Introduction

HISTORICAL SKETCH OF THE MOTOR CARRIAGE

THE history of mechanical road locomotion offers very little encouragement to those who are entering upon it now. The conditions have, however, changed in three very important particulars.

British achievement sixty years ago

Firstly, the railways, which absorbed all the attention and all the capital which the country could give to locomotion and to transport questions, and thus robbed the successes of Hancock, Gurney, Dance, Summers and Ogle, Maceroni and Squire, Hills, Russell, Church, Redmund, and others, of all the support which was required to establish steam locomotion on common roads, have now ceased to make material extensions either in length, means of distribution, or to be the most attractive means of investment. The railway trains, moreover, ran on private property, not the roads on which everybody was free to make demands and cause obstructions, or over which the baneful prejudice of bucolic magistracy had power, which the cyclist has lessened. This was a great advantage in favour of railway development.

Past and present influences, conditions, and laws

Secondly, the far-reaching influences and beneficial results of mechanical engineering have again so far commanded a sympathetic ear in our House of Commons, that the laws for the suppression of mechanical road transport have been repealed. This, however, was not done until other countries, through their freedom from restriction in this respect, had begun the building of a great industry from which our manufacturers were excluded. The laws which covered us with ridicule, and which placed a heavy tax on one of the first necessities to national prosperity, namely, cheap transport and intercommunication, were of comparatively recent origin. In the days when Hancock ran his service of steam coaches between the City, Islington, Paddington, and between the City and Stratford, they did not exist, and were only partially represented by the arbitrarily applied turnpike laws, under which the toll farmers were permitted to multiply the ordinary charges for four-horse coaches by from five to twelve against the steam coach. Between Prescot and Liverpool the 4*s*. coach toll became £2 8*s*. 0*d*.; on the Bathgate road the 5*s*. toll became £1 7*s*. 1*d*.; between Ashburnham and Totnes the 3*s*. toll

Turnpike laws

became £2. The opposition in some parts of the country to the introduction of the new mode of locomotion thus imposed a very heavy tax; but this would soon afterwards have been made impossible, for in 1831 a Select Committee reported to the Houses of Parliament completely in favour of steam coaches and the reduction in tolls. Moreover, the Government, in 1833, introduced a clause into a bill then passing through Parliament, which exempted steam coaches from the operation of the Hackney Carriage Act. This was done to relieve steam carriage invention during its infancy, and like several other acts of the Government of the time, showed that there was as much, if not more, enlightened consideration and appreciation of the importance of the benefits derivable from mechanical road transport than there was in the twenty years preceding 1896.

Enlightened government attitude in 1833

Modern mechanical and material advantages

Thirdly, a most potent change has arisen from the all-pervading extension of mechanical appliances, namely, the general use of machine tools of variety and precision. These make accurate work not only possible, but cheap also, as compared with the means of 1830. From this has been derived the practical possibility and commercial advantages of the high-speed engines of modern times. These things have multiplied many times the power of a pound of metal in the form of a motor, for in prime movers, such as steam, gas, and oil engines, rotative speed is power, and at the stroke of a pen one horse has become two, three, four, or more. Hence the steam engine, which in 1830 required large and valuable space in the body of a coach, can now be put into a small box on the fore-carriage, or under a seat, or slung out of sight under the frame.

Present conditions and use of experience of the past

These three great changes have then placed the designers, makers and users of mechanical road vehicles under very different conditions from those under which Hancock worked during his twelve years of experiments from 1824 to 1836. The designer of to-day has the advantage of superior materials, superior appliances, and of considerable knowledge of the results of the costly experience of those who have gone before.

Against all this, however, has to be set the greater excellence which must now be attained and offered, as compared with that which would have commanded success in 1830, before the railways had accomplished so much in reducing the cost and increasing the facility of travel and transport. It must be remembered too that a knowledge of the results of the work of others is a small contribution to the means of successful achievement, as compared with the possession of the experience which led to those results. By experiment, by much trial and error, this experience has to be regained to reach and appreciate that which was achieved when those of bygone days left off, and to enable us to start on the improvements they would next have made.

To have before us, however, even the forms of the vehicles made nearly three-quarters of a century ago, is a great help, and these, with some knowledge of their reasons and results, will place those who patiently study them in a position of advantage, which may be easily under estimated.

Select Committee Report of 1831

From this point of view it is a matter for regret that the records of the work done then, are of so fragmentary a character, and that were it not for the full report of the Select Parliamentary Committee of 1831, many doubts might arise as to the reality of the actual achievements. Remarkable as these were, however, it is clear that at the end of all the enterprise of the time, none of the designers, even including Hancock, would have claimed to have reached more than those good results and practical experience, which were indispensable for their guidance in future, to produce commercially satisfactory self-propelled carriages. In this book it is not intended to deal at length with the history of the steam coaches, to which reference has been made. For much of this history reference may be made to the author's *Cantor Lectures*, published by the Society of Arts, in 1896; to his paper on "Developments of Motor Carriages," read before the Society of Arts, 27th November, 1896; to his papers on the same subject, read in March, 1896, before the Manchester Association of Engineers, and to the Cleveland Institution of Engineers, published in the *Automotor*, No. 7, p. 250, April, 1897; to his lectures to Liverpool branch of the Self-Propelled Traffic Association (now the Liverpool branch of the Automobile Club), published in the *Auto Car*, 12th September, 1896, p. 550, and *Automotor and Horseless Vehicle Journal*, No. 5, p. 196; No. 15, December, 1897, p. 105; No. 7. April, 1897, p. 250; and in the *Engineering Magazine* for September and for December, 1897, and January, 1900; in *Industries and Iron*, from December, 1896, to December, 1898. A description of Cugnot's locomotive will be found in the *Proceedings of the Inst. of Mechanical Engineers*, for 1853. Particular reference will only be made to the most instructive result; to those of vehicles which gave England the credit of originating practical road locomotion.

Chapter I

DESIGN, CONSTRUCTION AND WORKING OF EARLY STEAM ROAD VEHICLES

Hancock's early work

WALTER Hancock's work undoubtedly claims most attention. Hancock was born early in 1799, and died in May, 1852. He began by making a steam engine with two inflating and deflating india-rubber "cylinders," conceived the idea of applying it to a steam coach, found it would not do, and then, having had his thoughts turned to steam road locomotion showed that his knowledge of what others had done was not lost upon him, by first directing his efforts to the production of a suitable boiler.

Those who had preceded him, though only by a few years, and were cotemporary with him, were many in number,[1] and many companies were formed to make steam carriages, and run regular services with them. Only three, however, seem to have run carriages or coaches for hire, namely: Gurney, whose coaches were worked by Sir Charles Dance for four months between Gloucester and Cheltenham; Hancock, who established the services already mentioned; and Scott Russell, who established a service between Glasgow and Paisley.

Hancock's boilers, 1827-33

Hancock first made a boiler, consisting of sixteen horizontal tubes, 4½ in. diam. and 4 ft. in length, connected together by small pipes, and a receiver, which acted also as a separator. The numerous pipe connections he found troublesome. He tried the same form of boiler with vertical main tubes, with a central smoke tube, 2 in. diam., through them, leaving a

[1] For an outline of the work done by many to whom reference cannot be made here, the reader may consult "Mechanical Road Carriages," *Cantor Lectures*, Society of Arts, 1896. *A Comprehensive Bibliography of Power Locomotion on Highways*, by Rhys Jenkins, should also be referred to for a complete index to the literature of this subject from the earliest times to 1896.

The first working road locomotive ever made, was undoubtedly that of a Frenchman, Nicholas Joseph Cugnot, in 1769. It was a three-wheeled vehicle, the front steering wheel carrying boiler and engine, the latter being a double cylinder high pressure, and actuating the driving wheel by two ratchet wheels and pawls with radius links, which were moved by direct connection with the piston rods. The vehicle was actually run on more than one occasion, and still exists in Paris; but it need hardly be said that it in no way led to either rail or road locomotion, any more than did the experimental carriage of Moore, of Leeds, in 1769, or so much as that of Murdoch in 1784.

smaller water capacity and increasing the heating surface. The numerous pipe connections were, however, equally undesirable, and hence his invention of the flat, narrow water-chamber boiler, illustrated by Fig. 1. This he patented first in 1837, and in the improved form shown, in 1833, the water-tube boiler being patented in 1825.

When first made, the flat water chambers of the 1827 boiler were separated by thin vertical iron bars, between which were numerous passages for the products of combustion. The steam pressure in the flat chambers or envelopes caused the thin sheet metal of which they were

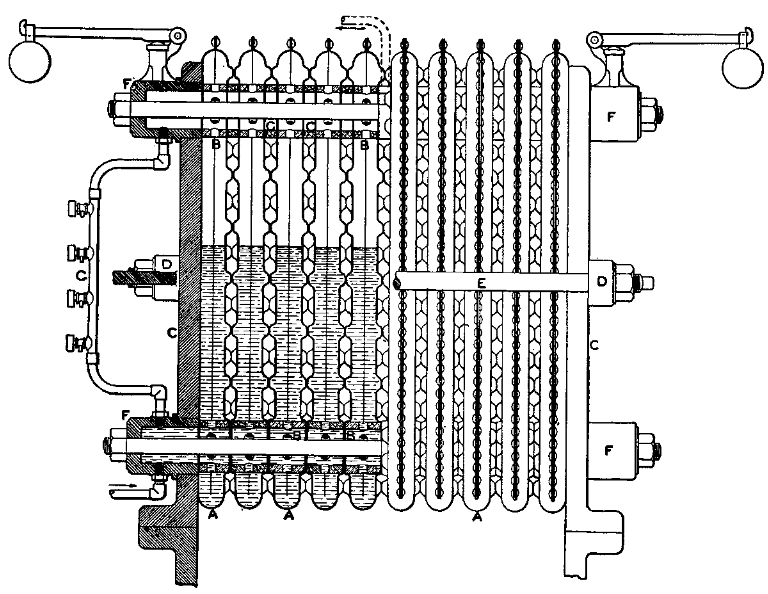

FIG. 1.—HANCOCK'S BOILER, 1833.

made, to bulge out between each bar, thus converting them into corrugated side plates. The bars thus became less necessary, the summits of the corrugations when brought together made the plates mutually supporting, and left spaces for the passage of the hot products of combustion.

Hancock's most approved method of construction arose out of this result. It was that shown, in which the sheet forming the two side sheets of the chambers were embossed by hammering the metal into nearly hemispherical cavities made in a flat cast-iron mould for the purpose. One half the sheet was done at one fixing, and the sheet, when finished and bent round at A to the thin bag form, had similar bosses on either side to rest against the bosses of its neighbour.

The vertical edges of the bags were made up with a thin outwardly flanged rivetted-in plate, as seen at Fig. 3, or the side sheets were pinched together and rivetted, as shown at the right hand of Fig. 1. In the centre of the lower and upper part of these bags large holes were made for the passage through them of large stay bolts, perforated distance rings B, being placed inside the chambers at these holes and plain rings C, between the chambers. These chambers were placed between end plates C C, as seen at Fig. 1, which were pulled up together tightly by the upper and lower central tie bolts E, the pressure from which was carried by the distance rings, between which and the sheets were thin copper rings for making joint. The ring distance-pieces constituted a water communication between all the chambers, and to them, by the perforated rings and the upper series of rings, similarly formed a steam communication and receiver. In some cases the outside distance rings were dispensed with by outwardly embossing the sheets, as shown at the lower left-hand corner of Fig. 1. The end plates were also supported by two exterior bolts and buck stays. Safety valve fittings were fixed in the upper distance rings or on a continuation F, of the trunk pipe formed by them, as shown in Fig. 1. A pipe connection was made, as shown between the water trunk and the steam trunk, and on it were four well made test valves for ascertaining the water level in the boiler.

This boiler seems to have been an excellent steam maker and did not prime. The tubular boiler, like most of the boilers of the time, gave a good deal of trouble in this respect, even with the separator referred to. The large flat surfaces and freedom of the steam separation from the water in the chambers contributed to this. The use of a very small steam pipe connection at the boiler also helped to prevent priming.

Very few particulars as to the dimensions of these boilers can now be found. The steam pressure ordinarily carried by Hancock was 70 lb. per square inch, but he appears to have varied the pressure as circumstances, in the form of hills, loads, and bad roads, demanded, and used any pressure up to 200 lb., and over that.

As an example of these boilers, as used in the *Automaton* coach, the following approximate dimensions may be given:—

Eleven chambers of about 30 in. by 20 in. by 2 in. in thickness, and of $\frac{1}{8}$ in. charcoal plate. The heating surface of this would be about 85 sq. ft., and the grate surface about 6 sq. ft., but the heating surface of one of the boilers is given as 100 sq. ft. The engines used in the same coach had two cylinders of 9 in. diameter and 12 in. stroke, and ran at the same speed as the road wheels. These were 4 ft. in diameter, and at ten miles per hour would make about 70 revolutions per minute. The engines may therefore be taken as what they were stated to be nominally, namely, from 14 to 20 horse power, according to the pressure used and the speed.

This would for a mean power give about 5 sq. ft. of heating surface per average effective horse power, and about 0·3 sq. ft. of grate surface.

The numerous journeys on an 8-mile stage, which one of these coaches ran, gave opportunities for taking water and fuel measurements. By sorting down the evidence on this subject I find that the boiler evaporated as much as 10 lb. of water at ordinary temperatures per pound of coke, and very little was done to heat the water on its way to the boiler. The boiler seems to have evaporated 8 lb. of water per square foot of heating surface per hour, and about 130 lb. per square foot of grate under forced draught of the fan.[1]

In some of Hancock's boilers the fire was directly under the boiler chambers, as in Fig. 1, but in others, which he preferred, it was placed to one side, as shown by Fig. 2. This arrangement constituted in a measure a gas furnace, and was probably an effective mode of converting a little of the exhaust steam into a water gas.

The whole of the exhaust steam seems to have been diverted into the case below the boiler at A, most of it passing upward through the space B

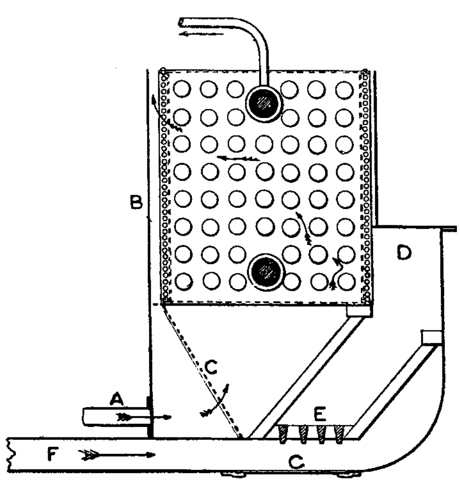

FIG. 2.—HANCOCK'S BOILER, FURNACE, AND AIR ADMISSION.

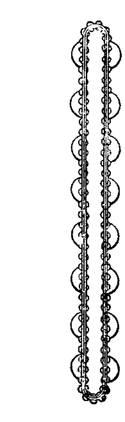

FIG. 3.—END OF ONE ELEMENT OF BOILER.

to the chimney, and being heated and dried on its way. Some of it passed through E and the finely perforated plate C, and was used as above mentioned.

The fuel was fed into the hopper D, and fell automatically into place as the coke was consumed below. The ashes were removed during the journey by shaking the bars E, which were cast in one piece. The two outer bars were provided with a rack underneath and a pinion geared into this for removing them end on through a hole in the side of the furnace case. As one set of bars was removed for cleaning, a second one was hauled in by a hooked end on the set hauled out. The hot set was left at a stopping-place on the out journey and taken up cold on the return. The main object of this arrangement was to reduce the difficulty in removing clinkers, a difficulty which used often to necessitate stops on the road.

[1] See papers by the author in *Proceedings of the Manchester Association of Engineers*, and in *Proceedings of the Cleveland Institute of Engineers*, March, 1897.

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Excerpt
More information

Forced draught

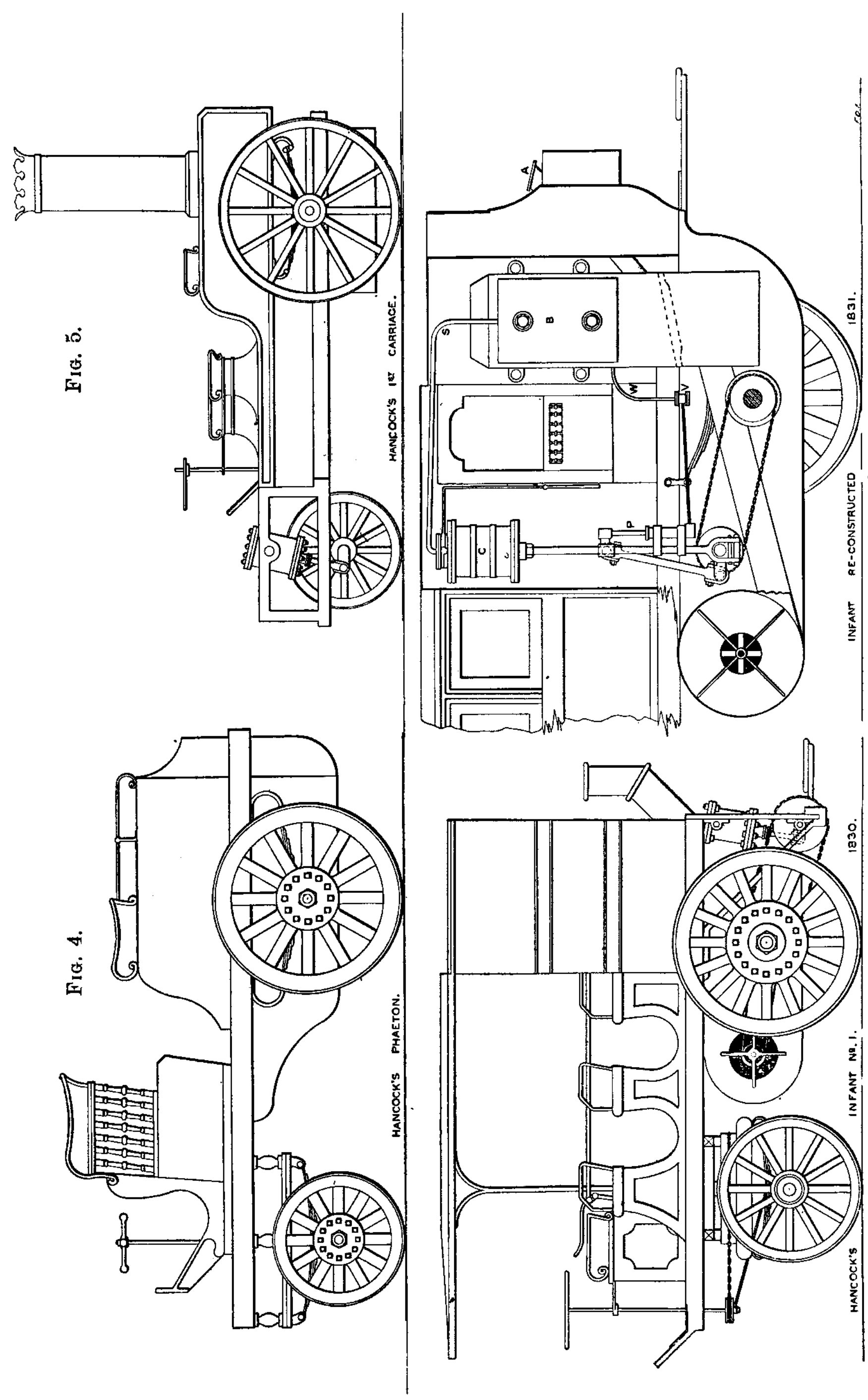
Hancock used forced draught in all his carriages, the air being sent by a fan through a flat air trunk into the space under the bars, as indicated in the engraving of the reconstructed *Infant*, Fig. 7, and in Fig. 2, where the air trunk is marked F. At the bottom of the latter was a sliding door G, through which the ashes and the whole of the fire could be dropped.

Hancock's first carriages 1828

Hancock made nine carriages, the first being the experimental carriage shown in outline by Fig. 5, on the top right hand of the page. This, like many of those by experimenters during the half-century following Hancock's endeavours, was a three-wheeled vehicle, the front wheel being the driver, driven by a pair of direct-acting oscillating cylinders, wheel and engine being carried in a frame jointed to part of the main frame for steering purposes. The outline engraving gives a sufficient idea of its arrangement. After running a few hundreds of miles its disadvantages led to a new design. Hancock has told very little of what these disadvantages were, but the springless foregear, the jointed steam connection, the heaviness of the mass to be moved in steering, and the small carrying capacity and incompleteness of arrangements for adjustment, were probably the chief. The new carriage which arose out of this was the *Infant*, which is shown in outline in Fig. 6. In this the engines were of the same type, but were fixed in a rear framing, and drove the wheels by means of an ordinary link chain. This vehicle, named the *Infant*, was a great advance, as it provided more seating accommodation, gave better steerage control, and inaugurated independent engines and chain gearing. The greatest difficulty is said to have arisen from the causes which are affecting many of our most recent carriages. He found that ashes, dust, and mud did not conduce to the longevity of piston rods, bearings and gearing, nor did these parts run quite so sweetly as when not buried in more or less effective abradents. What Hancock records is: "The difficulty of keeping the machinery clean, owing to its proximity to the fire place, as well as to the road, was found in practice to be so strong an objection that this form of carriage had also to be abandoned."

Hancock's second "Infant," 1830-31

This *Infant* was then rebuilt, or more correctly another *Infant* was built. As shown by Fig. 7, it was a much larger vehicle; the fore-carriage was the same, but in all other respects it was a different carriage. Vertical engines were employed, placed in a space near the centre of the coach. Behind this space was room for the engine attendant, and at the rear was the boiler, which was stoked by a fireman standing on a rear platform. The main axle was driven, as in the first *Infant*, by ordinary cable chain, the chain wheels on crankshaft and driving axle, being apparently of the same size, but this does not seem to have been the case on all the coaches. A feed pump was worked from the crosshead of each engine, and an adjustable radius rod at each end of the crankshaft maintained the proper distance between that shaft and the main axle. The adjustment was probably used to take up wear of the chain. This carriage ran to Brighton and back twice.



Figs. 5, 6 and 7.—Hancock's First Carriage, the "Infants," and (Fig. 4) his Phaeton.

Hancock's "Era," 1832

Hancock's next vehicle was the *Era*, a still larger vehicle, with a double coach body in front, in place of the chars-a-banc of the *Infant*. The arrangement of the engine, gear and boiler seems to have been the same. This coach did a great deal of work. It was completed in 1832. Its boiler was made with chambers of about $\frac{1}{8}$ in. thick, instead of about $\frac{1}{24}$ in., which was tried and failed in the *Infant*. It was intended to run the coach between London and Greenwich, but the "London and Brighton Steam Carriage Company," for which it was built, never got into working order.

A London and Paddington Steam Carriage Company was started in 1832, and Hancock's next carriage, the *Enterprise*, was built to its order. The only noteworthy accident with any of these coaches occurred with this one. The engine attendant had fastened the safety valve lever down with copper wire, and had started the engines and blower while the coach was standing. The effect of the forced draught was that intended, but the steam not being used as fast as made, nor free to escape at the safety valve, it got out elsewhere, and at the inquest which followed, the evidence was more complimentary to the boiler than to its attendant. The real weight of Hancock's carriages may be judged from a statement in p. 83 of his narrative, to the effect that the *Era* and *Autopsy* together, in working order, weighed not less than 7 tons.

Hancock's later "Autopsy," 1833

Hancock next built the *Autopsy*, Fig. 8, which he completed in the autumn of 1833, and ran to Brighton with it, and afterwards ran it daily for twenty-four weeks for hire between Finsbury Square and Pentonville. In 1834 he built, in three months, a steam drag for a purchaser in Vienna.

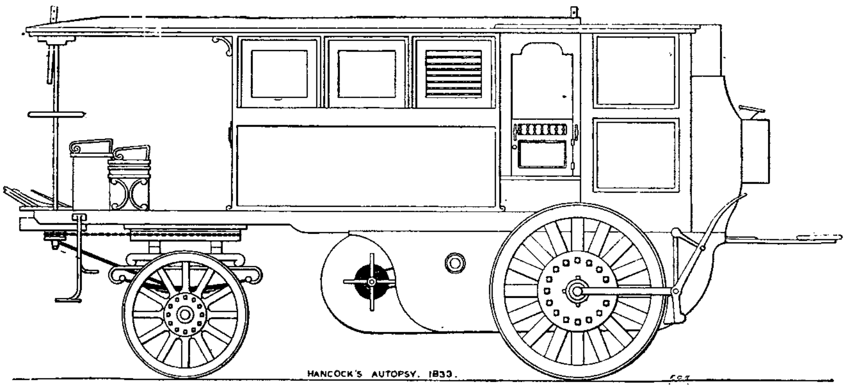


FIG. 8.—HANCOCK'S STEAM COACH "AUTOPSY," 1833.

This would carry six passengers, and driver and stoker, and haul a carriage carrying eight persons. This vehicle, as well as the *Autopsy*, had the same arrangement of machinery as that of the second *Infant*. It never went to Vienna, the purchaser first having ordered a carriage, then ordered its