore necessary that the water, already heated by the condensation of a part of the steam, shall be put in contact with uncooled steam.

3. The pressure of the jet obtained by the condensation of the steam may be notably greater than that of the motive steam.

4. A liquid may be thrown to a distance from a stationary ajutage within another one also stationary, communicating with a reservoir wherein there is pressure, without any loss of liquid occurring as a consequence of such transmission.

I hope that I have given proof of what lies close to my heart, and furnished enough details to cause it to be understood that Giffard alone was in the position proper for realizing the invention of the injector, because he had slowly and laboriously amassed those treasures of science and individual experience that permitted him to succeed.

He was an indefatigable and patient worker, who recorded in his note books all that he saw, observed, and calculated; and it was thus that, at an opportune moment, he was enabled to sum up in one powerful effort the long prepared elements of the problem that he had proposed to himself in youth.

When Giffard escaped from the Bourbon College to go to the Saint Lazare station, it was in order to make a study of the running of locomotives, and to become exasperated at seeing them too often expend their power in ridiculous movements made for the sole purpose of bringing to the boilers the water necessary for the supply of their strong steam engines.

The injector was not a lucky find, the result of an accidental experiment, the flash of an inspiration of genius; for Giffard calculated (as did Newton over the fall of the apple) from the experiments made by him in 1850 and after. It is we who to-day benefit by the fruit of the persevering and conscientious efforts of this immortal man, whose life was well employed for humanity.

DESCRIPTION OF FIG. 3.—A, steam pipe communicating with the boiler; B, another pipe receiving steam from the preceding through small holes, and terminating in a cone; C, screw rod, cone-shaped at its extremity, actuated by the winch, M, and serving to regulate and even intercept the passage of the steam; D, water suction pipe.

The water that is drawn up introduces itself around the steam pipe and tends to make its exit through the annular section at the conical extremity of the latter. This annular section is increased at will by means of the lever, L, which acts upon a screw whose office is to cause the pipe, B, and its system to move backward or forward. E, diverging ajutage, which receives the water injected by the jet of steam that condenses therein at I, and imparts to it a portion of its speed, in proportion to the pressure of the boiler; F, a box carrying a check-valve to keep the water from issuing from the boiler when the apparatus is not at work; G, a pipe that leads the injected water to the boiler; H, purge or overflow pipe; K, sight hole, which permits the operation of the apparatus to be watched, the stream of water being distinctly seen in the free interval.

Correspondence.

Does the Bee Injure Grapes?

To the Editor of the Scientific American:

It has long been believed, and is now almost universally accepted as a fact, that the bee destroys grapes and other fruits. I have watched the little workers for years, and have been loth to believe it. I observed long ago that they never attacked sound grapes. But when defective, or split as the result of a rainy spell, they would then suck out the juices. Being unable to convince others of the harmlessness of the insect in any other way, I devised for that purpose the following experiment, which any one may try for himself.

I placed at the mouth of the hives bunches of several varieties of thin-skinned grapes, and for days, although the bees were constantly crawling over them, not a berry was injured. I then punctured half of the berries on each bunch, and instantly the bees went to work on all so punctured, in a short time sucking them dry. The remainder of the berries were untouched, and remained so until punctured by me, when they in turn were attacked as promptly as the former.

This experiment demonstrates that it is necessary for the grape to have been previously injured so as to allow exudation of juice; otherwise the bee will not molest it. I have not observed so carefully in the case of other fruits, but it is my belief that this is the *modus operandi* in all cases.

Rot, splitting of the grape, injury by insects and birds (in this latitude a small yellowish bird is conspicuous), are the causes that render grapes liable to attack by bees. And when we reflect that the berries thus injured would decay, it will be seen that the bee actually saves to us what would otherwise be lost, by storing it up as honey.

I have been hurried into this communication by observing that in some quarters legislative action is about to be taken against an insect which I believe closer observation will demonstrate to be not only innocent of harm, but productive of good. T. T. ROBERTSON, M.D.

Winnsborough, S. C., Aug., 1882.

Heavy Locomotives.

To the Editor of the Scientific American:

In your publication of June 3, you say, in answer to correspondent F. A. S., that the heaviest of the usual class of locomotives is 55 to 60 tons.

The following is the weight of one of the bank engines used for overcoming the steep grades on parts of the Santiago and Valparaiso Railroad. This weight includes water but no coal: Engine, 46,742 kilos; tender, 28,387 kilos; total, 75,129 kilos, equal to 73·94 tons of 2,240 pounds.

O. BOWKER,
Engineer Antofagasta Railroad.

Antofagasta, Chile, July, 1882.

The World's Iron Product.

A critical estimate of the annual iron product of the world shows the yield to be close upon nineteen and a half million tons a year. Statistics for the more important countries are obtainable as late as 1881. For the others it is assumed that the yield has not fallen off since the latest figures reported. Under "other countries," in the table below, are included Canada, Switzerland, and Mexico, each producing about 7,500 tons a year, and Norway, with 4,000 tons a year.

	Year.	Gross Tons.
Great Britain	1881	8,377,364
United States	1881	4,144,254
Germany	1881	2,863,400
France	1881	1,866,438
Belgium	1881	622,288
Austro-Hungary	1880	448685
Sweden	1880	399,628
Luxembourg	1881	289,212
Russia	1881	231,341
Italy	1876	76,000
Spain	1873	73,000
Turkey	—	40,000
Japan	1877	10,000
All other countries	—	46,000
Total		19,487,610

The first four countries produce 88·4 per cent of the world's iron supply; the first two, 64·3 per cent; the first, 43 per cent. The chief consumer is the United States, 29 per cent; next Great Britain, 23·4 per cent; these two using more than half of all.