Curiosities of Locomotive Design.

From Development of the Locomotive Engine, by Angus Sinclair.
Railway and Locomotive Engineering—September-December, 1907

<u>The Enterprising Inventor.</u>

The man who ventures to stray from the familiar beaten path may stumble into a quagmire, but he may have the good fortune to discover a vein of rich ore which the beaten path would never reveal.

When an inventor scorning the common forms proceeds to work out new and original shapes for himself, he may produce something which is ridiculous and impracticable, but even when he does that, the enterprising person deserves praise, for it has been by departing from other people's lead that new and original inventions have been given to the world.

In publishing a chapter on Freaks and Curiosities in Locomotive Designs it is not done in a spirit of levity, but to give a record of well meaning inventions that did not perform the functions the inventors expected.

For the first twenty years after Trevithick built his locomotive, a belief was common that plain wheels would not adhere to the rail with sufficient tenacity to induce propulsion. It had happened that Trevithick's engine was what has become known as over-cylindered, the effect being that the engine was furiously slippery. Other pioneer locomotives suffered from the same defect and remedies were invented which now appear to be ridiculous.

The Mechanical Traveler.

The most notable invention of this kind is illustrated, Fig. 1, and was known as Brunton's Mechanical Traveller. Brunton was aware that the action of the horse up to that time had been the most successful means of hauling vehicles, and the question arose, why not utilize the action of the horse mechanically? The engine was duly built to put that idea in practice. It had a horizontal boiler and a single cylinder set on top with piston connecting with levers that acted the part of a horse's legs.

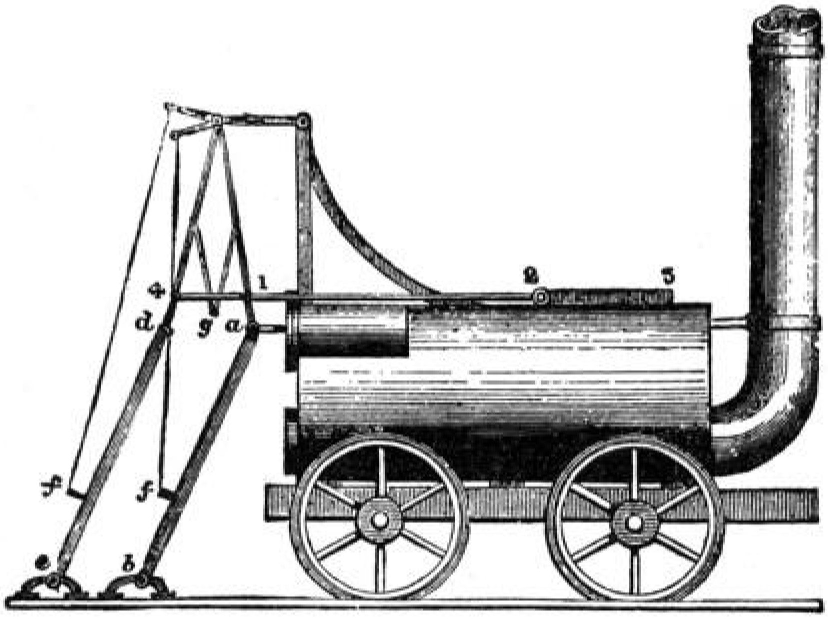

FIG. 1. BRUNTON'S TRAVELLER, 1813.

The invention excited much attention. It had the merit of acting as the designer intended it should, and one day that it was on trial, rushing along at a speed of three miles an hour, accompanied by a host of admirers, the boiler exploded, throwing hot water, pieces of iron, and disaster among the crowd. That ended the career of the Mechanical Traveller.

Cog Wheel Locomotive.

The first attempt to overcome the deficient adhesion of plain iron wheels on plain iron rails was made in 1811, by J. Blenkinsopp, who obtained a patent for a self propelling steam engine, Fig. 2, worked by a cog wheel engaging a rack rail, a practice now common on mountain railways.

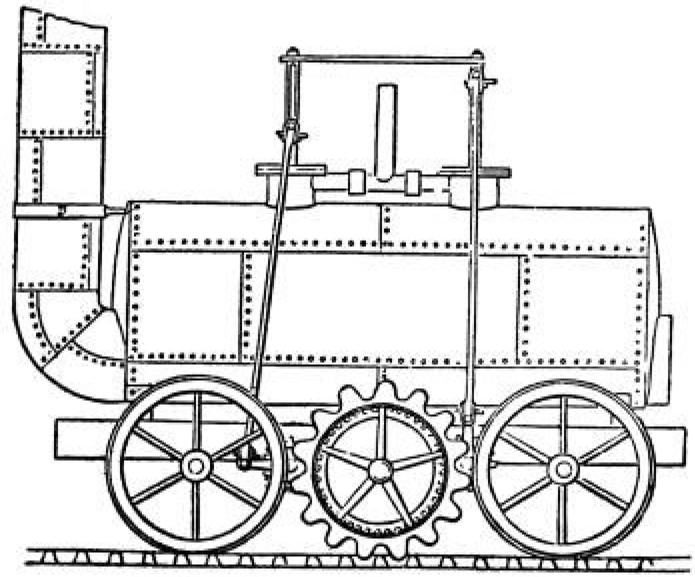

FIG. 2. BLENKINSOPP COGWHEEL LOCOMOTIVE.

This Blenkinsopp engine was the first locomotive to perform profitable traction work. It was well designed for the time, having two cylinders 8 x 20 inches, set partly into the boiler and transmitting power to right angle cranks which drove the toothed driving wheels. A sensible feature about this engine was that the piston crossheads worked in guides instead of being controlled by parallel motion, as the pistons of most early locomotives were. The engine was used for about twenty years.

Tentative Evolution.

In the course of evolution a variety of locomotives were built resembling Hedley's Puffing Billy, but they followed the line of improvement that led to the Rocket in 1829, which established the elements of a permanent type. In Great Britain there were not many departures from the foundation form of the Rocket.

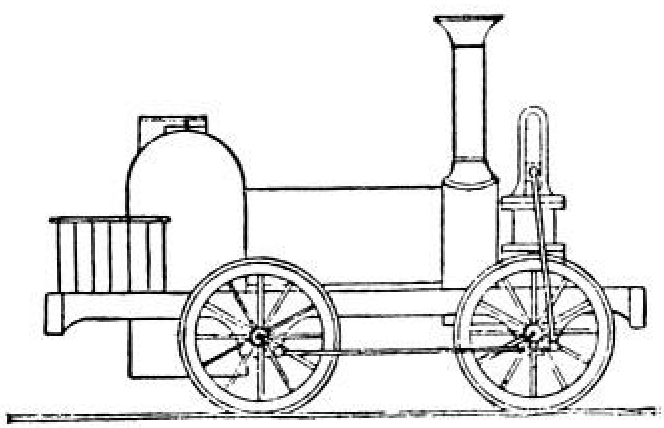

FIG. 3. GALLOWAY'S CALEDONIAN.

An engine called the "Caledonian," Fig. 3, was bought by the Liverpool and

Manchester in 1832. The vertical cylinders were secured in front of the smoke box, with pistons working through the upper cover to connecting rods that extended down to the driving wheels. That engine displayed a weakness for jumping the track, and was changed after a few months of service. Its only service to railways was emphasizing the mistake of using vertical cylinders.

<u>Roberts' Bell-Crank Locomotive.</u>

About the same time Richard Roberts, who afterwards became a noted locomotive builder, brought out what he called the "Experiment," Fig. 4. That engine had vertical cylinders operating bell cranks which drove rods connecting with crank pins outside of the driving wheels. This engine had piston valves. It was used only for a few months.

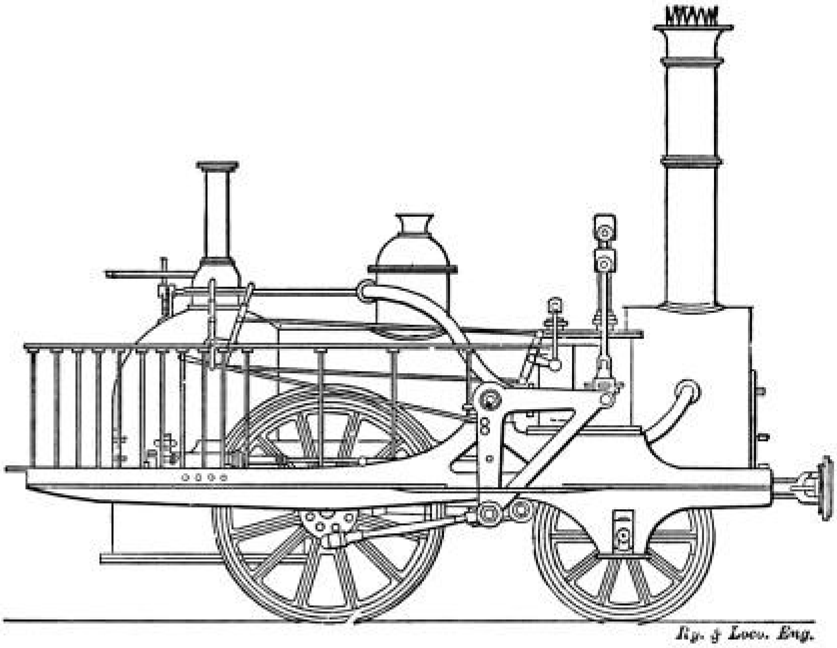

FIG. 4. ROBERTS' EXPERIMENT, 1833.

Similar locomotives were built for the Dundee and Newtyle Railway, in Scotland, one called the "Earl of Airlie," having attracted considerable attention, which did not save it from alteration after a short career.

The bell-crank method of transmitting power to the driving wheels has been used' successfully for special forms of locomotives in which it was not convenient to transmit the power direct. The real difficulty with Roberts' engines and those made for the Newtyle Railway seems to have been in the piston valves, which were crude devices.

Immense Driving Wheels.

Isambard Brunel, chief engineer of the Great Western, Railway, of England, who made the gauge of that railway seven feet wide, had a predilection for large sizes, among them large driving wheels. An engine shown in Fig. 5 had driving wheels 10 feet in diameter. About the time that engine was built the Great Western Railway received one of the kind shown in Fig. 6. The latter was made according to the Harrison patent, which called for driving wheels being secured on one set of frames, the boiler being carried on another set. The science of mechanical engineering was in its infancy in those days, yet one marvels how the designer of such a locomotive expected to obtain the necessary adhesion.

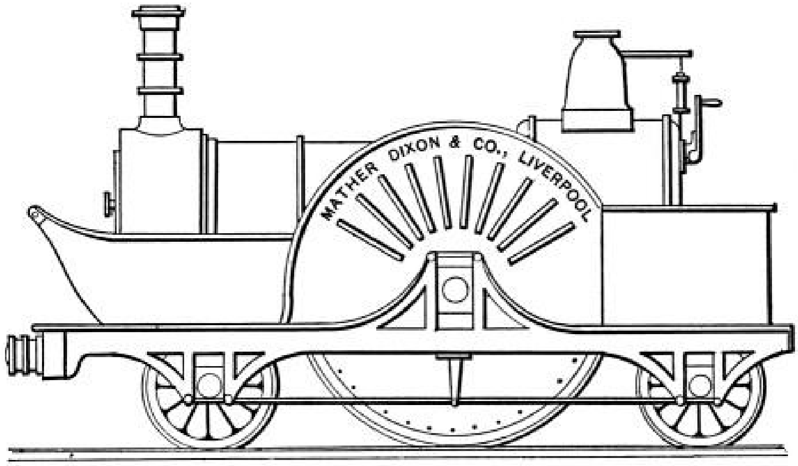

FIG. 5. EARLY GREAT WESTERN LOCOMOTIVE, WITH DRIVING WHEELS TEN FEET DIAMETER AND WIND-SPLITTING FRONT END.

A similar engineering blunder was made a few years later in the United States, when G. A. Nichols, superintendent of the Philadelphia & Reading Railroad, had a locomotive built with the boiler carried on a frame separate from the engine. Mr. Nichols' idea was fairly rational, however, for he was trying to make a boiler with grate surface sufficiently large to burn anthracite coal. Harrison departed from prevailing practice in order to apply abnormally large driving wheels.

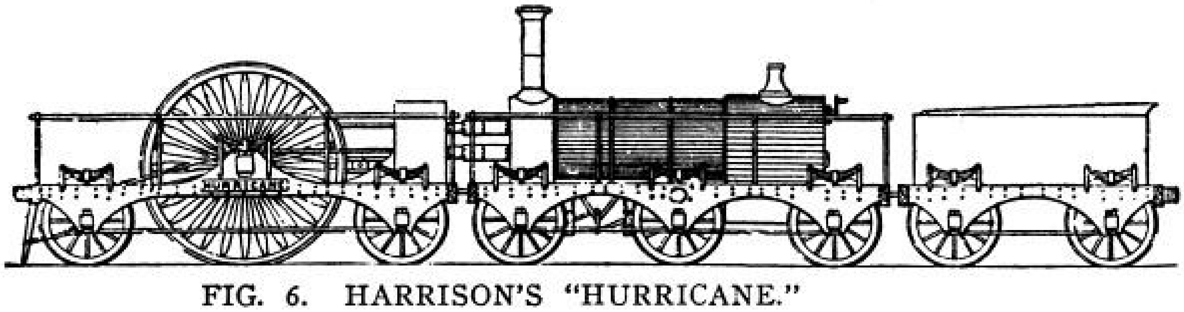

FIG. 6. HARRISON'S "HURRICANE."

The inclination to use huge driving wheels was based on the fallacy that the size of the driving wheels measured the speed possibilities of a locomotive. It took years of experience to demonstrate that the boiler was really what controlled the speed. Some of the high wheel Crampton locomotives, built in Europe and in the United States about 1850, had the boilers so small that want of steam reduced the speed before the train had gone five miles, when high speed was attempted.

Indirect Driving

Although it is a recognized physical axiom that in locomotive engineering a pull or thrust is most effective when worked horizontally, the fallacy of vertical or inclined cylinders influenced the design of locomotives for many years. Many attempts were made to increase power by means of intermediate driving axle arrangements of the type illustrated in Fig. 7. A very interesting attempt of this kind is illustrated in "Sekons Evolution of the Steam Locomotive." This engine was built at Bradford, England, for the Cambrian Railway. It was a vibratory engine, the special merit claimed for the arrangement of mechanism being that it produced perfect balance of the reciprocating and revolving parts. I wonder that the hammer blow alarmist never tried this engine.

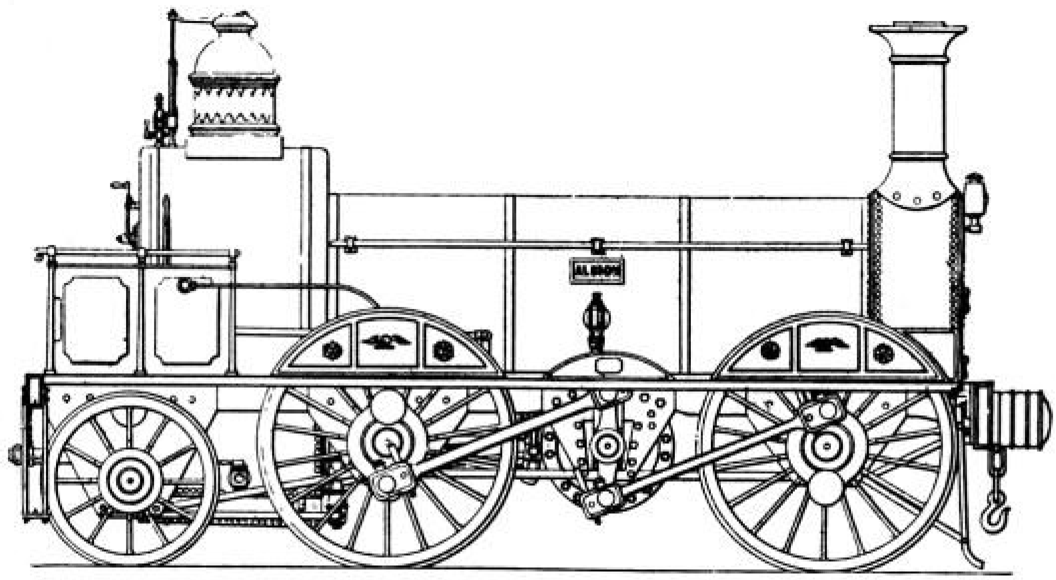

FIG. 7. "ALBION," BUILT FOR CAMBRIAN RAILWAYS.

The driving axle was secured between the frames and set parallel to the wheel axles. The driving axle was secured at each end to a strong disk which held power transmitting mechanism. The pistons, which were fan shaped, drove rocking shafts secured to the driving axle and it in turn vibrated the disks to which the main rods were secured.

It was an ingenious engine, and is reported to have done good service on small cost for fuel and repairs.

Locomotives driven through a supplementary driving axle were very common in the United States, but they were used mostly in the process of evolution. All the Baltimore & Ohio grasshopper engines were driven in this way and they worked quite satisfactorily. The Camden & Amboy monster, shown in Fig. 8, had heavy spur gears on the axles of the middle pairs of wheels which engaged with an intermediate gear performing part of the work done by coupling rods.

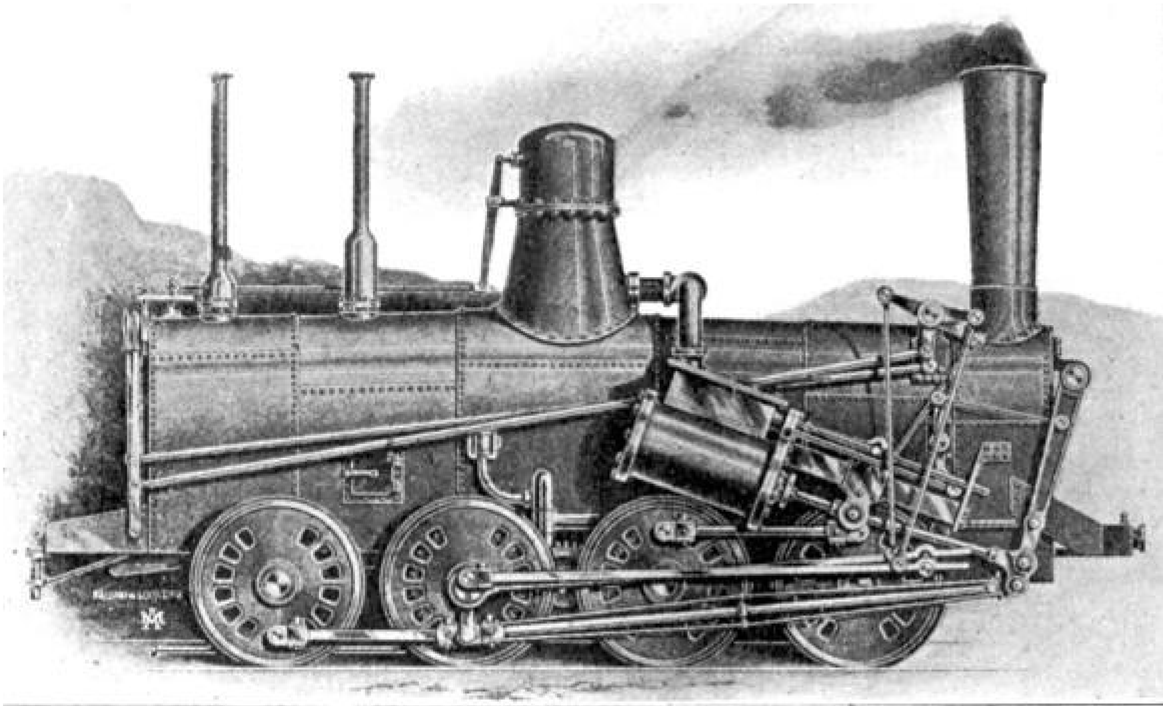

FIG. 8. CAMDEN & AMBOY MONSTER.

When locomotives of that character have been built by men seeking for the best form of engine to perform the work of train hauling, their efforts were commendable, but at various times amateur locomotive designers, saturated with egotism and personal conceit, have produced ridiculous engines and sometimes their friends have tried to

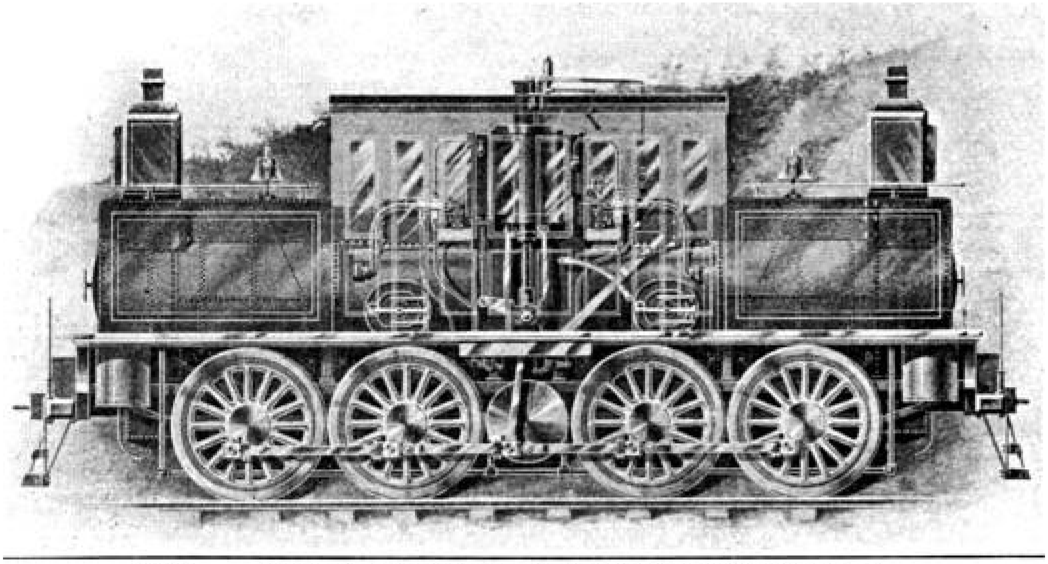

FIG. 9. RAUB CENTRAL POWER LOCOMOTIVE.

force them into use through stock-selling operations. A notable case of this character was the Raub Central Power locomotive, Fig. 9, built at Paterson, N. J., in 1892. The people interested in this invention tried to push it through the influence of sensational articles in the daily newspapers, their claims for speed and efficiency being senseless exaggerations, but their efforts were in vain. As usual, they blamed its unpopularity upon the prejudice of railroad men and the engineering press. The engine had two small boilers, each with a fire door on each side and a smoke flue going back to the stack in the centre.

Vertical cylinders were employed, transmitting the power through a central shaft. This engine was not only an oddity, it was a fake of the worst kind. Instead of an advance in design, it was returning to pioneer practices, being a product of combined ignorance, egotism and perversity.

Ever since people became inventors of mechanical appliances, there have been persistent attempts made to overcome the laws of nature by arrangements of mechanism designed to produce perpetual motion. In some instances inventors labored to produce apparatus that would maintain motion of their own unaided volition, others labored by combinations of mechanism to gain power by leverages or their equivalents.

Of this class of invention was the Harrison locomotive, shown in Fig. 10. In this engine the real driving wheels, which had geared peripheries engaged with cogs on the rail wheel axle. The expectation was that excessive speed could be maintained with reduced expenditure of power, as the piston speed could be regulated at what the engineers of the time considered most conducive to economy of steam. The engine shown was built by Hawthorns of Newcastle, in 1837, the gearing being 3 to 1, so that one revolution of the driving wheels caused the rail wheel to turn three times. The "Hurricane" was used a short time on the Great Western Railway, and was said to have maintained a speed of 100 miles an hour, but that did not preserve it from premature demise. Harrison's failure did not discourage others, from trying similar experiments.

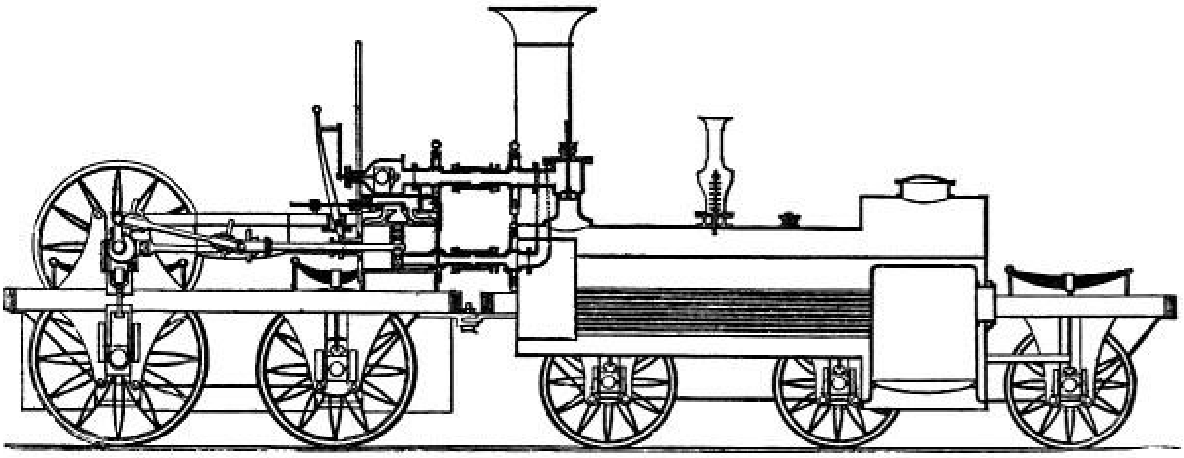

FIG. 10. HARRISON'S "THUNDERER."

The inventive habit has been cultivated for many years in the United States through liberal patent laws that enable an inventor to enjoy the fruits of his ingenuity. Owing to this there is an army of ingenious men ever ready to improve on foreign inventions, with the result that a mechanical oddity appearing in a foreign country soon appears on this side of the Atlantic in exaggerated form. The Harrison two-story locomotives had several imitations in America.

The Fontaine Freak.

In 1881 the Grant Locomotive Works, of Paterson, N. J., built a locomotive, Fig. 11, designed by Eugene Fontaine, of Detroit, which excited great attention for a few years owing to the radical departure from established practice in designing locomotives. Fontaine built his engine with the driving wheels above the boiler, so arranged that their tread pressed upon and transmitted motion to the carrying wheels by frictional contact. The reasons given by the designer for building this form of an engine were: "The question of faster speed in railroad travel is one that is now attracting attention on the part of the public, who demand it, and of the railroads, who are anxious to meet the demand.

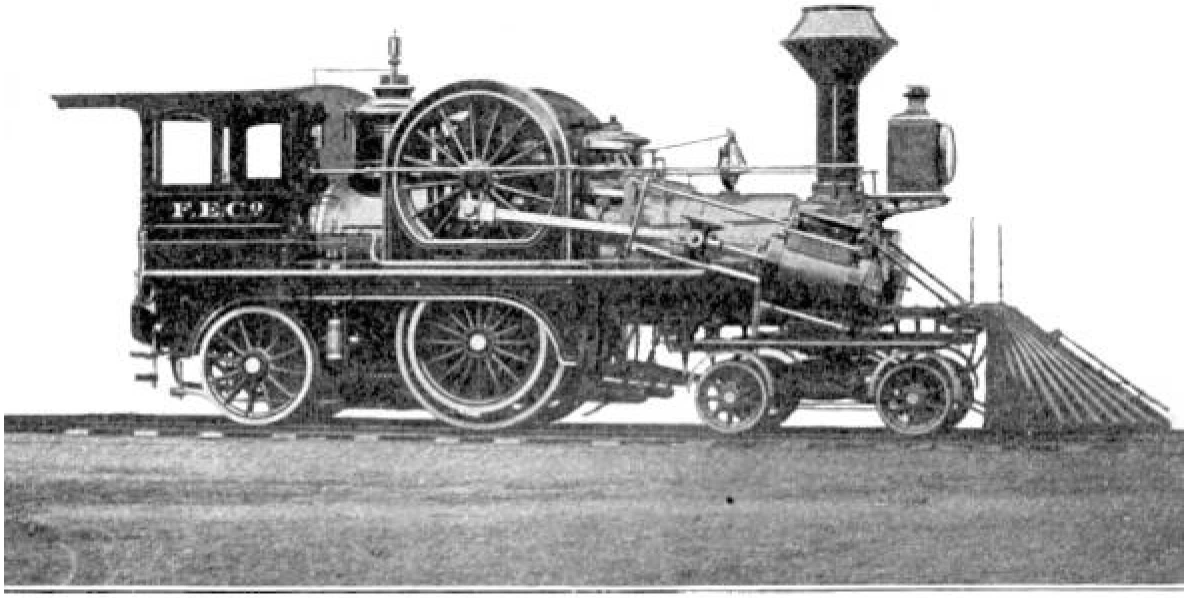

FIG. 11. FONTAINE LOCOMOTIVE.

"It is well known that to increase speed in locomotives, as now used, beyond a certain rate, can only be done by an increase of steam pressure, which can only be obtained by increased expenditure of fuel, and such an expense increases in a tenfold ratio to the increased rate of speed obtained, to say nothing about the additional strain upon the boiler."

To overcome these imaginary deficiencies the locomotive with two driving wheels set up in the air above two other driving wheels that rested on the rail was built and put in service. There was considerable discussion on the invention, but there were very few engineers who believed that any advantage of steam or economy could be secured by the wheel arrangement adopted. Their judgment was vindicated by the results of practical service. The engine was tried on all kinds of trains, but proved inferior in every respect to the ordinary engines of the same capacity. The engine was examined as a curiosity in a variety of roundhouses for a few years. There was always something needed to make its work satisfactory. After many changes the proper one was made when it was converted into an ordinary eight wheel engine.

Holman's Absurdity.

It might have been supposed that the Fontaine experiment would have deterred others from trying such an expensive experiment again; but when an amateur gets seized with the malady for designing a locomotive of an entirely new pattern, he generally produces something startling.

In 1887 The Holman Locomotive Company had built in Philadelphia the locomotive illustrated in Fig. 12. It was immediately assailed by practical railroad men and others for my opinion of this, the latest monstrosity. I had not seen even a picture of the engine, but descriptions were freely written. My opinion, expressed in LOCOMOTIVE ENGINEERING, was: "It is a humbug. It is sound engineering to hold that every piece added to a machine, after it has reached the practical stage, is a source of weakness. A triple set of wheels under a locomotive would be proposed only by one who is densely ignorant of mechanics."

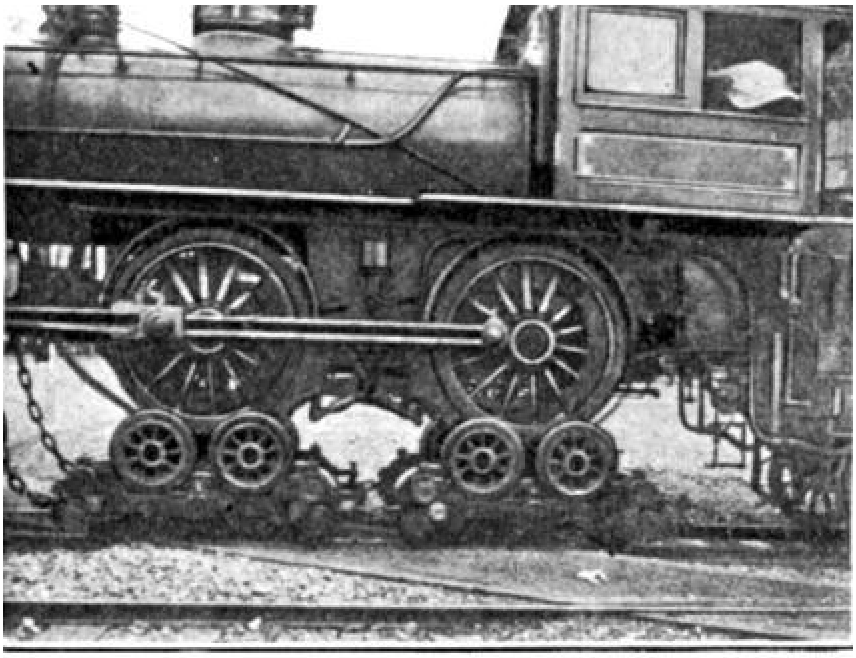

FIG. 12. HOLMAN LOCOMOTIVE.

Next notice in the same paper reads: "There appears to have been some method in the madness of the parties who got out the absurd Holman locomotive.

"They are advertising in Philadelphia papers that a company has been formed to sell this kind of locomotive, the capital stock being $10,000,000. They offer to sell the stock for $25 a share, the par value being $100. They make the claim that this sort of engine is destined to be the locomotive of the future."

Next notice, also in the same paper, reads: "The parties exploiting the Holman locomotive are advertising their stock in numerous newspapers, and claiming that the invention is certain to come rapidly into general use. The effect of that has been that numerous letters have come to us asking our opinion of the thing. We gave a general answer, the first paragraph of which reads:

"When we first heard of the Holman locomotive we supposed that it was the invention of some harmless crank who did not understand the elementary principles of mechanics, but we now believe that it has been, since its inception, an ostentatious machine designed to allure unwary capitalists into an investment which will be of the same real value as throwing gold coin over Niagara Falls."'

The engine was run a few trips on a straight railroad in New Jersey, which was used merely as a stimulant to stock selling. Unfortunately many people with limited savings were allured, into investing their hard earned money in this swindle, and they might as well have given it to a highway robber.

One painful case that was pushed to my attention will illustrate the danger of taking stock in things recommended by friends. Mrs. Marion French had sufficient money in United States bonds to produce her an income of $570 a year. Some idiotic friend advised her to invest in the Holman Locomotive Company's Stock, assuring her that she would more than double her income without risk. Our washerwoman never loses a chance to ask me when the Holman Locomotive Company will begin paying dividends.

The Austrian Duplex.

There is no question that destructive blows are imparted to the rail from the unbalanced weights of the driving wheels. Inventors were early in the field to eliminate this blow by an opposing force, and, incidentally, to make a smoother working engine. This idea brought forth in Europe the Haswell locomotive, shown in Fig. 13. That engine, which was built in 1861, at Vienna, for the Austrian State Railway, excited much attention at the International Exhibition of 1862, where it was exhibited. The engine had two cylinders on each side, the power from the pistons being transmitted to crank pins diametrically opposite to each other, the expectation being that the momentum of each set of reciprocating parts would balance the other set.

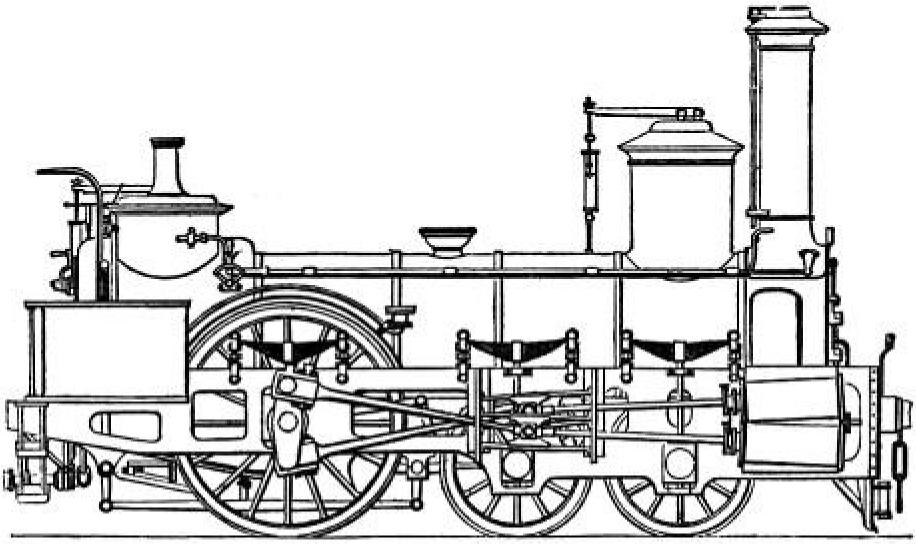

FIG. 13. "DUPLEX," AUSTRIA, 1861.

The "Duplex," as the engine was called, was very powerful for that day, the cylinders being 10-and-seven-eighths ins. in diameter, with stroke of 24-and-seven-eighths ins. The driving wheels were 81 ins. in diameter. There were 15 sq. ft. of grate area and the heating surface was 1,344 sq. ft. The designer of this engine expected that it could be run with absolute steadiness, at excessively high speed, and the reports made of its performance in train service justified the belief concerning steadiness, but the advantage gained was not considered of sufficient importance to justify the repetition of the experiment.

The railway world had not begun talking about the so-called "hammer blow" in 1862, but the unsteadiness of many locomotives at high speed made itself manifest and various schemes were resorted to for the purpose of remedying the defect which was largely due to bad counterbalancing of the driving wheels. The patent office records tell of many inventions being produced for making locomotives run steadier at high speed, but nothing of a permanent character has displaced counterbalance weights placed in the driving wheels. During the iron rail period considerable ingenuity was devoted to inventions calculated to reduce the wear of rails, due to impact of the wheels. It was supposed for years that a low center of gravity saved the rails from destructive shocks. Years of experience demonstrated that a low center of gravity tends to lead the wheels into imparting destructive side shocks to the rails, but that was an article of knowledge that came to the railway engineering fraternity by very slow degrees.

The Shaw Four-Cylinder Balanced Engine.

In 1881 there was built at the Hinkley Locomotive Works, Boston, a four-cylinder balanced engine, called the H. F. Shaw, Fig. 14, which was industriously exploited as being entirely free from the pounding and oscillating action of two cylinder locomotives. The locomotive was substantially the same as Haswell's Duplex, except that the cylinders were arranged side by side, transmitting the power to crank pins diametrically opposite each other. One of the crank pins connected outside the driving wheel at the same position an ordinary crank pin would be located, and carried a double crank, the middle of which was supported in a bearing secured in an outside frame. That bearing was the driving fulcrum, a main rod working at each side of it.

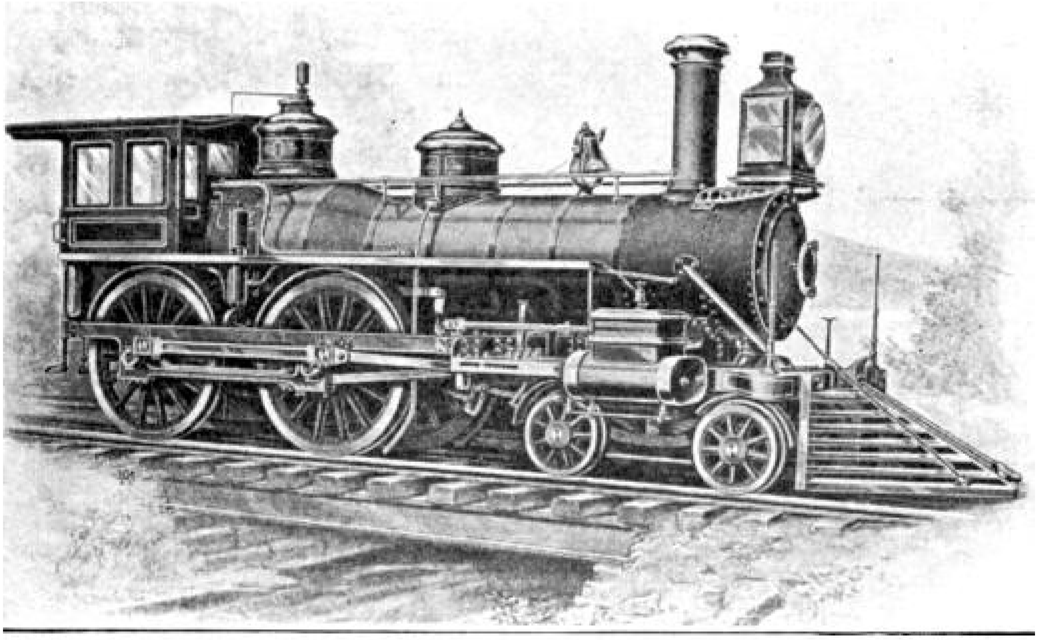

FIG. 14. SHAW FOUR-CYLINDER BALANCED LOCOMOTIVE.

The engine was equivalent to one with two cylinders 16 x 24 ins., and driving wheels 63 ins. in diameter. The weight in working order was 74,000 lbs., of which 25,600 lbs. was on the truck wheels. The boiler had 14.8 sq. ft. of grate area, and 981.75 sq. ft. of heating surface. The engine was well designed and built in first class manner. It was used to a considerable extent on train service in an experimental fashion, and worked quite satisfactorily. The advantages claimed for the Shaw were: Perfect balancing, an increase in the area of wearing surfaces, and, by dividing the work between four cylinders, reduction of wear and tear was accomplished, and, consequently, less risk of accident.

One claim read: "By utilizing all the force developed upon the piston directly upon the driving wheels to rotate them, the enormous loss through friction in ordinary locomotives is entirely avoided." The soundness of that claim is open to dispute and the other claims advanced are even more open to argument.

The Shaw did not languish unknown through want of advertising. A gentleman named William E. Lockwood had the exploiting of the invention at heart, and few railroad officials of any consequence failed to learn how the "hammer blow" could be entirely prevented.

Some of the locomotives designed with special view to securing low center of gravity are curious. Zerah Colburn was a sensible railway man, with a good practical training as a mechanical engineer, yet in 1854 he fell into the blunder of designing the absurdity shown in Fig. 15. That engine had a double boiler, 43 ins. diameter, arranged so that the driving axle was located between them. It involved the use of two fire boxes, besides two sets of tubes. The best that can be said about it is that it was a very courageous design, but it came to nothing.

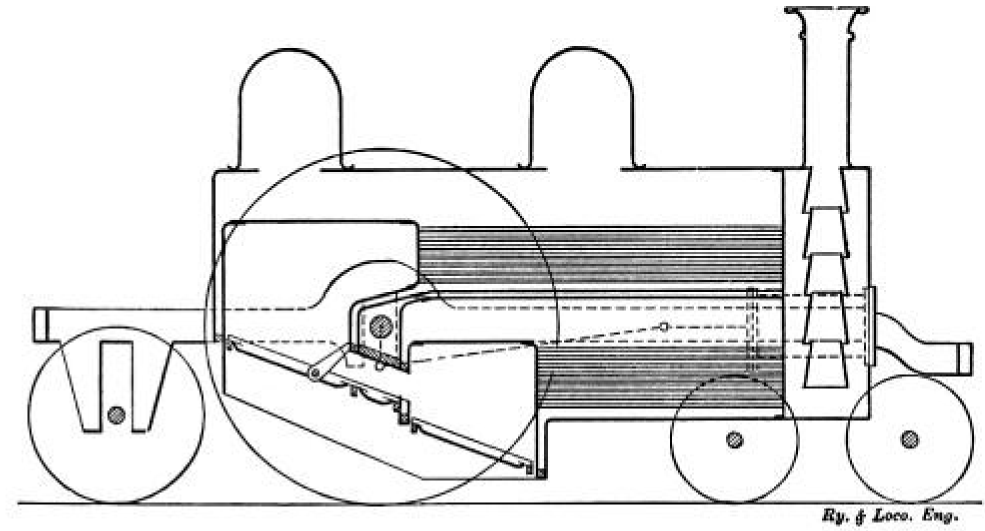

FIG. 15. COLBURN'S DESIGN OF LOCOMOTIVE DOUBLE BOILERS, WITH DRIVING AXLE BETWEEN.

The attempt to make big boilers with low centers of gravity is illustrated in Fig. 16, which shows Trevithick's "Cornwall" built in 1847. It was a very awkward arrangement and required a recess being made at the top of the boiler for the driving axle to pass through. In service it was found that the engine did not run any steadier than those with a much higher center of gravity did. The very low center of gravity is a fallacy so far as steady running is concerned, because when the wheel in its revolutions receives sharp blows due to inequalities the shock is delivered to the side of the rail. When the center of gravity is high, like what it is in our Wootten engines, the blow strikes more on the top of the rail than on the side.

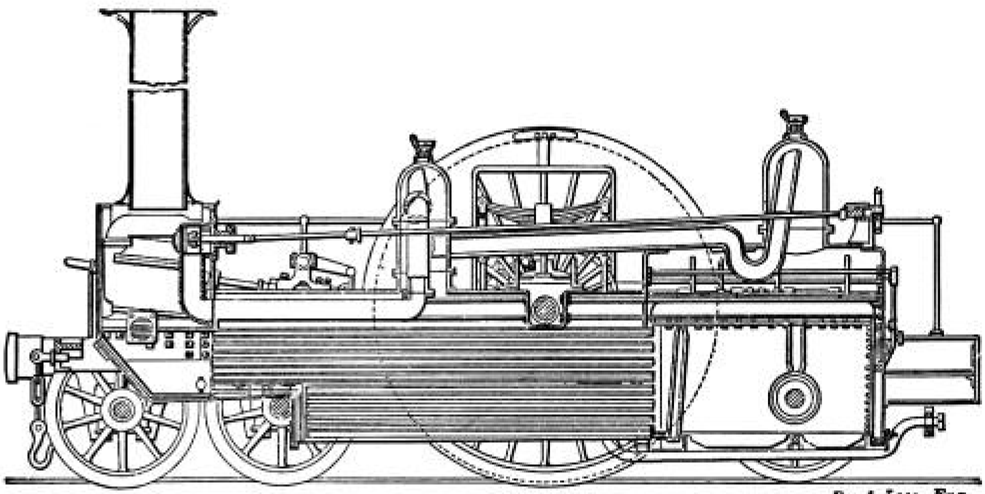

FIG. 16. TREVITHICK'S "CORNWALL," 1847.

One of the principal oddities appears to be Crampton's "Liverpool," which was built in 1848, and is illustrated in Fig. 17. It has a huge single pair of driving-wheels which was the Crampton peculiarity. The designer's idea of putting the driving wheels under the foot plate and the cylinders near the middle of the boiler was also the idea of getting a low center of gravity, and a comparatively big boiler. I had seen some experience with Crampton engines many years ago, and never saw anybody who had a good word to say about them, except those connected with the designing and building.

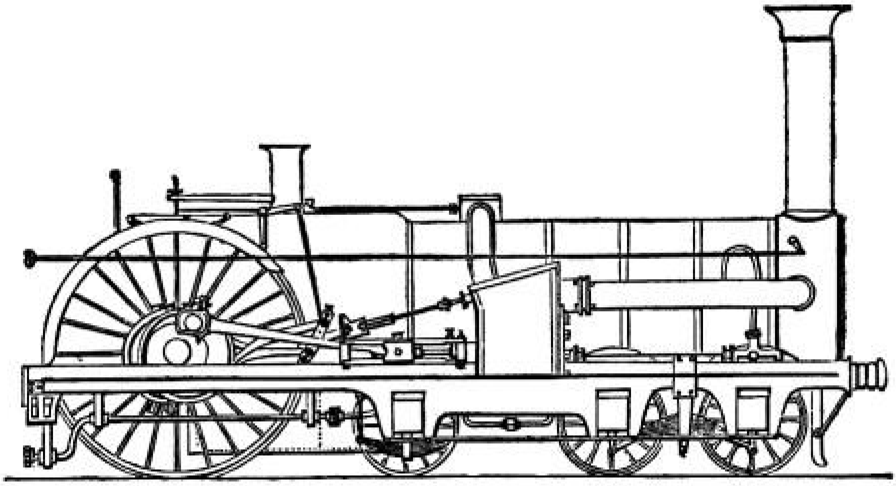

FIG. 17. CRAMPTON'S "LIVERPOOL."

Fig. 18 shows interesting specimen illustrating the attempt to introduce enormously large driving wheels in Blavier & Larpent's engine "L'Aigle," built in France, in 1855. The engine was exhibited in the Paris Exposition of that year, and attracted a great deal of attention, but never did acceptable work in service. It had cylinders 16½ by 22 in. stroke, and driving wheels 2.85 metres, equivalent to 9 ft. 4 ins. diameter.

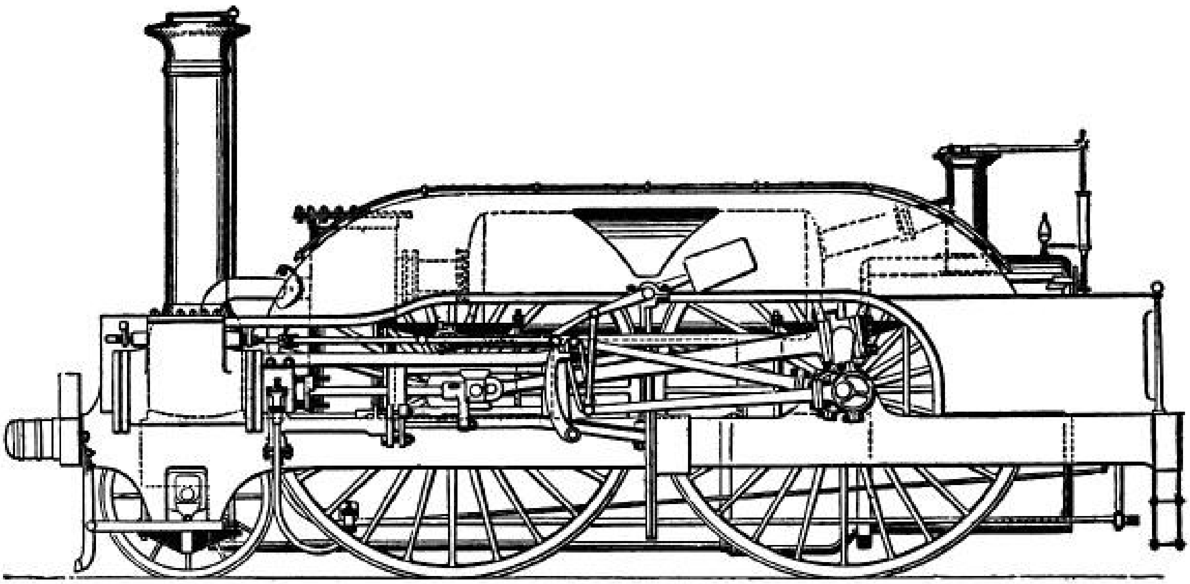

FIG. 18. MM. BLAVIER AND LARPENT'S ENGINE, "L'AIGLE," 1855.

Another engine built and designed to obviate the disturbing force due to the action of reciprocating is illustrated in Fig. 19 This engine was patented by Stephenson and Howe, in 1846. The cross section looks like Webb's famous compound, but it was a small engine, and was intended to prevent the nosing action so well known with badly counter-balanced, outside connected engines. The middle cylinder was 16-and-three-eighths by 18 ins., and the outside, 10½ by 22 ins. The engine in service did not act as the patentees expected it would, and the type was never repeated.

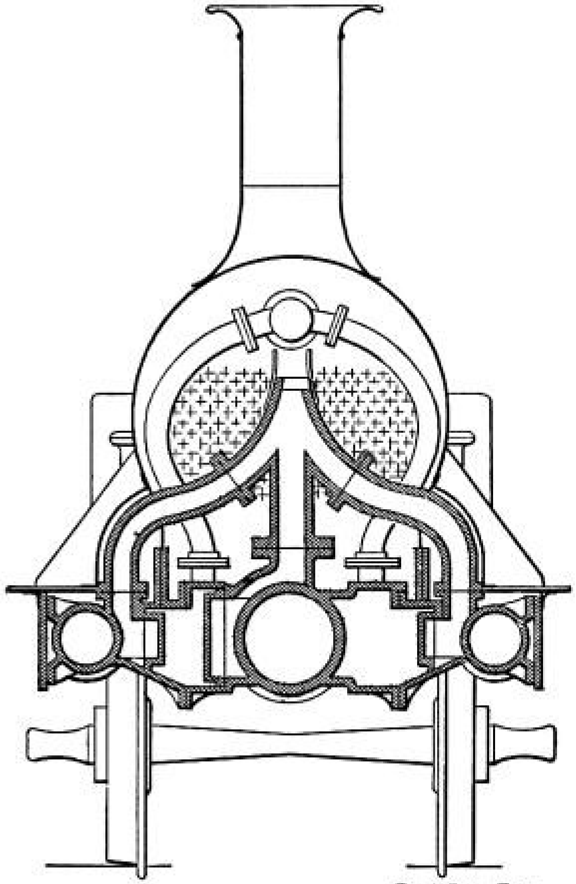

FIG. 19. STEPHENSON AND HOWE'S 3-CYLINDER ENGINE.

James Toleman's Four Cylinder Locomotive.

A most expensive sacrifice to good intentions was the "James Toleman," Fig. 20, another four cylinder locomotive, but decidedly different from the other two.

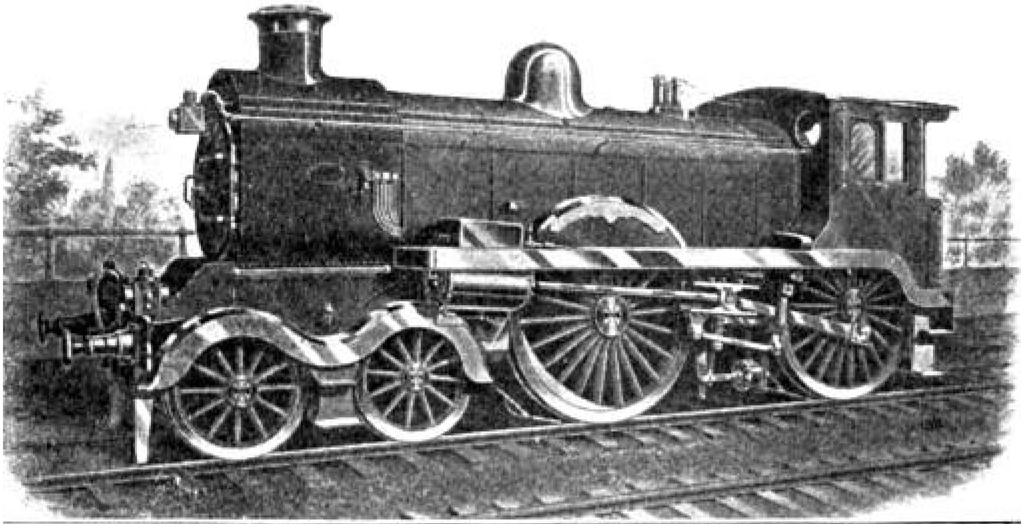

FIG. 20, THE "JAMES TOLEMAN," 1892.

The James Toleman was exhibited in 1893, at the World's Fair, in Chicago, and it evidently was expected to create something of a sensation in this country. The engine represented the ideas of an English engineer as to the best form of locomotive for handling heavy fast passenger trains. It was designed by a Mr. Winby, of London, and was built by Hawthorn, Lester & Co., Newcastle, England.

That the engine was radically different from the ordinary locomotive was apparent to the most casual observer; yet there were many novelties about the machine that could be found only after laborious examination. To obtain high speed and great power combined, two pairs of driving wheels, 90 ins. diameter, were employed, and each pair was driven by a pair of separate cylinders, the front drivers being driven by inside cylinders located under the smoke box, and the back drivers by outside cylinders set outside, back of the leading truck. The inside cylinders were 17 x 22 ins., and the outside cylinders 12½ x 24 ins. A striking point about the outside connections was the long piston rod necessary to reach the guides. The most commendable part of this engine was the arrangement that obviated the use of parallel rods. A shifting link motion was used for the inside cylinders and Joy's motion outside.

The boiler was one of the most curious features of this odd locomotive. To obtain as much heating surface as possible while maintaining a fairly low center of gravity, the boiler was made elliptical, narrowed in the middle of the horizontal diameter, so that it could be strengthened by cross braces.

A very serious objection occurred to me when I first examined the engine, which was the complication of parts and the difficulty that would be encountered in effecting repairs. I wrote:

"The designer appears to have had no consideration whatever of the fact that repairs would have to be done frequently to a locomotive pulling fast heavy trains. The engine is very handsome and displays admirable workmanship. It has large bearings and strong connections; but we would not like to have the duty of keeping a number of them in working order."

After the exhibition was over the James Toleman was put upon the Chicago, Milwaukee & St. Paul Railroad, to haul ten parlor cars, 82 miles in two hours. It failed very decidedly on that service, both from lack of steam and through breakage of parts.

<u>Fate of the James Toleman.</u>

Replying to a letter of inquiry which I sent, Mr. A. E. Manchester, superintendent of motive power of the Chicago, Milwaukee & St. Paul Railway, wrote:

"The engine 'James Toleman' was some seven years ago turned over to the Purdue University, La Fayette, Ind., as a museum feature, and I believe is still there.

"As to the performance of the engine on our road will say that we never got any practical results from it at all.

"In the first place the grate surface-and the size of the fire box were not equal to the demands on the boiler, and no adjustment of the front end or exhaust appliances was equal to Staking care of the demands on the boilers.

"You will remember that one of the features of this engine was that the flue sheet extended into the fire box. In other words, it was a combustion chamber reversed, and it was found in practice that all of the grate surface under this projecting portion of the cylinder part of the boiler would not burn the coal, consequently the grate surface was cut down to the limited amount that was between the end of the flue sheet and the back end of the fire box.

"The engine, as you no doubt remember, had four cylinders. The inside cylinders connected with a crank shaft to the front driving axle and was operated by a shifting link motion. The back cylinders were connected by a wrist pin to the back driving wheels and axles and were operated by a Joy valve motion. All of the cylinders drew their steam from one niggerhead and dry pipe, and the result of this was that whichever pair of cylinders, either inside or outside, took steam first, there was not enough went into the other cylinders to blow into the cylinder cocks, and it was only with a light throttle and moving slowly that all cylinders could be made to take steam at once. When but two of the cylinders were getting all the steam, the tractive power on that pair of wheels was not enough to take care of the work that the cylinders would develop, consequently the engine would stand and one pair of wheels would spin like a circular saw and the others would be doing nothing.

"Mr. Winby, who was the designer and owner of the engine, stayed with it, and had his mechanical engineer and a special engineer whom he brought from England with him for something like two months, until he became thoroughly disgusted and went off and left it. We have not had a word from him for a number of years. I think he has forgotten that he ever designed or owned the 'James Toleman.'"

French Favor Novelties.

France has given to the world a fair share of the freaks designed to send the ordinary forms of locomotives prematurely to the scrapheap, and, incidentally, to demonstrate what amateur designers could do in wandering away from well trodden paths of engineering rectitude.

Gallic sentiment leans kindly to things that look new.
"The earth was made so various that the mind
Of desultory man, studious of change,
And pleased with novelty might be indulged."

Heilmann Electric Locomotive.

The Western Railway of France experimented persistently in 1897 with electric locomotives, Fig. 21, which generated the electricity in driving it. This form of engine was invented by J. J. Heilmann, a Swiss engineer, residing in Paris. The first locomotive of that type tried was considered to work so satisfactory that two others, much more powerful than the first one, were made, one of them being the subject of illustration which was copied from the Railway World, of London. The body of the engine consisted of heavy steel girders which was carried by two eight wheel trucks. Above the rear part on the deck built upon the frames were placed the boiler and coal bunkers, while the principal steam engine, the two generation electric dynamos, the exciter with a special engine and the airbrake apparatus were carried above the leading truck.

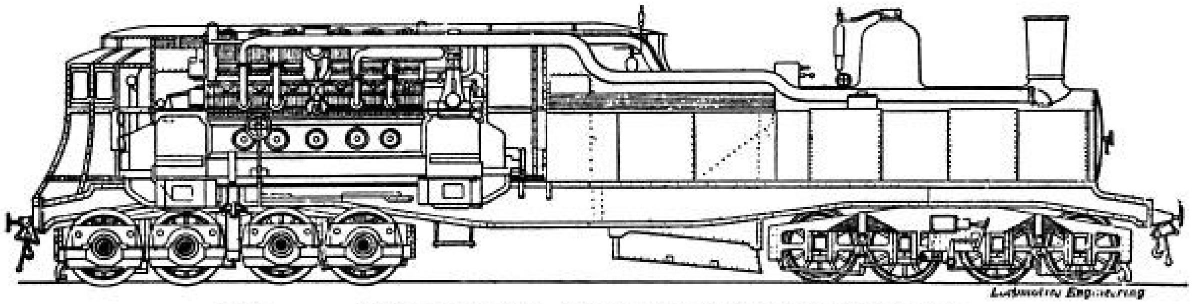

FIG. 21. HEILMANN ELECTRIC LOCOMOTIVE.

The boiler was of the locomotive Belpaire type, and provided 1,996.5 sq. ft. of heating surface. The grate area was 35.95 sq. ft. The boiler pressure carried was about 200 lbs. to the sq. in.

The engine was compound with six cranks set in a form that was reported to give perfect equilibrium. The engine drove two electric generators continuous current machines, independently excited. The current supplied by the generators was said to develop 125 horse power at 62 miles an hour. It was calculated that this locomotive would haul a train weighing 250 tons at the speed of 62 miles an hour, which seemed to me a small performance for the expense involved.

The Heilmann locomotive formed a spectacle to the people of Paris for only a few short months.

Thuile Locomotive.

Another expensive French novelty was the Thuile high-speed locomotive, exhibited at Paris in 1900 by Schneider & Co., of Crensot, France, and shown in Fig. 22. That engine was designed to haul trains from 180 to 200 tons, equal to about four Pullman cars, at 75 miles an hour on level roads, and was calculated to develop about 1,800 horse power.

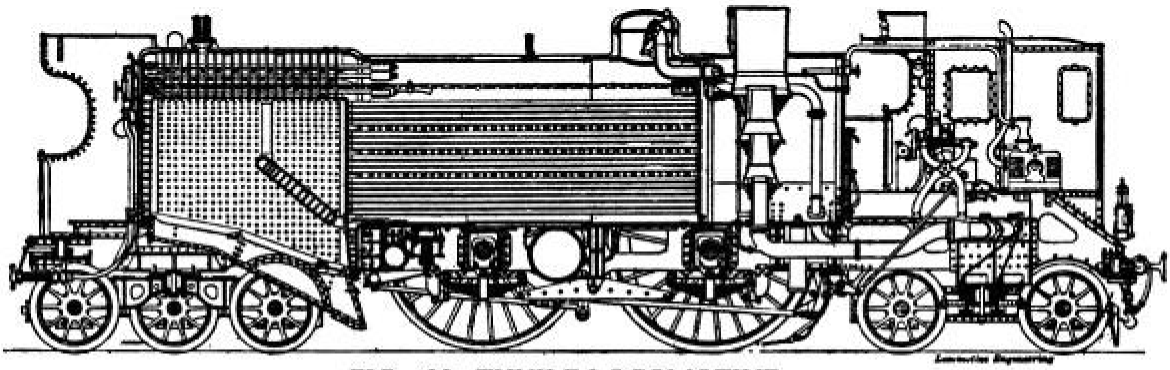

FIG. 22. THUILE LOCOMOTIVE.

There were four coupled wheels, a full truck at the front and a six-wheel truck under the back end, although the necessity for this was not apparent, as there were only 59,000 lbs. on this truck. This makes less than 10,000 lbs. on a wheel for this truck, and under 15,000 for a four-wheel truck, which would seem preferable to the extra pair of wheels.

The driving wheels carried only 65,000 lbs., or about 16,000 on a wheel—but little more than was carried by the trailing truck. The total weight of the engine in working order was about 165,000 lbs., and the tractive power 15,652 lbs.

The boiler was of a flattened section, as shown in Fig. 23, similar to the "James Toleman" boiler, to get it between the wheels, which were 8 ft. 2½ ins. diameter, and the method of cross-staying is shown in the sectional cut. The diameter of upper portion was about 54 ins., while the lower is 48.5 ins. The height was 79 ins. There were 183 ribbed tubes, 2¼ ins. in diameter and 14 ft. 3 ins. long, giving a heating surface of 2,941 sq. ft., which with 263 ft. in firebox gave a total of 3,204 sq. ft. The boiler pressure was 213 lbs. The grate area was very large for European practice, being a trifle over 50 sq. ft.

Cylinders were 20 x 27½ ins., and a Walschaerts valve gear was used. The total wheel base was 40 ft. 2 ins., and entire length of engine, 46 ft. The cab, which had a windsplitting attachment, was in front of the engine, while the fireman was at the rear over 46 ft. away.

The tender was also of peculiar design, having ten 42-in. wheels under it. The wheel base was 25 ft. 7 ins., and the tender weighed about 49,000 lbs., empty, and 121,000 in working order. It carried about 6,000 gallons of water and 7 tons of coal. I was indebted to Engineering, of London, for the data given.

I examined that locomotive very carefully at the Paris Exposition and discussed its peculiarities with some of the most eminent engineers who were visitors at the show. The following conclude notes which I wrote to my paper about the Thuile locomotive: "The engine shows traces of very careful designing and the construction work has been wonderfully well done. I listened to several well-known European engineers discussing the merits and shortcomings of the machine, and I certainly was surprised to find that the consensus of that opinion was favorable. The writer dislikes to be in the minority, but he has enjoyed many opportunities of passing judgment on so-called original types of locomotives that were going to push the common types out of service. He never made a mistake of judgment in telling that the ordinary original type of locomotive was a fake. He has now no hesitation in saying that the Thuile will fall into rank with the Fontaine, the Raub Central Power, the James Toleman and the Holman locomotives, which are all of amusing memory."

An Early Double Ender.

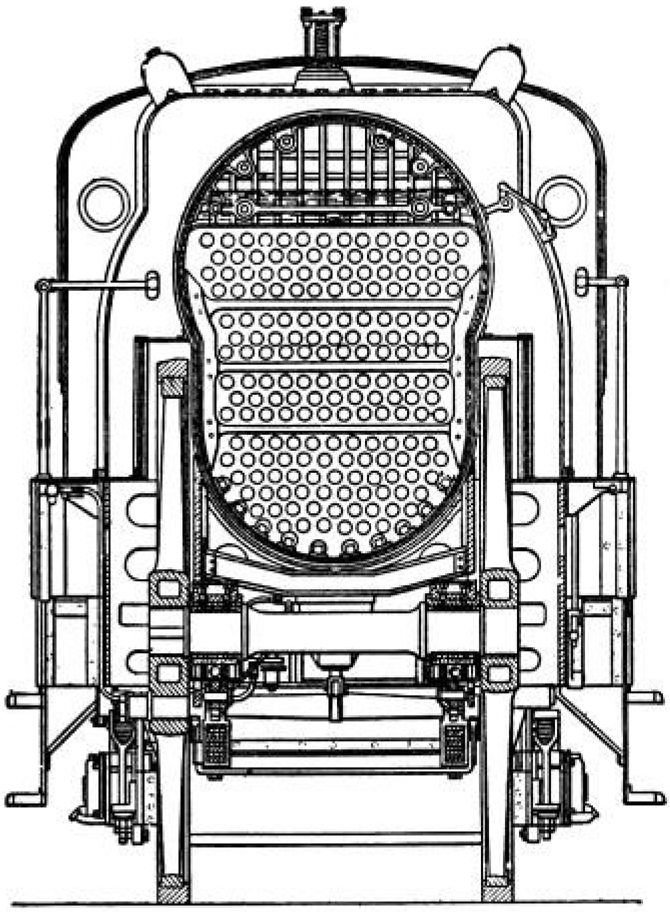

FIG. 23. SECTION OF BOILER OF THE THUILE LOCOMOTIVE.

The oddity shown in Fig. 24 was one of several locomotives built in 1862 by the Northern Railway of France. The best that can be said of this locomotive was a remark made on a ridiculous freak designed in the office of Locomotive Engineering, and called the Gilderfluke, as a take-off on idiotic designs of locomotives getting forced into notice. This engineer remarked, "the thing would move." As may be noted, this was one of the early double end locomotives.

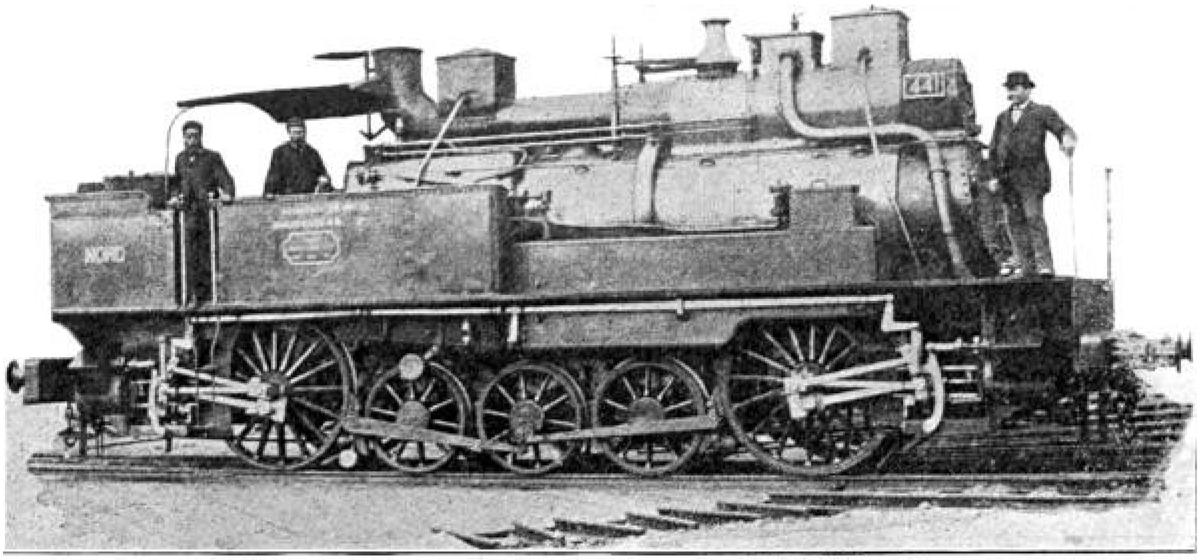

FIG. 24. A FRENCH EXPERIMENT IN 1862.

La Parisienne.

A remarkable freak that was to be seen in Paris in 1900 bore the above name. It had three pairs of driving wheels, 7 ft. diameter, coupled, and two pairs of wheels of the same size carried the tender. Its curious appearance was the only thing that made the Parisienne worthy of passing notice.

Johnstone's Double-Ended Compound.

A famous engineer once remarked to an inventor, who had presented an extraordinary complicated arrangement of mechanism as an improved valve motion, "You are suffering from abnormal inventive fertility." An engineer gifted with the inventive faculty is in danger of pushing his inventive fertility to a rank crop that is expensive to harvest. I have always thought it was some such inventing force that pushed F. W. Johnstone, mechanical superintendent of the Mexican Central Railway, to design the locomotive shown in Fig. 25, which was one of three built in 1892.

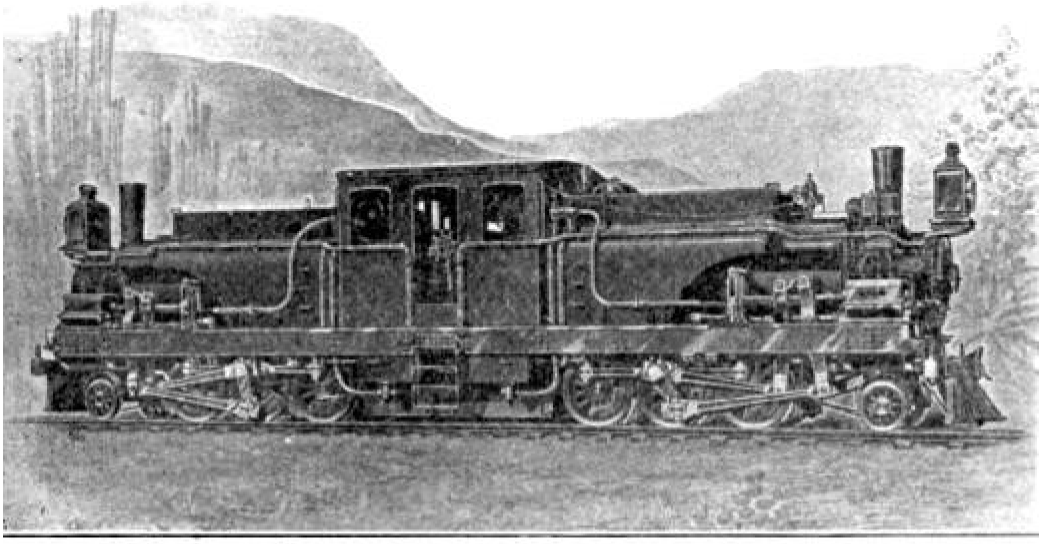

FIG. 25. JOHNSTONE'S DOUBLE-END COMPOUNDS.

The engine, as will be readily understood, was a most extraordinary form of a locomotive. It looks like two Mogul—2-6-0—locomotives fastened cab to cab; but it is structurally a good deal more than that. The reputed purpose of this odd type of engine was to provide an extraordinarily powerful flexible motor for climbing the steep mountain grades of the Mexican Central Railway, the flexibility being sufficient to go round very sharp curves with the least possible frictional resistance. The flexibility was obtained by securing the driving wheels in a truck, which was free to move in a line different from that followed by the main frames. In the Mason bogie engines, the driving wheels were grouped in a flexible truck which carried the cylinders. In the Johnstone engine, the cylinders and boiler were carried on the main frames, separate from the driving wheel truck

As the cylinders were not in line with the driving wheels in passing curves, it was necessary that a special method of transmitting the power from the cylinders should be employed. This was done in a very ingenious way through levers that transmitted the power and at the same time compensated for the varying distances between pistons and crank, due to the swivelling of the driving wheels. Without the compensating arrangement it would have been necessary to give the engine so much cylinder clearance that the loss of steam would have been very great. The power transmitting levers are seen in the back of the cylinders, connected at the top by a short link and the bottom ends pinned to the front end of the main rods. There were two of the latter, one connecting with a crank pin, the other with a return crank.

The piston transmitted motion to the back one of the two levers, and that gave motion to the front lever, which was fulcrumed securely to the frame near its centre.

The engines were compound, with annular cylinders, the high pressure cylinder being in the centre and the low pressure cylinder forming the outside concentric ring. The high pressure cylinder was 13 ins. diameter, and the low pressure 28 ins. The stroke was 24 ins. It was calculated that each pair of cylinders would develop power equal to a 19 x 24 in. simple engine.

That cylinder arrangement violated the principles relating to the conservation of heat, for the comparatively cold, low pressure steam encircling the high pressure cylinder would be certain to exert condensing effects upon the steam in the high pressure cylinder. Even in the hands of their friends it was difficult to keep the engines at work, and after a few years of unsatisfactory service they were changed to accepted forms.

An Original Form of Contractor's Locomotive.

Among the minor sacrifices to good intentions that were called locomotives w a s that shown in Fig. 26. This was the first product of the Pittsburgh Locomotive Works, and was built by Thatcher Perkins, engineer and superintendent of the company, for the contractor of a narrow gauge coal road near Pittsburgh named Bausman. The workmen called it "Bausman's Rhinoceros."

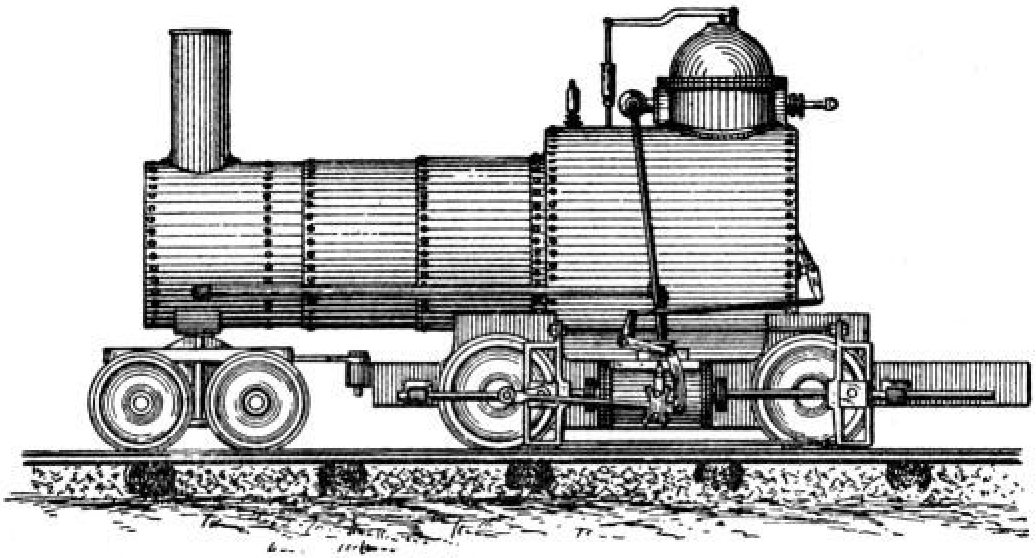

FIG. 26. PITTSBURGH SLOTTED CROSSHEAD LOCOMOTIVE.

The curious thing about the engine was that it had no main or side rods, the piston rods extending out on both ends of the cylinders and connected to slotted cross heads, fitted with sliding blocks, in which the crank pins worked. The valve gear was of the Carmichael type.

The Oldest Curiousity.

During the Diamond jubilee of the late Queen Victoria, when all London was decorated with flags, streamers and emblems, the headquarters of one of the well known cricket clubs in that city had among their decorations the words, "Well played; 60, not out." The old engine which we illustrate in Fig. 27 is still at work, and the North .Eastern Railway of England might well say of it, as the cricketers did of the Queen, "Well played; 84, not out."

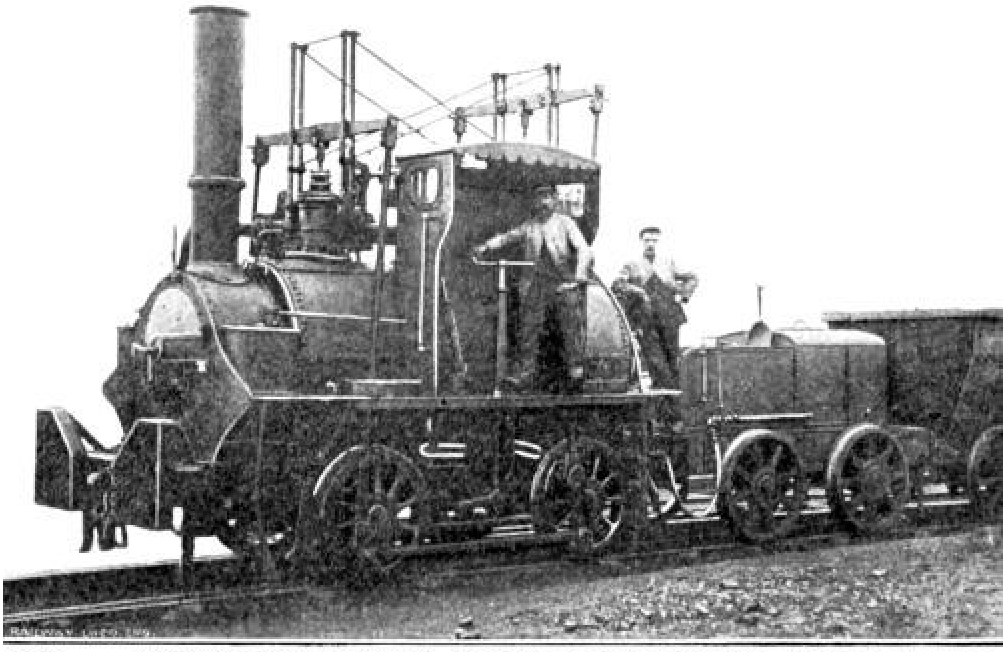

FIG. 27. OLDEST LOCOMOTIVE IN THE WORLD, DAILY UNDER STEAM.

We are indebted to Mr. Wilson Worsdell, chief mechanical engineer of the North Eastern of England, for the photograph, diagrams and information concerning this remarkable engine. Mr. Worsdell is of the opinion that it is the oldest locomotive in the world that is daily under steam, for it was built in 1822 and is now regularly used as part of the motive power equipment in the collieries of Sir Lindsay Wood, who is one of the directors of the North Eastern Railway. The collieries are situated in the county of Durham, at a place called Hetton-le-Hole, in England. The engine has vertical cylinders 10¼ inches in diameter and 24 inch stroke, with cross arms instead of cross heads working in upright guides which are braced diagonally from the top of one to the bottom of the other. The cylinders rest directly on the shell of the boiler, which is not covered with any lagging. There is a small cab on one side, in which the "driver" is evidently allowed to sit down. The halftone illustration shows him with his hand on the brake apparatus. This is a form used a good deal in the British Isles, and is an upright shaft placed in a hollow stand. The shaft has a screw thread cut on the lower end, upon which a nut works. The nut has two trunnions on either side, which take the place of a pin in a lever. The nut can be run up or down the shaft, according to the way the handle is turned, and the nut, although moving the end of a lever, always remains parallel to itself. The familiar "life guards" are to be seen in front of the leading wheels. These are the vertical metal bars which reach from the buffer beam to very nearly the rail level. They are used throughout the British Isles and on the continent at the present day. The sand box is seen comfortably nestling against the side of the smoke box on the running board level.

The line engraving, Fig. 28, shows the valve gear at A as it was originally built. The motion which actuated the valve was obtained from a cam working in a square box. This motion was conveyed through connecting links and rods to a lever fixed above the steam chest. The valve worked in a box on the side of the cylinder. The reverse motion was obtained by the driver withdrawing bolt C and moving the rod to the other end of lever and replacing the bolt at point marked E. This had to be done separately for each of the cylinders.

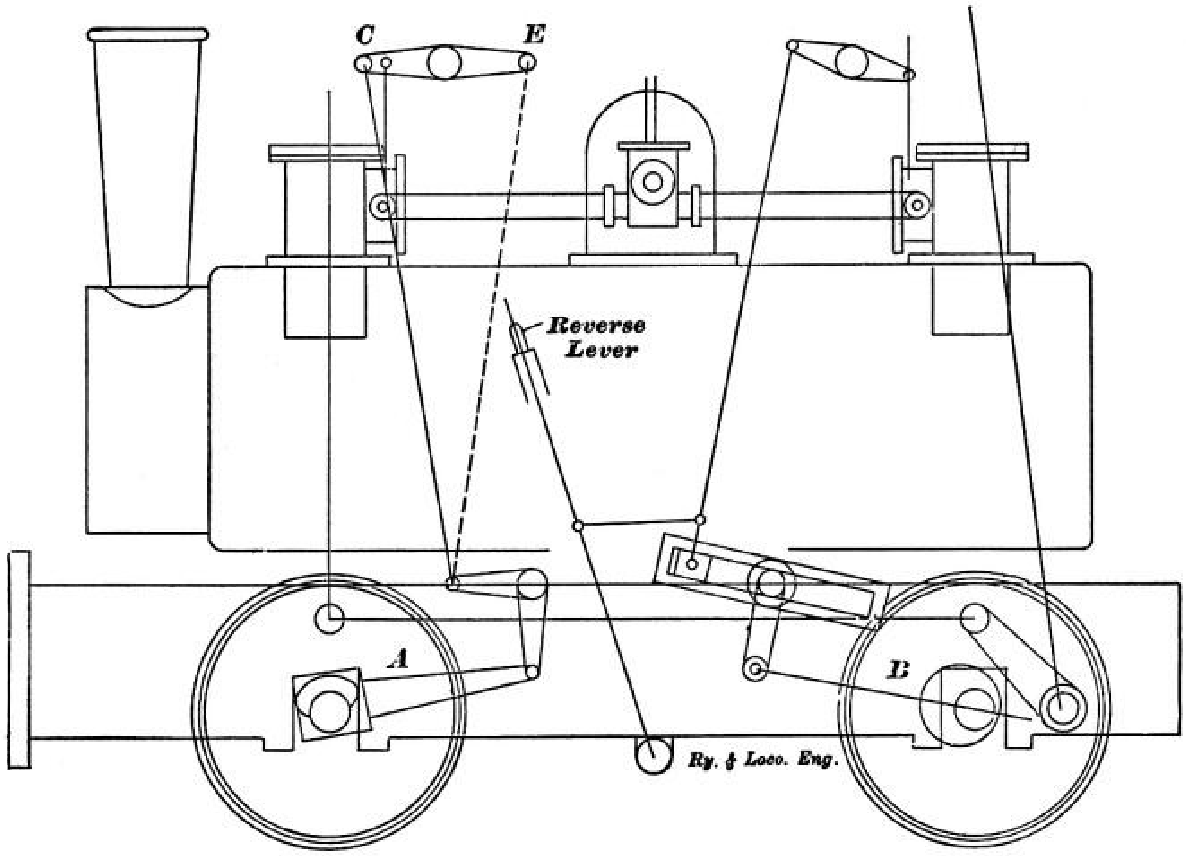

FIG. 28. ORIGINAL VALVE MOTION.

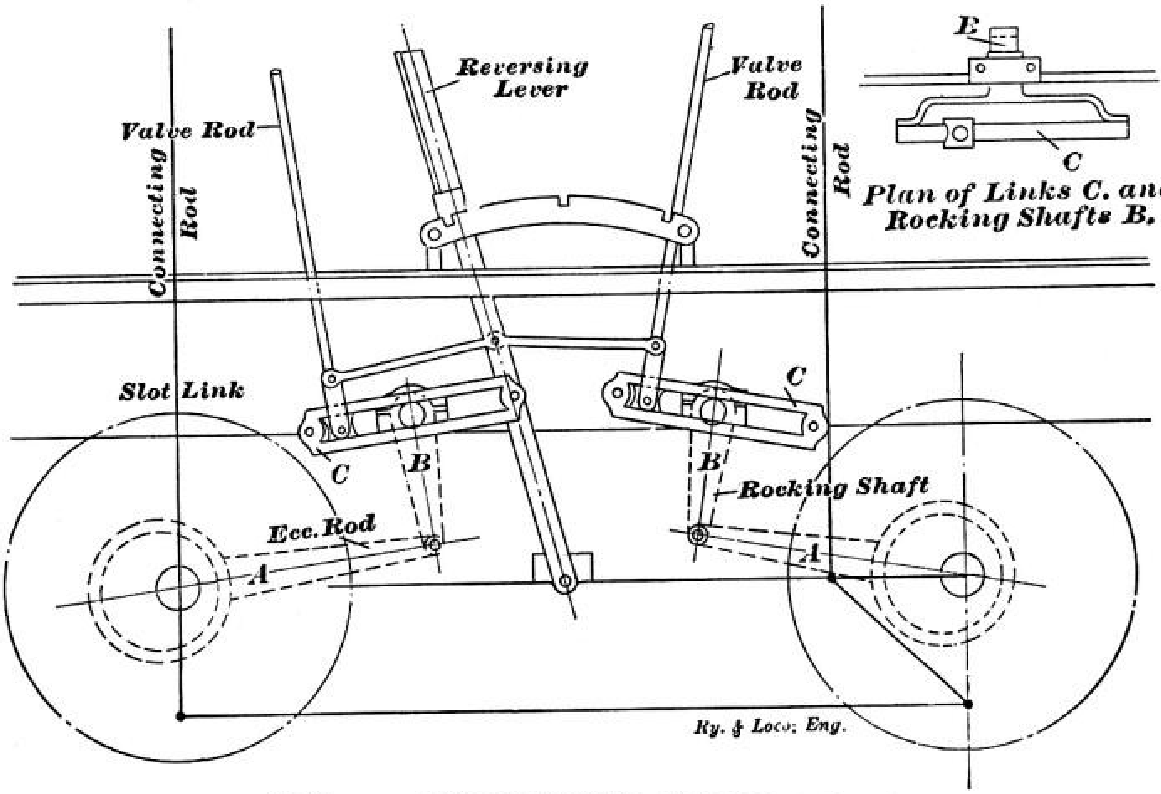

FIG. 29. MODERNIZED VALVE MOTION.

About the year 1880 the old arrangement was altered. An eccentric sheave was fixed on the axle instead of the cam, and the motion was conveyed through a link, as shown at B. This arrangement is more clearly shown in Fig. 29. The reversing lever was so fixed so as to shift the link block in the link. The halftone illustration exhibits this arrangement also, but the adjacent ends of the links and the bottom of the reverse lever and its fulcrum are hidden behind a metal plate.

According to our modern rule, the engine has a calculated tractive effort of about 4,700 pounds.

Oscillating Cylinder Locomotives.

Oscillating cylinders were in great repute, for steam engines for a few years, especially for marine power, and claims were persistently made that an oscillating engine would transmit more power to the crank pin than any other. Those favoring that kind of engine held that it had no dead center to speak of and that the leverage was correspondingly great.

FIG. 30. ENGINE WITH OSCILLATING CYLINDER AND NO VALVE GEAR.

A locomotive might not be regarded as a good subject for the application of oscillating cylinders, yet that has been done successfully and Dewey Bros., Goldsboro, N. C., are making such locomotives for logging railroads, one of them being shown in Fig. 30. As will be observed, the piston rods are coupled direct to the crank pin. The engine is reversed by means of a four-way cock which changes the steam pipe into an exhaust pipe and vice versa. The cylinders oscillate on a trunnion which passes through the middle casting. This trunnion passes through a coil spring which pulls the cylinder up against the saddle, allowing it to oscillate and yet make a tight joint. No valve gear is necessary.