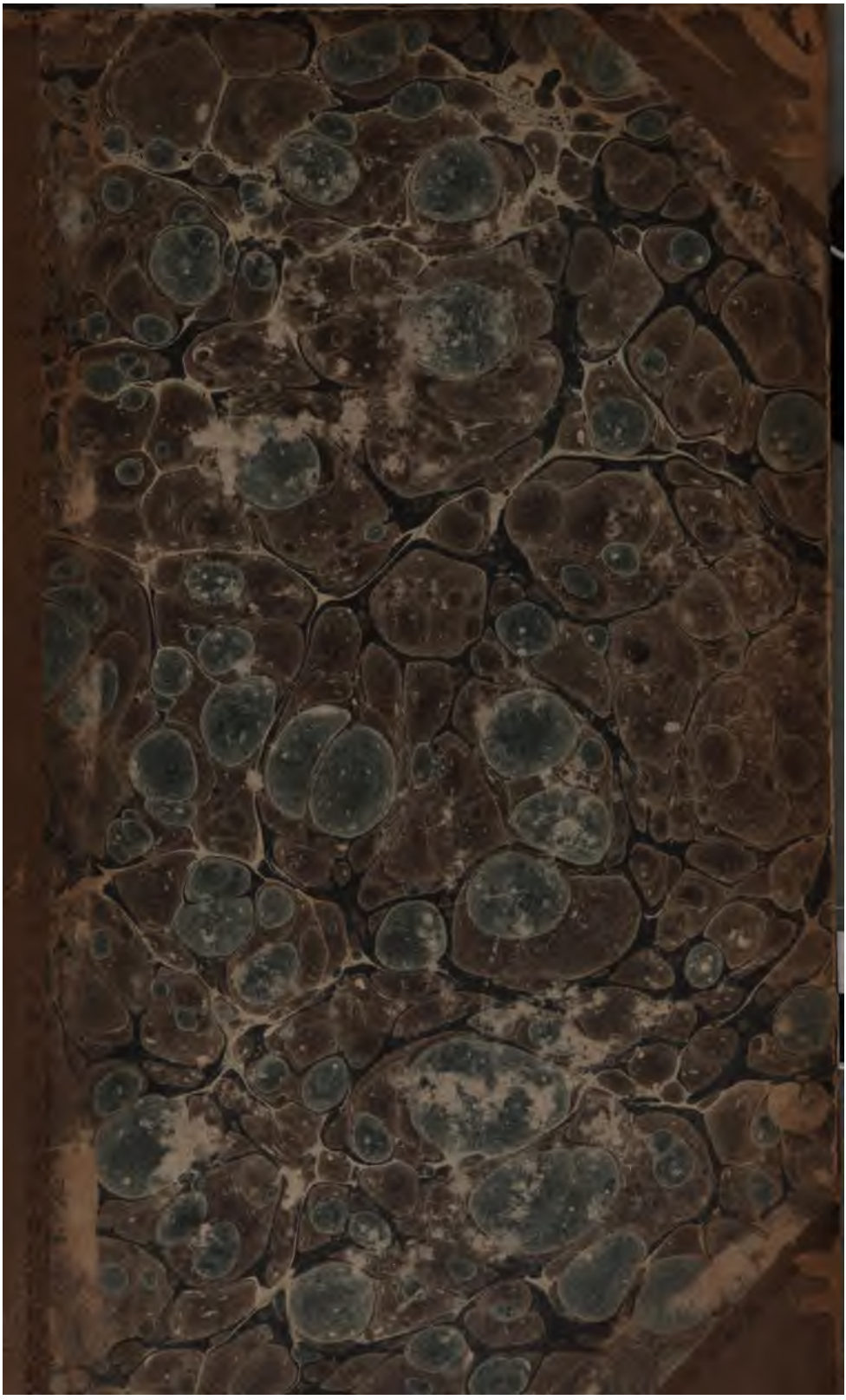

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AN ESSAY

ON

WHEEL CARRIAGES;

CONTAINING

A CONCISE VIEW OF THEIR ORIGIN,

AND A DESCRIPTION OF THE VARIETY NOW IN USE;

WITH

COMPARATIVE OBSERVATIONS ON THE SAFETY OF THOSE UPON TWO AND FOUR WHEELS,

AND

REMARKS ON THE DANGEROUS CONSTRUCTION OF

THE PRESENT STAGE COACHES.

TO WHICH ARE ADDED,

OBSERVATIONS ON THE MECHANICAL POWER AND OPERATION OF WHEELS, &c. &c.

BY T. FULLER,

COACH BUILDER, BATH;

INVENTOR OF THE PATENT SHAFTS FOR TWO-WHEEL CARRIAGES, AND THE PATENT LOCKING FOR THOSE WITH FOUR.

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1828.

PART IV.

PREFACE.

It is some time since any book on wheel carriages has appeared before the public; unless a posthumous work of Dr. Kitchener's may be said to form an exception, in which light it can scarcely be considered, as what is said therein on the subject appears more directed to the economy of keeping, than to a description of the various forms and uses of these vehicles.

The object of the following pages will be to convey a knowledge of the construction and most useful appropriation of the variety of carriages now in use. The reader must not expect elegant language; the author's literary acquirements are too limited. Fortunately for him, the subject does not require it: if the meaning is rendered clear and comprehensive, the more simple the better.

It may be useful to remark, that the various drawings of carriages are made to a correct scale of a quarter of an inch to a foot. A nearly accurate idea may be therefore formed, with the assistance of a common pair of dividers, and reference to the scale at the foot of each plate, of the height of the wheels, distance apart, and many other particulars which it may be desirable to know.

BATH, *Jan.* 15. 1828.

OBSERVATIONS

ON

WHEEL CARRIAGES.

PART I.

OF THE ORIGIN OF CARRIAGES. — ANTIQUITY OF CHARIOTS. — VARIOUS DESCRIPTIONS OF WAR CHARIOTS. — COACHES, THEIR EARLY USE IN FRANCE AND GERMANY: WHEN INTRODUCED INTO ENGLAND. — FIRST EMPLOYMENT OF HACKNEY COACHES, &c. &c.

WHEEL CARRIAGES in general signify all kinds of machines furnished with wheels; either for drawing great weights, or as vehicles for the uses of business or pleasure. It is intended in the following pages to describe those designed for the latter purposes only. Any attempt to trace the origin of wheel carriages would be difficult, if not impossible; as we find them mentioned in the earliest writings under the definitive name of chariots. In the 14th chapter

of the Book of Exodus, 1491 years before Christ, we read, "The Lord troubled the host of the Egyptians, and took off their chariot wheels, that they drave them heavily." — Homer, who flourished (according to some historians) 900 years B. C., makes frequent mention of war-chariots when speaking of his heroes. Mythology also has attributed a chariot drawn by four horses to the sun. Chariot races also appear to have formed part of the sports of the ancient Olympic games. But the chief employment of chariots by the ancients was for the purposes of war; and we find them called by several names, according to the number of persons they were designed to carry.

The most common were those which carried two men, who were probably the warrior and the charioteer; and we read of several men of note and valour employed in driving the chariot.

When the warriors came to encounter in close fight, they alighted out of their chariots, and fought on foot; but when they were weary, which often happened, by reason of their armour, they retired into their chariots, and from thence annoyed their enemies with darts and missive weapons. It appears that these chariots were made so strong that they lasted for several generations.

Besides this sort we find mention of chariots armed with hooks and scythes, with which whole ranks of soldiers were cut off together, if they had not the art of avoiding the danger. These were not only used by the Persians, Syrians, Egyptians, &c., but we find them among the ancient Britons; and notwithstanding the imperfect state of some of the most necessary arts among that nation before the invasion of the Romans, it is certain that they had war-chariots in great abundance. By the Greek and Roman historians these chariots are described by the six following names: *viz.* Benna, Petoritum, Currus or Currus Covinus, Essedum, and Rheda. The Benna seems to have been a chariot designed rather for travelling than war; it contained two persons, who were called *combennones*, from their sitting together in the same machine. The Petoritum seems to have been a larger kind of chariot than the Benna, and is thought to have derived its name from the British word *pedwar*, signifying *four;* this kind of carriage having four wheels. The Currus or Carrus was the common cart or waggon. This kind of chariot was used by the ancient Britons in time of peace for the purposes of agriculture and merchandise, and in time of war for carrying their baggage and wives and children, who commonly followed the armies of all the Celtic

nations. The Covinus was a war-chariot, and a very terrible instrument of destruction; being armed with sharp scythes and hooks for cutting and tearing all who were so unfortunate as to come within its reach. This kind of chariot was made very slight, and had few or no men in it besides the charioteer; being designed to drive with great force and rapidity, and to do execution chiefly with its hooks and scythes. The Essedum and Rheda were also war-chariots, probably of a larger size, and stronger made than the Covinus, designed for containing a charioteer for driving it, and one or two warriors for fighting. The far greatest number of the British war-chariots seem to have been of this kind. These chariots, as already observed, were to be found in great numbers among the Britons; insomuch that Cæsar relates, that Cassibelanus, after dismissing all his other forces, retained no fewer than 4000 of these war-chariots about his person. The same author relates, that, by continual experience, they had at last arrived at such perfection in the management of their chariots, that, "In the most steep and "difficult places they could stop their horses "upon full stretch, turn them which way they "pleased, run along the pole, rest on the har-"ness, and throw themselves back into their "chariots with incredible dexterity."

The Roman triumphal chariot was generally made of ivory, round like a tower, or rather of a cylindrical figure, upon two wheels; it was sometimes gilt at the top, and ornamented with crowns; and to represent a victory more naturally, they used to stain it with blood. It was usually drawn by four white horses, but oftentimes by lions, tigers, bears, leopards, dogs, &c. Drawings of these vehicles have not been preserved; but from what we have been enabled to judge from gems and antique impressions, there must have been another description of carriage used by the Romans, to which was attached an arched covering, that was sometimes hung with costly materials; and covered carriages seem to have become more and more appendages of Roman pomp and magnificence. But the manner of conducting war under the feudal system appears to have banished the use of them for some time. As it was of the greatest importance to the feudal lords that their vassals should be able to serve on horseback, they could not think of indulging them with covered carriages. They foresaw by such luxury the nobility would give over riding on horseback, and become much more indolent and less fit for military service. In proof of this, in the year 1588, Duke Julius of Brunswick published an order, couched in very expressive terms, by which his vassals were

forbid to ride in carriages. This curious document is thus given by Beckmann in his History of Inventions, article Coaches:

" As we know from ancient historians, from " the annals of heroic, honourable, and glorious " achievements, and even by our own experience, " that the respectable, steady, courageous, and " spirited Germans were, heretofore, so much " celebrated among all nations, on account of " their manly virtue, sincerity, boldness, honesty, " and resolution, that their assistance was " courted in war, and that, in particular, the " people of this land, by their discipline and " intrepidity, both within and without the king- " dom, acquired so much celebrity, that foreign " nations readily united with them; we have " for some time past found, with great pain " and uneasiness, that their useful discipline " and skill in riding, in our electorate, county, " and lordship, have not only visibly declined, " but have been almost lost (and no doubt other " electors and princes have experienced the " same among their nobility); and as the prin- " cipal cause of this is, that our vassals, servants, " and kinsmen, without distinction, young and " old, have dared to give themselves up to in- " dolence and to riding in coaches, and that " few of them provide themselves with well- " equipped riding horses, and with skilful ex-

" perienced servants, and boys acquainted with " the roads: not being able to suffer any " longer this neglect, and being desirous to re- " vive the ancient Brunswick mode of riding, " handed down and bequeathed to us by our " forefathers, we hereby will and command, that " all and each of our before-mentioned vassals, " servants, and kinsmen, of whatever rank or " condition, shall always keep in readiness as " many riding horses as they are obliged to " serve us with by their fief or alliance; and " shall have in their service able, experienced " servants acquainted with the roads; and that " they shall have as many horses as possible, " with polished steel furniture, and with saddles " proper for carrying the necessary arms and " accoutrements, so that they may appear with " them when necessity requires. We also will " and command our before-mentioned vassals " and servants to take notice, that when we " order them to assemble, either all together, " or in part, in times of turbulence, or to receive " their fiefs, or when on other occasions they " visit our court, they shall not travel or appear " in coaches, but on their riding horses," &c.

Philip II. duke of Pomerania-Stettin, reminded his vassals also, in 1608, that they ought not to make so much use of carriages as of horses. All these orders and admonitions, however, were of

no avail, and coaches became common all over Germany.

Carriages appear to have been used very early in France. An ordinance of Philip the Fair issued in 1294 for suppressing luxury, and in which citizens' wives were forbid to use carriages, is still preserved; but we find no further mention of carriages until the year 1474, when the emperor Frederic III. came to Francfort in a close carriage, from which time we find frequent mention of carriages having been used in Germany and France under the name of coaches; some of which were very magnificent. — Henry IV. of France was assassinated in his coach in the streets of Paris by the monster Ravaillac on the 14th of May 1610.

Coaches were not known in England until the year 1580, when, according to Stowe, they were introduced from Germany, by Fitz-Allen, Earl of Arundel. In the year 1598, when the English ambassador came to Scotland, he had a coach with him. Anderson places the period when coaches began to be in common use about the year 1605. The celebrated Duke of Buckingham was the first person who rode in a coach drawn by six horses, in the year 1619. To ridicule this new pomp, the Earl of Northumberland put eight horses to his carriage. Stow also makes mention of an older sort of carriage, used

by the ladies in England towards the end of the fourteenth century, under the now forgotten name of *whirlicotes*. When Richard II. was obliged to fly before his rebellious subjects, he and his followers were on horseback; his mother only, who was indisposed, rode in a carriage. This, however, became afterwards somewhat unfashionable, when that monarch's queen, Ann, the daughter of the emperor Charles IV., showed the English ladies how gracefully and conveniently she could ride on a side-saddle. Whirlicotes were, therefore, disused. But as coaches were known before this period in France, it is probable the carriage here spoken of is of the same description; and that alluded to, as introduced by the Earl of Arundel in 1580, might have been of more improved construction, which may account for Stow fixing the introduction of coaches into England at this period.

Authors differ as to whom are owing the invention of coaches. The name being now adopted, with little variation, in all languages, some have though to determine the question by the etymology of the word, which is said to be of Hungarian extraction, and derived from Kotsee, the name of a village in the province of Weiselburg. But, allowing the origin of the word to be correct, we are by no means certain what kind of a carriage we ought to understand

by it; and if under the name of coach was comprehended all covered carriages, the invention appears rather to be due to the French.

We are the more ignorant on this subject as few drawings or paintings of these machines have been handed down to us. We cannot even discover who first suggested the idea of suspending the body of the carriage from elastic springs: this was a great improvement, and probably a carriage with a suspended body is the coach mentioned by Stow as introduced in the year 1580, which may account for the circumstance of their so soon after becoming common; as the jolting of a carriage without such an advantage must have been very severe over the rude roads of that period, and it is no wonder the ladies preferred the more comfortable mode of riding on the side-saddle.

It also appears, that this improvement was not known in France until about the same period, as a French author has given three figures of carriages used in the reign of Henry IV., from drawings preserved in the king's library. Professor Beckmann, who relates this, observes, that these coaches were not suspended by leather straps, that they had a canopy supported by ornamented pillars, and that the whole body was surrounded by curtains of stuff or leather which could be drawn up.

It is therefore probable the merit of the invention of springs and braces is due to Hungary or Germany, and was from thence introduced into France about the same period as we infer from Stow it was brought to England.

Coaches appear to have been built very splendidly in Germany, as we read, that the wedding-carriage of the first wife of the Emperor Leopold cost, together with the harness, 38,000 florins. The coaches used by that emperor have been thus described: "In the imperial coaches "no great magnificence was to be seen; they "were covered over with red cloth and black "nails. The harness was black, and in the "whole work there was no gold. The pannels "were of glass, and on this account they were "called the imperial glass coaches (and hence "the term of glass coaches, at one time so ge-"nerally used in England). On festivals the "harness was ornamented with silk fringes. "The imperial coaches were distinguished only "by their having leather traces; but the ladies "in the imperial suite were obliged to be "contented with carriages, the traces of which "were made of ropes."

But this plainness in such equipages does not appear to have been general, and we are told that, at the magnificent court of Duke Ernest Augustus, at Hanover, there were, in the year

1681, fifty *gilt* coaches drawn with six horses each. So early did Hanover begin to surpass other cities in the number of its carriages.

We are informed, in Anderson's History of Commerce, that coaches to be let for hire were first established in London during the year 1625. At that time there were only twenty, which did not stand in the streets, but at the principal inns. Ten years after, however, they were become so numerous, that Charles I. found it necessary to issue an order for limiting their number.

In the year 1637, there were in London and Westminster fifty hackney-coaches, for each of which no more than twelve horses were to be kept. In the year 1652, their number had increased to two hundred; in 1654, there were three hundred, for which six hundred horses were employed; in 1694, they were limited to seven hundred, and in 1715, to eight hundred, since which they have been considerably augmented, besides the addition of hackney-chariots and cabriolets.

The situation of the coachman in England is ordinarily upon a seat raised before the body of the carriage. The first deviation from this custom originated from Spain, on occasion of the Duke d'Olivares, who found that a very important secret, whereon he had conferred in his

coach, had been heard and revealed by his coachman: the Spanish policy has therefore displaced him by royal ordinance, and since that time the place of the Spanish coachman has been upon the first horse upon the left; the same as the French stage-coachman and our postilion.

PART II.

DESCRIPTIONS OF THE COACH AND CHARIOT, LANDAU AND LANDAULET, BAROUCH AND BAROUCHET, BRITSKA, PHAETONS.

The Chariot and Coach.

THE chariot, from the antiquity of its name, claims our first attention, although in its construction the modern chariot differs so materially from the ancient, that we ought rather to place it after than before the coach. But as it appears that the word coach does not from its name determine any particular form, but was understood originally to embrace all kinds of covered carriages, we shall perhaps be more in order by commencing with the chariot, and then describing the coach, which is now understood to mean a carriage with seats facing each other under the same covering.

It has been observed the ancient chariot was constructed upon two wheels, the body uncovered, and containing the charioteer who guided the horses. The modern chariot is understood to be on four wheels, the body part covered, and

differing from the coach in having one seat only, instead of seats facing each other. In weight both carriages are nearly equal; in fact, many modern chariots are constructed of greater weight than the generality of coaches. Chariots are usually required for two principal purposes; *viz.* for town use and for travelling. Those for the former purpose are furnished with a seat in the front for the driver; which seat, in well-finished carriages, is ornamented with a handsome drapery of cloth, trimmed round with fringe, &c. as will be hereafter described, under the name of "hammer-cloth." Those for the latter purpose have a seat behind, the horses being driven by a postilion: by this arrangement the view from the carriage is unobstructed. By far the greater number of modern chariots are made to combine both these properties; as the following explanation, with the assistance of the drawings in Plate I., will shew.

No. I. is the representation of a modern travelling-chariot with its various appurtenances and accommodations for luggage. The body (by this is meant the covered part, having one seat of sufficient width to contain three persons, a door on each side, folding steps, and glasses to draw up, &c. and is suspended by leather braces, from springs upon each corner of the carriage part), fashion requires this part to be made

large, very large in comparison with those which were made some few years since. This increase of size affords so much more interior accommodation, that small seats for the younger branches of a family are not unfrequently placed under the front windows, facing the back seat, and being made to remove at pleasure, does not affect the appearance of the carriage as a town chariot, and affords, in many instances, the accommodation of a coach. Between the front of the body and the splashing fence is carried the bonnet case, marked (*c*). Upon the roof of the body are two imperials, marked (*i i*). Upon the front of the carriage part (by this is meant the whole of that part of the vehicle to which the wheels and axles are attached, with the springs before named, upon each corner for supporting the body) is a large boot, marked (*b*), in which is received a trunk or boxes, and upon it may be carried the imperial, marked (*b i*), usually designated "the boot imperial." The hind part of the carriage supports a seat for two servants, which is constructed upon a boot of a suitable form, usually denominated "the hind rumble," and is calculated to contain two large boxes or trunks.

By removing from this carriage the bonnet case (*c*), the imperials (*i i*) and (*b i*), and the hind rumble seat, and then attaching upon the

front boot a driving seat, and also a pair of standards upon the hind part of the carriage from whence the hind rumble has been removed, and you have the complete town chariot No. 2.

This description of chariot is very heavy, and although it is used for town work with a pair of horses, will require four when loaded with its appendages for travelling.

The front or driving seat is sometimes used also, in which case this chariot affords accommodation for seven persons: *viz.* three in the body, two upon the driving seat, and two upon the hind seat; and sometimes, as before mentioned, two small seats are introduced to the inside of the body, making in all nine persons; affording, as already observed, the conveniences of a coach with the additional advantage of a very useful article for package, *viz.* the bonnet case (*c*), which the form of the body of a coach does not admit.

No. 3. is a different style of chariot; its appearance as a town chariot is sufficient for general purposes, and being somewhat lighter in its construction than No. 2. is more suitable for the country. This chariot also admits of a similar adaptation for travelling, although on a more limited scale. Thus, the driving seat can be removed from the front boot (*b*) to the hind platform (*p*), and the imperial upon the roof with the bonnet case in front, as described in

No. 1., might be added: such a chariot with these appendages might at all times be drawn with a pair of horses.

Before we proceed farther, it may be proper to remark, that all kinds of carriages are described by coachmakers in two material parts, *viz.* the *body* and the *carriage.* The former has already been briefly noticed, and is too well known to require further description: the latter includes the whole of the under part, with the axles and wheels, and is divided into two parts, termed the "upper" and the "under carriages. The upper carriage consists of the hind wheels, the perch, and that portion of the front part to which are fixed the springs for supporting the body: the under carriage comprises the front wheels and beds supporting the upper part at the front, to which it is connected by a centre pin passing through both: upon this pin, the under carriage and front wheels are turned or locked, and the progress of the carriage directed."

Much care is required in the construction of the carriage part. It is only with good workmen in the different branches, under the direction of an experienced principal, that a good *carriage part* can be built. Upon the form and proportioned strength of the iron work, the shape and elasticity of the springs, and the position

and track of the axles and wheels; upon these particular points depend not only the durability and appearance of the whole, but the following of the machine itself after the horses.

There are also a number of minutiæ, which, if not attended to, the "running," as it is termed, of the carriage soon becomes affected, and the machine itself gets out of order. This accounts for the circumstance of some carriages making so much more noise than others.

The greater part of the better finished carriages for town use are now constructed with springs horizontally fixed upon the axletrees: these are denominated "under spring carriages." By the action of such springs the carriage part is relieved from the shaking of paved roads, and its durability much increased. A carriage so constructed admits of the boots and seats for servants to be fixed upon the beds of the carriage part, instead of being attached to and swinging upon the same springs as the body. The drawings Nos. 1. and 2. are upon this construction. No. 3. being without this improvement, it will be observed, that the boot in front and the platform behind are attached to iron work branching from the body: the whole is in consequence supported by the same springs, which are required to be made stronger for that purpose.

The additional strength of springs thus required for a chariot of this description does not sensibly affect the ease of the body, provided the springs themselves are well made and tempered, and the suspended parts properly attached; added to which such carriages being generally used in the country where the roads are commonly soft or smooth, the under springs would come little into action; but, on the other hand, the increased weight of the additional accommodations of Nos. 1. and 2. would require the springs to be made so much stronger as to materially affect the ease of the body when divested of its travelling appendages, and used as the town chariot No. 2., therefore the under springs in this instance are found to be of great advantage.

The coach, as before observed, differs only from the chariot in the form of its body, which is made with seats facing each other. The large modern chariots having almost superseded coaches for the purposes of travelling, excepting with families of large establishment, coaches are now mostly used for town work, for which purpose they are sometimes very expensively finished. No. 4. is the representation of a town coach: the body is usually built of sufficient size to contain two persons on each seat. The driving seat is supported upon the front beds of the carriage by what are termed "coach-box stand-

ards," and is furnished with a hammer cloth; upon the centre of which is placed the crest, and sometimes the armorial bearings, in embroidery, or chased in silver or yellow metal, to suit the furniture of the carriage. A row of deep fringe is continued round the bottom edge, and occasionally another of less depth upon the top.

Upon the hind beds are the footman's standards. This appendage is not only ornamental, but is found of great use in places of public resort, as it prevents the poles of other carriages coming too close. These appendages are not confined to the coach; they are applied with equal effect to the town chariot; but as they appear more in character with the former vehicle, we have described them in connection with it. Coaches are sometimes made to contain one person only on each seat: such a carriage is designated a *vis-à-vis*, and is used only by persons of high fashion and large establishment.

The style of finishing modern carriages has been for some time past with as little external embellishment as possible (those kept expressly for town-work excepted). Fashion seems now to require some additional ornament.

The linings are of superfine cloth, with squabs of morocco leather or silk tabberett,

trimmed with handsome laces of silk and worsted, and sometimes entirely of silk: the colours are claret, crimson, and different shades of drab: these are determined partly by the taste of the owner, and partly by the colour of the painting, upon which fashion does not appear to exercise much influence. At present, clarets, pale greens, browns, and yellows appear in almost equal proportions.

Landaus and Landaulets.

The observations already made upon coaches and chariots apply equally to these carriages; the only difference being in the bodies, which are made to throw open. To effect this properly, much skill is required in making the body itself, or the doors will soon be found to open and shut with difficulty. The means employed to remedy this inconvenience affect the grooves in which the glasses slide, and render repair necessary to these parts also: this soon leads to a derangement of the whole.

The use of these carriages has of late much declined, probably in some measure from this circumstance, but chiefly on account of the additional attention required to them, and their increased weight, from the greater proportion of iron work employed in their construction.

The Barouch and Barouchet.

The Barouch was introduced from Germany to this country about the year 1802. It was the fashion at that time to build carriages extremely low; and the better to effect this purpose, the front part of the body was arched upwards, as in the drawing No. 5., to admit of the front wheel passing under the body in locking the carriage for the purpose of turning. The barouch has seats inside facing each other, similar to the coach and landau; but with a view to lightness the half head was contrived, which, when put up as in the drawing, covers only the hind seat. These constitute the leading features of the barouch: the most conspicuous is the arching up of the front part, which soon became fashionable, and was applied to other carriages, particularly to landaus, and these carriages when so made were termed barouch landaus.

As higher carriages became fashionable, this arched front part being no longer of use, was gradually abandoned; yet, notwithstanding, the half-headed carriage still retains the name of barouch.

The barouchet bears the same affinity to the barouch as the landaulet does to the landau; *viz.* that of having only one seat in the

inside, instead of seats facing each other. No. 6. is the representation of a barouchet.

The barouch and barouchet will accommodate the same number of persons as the landau and landaulet; and being made of much lighter construction, they are on this account greatly to be preferred for summer use and short excursions in fine weather. Indeed, the barouchet is often built so light as to allow of being drawn by one horse. For this purpose the body is usually constructed upon what are termed "nut-cracker" or elliptical springs, similar to No. 7. If due attention be paid in the building, a carriage on this construction may be made sufficiently light to form a very neat and convenient one-horse equipage.

The Britska.

This carriage is also of continental origin, and was introduced to this country soon after the peace of 1814. The Britska is a carriage peculiarly adapted for travelling, being so well calculated for receiving luggage. The bottom of the body is nearly straight, with a large boot in the front part in continuation: this boot and the spaces under the seats admit of large square boxes, and the form of the body allows of the perch being made nearly straight, and shorter

than to other carriages: the steps being placed on the outside, gives room for two ample pockets in the space which they would otherwise occupy if folded into the carriage in the usual way. The head is furnished with glasses in mahogany frames which inclose the whole of the front, and are so contrived as to fold up in a portable form, and fasten to the upper part of the head when not required.

These carriages are constructed either with one seat, like the barouchet, or with seats facing each other, like the barouch, as may be required. No. 8. is the design of one with a back seat only, which is generally made of sufficient width to contain three persons. The folding glasses in front render this seat equally secure from wet as that of a chariot. The front part of the body, as well as the boot in continuation, are usually appropriated to luggage, or will afford sufficient space for those who travel inside to repose at length.

The seat behind contains two servants, with room in the boot part below for additional luggage. Another seat, capable of accommodating one or two persons, is obtainable in the front by affixing the small portable seat (marked P. S.) upon the boot, with the small footboard at the bottom, which, when not required, turns back underneath the body.

These carriages are very convenient for travelling, and a pair of post-horses will generally draw them at a quicker pace than most other carriages, although when loaded the weight might be greater: this arises from an idea of lightness on account of the shortness of the carriage, and the luggage being concealed by the form of the body.

The Phaeton.

About the time that driving became fashionable, the Phaeton was introduced; and as this appears to be the only four-wheel carriage of any decided character of English origin, it may not be uninteresting if we introduce a drawing of one of these carriages used about forty years back, soon after their invention: see Plate 3. No. 12. As few of my readers may have seen or bear such a machine in recollection, this drawing is given on a larger scale than the others, in order that a better idea may be formed of its construction. I am aware this opinion of the phaeton being a carriage of English origin allows of dispute; as about the same time a carriage was introduced from Germany, called a Berlin, which became in general use, so much so, that we even now read the name on most tables of tolls affixed against turnpike houses. But this carriage, however it

may have suggested the idea of the phaeton, was totally different in its construction. As it is now out of use, a particular description is unnecessary: we shall merely observe, the Berlin was a light four-wheel carriage with one seat, which was placed near the hind wheels, upon which it was attached by two horizontal springs: it had no perch, and the front wheels locked entirely round: the body was too far back to be driven from, for which reason it was used with a postillion. Modifications of the phaeton, and the superiority of the lighter sorts of barouchets, have entirely superseded the Berlin.

In returning to the phaeton, we must refer the reader again to Plate 3., and solicit attention to the preposterous situation of the body, which was gradually brought to this extremity with the view of obtaining a better command over four horses. In descending hills, the weight of this body frequently preponderated so much as to raise the hind wheels from the ground, to prevent which it became necessary to place a weight between them. This phaeton was for a considerable time looked upon as a most elegant carriage, and the only one from which four horses could be driven. Indeed, our most gracious sovereign himself, to whose valuable patronage the coachmaking trade are so deeply

indebted, used frequently to drive an equipage of this sort.

As driving became more fashionable, more attention was bestowed upon the driving-seats of other carriages, and the compact and then novel form of the mail-coach gave rise to the adoption of carriages upon this principle for driving four horses; and about twenty-five years since, a number of fashionables, termed the "Whip Club," used to assemble with elegant equipages of this form drawn by four horses in hand.

The author has frequently seen from twenty to thirty assemble in the vicinity of Cavendish Square, and drive off in procession. A more imposing and gratifying sight could not be imagined. From this period phaetons have been looked upon as carriages more suitable for a pair of horses; and they now appear to be brought to perfection, as they seem to want nothing either as to ease or convenience.

The great variety of these carriages precludes the possibility of describing them all; we shall therefore select those only which appear of the most decided character, and from which others may be said to be variations to suit the convenience of the owners, or suggested by the ingenuity or fancy of the builder.

The first we shall describe is No. 9., which is certainly the most complete and serviceable phaeton now in use; it is usually denominated the double-seated phaeton, and is generally constructed upon horizontal or mail-coach springs. The advantage of this plan consists, in the weight being supported by each corner, immediately over the bearing of each wheel; and each spring being fixed at its centre, allows the carriage part to be constructed much shorter and lighter, and at the same time with more strength and simplicity than if the body was suspended from upright springs and leather braces.

The body part, containing both seats, is one continuation of light frame-work, cased with pannel board, affording space inside for large boxes and other accommodation. These seats are also so contrived as to admit of being changed from back to front at pleasure, a source of great convenience when a servant is required to drive. It will be observed, that the carriage part of this phaeton is constructed with a perch, consequently the front wheel can only lock to a certain degree; but as gentlemen keeping such equipages are generally proficients in the art of driving, this circumstance becomes a matter of little moment: should it be otherwise, an iron

perch can be used, which could be arched upwards to admit of the wheel passing under: this is termed a swan perch, and possesses all the advantage in this respect of the old crane neck carriage, which has been laid aside for some time on account of its weight.

No. 10. is another plan of phaeton: its construction differs considerably from the other, being built without a perch, and possessing all the advantage of a crane-neck carriage without its weight. The greatest proportion of these phaetons are built sufficiently light to allow of being used with one horse, for which purpose the property of locking freely round is of great importance, as one horse will turn more suddenly than can a pair of horses harnessed together; and the event of a sudden and violent turn (if the front wheel has not a free lock) must be to overturn the carriage or break the shafts. The same effect takes place if the horse should back on a hill, as the slightest deviation of the hind wheels from a straight line brings the carriage upon the lock, when, if checked, the same consequence necessarily follows.

A phaeton, if required to carry two persons only, and to be drawn entirely by one horse, can be built equally light as a Stanhope; and by arching upwards the bottom of the body, a higher front wheel may be obtained, thereby

rendering the carriage much more suitable for using with the sort of horse generally driven in Stanhopes. No. 11. will give an idea of such a carriage. The form may be varied to suit the pleasure or accommodation of the owner. An additional seat for two persons may be added, when required, to the hind part; or it may be so contrived as to turn back and form a seat.

Some of these carriages are constructed on a smaller scale to go with lesser horses; others have seats behind, which are made to fold into the hind part of the body when not required, similar to No. 10. or 11., and a considerable proportion are made with detached seats in the front to drive from. Some of these cannot properly be termed phaetons; they appear to have more claim to the appellation of barouchets, or perhaps barouch phaeton may be an appropriate name. The word phaeton is certainly meant to imply a carriage to be driven from; that is to say, the body itself should form the seat for the driver, and, when the construction of the carriage and form of the body does not allow of this, the name of phaeton is clearly misapplied.

The additional safety of a carriage upon four wheels over one with two only, is a circumstance of great importance to the timid and infirm; yet many are induced to forego this advantage

from an idea of the increased weight and resistance of four wheels in draft. The better to enable the reader to judge how far this opinion is correct, we propose to make some further remarks on these carriages in comparison with those upon two wheels, in the course of which we shall point out the peculiar advantages of each.

PART III.

OBSERVATIONS ON THE CONSTRUCTION OF TWO WHEEL CARRIAGES. — DESCRIPTION OF THE CURRICLE, CABRIOLET, TILBURY, STANHOPE, &c. — AUTHOR'S IMPROVEMENT IN THE SHAFTS OF TWO WHEEL CARRIAGES. — COMPARATIVE SAFETY AND OTHER ADVANTAGES OF CARRIAGES UPON TWO AND FOUR WHEELS. — AUTHOR'S IMPROVEMENT IN THE CONSTRUCTION OF THE LATTER. — STAGE COACHES — DEFECTIVE CONSTRUCTION OF THESE VEHICLES. — HIGH COACHES AND SHORT PERCHES NOT ADVANTAGEOUS IN DRAUGHT. — STEAM COACHES.

Two Wheel Carriages.

CARRIAGES upon two wheels are more dependent upon the horse than those with four, inasmuch as a carriage upon four wheels, having its weight distributed upon four bearings, can be propelled by any force brought to operate upon it; whilst a carriage upon two wheels, having only two bearings upon the same axle, would, if balanced ever so exact, be constantly vibrating upon that axle or axis; added to which, if the carriage itself was contrived with sufficient accuracy, it would be impossible to dispose of the load so as to preserve the equilibrium. It therefore be-

comes necessary, in order to render the carriage steady, that a portion of the weight be carried by the horse. This constitutes a third bearing, and before the carriage could be propelled by the same force or power as the four wheeled one, we must substitute another wheel in place of the horse to support this third bearing.

From this it will be clearly seen how much more is depending upon the horse in a two wheel than in a four wheel carriage; more care is therefore required in suiting the horse to the carriage; his height in particular should be regulated by that of the carriage he is required to draw. The harness also requires its share of attention. The experienced driver invariably looks to the following particulars: — If the back strap which suspends the shafts from the horse's back be of a proper length to keep the body in a horizontal position; if the traces are sufficiently long to give room for the horse's action, without risk of his hind legs striking against the drawing bar (the part to which the traces are fastened); if the breeching be so contrived as to give sufficient room for the action of his hind legs only, as beyond this will allow the carriage to come too close upon him in descending hills.

To the want of attention to these particulars are to be attributed most of the accidents which befall two wheel carriages.

Much attention is also necessary on the part of the coachmaker in the construction of the carriage itself. Care must be taken to apportion just sufficient weight forward as will serve to keep the carriage steady: beyond this will press too heavily upon the horse when going down hill, and being immediately over his fore legs, in case of tripping, there is every impediment to his recovering himself, and in the event of his falling, it is with an accelerated force, as the pressure increases as the front part of the carriage descends.

If, on the other hand, there be not sufficient weight, the balance will then preponderate behind, and will be found to operate with almost equal disadvantage when ascending a hill, as this preponderance will increase in proportion as the declivity increases, becoming very dangerous to the rider, the shafts being only prevented from flying upwards by the belly band; a part of the harness not calculated to bear much pressure. At the same time, this situation is particularly distressing to the horse, as it deprives him of the advantage of his own weight when he most requires it to overcome that of the carriage, which is continually pressing against him.

Hence it also appears that as the horse constitutes a third bearing in a two wheel carriage, he communicates to it, when in action, an up

and down motion which is extremely unpleasant to the rider. To remove this has always been an object of great solicitude, and to the extent with which it is accomplished depends entirely the ease and comfort of a two wheel carriage. We shall have occasion to refer again to this subject; in the mean time, we proceed with a general description of these carriages. The first in order is the

Curricle.

This carriage is the chariot of antiquity. The name of curricle is derived from the Latin word *curriculus*, from *curriculum*, a course, or *curro*, to run.

The curricle is a carriage so generally known, and at the same time so little in use at present, that a slight description will sufficiently answer our present purpose without any graphic illustration.

The curricle is usually constructed with large springs behind, and lever springs in the front. Like other two wheel carriages, it is necessary that the preponderance of weight should be in the front part: this weight is supported from a bar attached to the horses' backs, by upright irons fixed in a secure manner upon the saddles: from the centre of this bar is a brace, by which is suspended the pole of the carriage between the

horses; the pole is connected to the brace by a long spring, the elasticity of which relieves the rider from the up and down motion communicated to the carriage by the action of the horses. Curricle horses require to be matched with great attention; for unless they step together, the motion of the carriage becomes extremely unpleasant.

Under proper management, the curricle forms a most elegant carriage. If built by an experienced builder, who would not fail to attend particularly to its construction, more especially to the form and hanging of the body, the apportioning of just sufficient weight to the horses' backs as is necessary to keep the carriage steady, and to tastefully ornament and *finish* the whole; if to such a carriage be attached a pair of horses not less than 16 hands high, matching in courage and action, with two outriders behind, no style of carriage can equal it. The park loses much of its splendour by the absence of such equipages as these; and this circumstance is the more to be regretted as we find them supplanted in a great measure by the

Cabriolet.

We are indebted to our neighbours for this machine: with them it may be a useful carriage, answering, no doubt, the purposes of in-

dividuals of limited means sufficiently well. With the usual superiority of English materials and workmanship in carriage building, the cabriolet has been much improved in ease and convenience, but at the same time the weight has been very little diminished.

The modern cabriolet is large and commodious in the body, which is furnished with a head, and framed knee-flap. Hung with curricle cee springs behind, long under springs in the front, and others horizontally fixed under the shafts, and a platform behind for a servant to stand upon, this carriage is equal in weight with a curricle. That it is convenient cannot be denied; but it has no claim to elegance. The eye is at once offended by the disproportion of the means employed to draw it. Certainly some of the finest horses in Europe are driven in them, and, perhaps, to this circumstance is to be attributed the preference given to these carriages by persons of rank and fortune; as the high price such superior horses command will always prevent the cabriolet becoming too common.

The lighter descriptions of two-wheel carriages were generally comprehended under the names of gigs and one horse chaises, until Mr. Tilbury, of South Street, Grosvenor Square, introduced the carriage which has borne his name.

The Tilbury.

The principal advantage of this carriage is its superior adaptation for a large horse. This desirable property chiefly consists in compassing the shafts upwards, to the horse's back, thereby obtaining a short back strap without depressing the hind part of the carriage; and by giving them at the same time a similar direction sideways, the animal has room to move without his sides being chafed by the close contact of the shafts: thus, by this contrivance, a low carriage was rendered completely suitable for a large horse. In addition to this, the *body* being hung between the shafts by means of springs and leather braces very advantageously arranged, it was found to be a carriage peculiarly adapted for town use; the action of the springs and braces being sufficient to relieve the rider from the concussions arising from the uneven pavements of the London streets. The Tilbury became very general, and for a considerable time scarcely any other two-wheel carriages were used. It is now almost superseded by

The Stanhope.

This carriage possesses the same advantages as the Tilbury, with more convenience for tra-

velling, the body being formed to receive large boxes or luggage under the seat. This carriage as well as the Tilbury is too well known to require the assistance of drawings for illustration. Indeed, a two-wheel carriage can be only imperfectly represented by a drawing in elevation. It must be seen *round* before an idea can be formed: in fact, it should be seen with the horse in it. As much depends upon the form and position of the springs as upon the construction itself. The adjustment of the weight to the horse's back and the line of draught are principal objects; besides which, there are a variety of minutiæ without attention to which the carriage is not complete, and the experienced driver will soon perceive that something is wanting. This carriage and the Tilbury require fine-actioned horses with plenty of bone, about fifteen hands two inches high. With a Stanhope a lower and more compact horse is sometimes used; but, when speaking of a Tilbury horse, the description of animal first mentioned would be understood.

A variety of other two-wheel carriages have been contrived to suit the taste or convenience of the owners; but none have arrived at sufficient notoriety to require any separate notice. Some have been called *buggies*, others dennets, others having capacity for carrying dogs have

been named Dog Carts. The construction of these carriages is various.

We have already observed, that two wheel carriages being partly supported as well as drawn by the horse, are thereby subjected to a motion arising from his action. Those carriages which have the body parts constructed upon springs separate from the shafts, are less affected by this motion, as the vibration of the shafts is counteracted by the action of the springs; but there is much additional weight of iron work in carriages so constructed, and the horse works to great disadvantage: as he is between shafts which are lined with iron and bolted upon the axle, that will not yield in the slightest degree to his action, he carries an unyielding weight upon his back, jarring with all the concussions of the roads.

If, on the other hand, the body be attached to the shafts and the whole upon springs, the horse is relieved from the jarring, and the weight lessened upon his back by the elasticity of the springs, and the carriage itself rendered lighter; but then the rider is subjected to the motion arising from his action. If, therefore, the rider can be relieved from this unpleasant effect, the event will be to produce a more perfect two-wheel carriage than has yet been constructed. This very desirable object the author flatters

himself he has accomplished, as the following explanation will show.

Fig. I. plate 5. represents a gig of the Stanhope form without shafts. The body is constructed upon three springs, and attached to the axle and wheels in the usual way. The machine in this state is capable of supporting the whole of the weight to be carried; but without some further contrivance the weight would preponderate before or behind. In order, therefore, to preserve the carriage steady, a greater proportion of weight, as has been before explained to be necessary, is placed to the front part, which is supported by the horse. Now the shafts may be considered as two long levers, by means of which he is enabled to support this weight. In the ordinary way of attaching these shafts or levers, they are so connected as to form a part of the machine itself: the effect is, that when raised or set in motion by the action of the horse, the whole machine vibrates upon the axle, which may be called the fulcrum of this lever; the consequence of which is very disagreeable to the rider, and has not been inaptly termed "knee motion."

The author has contrived to attach his shafts to the front or drawing bar immediately under the footboard, and marked *b*, fig. 1., by means of shackles and centre pivots, upon which the

shafts freely move. Fig. 2. is a detached view of the shaft (*f*), the place to which it is connected at (*b*) fig. 1. The shaft itself is made of lance wood: the hinder part being gradually tapered from (*f*), and lined with whalebone, is rendered elastic. The extremity is finished with a thin plate of iron clipping the wood and whalebone, and forming an *eye*, which is received into the shackles (*s*) of the transverse hind spring (*h*). This is rendered more evident by the back view of the carriage, fig. 3. Continuing to view the shafts as levers, we shall now find the fulcrum or bearing point is removed to these shackles and pivots upon the drawing bar (*b*). Therefore, if the hinder parts of the shafts and the transverse hind spring (*h*) to which they are attached are made sufficiently elastic, these parts easily give way as the front parts are raised or depressed by the motion of the horse, the body itself remaining perfectly steady, and the rider entirely relieved.

The horse is also greatly relieved, inasmuch as these shafts freely accommodate themselves to his action; a circumstance of great moment in all situations, but particularly when going down hill. Fig. 4. shows the effect of a complete Stanhope with the improved shafts.

There are also the following advantages attending these shafts, in addition to those already explained.

They are easily disengaged from the gig by withdrawing the pivots from the fulcrum joints and others; more or less compassed to suit higher or lower horses; can with facility be substituted, thereby rendering the carriage suitable to any horse at pleasure: there is also equal facility in producing a curricle, or, by the addition of a pair of front wheels and a driving seat, a very complete and well-appointed phaeton. The author has obtained a patent for this invention.

The idea of two wheel carriages being unsafe has lately gained much ground in public opinion; but when we consider the extensive use of these carriages, the improper horses so often applied to them, and the unskilful or inexperienced hand which so frequently undertakes to direct them, it is only surprising we do not hear of more accidents.

That there is more security in a carriage upon four wheels cannot be denied; but this security has been much overrated, as it applies to their being used with one horse.

If a spirited horse, such as are generally driven in Tilburies or Stanhopes, were put to some of these four wheel carriages, it is doubtful if any additional security would be gained. The slightest defect in the construction or operation of the carriage would produce serious conse-

quences, as such an animal would be too quick in his movements to submit to sudden check or violence. Here it may be necessary to remark, that no description of carriages are more defective in construction than a large proportion of these carriages (or as they are usually termed one horse and pony phaetons): they are mostly fitted up with a view to economy by individuals possessing neither capability nor experience.

The whole machine is often vended for a sum little exceeding the expence of four wheels and axles alone, made by good workmen.

There is a description of horse much used in the west of England, from fourteen and a half to fifteen hands high, and worth about thirty-five pounds. Some of these horses, although they look well from good keep and grooming, are heavy in the shoulder, and not calculated for quick travelling. If a horse of this sort be driven in a Tilbury or Stanhope, in event of a stumble (*which is very likely to occur*) he must fall; and as the front part of the carriage descends with him, the riders are necessarily thrown out. The fault is then attributed to the carriage, when it more justly appertains to the horse; and if such an animal was driven in a four wheel carriage, the riders would have remained steady during a similar fall, and thus escaping injury, the occurrence would not be called an accident. For

horses of this description, it is scarcely necessary to observe, a carriage with four wheels is the most suitable. Hence it becomes evident, before we condemn two wheel carriages as unsafe, or reckon upon the advantage of one with four wheels, we should pay some attention to the horses to be used in drawing them.

It must be understood that these observations thus far are intended to apply to carriages with one seat. If further accommodation be required, either by an additional seat behind, or a similar contrivance in front to drive from, a carriage with four wheels is decidedly preferable, as such appendages to a two wheel carriage cannot be contrived without causing a great preponderance of weight before or behind the axle, which it is extremely difficult, if not impossible, to adjust to the horse's back.

Having now taken a hasty, yet we hope correct, view of the comparative safety of carriages upon two and four wheels, let us extend our enquiry to the relative advantages of each carriage in draught.

Many individuals deny themselves the advantage of a carriage with four wheels from an idea of the increased labour in drawing them: they are of opinion that there is more friction attending the use of four wheels than with two. The term *friction*, as connected with carriage wheels,

we shall discuss more at length in the next Part: we shall for the present merely observe, that the principal resistances to draught, are axle friction and the roughness of roads or hills. By carefully polishing axles, and anointing their surfaces with oil, friction in these parts is so much reduced as to form a very trifling portion of the resistances to draught.

The principal opposing force is therefore in the roughness of the roads and hills. Roads are also found to yield more or less to the pressure of wheels, the opposing part operating like a perpetual hill against the progress of the carriage. It is this circumstance which accounts for the much greater difficulty of drawing carriages over soft than hard roads, and is the reason why heavy carriages are drawn with such facility over the paved streets of London. The same argument will account for the fact of horses wearing out sooner on flat than on hilly roads. The latter, from more complete drainage, being generally harder than roads in level situations, the wheels consequently make less impression. Many have attributed this difference in favour of hilly roads to the occasional relief horses experience in the alternate descents. Possibly there may be some advantage on this account; but it appears more reasonably accounted for in the former circumstance; and in

further proof we have only to look at the increased difficulty of drawing a carriage up the same hill after being rendered soft by the breaking up of a frost or other causes, than when in its usually hard state.

Let us now suppose, for comparison, two carriages of equal weights — one upon two wheels, which we will term a *gig*, the other upon four, which we will denominate a *phaeton* — each carriage with its load to weigh eight hundred weight. The weight of the gig being supported by two wheels will sustain a pressure of four hundred weight upon each; whilst the phaeton having four bearings supports only two hundred weight upon each wheel. Hence it appears that, as the phaeton wheels press the road with only half the force of those of the gig, the hill or resistance to its progress must be lessened in the same degree; and if care be taken, in constructing the carriage, to make the hind wheels follow in the same track with the front ones, they would meet very little resistance on account of the opposing hill having been already borne down by the front ones.

From the above calculation it would appear that the advantages are in favour of the phaeton; and such would undoubtedly be the case, if the construction of such carriages were properly attended to. But from some unaccountable causes

these sorts of carriages, as far as applies to their being used with one horse, have been and still are held in little estimation by the fashionable world, probably in some degree from the circumstance of such numbers having been made by incompetent workmen with improper or inferior materials, and upon very defective constructions.

One very great disadvantage attending the use of phaetons with large horses, is the custom of making the front wheels so much smaller than the hind ones. This practice originated, no doubt, in the necessity of the front wheels locking under the bottom of the body, the height of which from the ground is regulated by fashion or other circumstances. But, however this may apply to other carriages, it is not imperative in a phaeton, as the form of body generally allows of the bottom being arched upwards to admit of the wheel locking under, without lessening its accommodation, as shown in No. 11. Therefore, as a high front wheel may be used without raising the body more than is desirable, what reason can exist for continuing the present disproportion?

Some persons consider that the hind wheels, from being highest, assist the front ones up hill. The absurdity of such an idea is too evident to merit any refutation: however, custom appears to have identified such disproportion in the construction of all four-wheel carriages, and it now appears essential to please the eye.

There is another circumstance connected with the construction of four wheel carriages which operates considerably against the advantage arising from the division of weight, which may be thus explained.

The construction of these lighter sorts of phaetons being usually the same as represented in the drawings, Nos. 10 & 11. Plate IV. it is evident that if either of the front or hind wheels pass over a stone or any elevated obstruction in the road, the whole side of the carriage is lifted up at the same time, and the weight sustained by the elevated wheel and axle, with the spring connected to it; therefore, it is necessary to construct these parts of double the strength that would otherwise be required, thereby adding to the weight and lessening the ease of the carriage.

The author has just perfected and obtained a patent for an invention which completely removes these serious disadvantages. The drawing and following description show in what manner these important objects are attained:

The improvements on wheeled carriages here described, consist in the adaptation of an apparatus to the front part of a phaeton, or other vehicle running upon four wheels; and is designed to prevent these carriages from overturning, by preserving the body part at all times in a horizontal position; even when one of the wheels accidentally passes over a large stone in

the road, or up a bank by the road side, or any other obstruction which would overthrow a carriage built upon any of the ordinary plans at present in use.

This invention is best adapted to those carriages which are constructed without perches. The greater number of phaetons, and the lighter descriptions of four-wheel carriages, are of this class. The principle and object of the improvement will perhaps be best understood by first describing the difficulty with which carriages upon such construction are drawn over impediments or uneven roads.

The body part being connected to the axles and wheels by springs at each corner, it is evident, that in passing over uneven roads, the carriage itself must frequently run on three wheels, as the body part does not admit of the least flexibility or twist. It is further evident, that if one corner bearing be raised by a wheel passing over a stone, or any other sudden rise in the road, that one half of the carriage will be raised at the same time, and the whole weight of the half so lifted will be supported by the elevated wheel, and its axle and springs, at the corner which passes over the obstacle; the spring being thereby greatly depressed. Each wheel, axle, and spring, therefore, are occasionally required to support double the weight that they are designed to carry, and this being

thrown upon them suddenly, renders it necessary to construct those parts of the carriage of double the strength that would otherwise be required.

The present invention is calculated to remove these very important objections, and is carried into effect in the manner shown in Plate 6.

A circular horizontal locking wheel, formed of the usual materials, is affixed to the front part of the carriage, as at *a*, fig.1, which is rendered more evident by the detached view, fig. 2, as it would be seen from above upon a larger scale without the other parts of the carriage. This wheel bears upon the axle tree bed *b*, *b*, and upon segments, supported by arms *c*, *c*, extending from the axle tree bed, which are enabled to turn round horizontally npon these bearings in the act of locking, the axle tree bed itself being attached to and supported by the front springs *d*, *d*, which are connected to the front axle and wheels. A bar *e*, *e*, crosses the middle of the locking wheel *a*, and is attached to it by ears and bolts, the centre of this bar having a circular hole through which a pin *f* passes for the purpose of forming the pivot or axle on which the before-mentioned axle bed *b*, *b*, &c. turns or locks round. The extremities of the bar *e*, which extend beyond the wheel, are made cylindrical, and to these are attached the plummer boxes, or gudgeons *g*, *g*, from whence the bent arms *h*, *h*, extend for the purpose of supporting the

front part of the body of the carriage, as seen in the first figure.

It will now be perceived, that in the event of one of the fore wheels running over a large stone, or any other elevated obstruction in the road, the axle-tree *i* will be thrown out of its horizontal position; but the body of the carriage in front being supported solely upon the pivots at the ends of the bar *e*, the plummer boxes *g*, *g*, will turn upon the pivots, and cause the bent arms *h*, *h*, to keep the body of the carriage in its erect position, although one of the forewheels is raised up so considerably.

A carriage with this improvement will be found to possess the following advantages: —

1st. The weight being at all times equally distributed upon the four corners, each spring can only be required to support that portion of the load immediately over it; these parts may therefore be made proportionably lighter, and the vehicle altogether built of considerably less weight.

2d. The resistance in draught is much lessened, the horses having only to exert sufficient force, in drawing over every opposing substance, one-fourth, instead of one-half, of the entire road: this advantage on uneven roads must be immense.

3d. The liability of the carriage to be overturned is much lessened: in fact, this circumstance is rendered impossible, as far as regards the front wheels, either of which may be raised

any height without disturbing the equilibrium of the carriage body. The same advantage attends the hind wheels, though, though not to so great an extent; but it may be here remarked, the shock from a front wheel meeting an obstacle is much greater, and more likely to overturn the machine, than a similar concussion with the hind wheel.

A stage-coach properly contructed, with this improvement adapted to it, would be found to possess very considerable advantages over those now in use.

The number and weight of the springs might be reduced, and obstructions which would inevitably overthrow stage-coaches, as at present constructed, would by means of this improvement be passed over with perfect security.

It may be necessary to observe, that to a perch-carriage, having the body part suspended by leather braces from cee-springs, &c. this invention is not applicable.

Stage Coaches.

In the present advanced state of science, when the most enlightened views seem generally to prevail, and the slightest improvements in subjects of minor importance are eagerly received and encouraged, it is a most surprising circumstance so much prejudice should continue to exist on the construction of stage coaches. Not one step have these machines advanced towards improvement for these last

forty years past. By improvement is understood approaches towards safety; for surely those alterations which have effected the means of carrying three-fourths of the load on the top, cannot be called by the name of improvement! And we have only to refer to the accounts of accidents the newspapers are so continually detailing, to convince us of the dangerous consequences arising from such construction, and to show that stage coaches have retrograded rather than advanced in real improvement.

One very great bar to improvement has been the inflexibility of the stage coach proprietors, in the opinion that a coach of high construction, with the wheels close to each other, will follow the horses much lighter than a machine of similar accommodation and weight upon a lower construction, with wheels farther apart. Now both these opinions are not only erroneous, and very detrimental to safety, but absolutely increase the evil they are considered to lessen: it is also evident, that by raising the machine its liability to fall over on either side is greater, and by bringing the wheels so close to each other the base is contracted, and the same liability to overturn greatly increased.

Let an unprejudiced individual observe one of the modern stage coaches, with ten or twelve persons and a quantity of luggage, elevated twelve feet from the ground, tottering upon a base of six feet by four feet and a half, and vibrating from

side to side according to the slightest unevenness of the road. What would be the impression on the observer's mind in contemplating such a situation? would he feel any surprise at the frequency of accidents? No; he would rather wonder such casualties did not happen more often.

If the coach proprietors, before they persist in subjecting the public to so much unnecessary risk, would only listen to a few plain observations, they must be convinced the advantages so pertinaciously attributed to high coaches, with short perches, are founded entirely in errror. Indeed a few moments' reflection is alone sufficient to dissipate such extravagant notions; we have only to consider a little the nature of the resistances to motion, or, in other words, the opposing forces to the draught of the horses. By far the most considerable of these resistances, we are well aware, arises from the friction produced by the asperity of the roads and hills over which the coach has to pass; with the assistance of the wheels and axles we greatly reduce this friction or resistance: it is therefore to the construction of these parts of the machine that our attention must be directed to lessen the horses' draught. Can any one be so unreasonable as to suppose, that the power of the wheels is to be increased by elevating the load upon them? If the surface of the roads were smooth as ice and perfectly level, the coach would then

require very little power to move it, the only opposing force being atmospheric resistance. The advantage of a low coach over a high one under such circumstances are too obvious to notice further; indeed, many instances are on record of stage coaches having been literally blown over on level roads by the power of wind alone. Is it not, therefore, evident, that if the specific weight of the machine is the same, if the wheels are of equal height, and the springs of similar elasticity, that the low coach must follow the horses with less resistance than the high one?

That subjects so philosophical as the above should be noticed thus familiarly will produce a smile from the scientific reader; but as reasoning of this kind will sometimes carry conviction, when more copious demonstration would fail, the Author hopes to be excused.

Now, with respect to the other presumed advantage — that of short perches: the fallacy of this opinion might be shown by making a few experiments with a common timber carriage, drawn by a weight running over the roller of a well. First, let the hind wheels be brought close to the front ones, and attach sufficient weight to the end of a rope as will draw the carriage; next remove the wheels as far back as the perch of the timber-carriage will allow, and repeat the experiment, and it will be found that the same weight will draw the carriage as before.

Added to this there is a decided disadvantage attending the use of short carriages, by reason of the greater preponderance of weight being thrown upon the front and hind wheels, when passing over uneven roads, or in ascending and descending hills. Thus, suppose the front wheels to fall into a hollow in the road, the greater proportion of the weight of the machine falls upon them, and when the horses by extra exertion of strength have raised them out, the hind ones descend into the same situation, and the greatest proportion of weight is then thrown upon the hind part, owing to the greater elevation of the front wheels; the consequence therefore is, that the horses have to draw the same weight twice out of the same hollow in the road.

The author's invention, as described in page 51., would be found of great advantage to stage coaches: but whilst the proprietors continue to reject all deviations from their own ridiculous notions, there is no hopes of any real improvement in these vehicles.

The public attention has of late been much engrossed by the report of a machine possessing the powers of locomotion over common roads having been at length completed under the form of a steam coach, and the newspapers have fixed various periods for the appearance of this eighth wonder; but all our expectations have hitherto ended in disappointment. Report in-

forms us several of these machines are in progress, and particular mention is made of one under the direction of Mr. Gurney, at his manufactory in the Regent's Park. The flattering accounts given us of various trials with this machine, would lead us to suppose Mr. Gurney had really made some grand discovery in the mechanical arts, towards the accomplishment of this interesting object; from what has gone forth to the public, such, however, does not appear to be the case.

To say that a coach *cannot* be made to pass over common roads by means of any power of locomotion in itself, would, perhaps, in this age of invention, and seeing how much has already been effected by the amazing and extensively applicable power of steam, be advancing more than is prudent; but as the difficulties to be overcome ere such an object can be attained, are of that magnitude as hitherto to have defied all mechanical power, we feel no hesitation in asserting that such a consummation by any of the means now employed, is, to say the best, a very improbable circumstance. The following observations, in our usual familiar manner, will give the reader some idea of the nature of these impediments, and, perhaps, induce him to agree with us upon the improbability of the successful appearance of a *steam coach.*

The reader is well aware the ordinary means of employing steam power is by a crank, the evolu-

tion of which regulates the length of the working cylinder of the engine. Perhaps there is no purpose to which this power can be so disadvantageously employed as to a carriage wheel; for should the surface over which the carriage is required to pass be smooth, there would be no friction between the outer circumference of the wheel and such smooth surface, consequently the wheel would be turned round in the same manner as if suspended in air, and the carriage would remain still. The same effect takes place if the surface or road be composed of loose materials, as these loose materials would give way to the pressure of the wheel. In like manner, when ascending a hill, the gravitation of the carriage at a certain elevation becomes greater than the friction of the wheels upon the ground can oppose. Under these circumstances, nothing appears more likely to succeed than a contrivance which shall take hold upon the ground after the manner of the hind feet of the horse: these means we are told Mr. Gurney has employed, and it remains to be seen how these propellers (as they are called) will act. But, after all, it seems to us the question will be, can such a machine be worked with less expence than those with horses? Until some power or method of application very different from any at present known be discovered, the coach proprietors have no cause for alarm.

PART IV.

OBSERVATIONS ON THE MECHANICAL POWER OF WHEELS. — DIFFERENCE BETWEEN THE WHEEL AND AXLE IN MACHINERY AND A CARRIAGE WHEEL. — ON THE ADVANTAGES ATTRIBUTED TO HIGH WHEELS. — LINE OF DRAUGHT. — AXLES, THEIR FORM AND POSITION. — FRICTION, &c.

On Wheels.

In a mechanical view of the construction of a wheel carriage, the first part which claims attention is the wheel itself. It has been already premised, that the observations upon this subject will be made in as familiar language as possible: the conclusions will be drawn more from actual experience than scientific theory. Those who are desirous of enquiring farther into such subjects, are referred to the various treatises on mechanics; among which, that by Dr. Olinthus Gregory is perhaps the most comprehensive.

The learned doctor observes in his preface to the work just alluded to, that familiar treatises are of little or no use, or, at all events, fitter for children than men. An expression of this sort from such high authority had nearly prevented the

present attempt; but further reflection having suggested the doctor's meaning to be, that the science of *mechanics* and others connected with it could not be taught familiarly; with this idea the author pursues the subject, and hopes permission to address the following observations to those of his readers who have not studied the now complex science of mechanics, without incurring the charge of puerility.

It is very probable that, in the infancy of the arts, sledges were used before wheels were invented. Perhaps the accidental interposition of a roller between some heavy body and the ground in dragging it forward, first gave the idea of a wheel. Sledges are indeed still used in this country for certain purposes; and in some of the cold countries where ice is met with in great quantity, and the ground is covered with frozen snow the greater part of the year, sledges are principally used, and run upon the smooth surfaces of these bodies with as great ease as wheels run upon the ordinary ground. Upon very smooth ice, indeed, or upon any surface perfectly smooth, wheels would not turn at all; for the only reason why they turn in the ordinary way, is the continual inequality they meet with. If we suppose the wheels to be carried in the air, it is plain they would not turn, there being no more resistance to one

part of the circumference than to another; and the same would be the case if we suppose ice or any other body to be so smooth as to give as little resistance as air. On common roads, however, wheels meet with obstructions at the bottom which retard that part; and in consequence of this the upper part moves forward, and a circulating motion immediately begins to take place. By means of this circulatory motion, the friction becomes very much less than what it would be if the weight were drawn along the ground upon a sledge.

The advantage of wheels over sledges may be further understood from the following considerations. A sledge, in sliding over a plane, suffers a friction equivalent to the distance through which it moves; but if we apply to it an axle, the circumference of which is six inches, and a wheel whose circumference shall be eighteen feet, it is evident that in moving the carriage eighteen feet over the plane, the wheel will make but one revolution; and as there is no sliding of parts between the plane and the wheel, but only a mere change of surface, no friction can take place there; the whole being transferred to the box fixed in the nave or centre of the wheel and acting upon the axle, so that the only sliding of parts has been betwixt the inside of the box and the axle; which, if they fit one

another exactly, is no more than six inches: and hence it is plain, that the friction must be reduced in the proportion of one to thirty-six. Another advantage is also gained, by having the surfaces confined to such a small extent, by which means they may be more easily kept smooth and fitted to each other; and, by anointing these surfaces with oil, the advantage becomes astonishingly great. The only inconvenience is the height of the wheel, which must in many cases be added to the carriage itself.

We now come to the consideration of the height of wheels. It is a very general opinion that a carriage with high wheels follows the horses much lighter than the same carriage would with lower wheels. It is of consequence we ascertain in how great a degree such advantage is really gained, as many carriages are rendered inconveniently high with a view of possessing this very desirable property.

One advantage attributed to high wheels is the reduction of axle friction, by reason of a greater space being passed over with the same evolution upon the axle. We have just explained, if the surfaces of the axle and box be well smoothed and lubricated with oil, that friction in these parts is reduced to a mere nothing; hence there is little foundation for

sacrificing safety and convenience on this account.

The other advantage urged in favour of high wheels, is their increased power as levers in surmounting hills and other obstacles in the road. Before we subscribe to this opinion, let us enquire into the operation of a carriage wheel; and (if I mistake not) the result will be to show that this lever power has been very much over-rated. The subject will perhaps be better understood by first pointing out the difference between the wheel and axle as a machine and a carriage wheel.

The wheel and axle, according to Fergusson, is the second mechanical power, acting entirely on the principle of the lever, and has therefore sometimes been called a perpetual lever. The axle is at rest and supports the weight of the wheel (or, as it may in this case be called, the machine), whilst the power being applied to the outer circumference, a succession of levers take place as the wheel revolves. This is the operation of the wheel and axle in machinery.

Now the axle of a carriage-wheel partakes of the motion of the carriage: the power required to draw the carriage is not applied to the circumference of the wheel, but to the axle itself. The operation may be thus described.

If we could suppose a carriage with four

wheels to stand upon a horizontal platform, the carriage would remain at rest, as each axle would press the box in the nave perpendicularly upon the bearing of each wheel upon the level surface of the platform. But if one end of such platform be raised so as to produce an inclined plane, the pressure of the axles will continue on the lowest part of the boxes in the naves of the wheels, perpendicular lines from which will fall behind the bearings of the wheels upon the platform, and cause the wheels to revolve, carrying the carriage down the inclined plane. Let us suppose the platform to be once more horizontal, and apply power to move the carriage forward, the same effects are produced, as by so doing the axles are shifted from their perpendicular bearings, and are pressed against the front part of the boxes in the wheels, which of consequence immediately begin to revolve, and the carriage is set in motion, which motion it will continue to maintain so long as sufficient power is applied to draw the axles forward.

Thus it appears, that the wheel and axle in machinery and a carriage wheel differ very materially: the former being an endless succession of levers moving on a fixed axle or centre, which may be termed the fulcrum of this continued lever; whilst the latter approaches nearer to the simple roller: its employment is indeed for

attaining the same object, *viz.* that of removing the friction which would otherwise take place if the carriage rubbed instead of rolled over the space it be required to pass. Its mechanical power as a lever consists in the overcoming of such obstacles as are commonly met with in roads. Thus let the circle of Fig. 1. represent a wheel, A the centre or axle, O an obstacle, now the lever power will be in proportion as the distance from B to F is greater than from F to O: for without troubling the reader with any mathematical calculation, we may safely assume the imaginary point F to be the fulcrum of the lever. In this case we consider the carriage to be drawn on level road; but we shall find it to be very different in ascending a hill, as although the wheels continue to act as levers, we shall find that the action of the weight from gravitation will increase with the power gained by the increase in the size of the wheel; and consequently that such enlarged size will be of no farther use than that of lessening axle friction, the trifling consequence of which has been before noticed. The advocates of high wheels do not appear to be aware of this circumstance: to illustrate it further, let us have recourse to a diagram.

Suppose the large circle in Fig. 2. to represent a wheel of four feet diameter, and the smaller

circle a wheel of only two, both of which are made to ascend the inclined plane L M, by powers applied from each centre or axle; it will be found, that by describing the lever as in the former case, although the arm of the lever from B to F be double the length in the large wheel that it is in the small, the other end of the lever from F to the bearing of the wheel on the hill is also augmented in the same proportion.

It must be admitted, that this imaginary fulcrum attributed to the lever power of wheels, marked F in the foregoing diagrams, exists only momentarily in the operation of surmounting obstacles which may occur on level roads; it being evident that, as the carriage advances, the distance from F to O decreases, whilst that from F to B increases, until the axle A arrives in a line perpendicular to the obstacle, when the lever of gravitation ceases altogether, the weight of the carriage being supported by the obstacle. The case is very different in ascending the hill L M, as the relative distance from F to B, and from F to the bearing of the wheel on the hill, remains always the same, consequently the gravitation of the carriage will continue to act against its progress upwards with a lever proportioned in length to the height of the wheel.

From these observations it appears, that the mechanical power of wheels, in the capacity of

levers, will act with most advantage in overcoming obstacles on level roads, as, in addition to what has been before stated, much assistance is derived from the motion of the carriage. But if we consider a little further upon the situation of high wheels on hills, the fact of the increased power given to gravitation clearly proves the necessity of a greater force to check their descent; therefore, as greater resistance in such situations will be required from the horses, is it not evident, that the advantages attributed to high wheels on hilly roads are without foundation?

Hitherto our observations have been directed to the operations of wheels in general; we must now make some remarks on the means employed to draw them. In Britain, horses are commonly made use of for this purpose; but all four-legged animals are calculated for horizontal draught, and mules, oxen, sheep, and dogs are employed in different parts of the world. In all animals, however, the capacity for drawing depends upon their weight as well as their absolute strength. Thus it may happen, that a very heavy horse will draw a load which a lighter though stronger one could not move; but if something was thrown on the back of the latter, to render his weight equal to the former, he would draw the load with the same ease. It is also stated, that the weight

of the carriage to be moved re-acts upon the horse, and pulls him back as much as he pulls it forward, until the exertion of the muscles of the animal, resisted by the solid ground, overcomes the resistance of the load upon the moveable wheels; it then goes forward in proportion to the excess of the one power over the other.

A line parallel to the plane upon which the carriage is to be moved is doubtless the best adapted for the application of the power for draught; but there are circumstances connected with the construction of the carriages now in use which prevent the employment of such horizontal line with advantage. We have already observed, that style and fashion predominate over mechanical rules in the construction of wheel carriages; so we find that, in conforming to such imperative laws, the height of the front wheels of four wheel carriages must not exceed three feet six inches. Upon reference to Plate 6. fig. 5. it will be observed, that the axle of a wheel of that height will be at A, whilst a line horizontally drawn from the horse's collar would communicate with the carriage at B; and as the axle A would encounter the shock of all resistance to motion, it will be seen that power thus applied would act injuriously upon that part of the carriage occupying the space between A and B, as it is evident the axle A would be

driven backwards by the constant application of the power being so much above the point of resistance. In order to avoid such consequences, it is considered more advisable to adopt a line of draught inclined from the horse's shoulder to the axle A, as represented by the dotted line. Such depressed line, if not carried beyond a certain degree, does not operate with any sensible disadvantage to the horse, as, from a slight view of the anatomical structure of this noble animal, it will be perceived that the collar from which he draws inclines backwards, and appears to fall into this position from the form of the shoulder: now, if he drew in the horizontal line to B, it is evident that the pressure would be upon the lower part of the collar, against which are opposed those muscular parts of the shoulders that are most in action, and his windpipe; the effect of which would be, to check his respiration, or to chafe those muscular parts.

Now a depressed line of draught, approaching nearer to right angles from the collar, will cause a more equal pressure, and thereby relieve him from these consequences.

We may therefore safely conclude, that the trifling disadvantage arising from the deviation from a horizontal line of draught, is more than compensated by the relief afforded to the horse.

We shall now proceed to make some observa-

tions upon the forms of wheels and axles. As there are some peculiarities attending the application of the latter to carriages, we will first direct our attention to them.

Carriage axles are of two kinds, cylindrical and conical. The difference between a cylinder and a cone is too well known to require description; but as a few words will explain it, and we profess to be familiar, the reader will excuse our observing — A roller, having both ends of equal diameter, is of a cylindrical form, and if propelled forward will roll in a straight direction; but if one end of a roller be of smaller diameter than the other, it will form a cone, and if set in motion will describe a circle; neither can it be drawn in a straight line without a rubbing of some parts of its surface. From this it is calculated, that as the direction of a carriage wheel is straight forward, so must axles of a cylindrical form be the best calculated for reducing friction or the resistances to draught. We have already observed, there are circumstances connected with the construction and use of carriages, which oblige us to deviate occasionally from plain mechanical rules; so will the peculiarities attending carriage axles, as before mentioned, authorize our departing from them in the present instance.

If the position of a carriage axle was hori-

zontal, there could be no question upon the superiority of the cylindrical form; but as it has been found, that wheels revolving upon such axles throw the dirt adhering to their outer circumferences upon and into the carriages, producing very disagreeable consequences to the riders, especially in open carriages, besides loading the machine itself to a serious extent when passing over dirty roads, it has been considered more advisable to depress all carriage axles at the points, which communicate to the wheels an inclination outwards at the top, and cause the dirt, &c. from the roads to be thrown from the carriage. This depressed position of the axle is detrimental to draught, yet it has been considered advisable to submit to it, rather than to incur the greater evil of being covered with mud, from the use of the horizontal axle.

The same argument in favour of cylindrical axles equally applies to the form of wheels, and the advantages of cylindrical wheels have been very much dwelt upon; but a reference to fig. 3. Plate V. will show that a wheel of this form cannot be used if the axle be depressed at the point in the manner already mentioned. It will be observed, that a cylindrical wheel in this situation bears only on the outside edge; therefore, in order to bring the bearing level on the ground, it becomes necessary to make the outer circum-

ference of the wheel to the form described by the dotted lines. From this it is evident that a conical-shaped wheel follows as a matter of course, and hence also the necessity of making wheels of a concave, or as it is generally termed dishing form; by which means the spokes are brought to support the weight of the carriage in a perpendicular position, as represented by the lines in the fig. If the wheels were made upright, the spokes being in right angles from the axle, would fall into the situation marked by the dotted lines, and materially lessen the strength of the wheel.

Further observation of fig. 3. will show, that the inclined position of the axles must cause the weight of the carriage to press considerably upon the inside shoulder, or as it is termed back collar of the axle, marked (*b*). This is the source of much additional friction, as is proved by the circumstance of the leather washer (used in this part to prevent noise from the collision of the box of the wheel against the iron collar) requiring frequent renewal.

I have been particular in stating these facts, as they appear to suggest some doubts relative to the advantages attributed to cylindrical axles. Let us refer again to the figure: it will be observed, that the direction of the bearing of the cylindrical axle upon the wheel will be in the most

depressed line, whilst that of a conical axle would be in the direction of the dotted line. Hence, as the line of bearing in the conical axle is less depressed than that of the cylindrical, so must the shoulder pressure be reduced also; and it may be further observed, that each radius of the wheel, from the outer circumference to the bearing upon the conical axle, is greater than to the cylindrical, consequently the wheel itself in its operation approaches nearer in effect to a cylinder.

For these reasons I am of opinion that carriage axles may be made in a slight degree conical with advantage.

The reader will understand, this opinion in favour of conical axles applies only to those which are from necessity depressed at the point from a horizontal line. The reasons for giving them this form, although of sufficient consequence to justify their application to carriages used for pleasure and convenience, are of little or no importance to waggons or machines of slow motion: the axles of these carriages should invariably be fixed in horizontal lines, and the cylindrical form, with wheels of the same construction, necessarily follow.

There is another circumstance connected with the resistances to draught, which it may be well to notice before leaving the subject of wheels;

and that is, the width of the outer circumference or *tire*. This has been considered a subject of great importance, as far as relates to the preservation of the roads; with a view to which, high tolls have been imposed on waggons with narrow wheels, and as the width of the tires have been increased, so have the tolls been lessened. This is a very salutary regulation as applying to waggons; for considering the immense weights these machines carry, and being made according to an ancient regulation of a certain width on the ground, they would be found to inflict much injury on the roads, particularly as one waggon generally follows in the track of another, the drivers of these machines rarely endeavouring to pass each other. It is not necessary to say more on waggon wheels here, having before observed, that the same argument does not apply to them as to carriage wheels. Those who would enquire further into the subject will find much useful information in the works of Mr. Richard Lovel Edgeworth and Joseph Storrs Fry of Bristol, already referred to in the foregoing part.

To return to carriage wheels: the weight supported by them being so trifling in comparison with what are carried in waggons, the width of the tires is of little consequence to the roads; hence there can be no objection to making them as narrow as a due attention to the strength of

the wheel will allow. We are told that the width of the tires does not affect the operation of the wheel in draught, and are referred to the following experiment of Fergusson's in support of such argument.

Let one end of a piece of packthread be fastened to a brick, and the other end to a common scale for holding weights; then, having laid the brick edgeways on a table, and let the scale hang under the edge of the table, put as much weight into the scale as will just draw the weight along the table. Then, taking back the brick to its former place, let it lay flat on the table, and leave it to be acted upon by the same weight in the scale as before, which will draw it along with the same ease as when it lay upon its edge. In the former case the brick is to be considered as a narrow wheel on the ground, and in the latter as a broad wheel. And since the brick is drawn along with equal ease whether its broad side or narrow edge touches the table, it is concluded that a broad wheel might be drawn along the ground with the same ease as a narrow one.

However well the above may appear in theory, the experiment is too rude to produce any satisfactory results. The friction of the brick is too near its weight for the effect to bear comparison with the diminished friction of the wheel and

axle; added to which the wheels roll over the ground instead of rubbing like the brick on the table. Now rolling and rubbing may be considered as two distinct species of friction, of which we will speak further presently: it is sufficient for our immediate purpose if we observe, that by pressure of the tire on a soft road, the air being expelled, a very sensible attraction from cohesion takes place; and although at first view this may appear a trifling circumstance, it will be found to operate considerably in the increase of draught. For these reasons, when lightness of draught is the primary object, the tires of carriage wheels should be made as narrow as may be consistent with the strength required from the wheel.

In the foregoing observations we have made frequent mention of the term *friction*: perhaps a few observations in explanation of the word may not be unacceptable.

Friction.

Friction has been treated upon at great length, and divided into several branches by modern writers; but the greater part of their ingenious experiments is of little use in real practice. The few remarks here offered on the subject will have no pretence to the establishment of any new theory, but are the results of actual experience.

The species of friction we have here undertaken to describe is caused by the rubbing of one surface upon another over which it is required to move. Now we have already explained, that the wheel of a carriage rolls over the space through which the carriage passes, thereby transferring the rubbing or friction to the axle and box in the centre of the wheel; these parts are therefore of considerable importance in the construction of wheel carriages, as security and ease of draught depend in great measure upon them. However the various theories may differ in other respects, the following rules are universally admitted:

1. That friction is diminished by making the surfaces smooth which move upon each other. Now, before the necessary degree of smoothness can be given to iron axles, it is necessary that they undergo the process of case hardening: by this means the surfaces are carbonated, and rendered equally hard with the highest converted steel, with this very considerable advantage, that as the carbon does not penetrate farther that $\frac{1}{32}$ part of an inch from the surface, the necessary degree of hardness for receiving a high polish is obtained without affecting the tenacity of the iron. If this process of case hardening is omitted (which is usually the case with the common sorts of axles), frequent greasing is necessary; for if the surfaces are

allowed to come in contact, the softer parts of the iron yield under pressure, whilst the projecting parts of each surface fastening upon each other soon become firmly united, or from increase of friction produce so much heat as to occasion the wheel to take fire!

2. Friction is diminished by introducing some oily substance between the rubbing parts. The fitness of this medium must be determined by the quality of the surfaces rubbing upon each other. If the axle and box are case hardened and well smoothed, pure olive oil answers the purpose; but the common axles require a medium of greater consistency, such as animal fats. Various compositions are mixed up for the purpose; pure hogs' lard and plumbago, in the proportion of six of the former to one of the latter, makes an excellent anti-attrition composition. *

3. Friction is lessened by reducing the surfaces in contact. According to the operation of the brick on the table, this is not the case. In dissenting from the result of this experiment, we mentioned something of attraction from cohesion. Now the word attraction being so

* It may be useful to notice here the very unfit mixture used at inn yards for greasing carriage wheels. The hostler, who generally attends to this operation, collects his material from the kitchen, where it receives from the cook a proportion of flour and common salt.

differently understood, and so extensively used of late in mechanical philosophy, it is introduced here with great diffidence; but as no other term is so likely to convey the meaning intended, we have been induced to employ it. Thus it is submitted, that when the surfaces already spoken of are so accurately smoothed and fitted as by their equal pressure to exclude atmospheric air, the oily medium is with difficulty drawn in, and *attraction* from cohesion takes place. Hence, in this case as with the tires of wheels, it is advisable to reduce as much as possible the surfaces in contact.

But it must here be remarked, that it is only those axles which are case hardened that can be reduced with advantage. Common axles, from the pressure being reduced to a smaller surface, would more readily yield in the softer parts, and the friction thereby be increased.

Having drawn the reader's attention to so much of the theory of friction as may be practically applied to the axles and boxes of carriage wheels, before quitting the subject it may be well to notice a circumstance attending their construction which appears to have escaped attention. The cylindrical and conical forms have been explained in a former page. Several patents for improvements in axles have been obtained, among which, that of Mr. Collinge

is justly the most celebrated; it possesses the advantages of the surfaces being hard, well polished, and sufficiently reduced, besides a secure and ingenious method of fastening on the wheels. Other patents now in use appear more like variations from than improvements upon Mr. Collinge's. From what has already been said upon the necessity of an oily medium between the rubbing parts, it is evident that some contrivance is required to furnish a continual supply, and the inefficacy of the present plan is the circumstance we wish to notice. The contrivance now employed is this: — the box is furnished with a reservoir at each end for containing oil, which is presumed to be distributed over the axle in the evolution of the wheel. A very slight reference to the laws of motion will show us this does not take place: indeed, the following familiar experiment renders the fact sufficiently clear. Every body has seen the common feat performed by slackwire dancers and others, that of placing a tumbler glass nearly full of water on the inner surface of a hoop, then holding the hoop by the finger at the opposite side, and giving it a rotary motion, when the glass and water are found to adhere closely to the hoop, opposite to the centre or finger, without spilling a single drop. The same effect takes place in the action of the wheel, the oil being driven by

the rotary motion of the wheel to the farther sides of the reservoirs.

This deficiency would be remedied by taking off one or more sections of the axle: thus, let fig. 4. represent an end view of the axle and box; (*a*) the axle, the outer line (*b*) the box, and (*x x*) the sections to be removed from the surface of the axle, which will leave free space for the oil, and furnish a supply to the bearing parts below.

Having dwelt on these subjects as long, perhaps indeed longer, than may be interesting to the general reader, some apology is due to my scientific friends for treating matters of this kind so familiarly. In extenuation, I beg to submit, that where so many local causes prevail, as in the construction of wheel carriages used for pleasure, &c. scientific demonstrations are not always satisfactory; neither can such arguments, with the jargon lately introduced into the science of mechanics, be rendered intelligible to ordinary minds. The inferences set down in the foregoing pages are drawn from practical experience, and are written more with an idea of being understood than of displaying erudition.

THE END.

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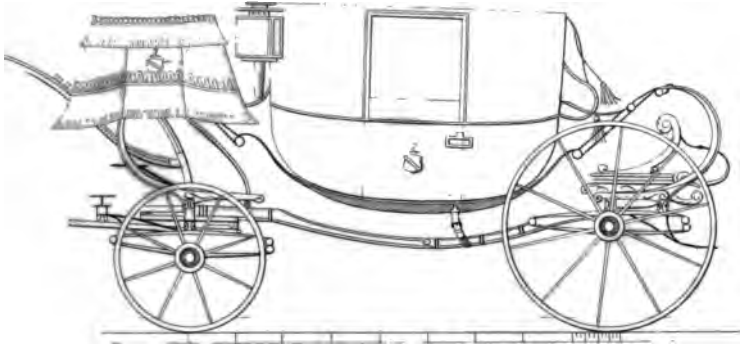

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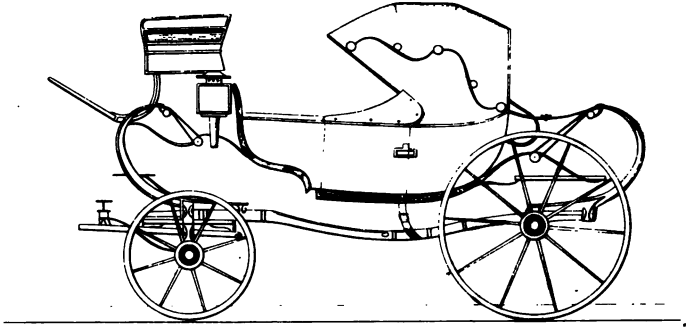

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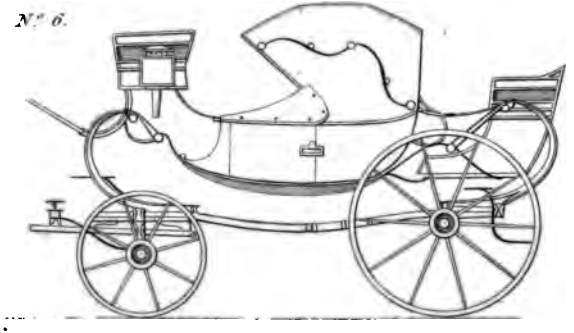

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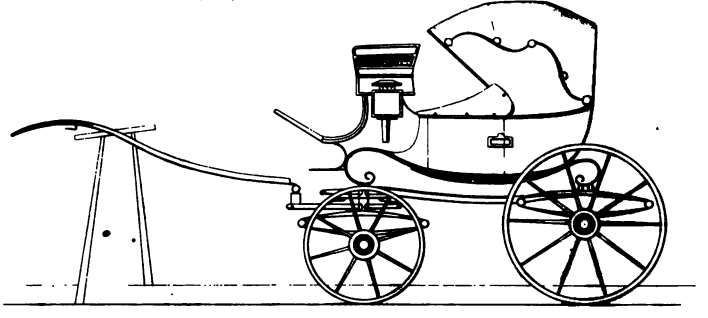

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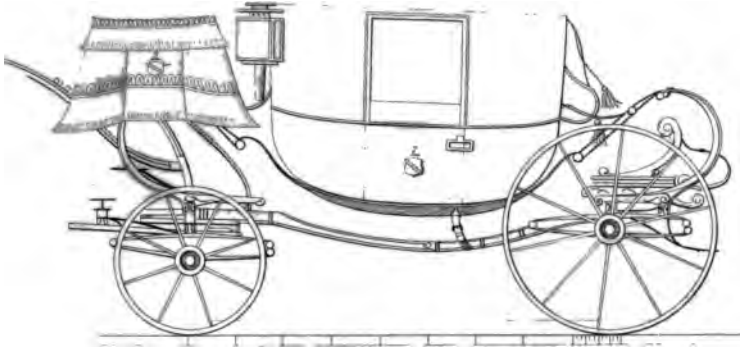

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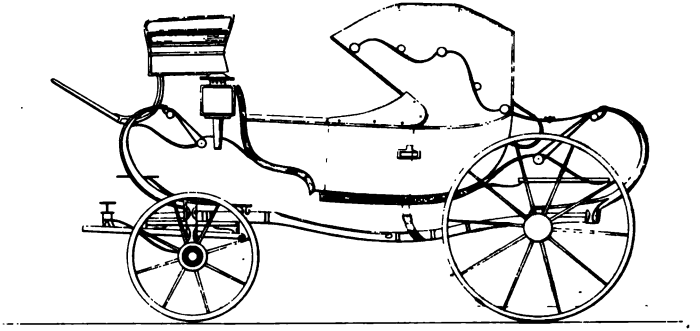

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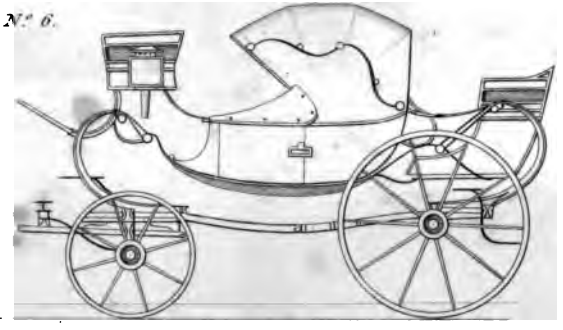

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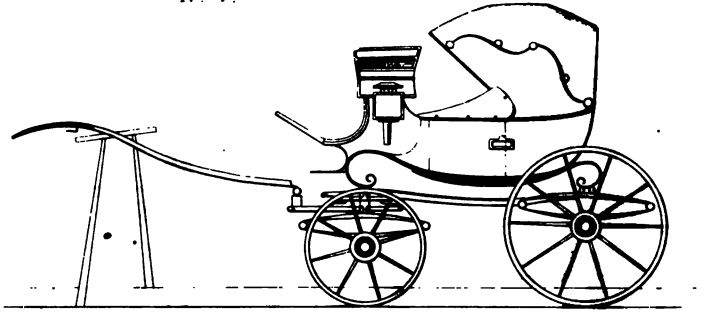
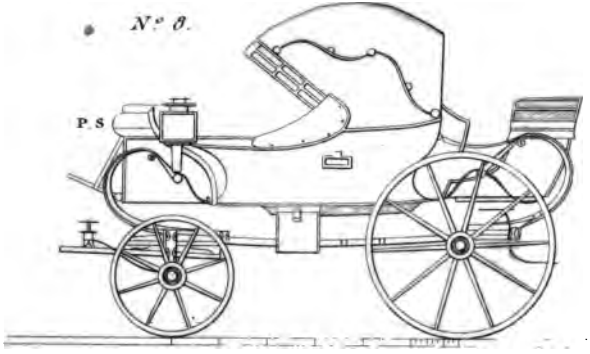


Plate 4.

N.º 8.



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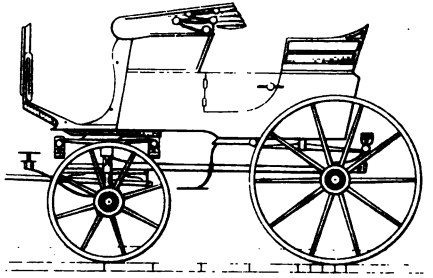

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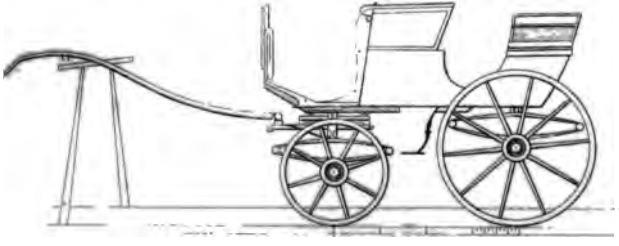

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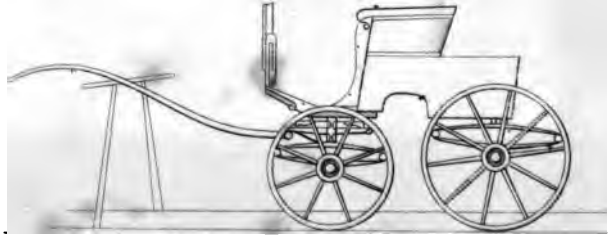


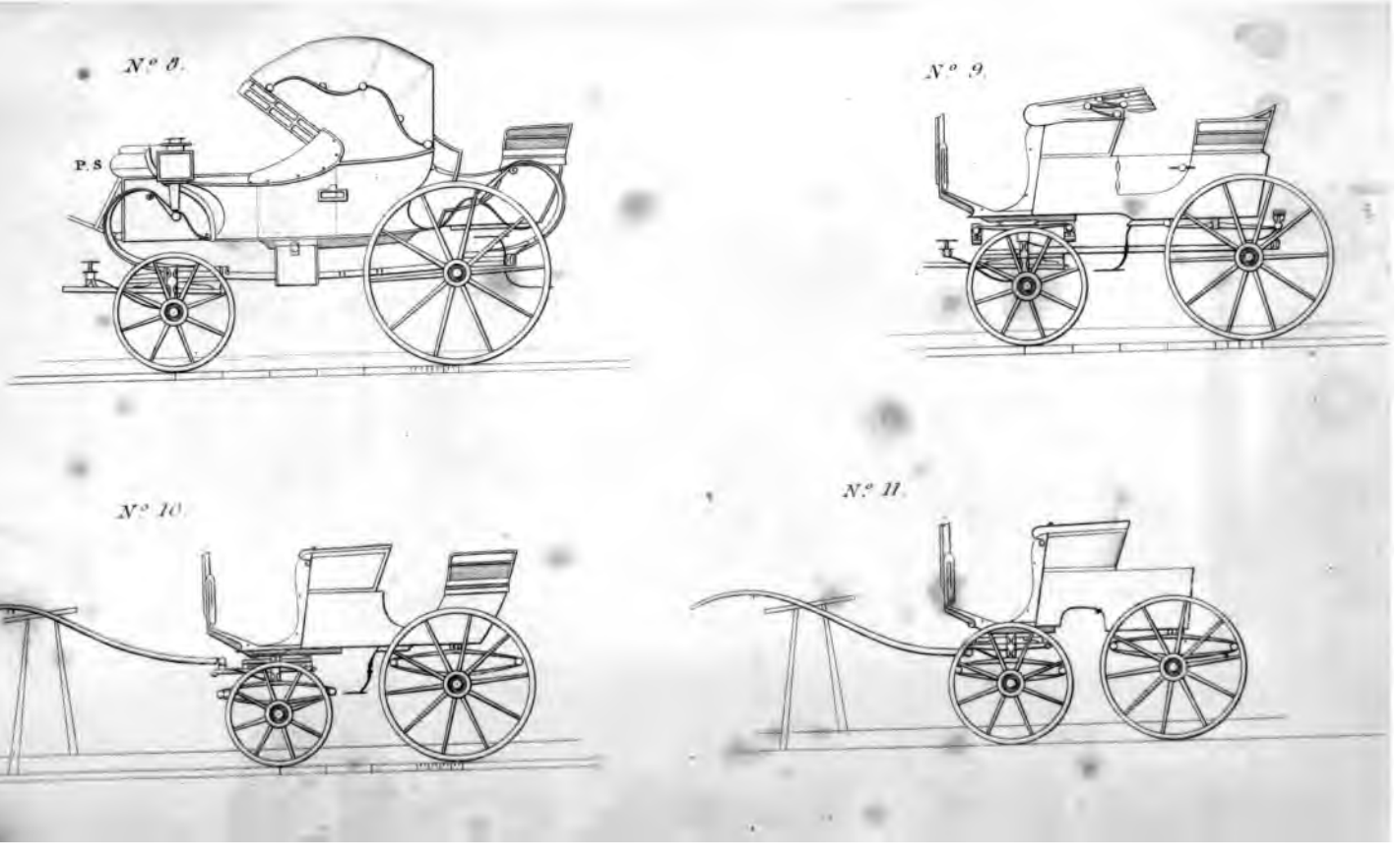

N.° 8.
P.S
N.° 9.
N.° 10.
N.° 11.

Fig. 1.

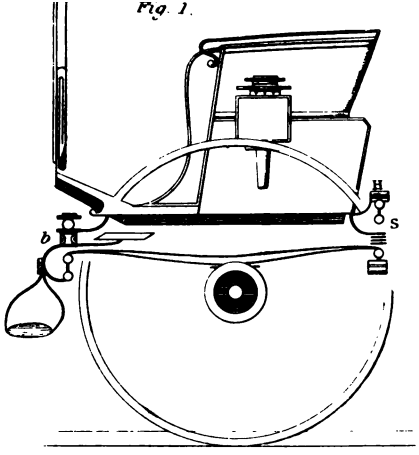


Fig. 2.

Fig. 4.

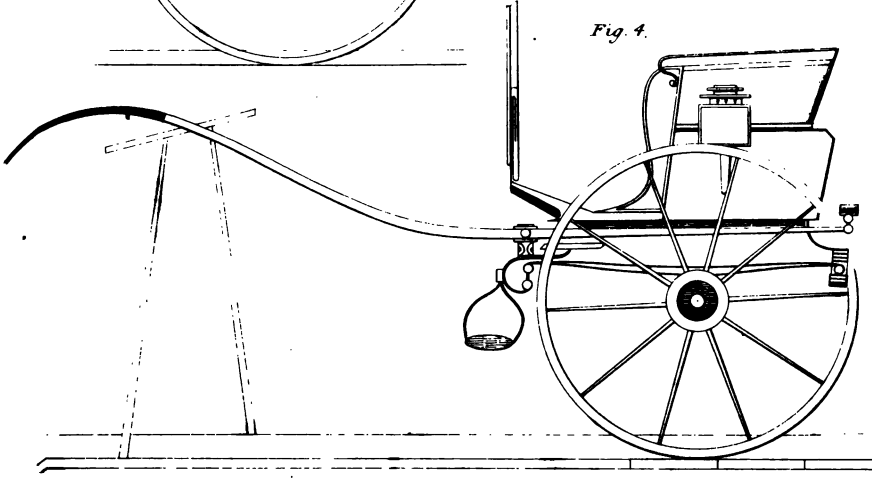


Fig. 3.

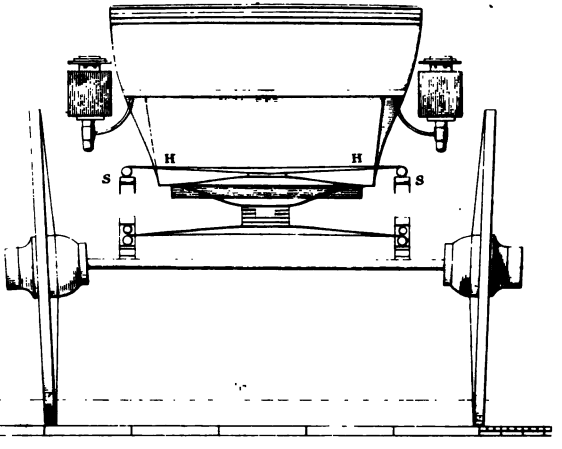


Fig. 1.

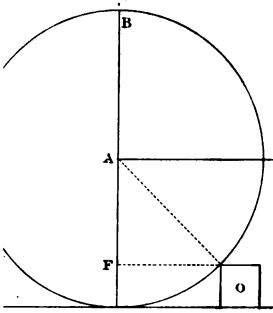


Fig. 2.

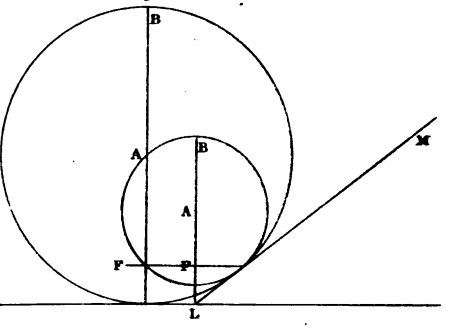


Fig. 3.

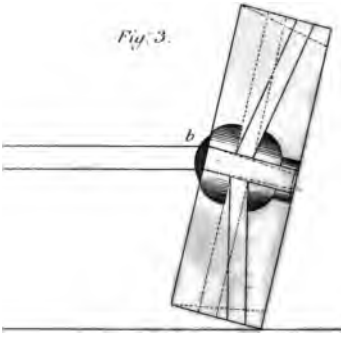
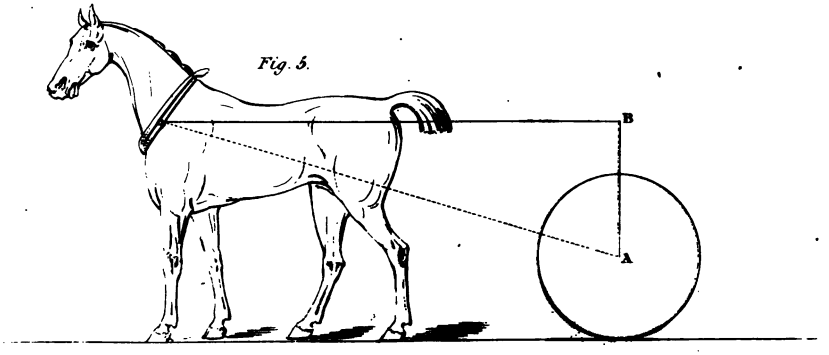


Fig. 4.

Fig. 5.



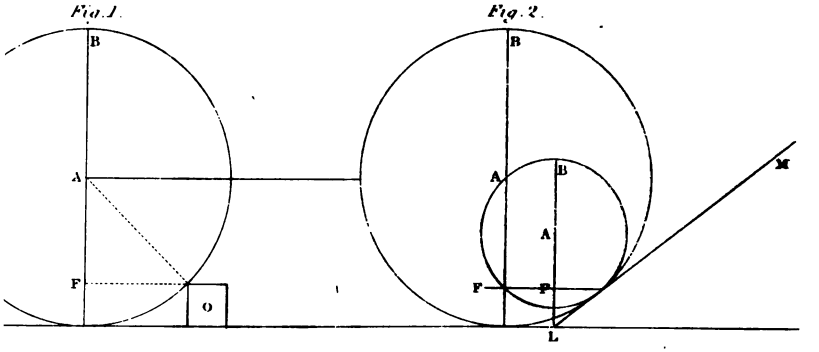


Fig. 1.
B
A
F
O
Fig. 2.
B
A
B
A
F
F
M
L

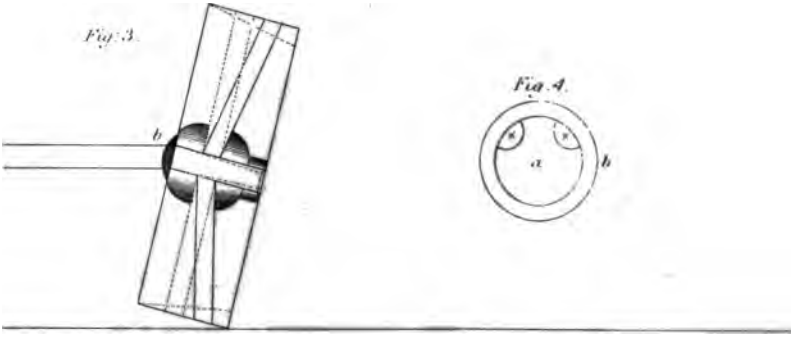


Fig. 3.
b
Fig. 4.
a
b

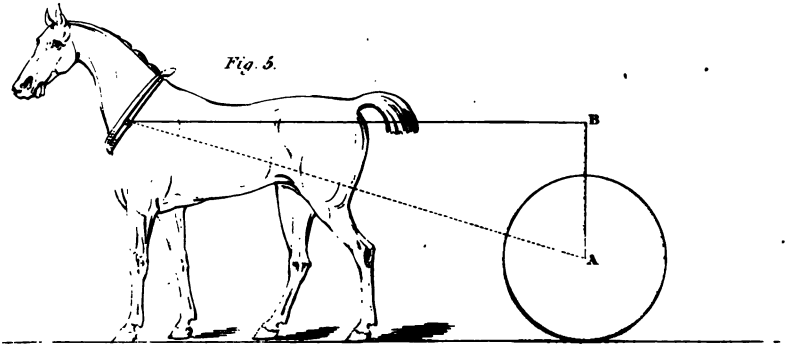


Fig. 5.
B
A