

CYCLES

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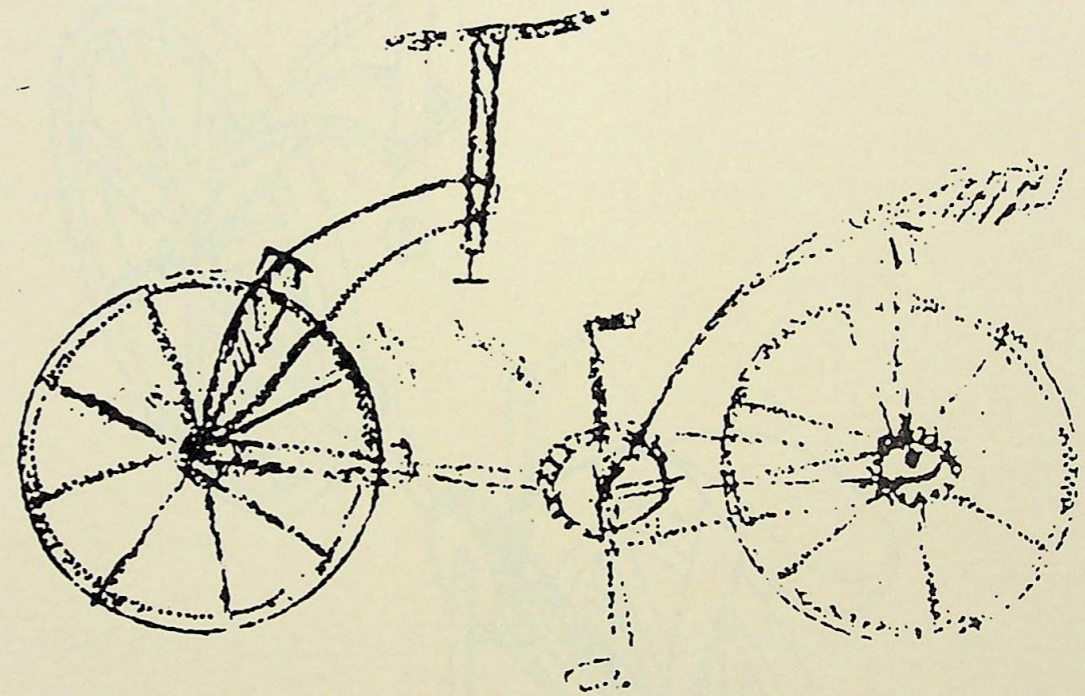
## INTRODUCTION

## Leonardo and the bicycle

The man powered vehicles or "velocipedes" are a recent invention as there are no ancient civilizations known that had anything even resembling a bicycle.

Possibly the earliest surviving evidence of a bicycle type machine was a drawing by the artist and inventor Leonardo da Vinci. The drawing dated 1493 shows a far more advanced bicycle than the early hobby horses of the beginning of the nineteenth century.

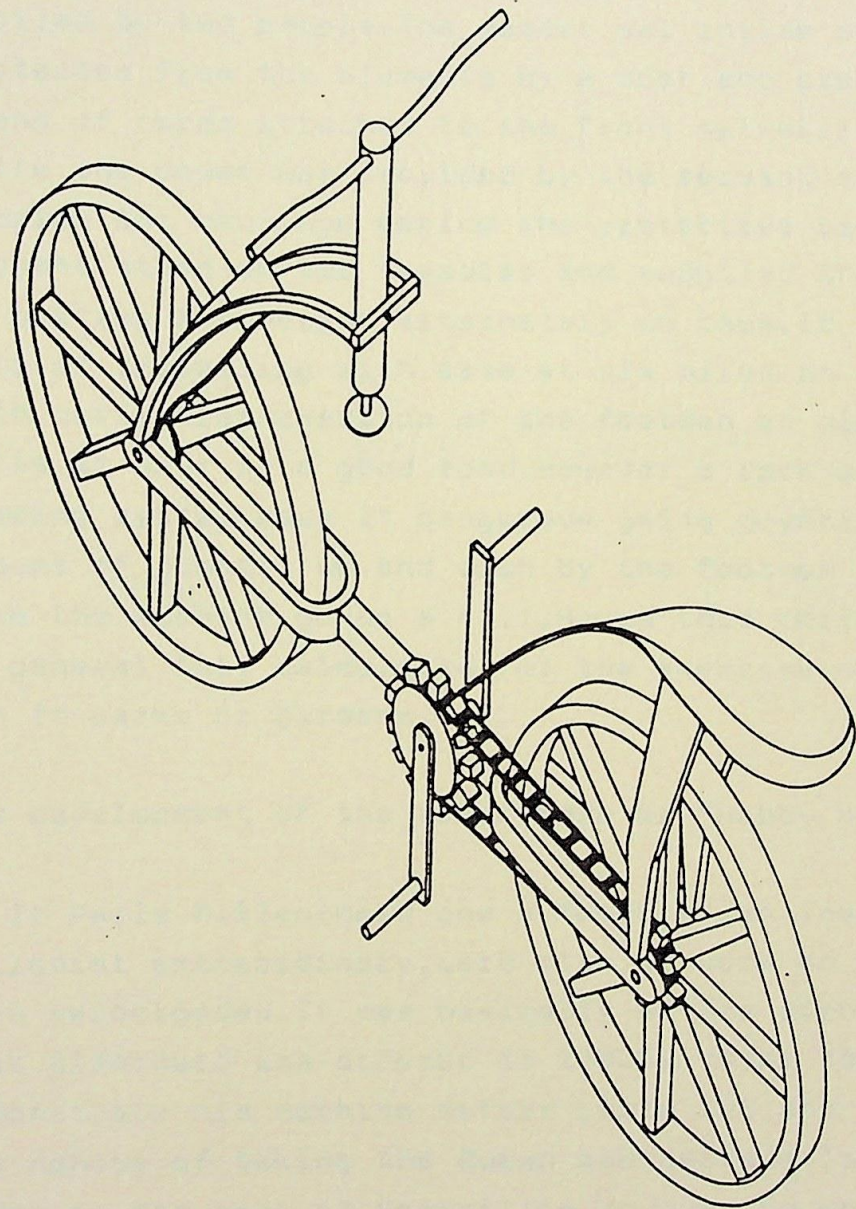
Diagram (1)



Leonardos bicycle 1493

Both the wheels are of the same size and the eight spokes are coloured brown to imitate wood. The front wheel is equipped with handlebars for steering and the saddle is over the back wheel. The chassis is entirely horizontal, with two gears to hold the wheels. There are braces propped against the back hub to support the

large saddle, which has a third point of support on the centre of the chassis. What was centuries in advance was the method of propulsion which consisted of two pedals fitted to a toothed gear with cubic rather than pointed teeth, to better withstand traction. The chain subsequently passed over a smaller gear on the rear wheel so that the power from the rider's feet was transferred to driving the back wheel. However this idea was not adopted on bicycles until the 1870's.



## THE HORSELESS CARRIAGES

In the middle of the seventeenth century Johann Hautch, a famous Nuremberg inventor, built a number of horseless carriages. They went backwards and forwards and attained a speed of 3,000 paces an hour. The driver steered the vehicle with a lever but the power was provided by two small children inside the carriage turning two cranked handles ! Dr. Elie Richards, a French man devised a similar yet smaller machine to be controlled by two people. The master sat inside suitably protected from the elements by a roof and steered by means of cords attached to the front swivelling axle while the power was provided by the servant standing outside the carriage behind the protective canopy. The servant stood on two treadles and supplied the power by putting his weight alternately on them. It was capable of travelling with ease at six miles an hour, and with particular exertion of the footman at nine or ten miles an hour on a good road. However a lack of any braking system made it dangerous going downhill and no amount of jumping up and down by the footman could make the machine go up a hill. Hence this carriage was in general only calculated for the exercise of gentlemen in parks or gardens.

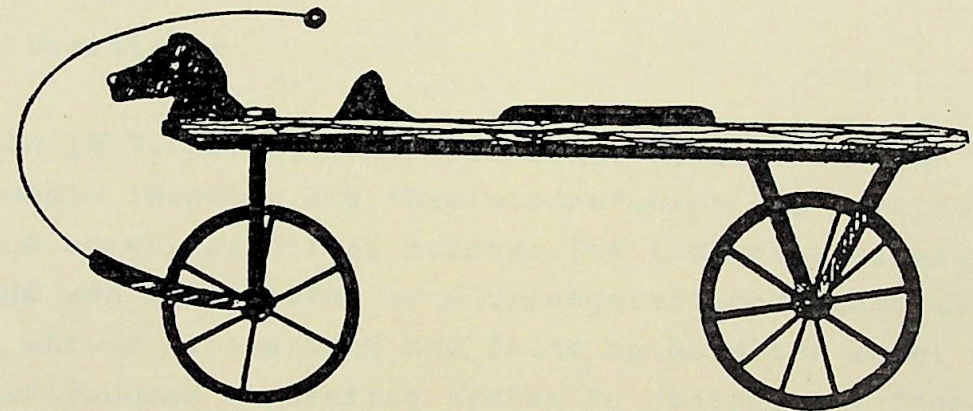
The development of the Velocipede or "Hobby Horse"

In Paris M. Blanchard and M. Masurier, an inventor and balloonist extraordinary, were also at work on these two main velocipèdes. It was basically on the Richards style that Blanchard was ordered in 1790 by royal command to demonstrate his machine before Louis XVI, and obtained the honour of taking the Queen and certain ladies for rides in the park at Versailles. However no one seemed very impressed with the machine and it soon faded and disappeared.

### The Céléfière

In 1805, the Comte de Sivrac, a famous French eccentric, was seen in Paris on the back of a small carved wooden horse fitted with two wheels, propelling himself by moving his legs alternatively in a way similar to running. There was no steering and it could only be turned by the rider leaning over in the direction which he wished to take. The machine was named the Céléfière, and soon numbers of "Incroyables" were seen scudding around the gardens of the Palais-Royale to catch the eyes of the prostitutes who sat there or paraded in the arcades. In 1793, the machine was renamed the Vélodifère and was extremely popular, but more as a fashionable toy than a machine of practical use.

Diagram(2)



The Hobby Horse

The body work on the Hobby Horses was by no means exclusively horses and some were fitted with carved lions heads. At the turn of the century clubs were formed and races held along the Rue Royale and the



Champs Elysées by the young aristocrats of the time Racing was dangerous on these machines as the Céléfière had no steering or brakes and the uneven road surfaces claimed many a casualty to the delight of the onlookers.

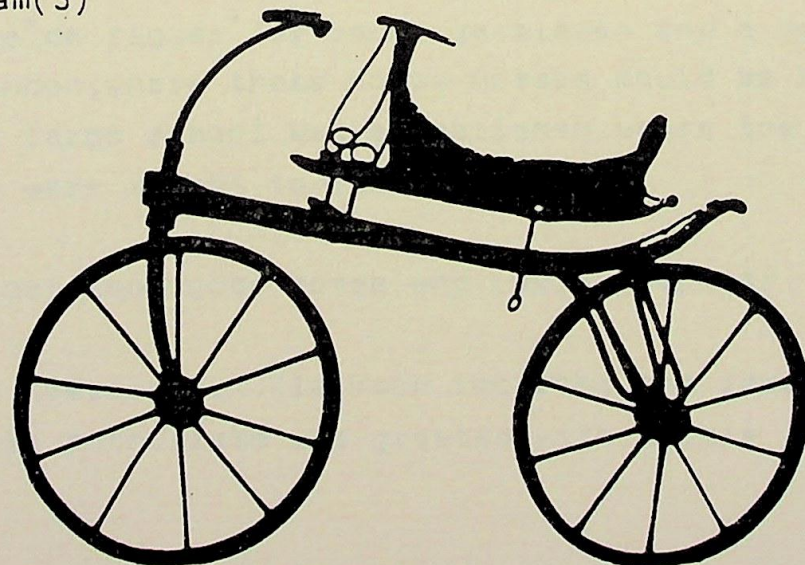
#### The Céléripède

By this time the machine had been slightly redesigned and renamed the Céléripède. This new model had a more comfortable saddle and a more streamlined wooden body. It had two wheels connected by struts to a simple crossbar that ran the length of the machine; but still no steering column to steer the front wheel. However the fad quickly faded as all fashion does and was not resurrected until 1816, but still remained an object of fashion rather than one of practical use.

#### The Draisienne

In 1817, Charles, Baron von Drais de Sauerbrun of Mannheim invented the "Draisienne" which was constructed for a purely practical purpose. The ludicrous horse-like image was substituted by a triangular wood frame with two struts at the back and front to hold the wheel and he introduced a steering system to control the front wheel. He also included a padded armrest on the steering bar so that greater efficiency could be obtained with the feet over rough ground.

Diagram(3)

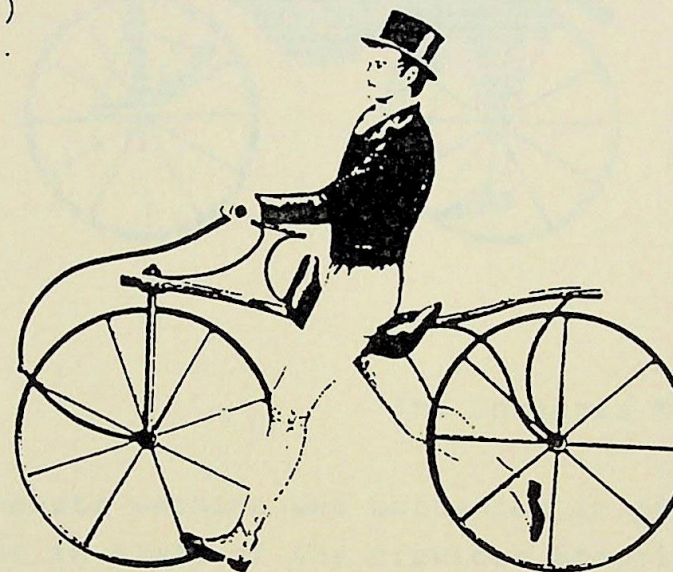


In 1819, a ladies version was produced but it was viewed solely as a pastime rather than a practical means of transport for ladies. The price of the Draisienne varied from eight to ten guineas, and its weight did not exceed fifty pounds!

#### Johnsons Draisienne

The Draisienne was soon introduced into other countries namely England, France and the United States of America. In England it was patented by Denis Johnson and he renamed it the Pedestrian Curricule.

Diagram(4)



The Pedestrian Curricule

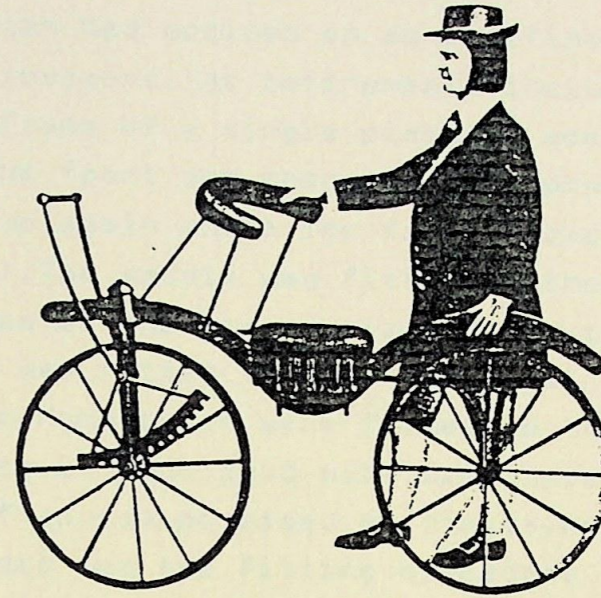
Once again the machine as it had done previously appealed to the fashionable "Dandies" or the "Corinthians" of the Regency period as it had done to the "Incroyables" in France. They were very popular and soon became "de riguer" for young gentlemen and a common sight in London, where these Hobby Horses could be hired out and a large school was established where the aristocrats were taught to ride.

#### The American Hobby Horse and Louis Gompertz

In America, W.K. Clarkson imported the idea in 1819, but his enthusiasm was greeted with little interest.

Before the Hobby Horse craze slowly faded in 1821, Louis Gompertz made some notable improvements to these crude machines.

Diagram (5)



The Gompertz Machine

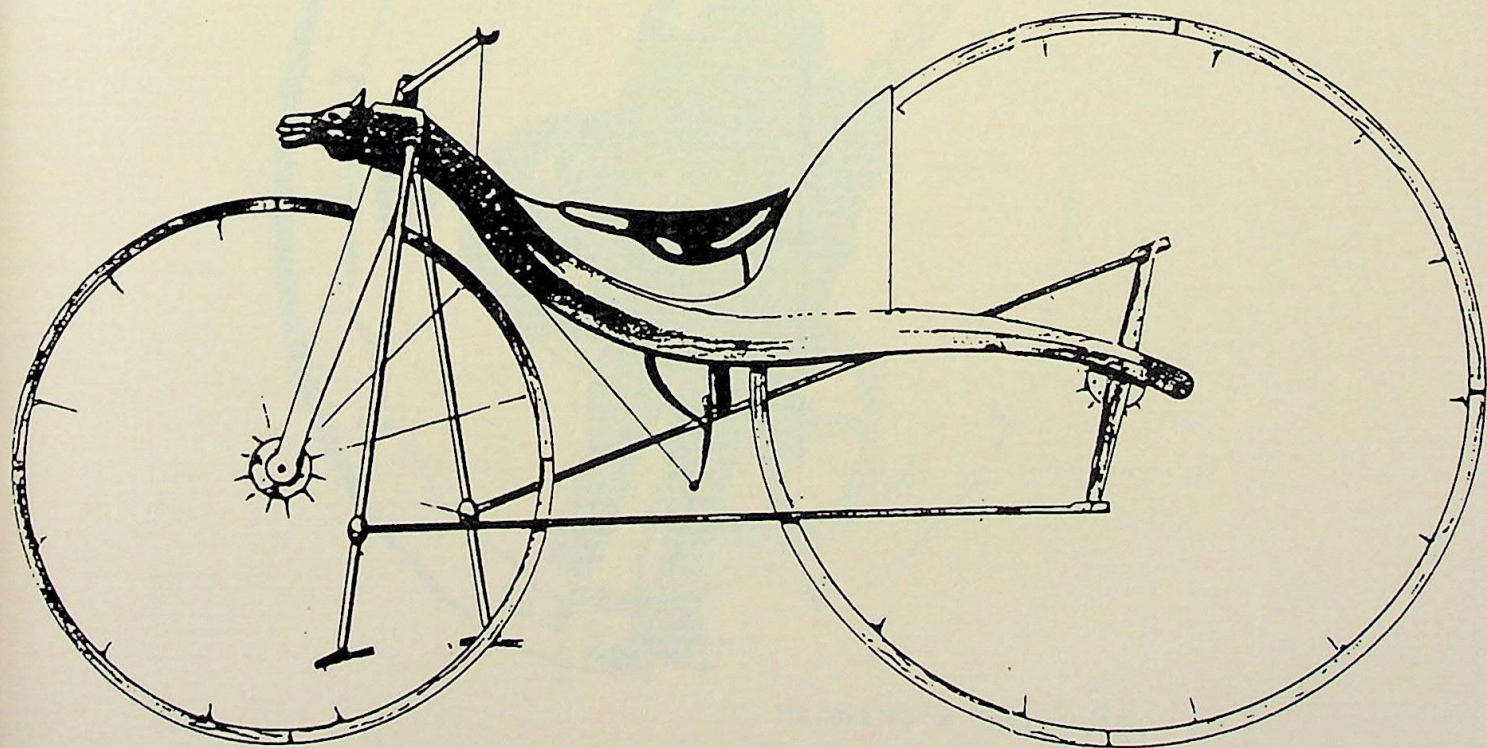
The Gompertz machine was unchanged in appearance except that in place of the previous steering bar he fitted a crossbar with two connecting rods on the end of which was a toothed quadrant which engaged a pinion on the end of the hub. The action of pulling the bar back and forth made the quadrant act on the hub and turned it. A padded chest rest above the saddle was also added to make the machine more efficient.

Interest in the Hobby Horse foot propelled or otherwise soon dwindled by the late 1820's and 1830's, and most of the new ideas of this period were channelled into three and four wheeled horseless carriages. In 1839 however Kirkpatrick Macmillan, a Scottish blacksmith, produced the first pedal driven bicycle in a forge at Courthill in Dumfriesshire.

## THE FIRST PEDAL POWER AND THE BONESHAKER

## Macmillan's mechanically propelled bicycle

Macmillan had decided on some refinements and one great improvement. The refinements included a better designed frame of a single piece of wood shaped from high at the front and then sweeping down and then slightly up again where the frame forked to take the rear wheel. The saddle was fitted on the downward curve and because of the larger size of the rear wheel a protector was fitted to stop the wheel from touching the driver. Handlebars were fitted to the front, the wheels were of wood shod with iron tyres and the machine of course possessed no brakes. However the great step forward was the fitting of pedals or "treadles". Bars were fitted on each side of the top of the frame beneath the handlebars and descended to a suitable level and a foot rest fitted. These bars at the front were connected with rods to cranks on the back axle. The backward and forward movement of the treadles were therefore transmitted to the rear wheel and turned it. Diagram(6)

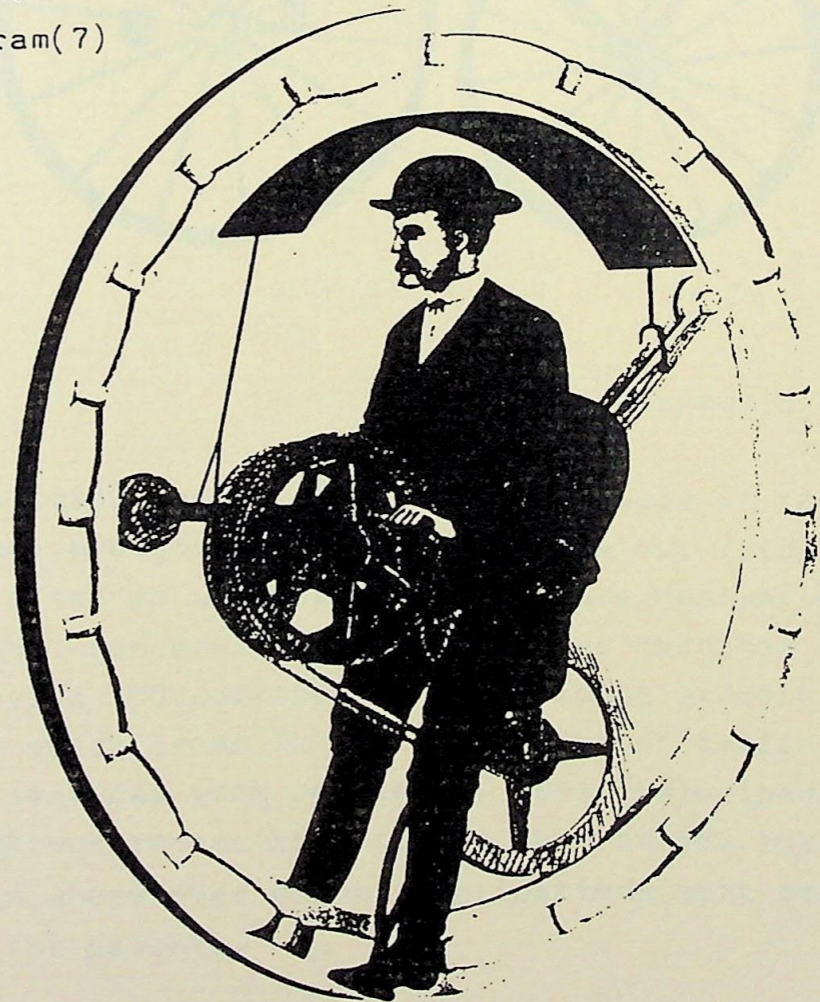


In 1846, Thomas McCall of Kilmarnock built several of these machines which he now fitted with brakes, better steering and alterable connecting rods for long or short legs - all for the price of £7.

Despite Macmillans place as the inventor of the bicycle, in 1801 E.M. Artamonov, a Russian Serf had apparently designed a machine which had a large front wheel and a small back one like the later Pennyfarthing and was driven by pedals fitted to the large front wheel. however despite this claim, it seems highly unlikely that the date of this "invention" is correct.

For the next few decades the development of the bicycle was to take a back seat to velocipedes of three or more wheels. Those that were made with two wheels were either impractical, useless or no improvement on what Macmillan had accomplished. One such machine was Hemmings Unicycle built by Richard Hemmings of Connecticut, U.S.A.

Diagram(7)

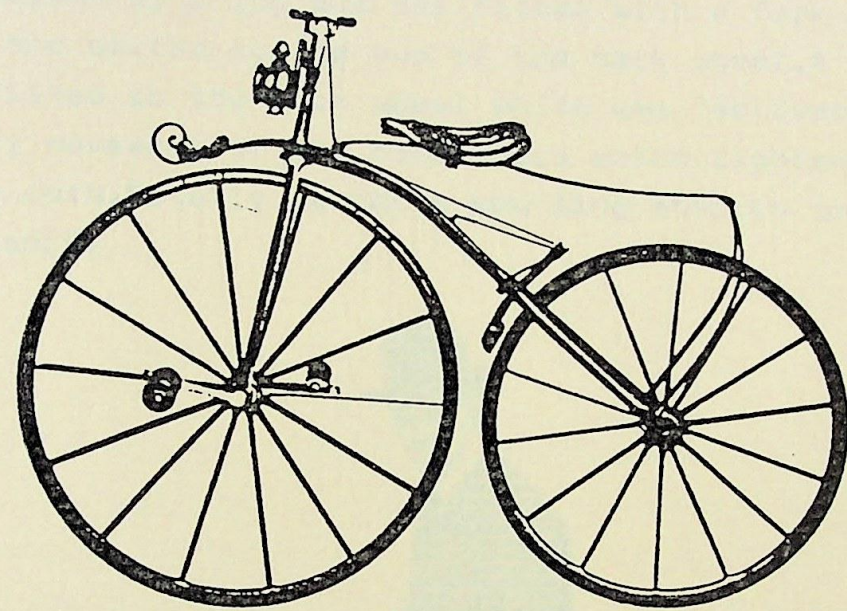


Hemming's Unicycle

Pierre and Ernest Michaux and the first pedal driven bicycle.

In 1861 Pierre and Ernest Michaux produced the first commercial two wheeled pedal driven bicycle. They fitted two cranks on either side of the hub of the front wheel and attached wood pedal blocks to them. And so was born the first pedal driven bicycle.

Diagram(8)

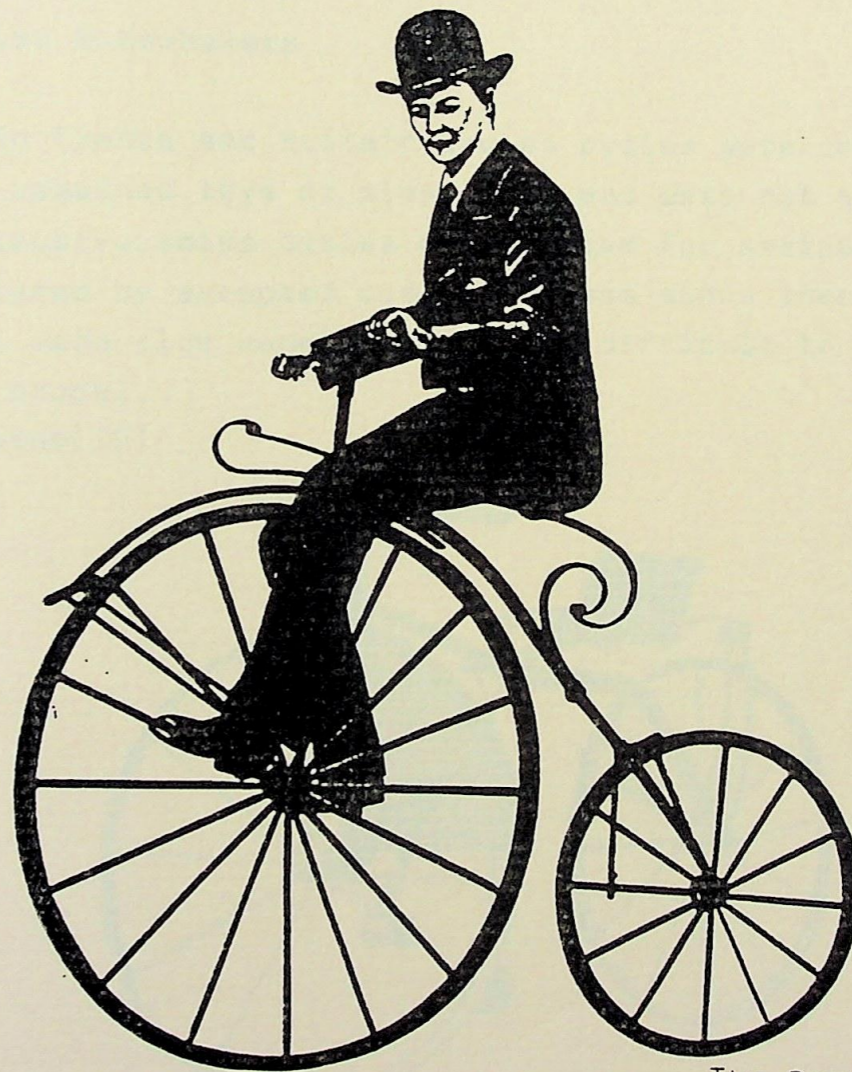


The Michaux Bicycle

In 1863, Pierre Lallement, an employee of the Michaux company, brought the idea to America but returned in 1867 after an unsuccessful adventure. Meanwhile the Michaux concern was producing five machines a day and employing 300 workmen, and soon riding schools were once again established to teach the "art of cycling" and hire services were popular. By 1869 "Velocipedomania" had struck respectable cities such as New York and Boston, where over eighty applications were received a week for patents.

## The Boneshaker

The bicycle was soon to be known as the "Boneshaker" and its frame was made from wrought iron diamond section bar which formed a fork section at the rear to accommodate the wheel (slightly smaller than the front wheel) while the front wheel, fitted with brass bearings, was placed between a fork which was in turn fitted to the frame so that it could turn from side to side. The saddle was fitted on a leaf spring stretched from the steering column by a lug and was fitted with a fork at the rear and bolted to the hub of the back wheel. A brake was fitted to the back wheel which was "activated" by a rotary movement of the handlebars which tightened the brake cord. Finally it had a mounting step on one side. Diagram(9)



The Boneshaker

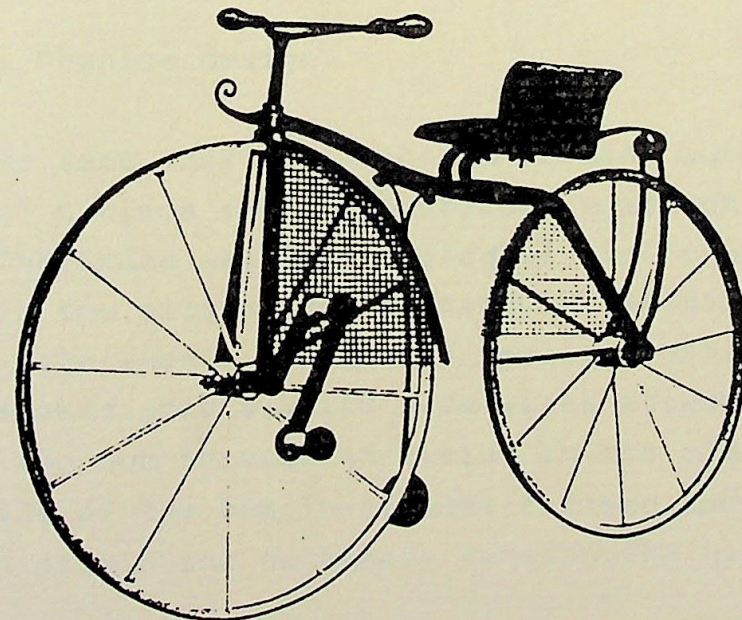
In 1871 the American Velocipede was dead, mainly because it had been treated as a fad or fashion rather than as a serious means of propulsion. In America it had been considered as a toy; but in France and Britain it was still considered a worthwhile and useful machine capable of many applications and providing a means of reliable transport.

French and British cycle clubs were soon established along with cycling magazines and shows. Two and three wheeled cycles and some with even more wheels were now in existence. Wheels were now fitted with spokes, some with solid rubber tyres or treads and some cycles had an elementary form of springing on the front wheel to help cushion the driver against bad road conditions. Tubular metal frames had also been introduced along with brakes.

#### Ladies Boneshakers

In France and Britain ladies cycles were constructed but remained toys or playthings and were not taken seriously. Ladies cycles constructed for serious use were hampered by accepted codes of dress since these machines were made side saddle; which were difficult to control and propel.

Diagram(10)





With the invention of the "Bloomer", a type of Eastern pantaloons for women worn first by Mrs. Miller of New York (and not by Mrs. Amelia Bloomer), women's cycling really caught on; especially in France. In 1868 the first ladies cycle race was held, with some skirts flying and the more adventurous ladies donned in Bloomers showing a "scandalous" amount of leg.

By 1870 France and Prussia were at war. Although cycle production resumed after the war and the French defeat, Britain had forged ahead, while in America the mania had disappeared.

Two wheeled machines had been ignored in Britain until 1869, when Rowley B. Turner, an Englishman studying in Paris and an agent for the Coventry Sewing Machine Co., established a company for the manufacture of "Bone-shakers". Business boomed for him in France, and Turner contracted his uncle Josiah Turner, manager of the Coventry Sewing Machine Co. and James Starley the head foreman at the works, to manufacture 400 Boneshakers which could be sold in France.

However, before this order could be completed, war had broken out in France, and so these "frustrated exports" were put on the British market.

With the "launching" of the cycle in earnest on the British market, cyclemania struck London and other cities and towns but mainly in Liverpool.

#### Reynolds Phantom design

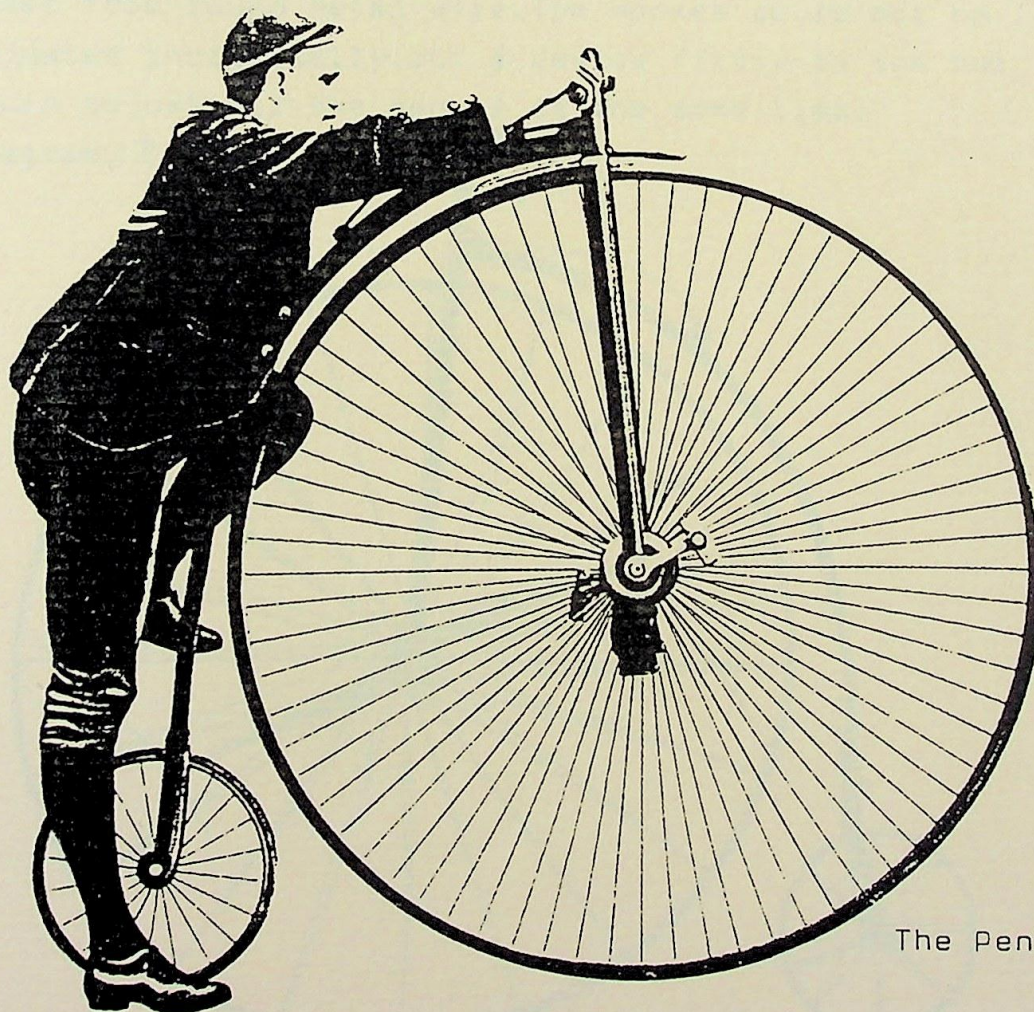
In the same year W.F. Reynolds brought out his "Phantom" cycle, a revolutionary new approach to cycle design. The frame was constructed of iron rods and was hinged in the middle. This allowed the steering to be done by both wheels and gave a smaller turning circle. It had spoked wheels, which were wires attached to one side of the hub through an eyelet in the rim to the other side of the hub. There were fifteen spokes per wheel. To obtain the necessary tension, the hub was made

in two parts which were wedged together after the wheel had been made. The wheel also had a solid rubber tyre attached to it. This innovation caught on rapidly and within three years the wood wheel for the cycle had disappeared. An advantage was that this machine weighed only 53 pounds!

#### A growing front wheel

Another development had also taken place: this was the increasing size of the front wheel. This came about because the larger the wheel the more distance was covered in a single turn of the front wheel. This theory was to be taken to absurd lengths during the 1870's, before the gear, the chain and shaft-driven machines were invented, later to be known as "Ordinaries" or "Penny-farthings".

Diagram(11)



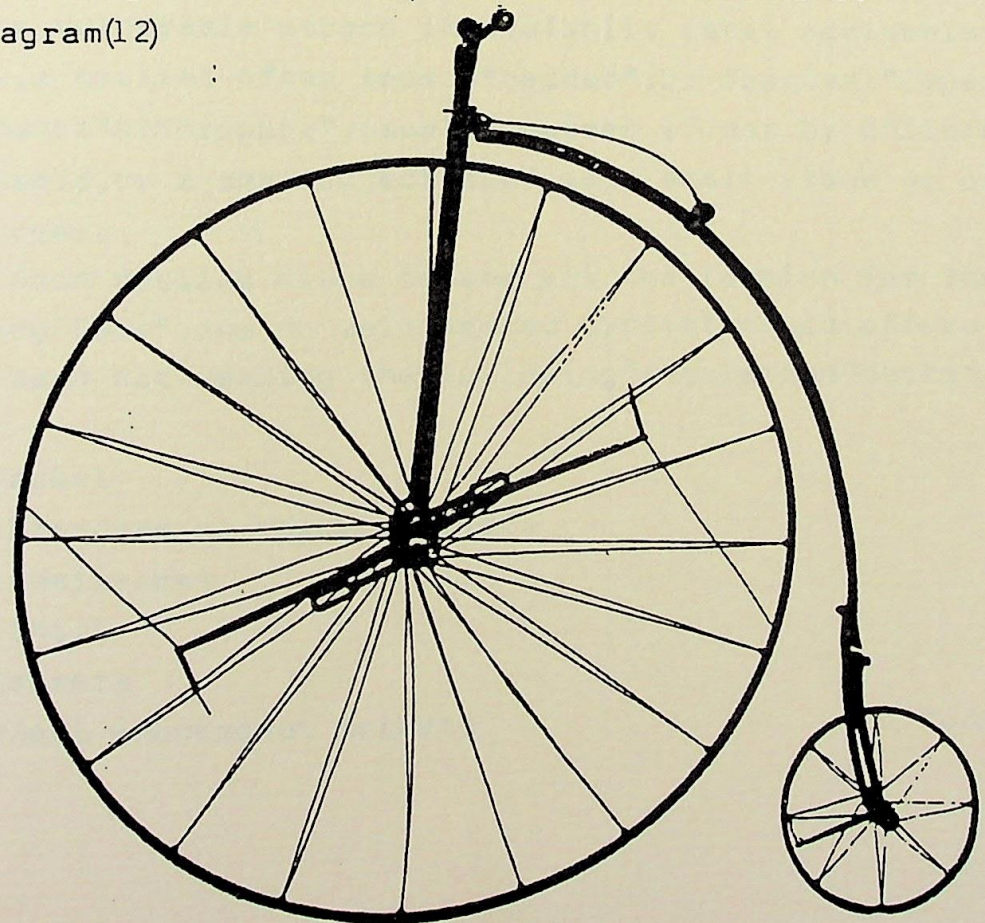
The Penny-Farthing

## ORDINNARIES AND DWARF ORDINARIES

James Starley's "Ariel", the first "Ordinary".

The Boneshaker continued to be manufactured until around 1872, but was declining in popularity, namely because it needed a lot of leg muscle power to get the machine to go anywhere. However it was already in 1869, that James Starley, "the father of the cycle industry", had brought back the doomed bicycle industry with the introduction of the larger front wheel, which enabled a rider to cover more ground with a single revolution of the pedal, the machine having a front wheel of 48 ins. and a rear wheel of 24 ins. in diameter. This latest design of bicycle was named the, "Ariel", a unique machine with an iron frame and wheels which were fitted with tangential spokes. These ribbon spokes were first made from sheet brass, then strips of steel and finally later from round metal wire. The spokes could not be adjusted individually, but a device fitted to the hub could adjust all the spokes at the same time.

Diagram(12)



The Ariel

Within two years the Boneshaker was outmoded by these "Ordinaries", whose wheel diameters grew up to sixty in's! In 1873 Starley patented his tangent spoking for wheels which is the method still in use today. Starley's method was to set the spokes in a rim at a slant so that they crossed each other and provided extra tension and strength.

By the mid-1870's, 50,000 ordinaries or "Penny-farthings" (so named in England because of an apparent allusion to the image of the large English penny next to the diminutive farthing.), were terrorising the roads. Speeds never dreamed of could be obtained on these dangerous and difficult machines, however poor roads were still abundant and doubled the risk of a fall! They were in general a public nuisance, very dangerous and frightened horses. Police and magistrates interpreted the law with a bias against cyclists and the public dubbed them with such names as "Cads on castors". Young boys delighted in upsetting these "Cads" by pushing sticks through the spokes. Along with a high unstable driving position, thin wheel rims and tyres, the "Ordinary" cyclist was a very vulnerable person indeed! While fatal accidents were few, a cyclist often took a "header", or frequent "Imperial-crowner" or "cropper", usually caused if not by children or animals, by a small object such as a small stone or piece of coal.

Soon cycling clubs became all the fashion for these young "Cads", and no well heeled cyclist could afford to be seen not wearing the following "regulation" outfit:

- i) Jacket
- ii) Breeches or Knickerbockers
- iii) Waistcoat
- iv) Shirt
- v) Gaiters
- vi) Soft knockabout helmets

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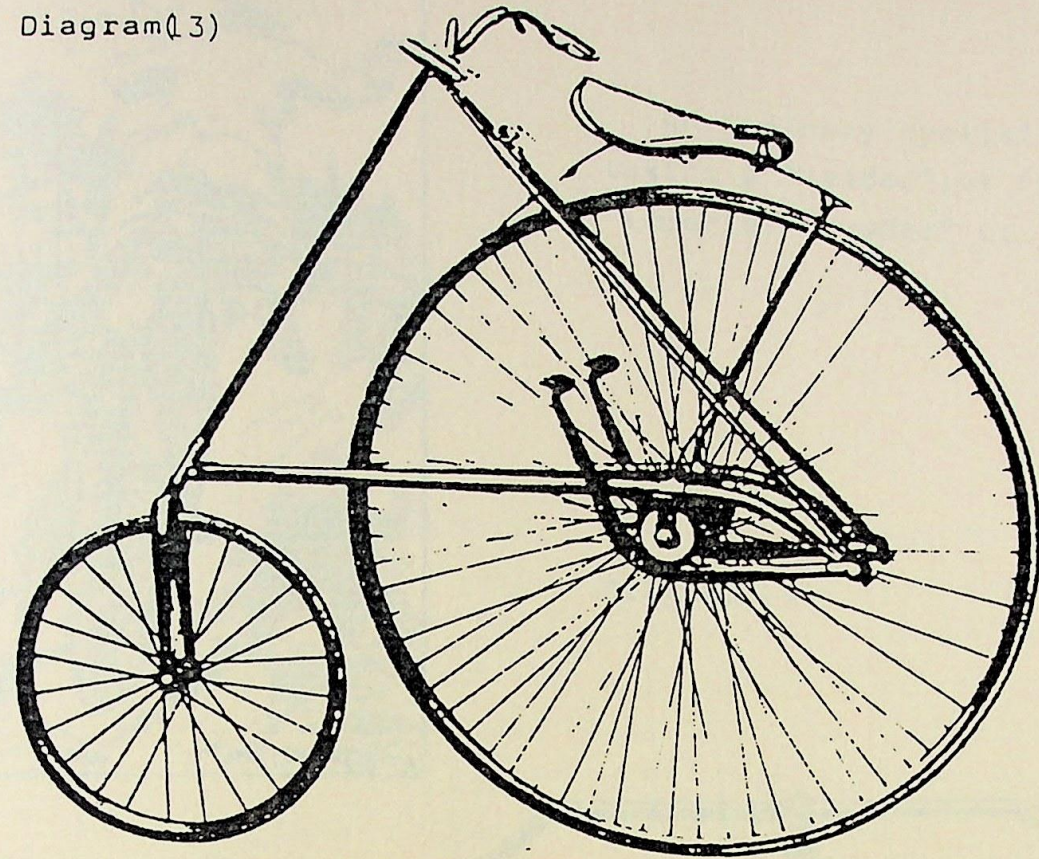
- vii) White straw hats...with registered ribbon
- viii) Registered ribbon
- ix) Polocaps
- x) Dearstalker or Wideawake
- xi) Puggarees for helmet
- xii) Stockings
- xiii) Gloves
- xiv) Silk handkerchiefs or Mufflers...registered 14ins.sq.

By 1876 many races were being held and these racers had established a number of records. A lighter "stub" axle for the rear wheel had been invented which lightened the machine by doing away with the fork. In the same year ballbearings were introduced to replace the traditional rear and front brass bushes. By the end of the 1870's the Ordinary had reached its peak of perfection and although by the early 1880's its popularity was decreasing it took another ten years before the manufacturers of the Ordinary ceased.

#### W.S.Kelly's "Star" bicycle

In 1881 W.S.Kelly, an American, designed his improved "Star" cycle. The Star cycle had a large rear wheel and a small front wheel, was lower on the ground than the Ordinary and had front wheel propulsion but rear wheel steering. The seat was strategically placed to enable the rider to mount before moving off. It was a very efficient design but died out from the competition with more advanced designs.

Diagram(13)

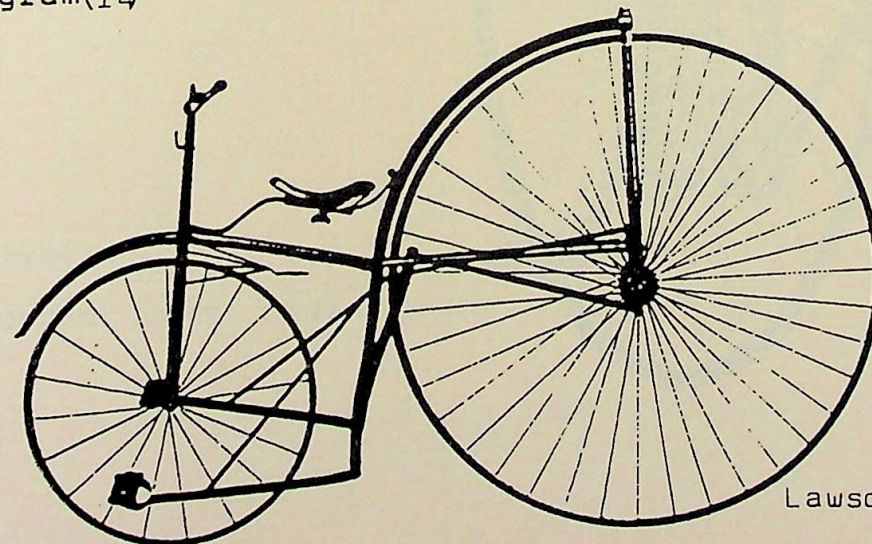


The "Star"

Lawson's Bicyclette

The first so-called dwarf safety bicycle that was actually put into production—a rear driven, chain-driven machine, was designed by H.J. Lawson. It was an ordinary in reverse with steering on the front wheel, the saddle was situated between the two wheels and therefore nearer the ground. It was propelled by means of pedals which worked on long thin cranks to the back wheel hub.

Diagram(14)

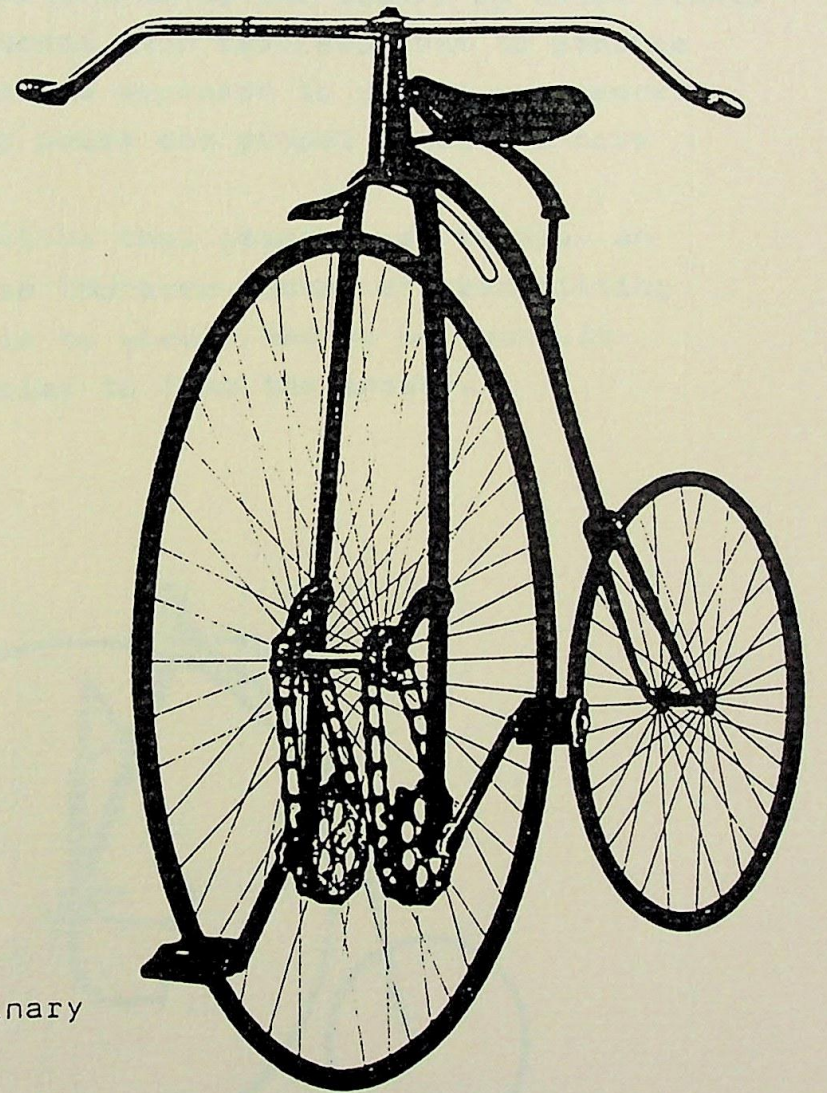


Lawson's Bicyclette



An Ordinary cyclist  
taking a "Header", or frequent  
"Imperial Crowner" or "Cropper"

Diagram(15)



Diagram(16)

"Kangaroo" Dwarf Ordinary

### The Xtraordinary

Next came the "Xtraordinary" a serious rival to the Ordinary. Its saddle was slightly farther back than usual and the pedals had levers and links so that the rider could reach them.

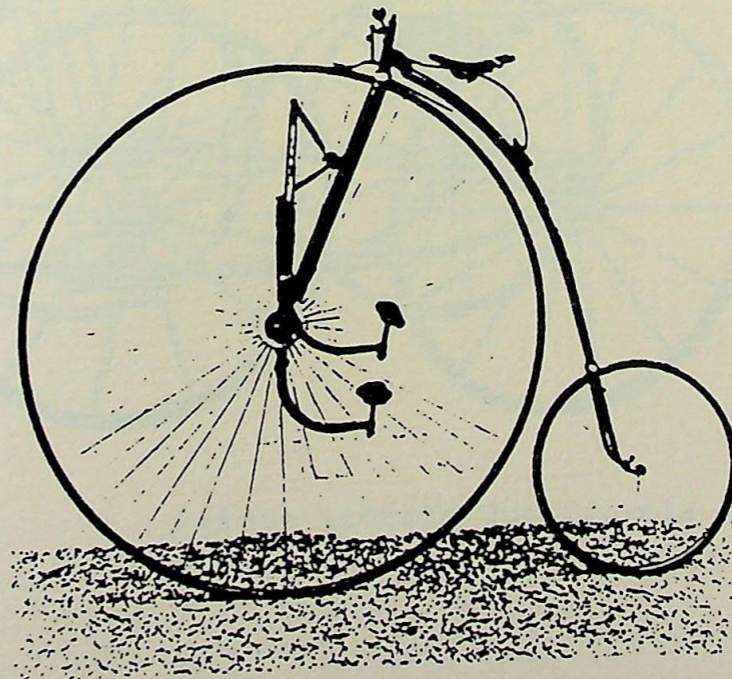
### The Facile

The Facile bicycle went one better by reducing the front wheel to a mere 42ins. placing the saddle back slightly and employing pedals, which were lowered and worked on levers which were mounted below the hub. These levers were pivoted at the front end to a specially extended front fork and joined to the cranks by short links.

However manufacturers soon realised that to produce a more safer cycle a new approach to design was needed to harness human leg power and propel a machine more efficiently.

It was by now obvious that gearing was to play an important part but an improved method of transmitting the power from pedals to wheels had to be found. It took John Kempt Starley to find the answer.

Diagram(17)



The Xtraordinary

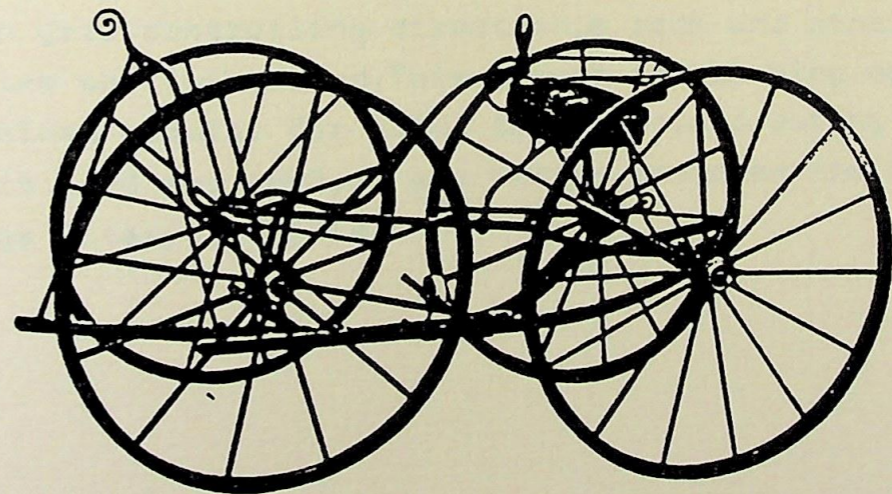


## QUADRICYCLES, TRICYCLES, TANDEMS AND OTHERS

The tricycle was, until the advent of the safety bicycle, the bicycle's most serious rival. It was more stable, provided women with elegant transport and could be ridden by two if so designed. The earliest machines designed had at least three and more often four wheels. During the 1860's, William Sawyer was the most well known designer of Quadri and Tricycles. His clients were mainly amongst "elderly gentlemen, ladies and persons of a timid or nervous nature", who for one reason or another, mainly social, drove slowly around to be seen.

## The Quadricycle

Perhaps the most famous Quadricycle or "four wheeler" was that made by J. Ward for Prince Albert. It was rather heavy and had a central steering bar, operated by an upright handle connected to the front wheels. It was powered by two treadles fitted to cranks and the wheels turned by a forward and backward movement of the feet. Diagram(8)



Prince Albert's Quadricycle 1851

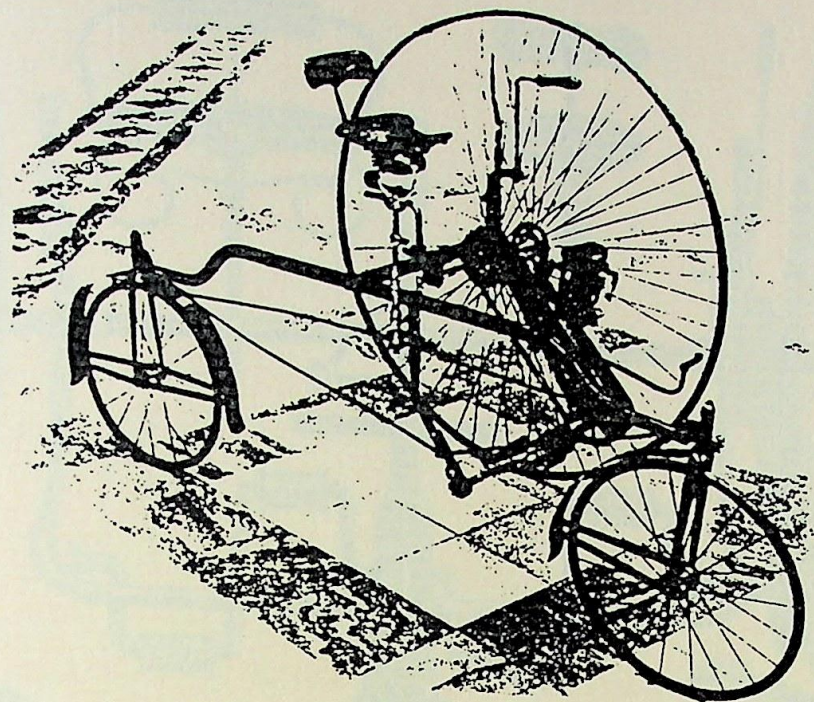
### The Sociables

The largest number of more than two wheeled machines fall into the tricycle category and were responsible for the later cult of "sociable" cycling in the late 1800's.

### The Tricycles

The first Tricycles were really just modified Bone-shakers, with an extra rear wheel and axle. However some variations included the two-seater tricycle and the Dublin tricycle, which had a large single rear wheel with two smaller front wheels. It was propelled by wood treadles which worked levers and rods attached to cranks on the rear wheel and the seat was mounted in front of the rear wheel in the centre of the machine. The seat had a flat base and back and was mounted on coiled springs for a more comfortable ride. As a tricycle it was a unique design because when it was viewed from the front it had a large wheel on the right hand side and two small ones on the left. The large wheel was driven and the smaller ones steered the machine. Initially it was powered by levers and cranks but was later altered to the more conventional chain drive. The steering was also improved. Instead of a single rod with grip controlling direction, a rack and pinion system was introduced. This rather odd looking machine remained popular for about ten years, and during the years 1880 and 1890, it was better known as the Coventry Rudge Rotary Tricycle.

Diagram(19)

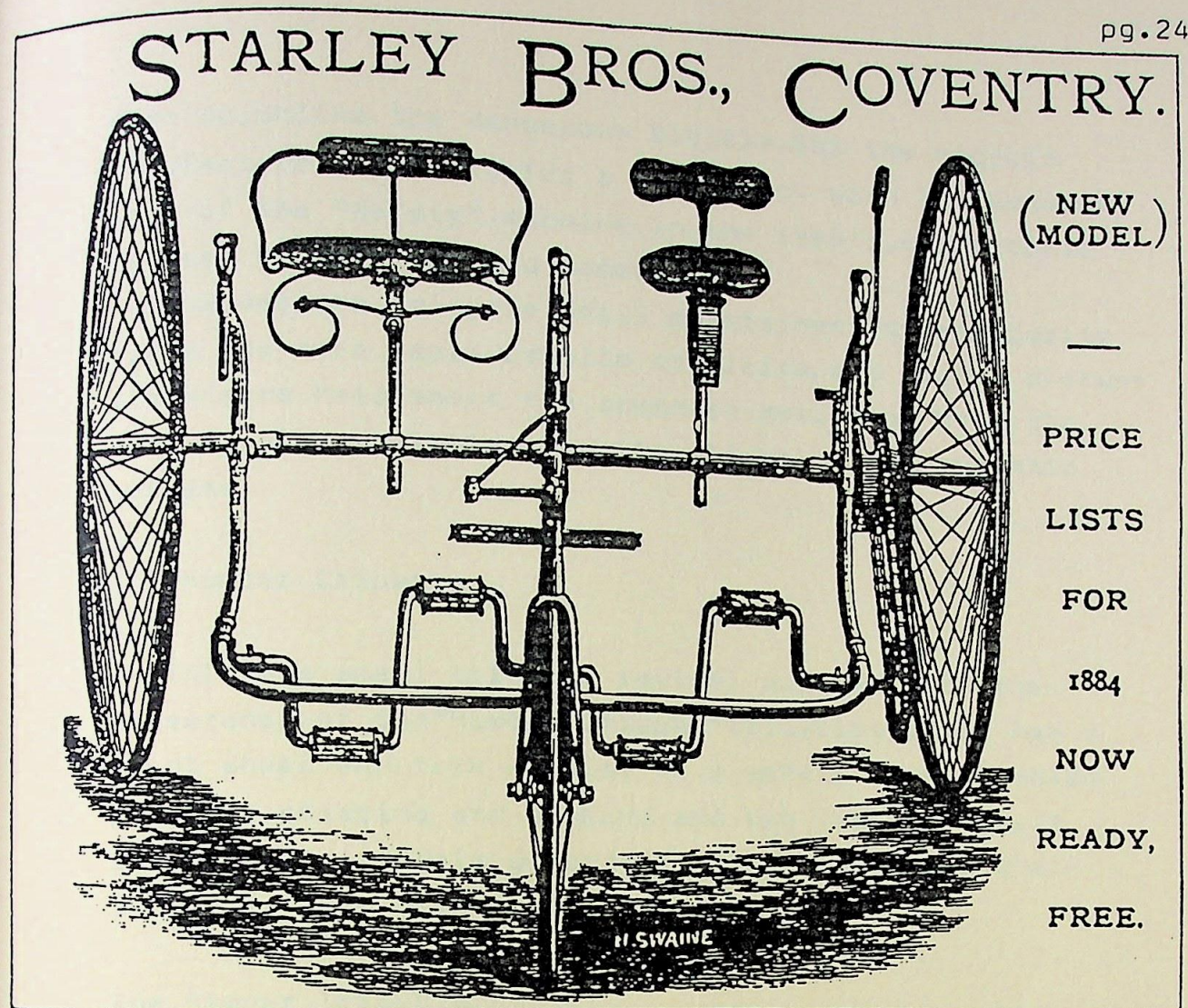


The Coventry Rudge Rotary Tricycle

## The Salvoquadricycle or Royal Salvo

The most unique aspect of this machine was the use of Starley's newly patented bevel gear differential unit which was used to equalize the revolutions of the driving wheel. He split the axle in two parts and joined them with a unit of bevel wheels and pinions which allowed an equal power transmission to both driving wheels and had the added advantage that when cornering, the outer wheel rotated faster than the inner one. However the Salvoquadricycle was actually a tricycle as Starley had removed one of the small central wheels and provided an arm with a minute wheel as a steadying wheel at the front.

The name however was soon changed again to the "Royal Salvo" because in June 1881 Queen Victoria ordered two of these machines.



The Royal Salvo

Bicycles were still more popular than tricycles, but perhaps one of the major influences in the social acceptance of the tricycle was Queen Victoria, especially for ladies. Although she never rode one herself she obviously "approved of the machine for women and this caused an upsurge in the "socible" type of machine, where men and women sat side by side. Gentlemen, however preferred the tandem arrangement on tricycles being more sporty and speedier.

It now seemed that the tricycle, the tandem and socible especially were becoming more popular than the bicycle. This occurred because of the sociable aspect of the machine, and the fact that it was quite acceptable for a lady to saunter slowly with her husband or paramour on one and that it was easy to ride and respectable to be

seen on, unlike the dangerous bicycle. But the bicycle manufacturers were in for a rude shock with the appearance of the "Safety" machine in the 1890's, which could be used by both men and women.

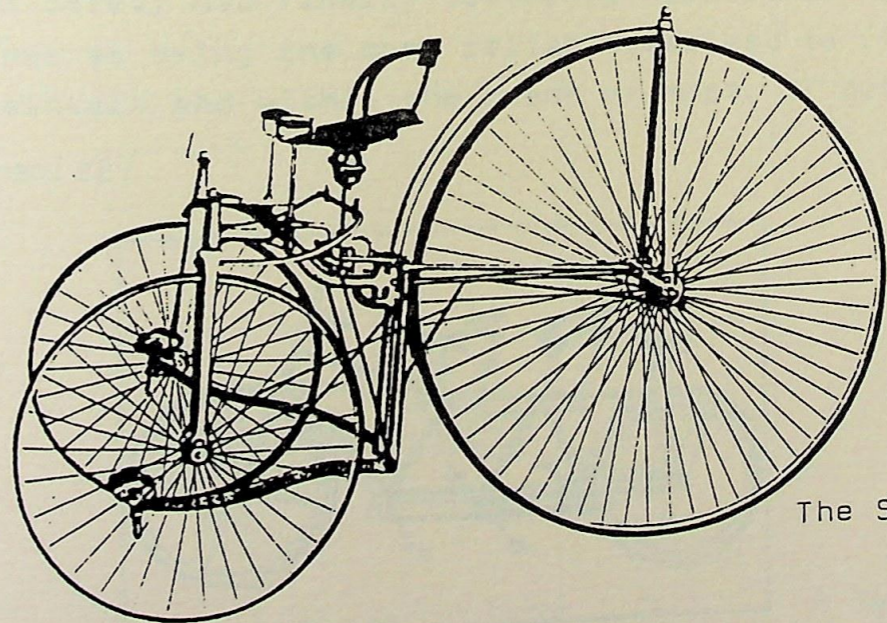
However the tricycle still maintained its popularity for a few more years despite criticism, and heated discussions were held about the romantic merits of both the side-by-side sociables and the slightly less romantic tandems.

#### The Humber Crippers

In 1886 a small tricycle revival occurred, with the appearance of the "Humber Crippler" tricycles which had a front wheel and fork similar to a safety machine which provided steering and braking and two rear wheels. It was driven by pedals working a cogged wheel and chain to a rear axle with a differential.

#### The Singer Tricycle

Naturally Starley came up with a similar design which he called the Singer tricycle. It had slightly smaller rear wheels and a larger front wheel with a lower saddle and seemingly more relaxed driving position.  
Diagram(2)



The Singer Tricycle

## The Tandem

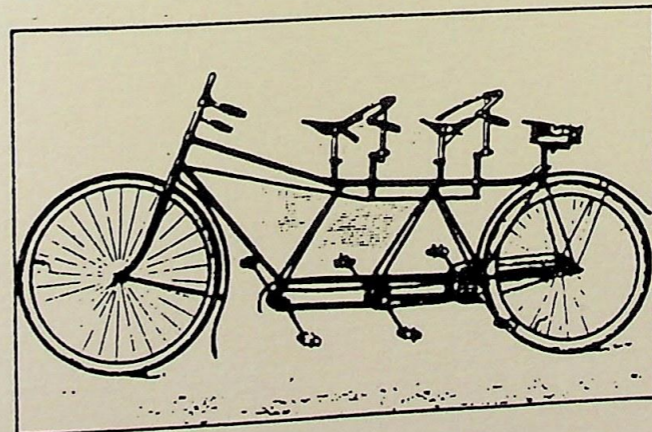
The idea of a simple "Tandem" was taken to amazing lengths and machines that took four, six, eight and even ten riders were manufactured. One of the biggest single frame tandems was the machine designed for fourteen men one behind the other. It was over thirty feet long and named the "Quatroddecimalope!"

By the late 1890's the tricycle and other multiwheeled machines began to lose their popularity when the acceptance of the Safety bicycle and improved performance and sturdiness made cycling possible for all. However, unlike the Quadricycles which became totally obsolete, the Tricycles were still to be found in small numbers as delivery vehicles and in the military where they were mounted with machine guns. Even today the tricycle continues to be a sturdy well balanced, reliable machine and is still regarded as the only machine for the very young.

By the turn of the century the Tricycle had attained its ultimate level, with all its wheels being of equal size and in every other appearance the same as the Safety. Although the Tricycle still had a large commercial following and was used for deliveries by tradesmen as well as the post office, by the turn of the century, the Safety with special arrangements for carrying goods and parcels was the more accepted machine.

The Safety had finally triumphed over other forms of machines as being the most reliable, easiest to ride and maintain and within the reach of most, if not all.

Diagram(22)



A Tandem Triplet

## THE SAFETY BICYCLE TO 1900

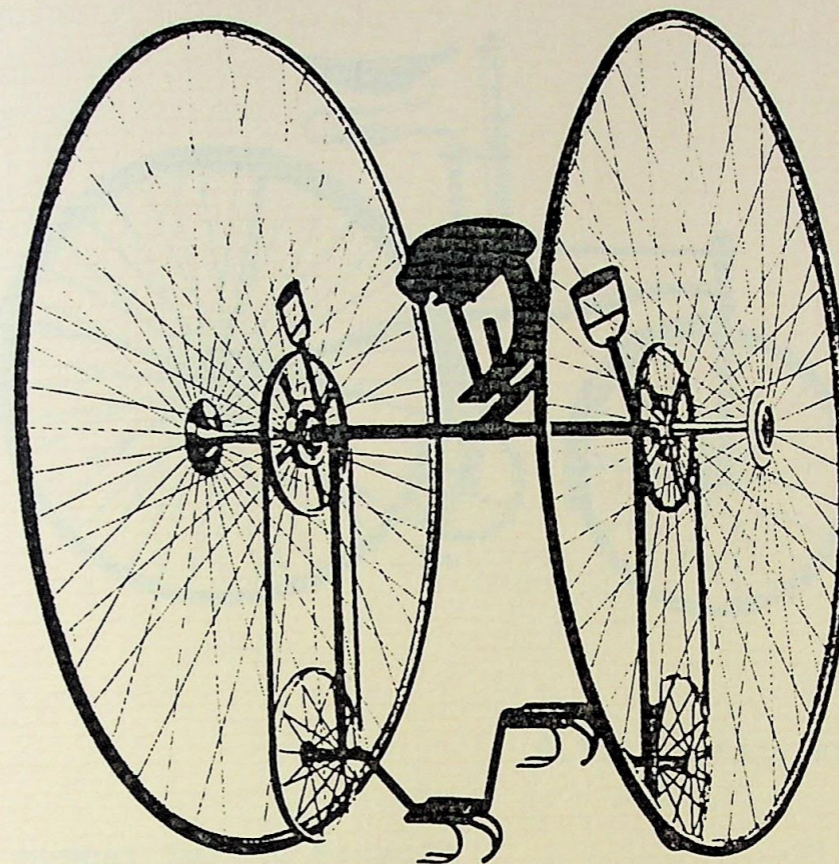
## The Safety

The Safety bicycle evolved over a number of years with various manufacturers and designers contributing to its advancement. The dwarf ordinaries were a step in the right direction of the Safety, but they were still propelled by driving the front wheel. Perhaps closer to the origins of the Safety bicycle was a machine patented by Thomas Shergold in 1878, as his machine had a chain drive to the rear wheel, two wheels the same size a saddle over the centre of the rear wheel and two forks from the frame which held a cogged wheel to which was attached cranks and pedals. The larger cogged wheel was attached to a smaller cogged wheel (providing suitable gearing) which was the centre of the rear wheel. So by pedalling the power was transmitted, geared up, to the rear wheel.

## The Otto Dicycle

In 1880 B.S.A. produced the Otto Dicycle which had two large wheels side by side with a space in the centre and connected with an axle and frame, to which a saddle was fitted, slightly behind the axle pedals. Cranks were fitted to driving wheels on the frame extension and connected to another set of wheels at the hub of the large road wheels by a steel belt. However, soon the Otto was abandoned except for a few enthusiastic "Ottoists".

Diagram(23)



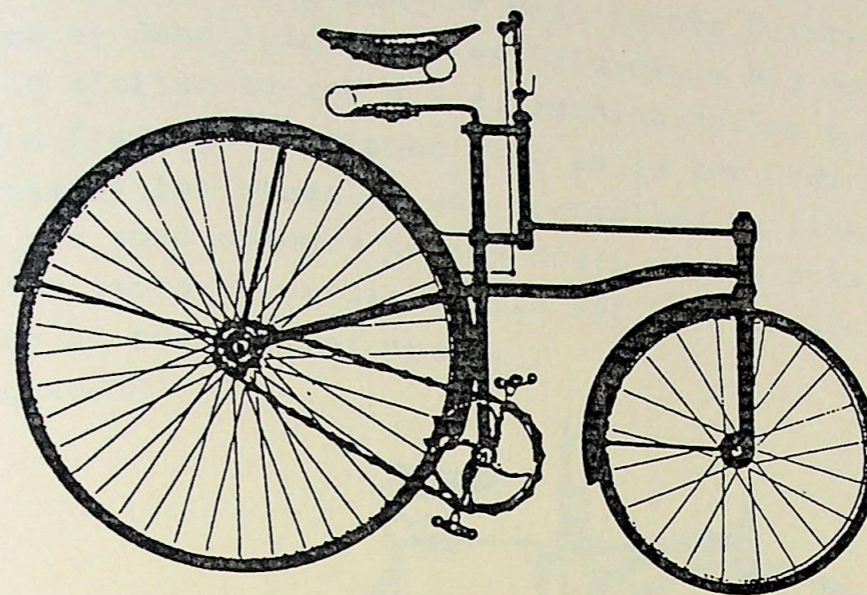
Otto Dicycle

## British Small Arms (B.S.A.)

By 1884, B.S.A. patented another bicycle made up of both left over Tricycle and Otto Dicycle parts, and old rifle clearing rods, which gave it its odd shape. It still had the traditional larger rear wheel and footrest on the smaller front wheel for coasting (there being no "free wheel" on the machine). It had mud guards and handlebars to which the rifle clearing rods were linked and subsequently turned the front wheel.



Diagram(24)

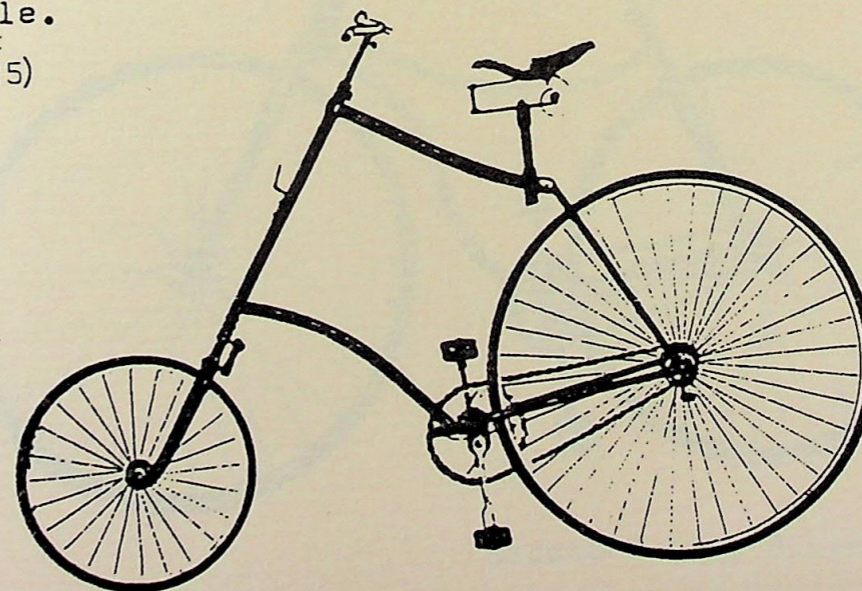


B.S.A. Safety Bicycle

#### The Humber Safety Bicycle

In the same year Humber and Co. produced their own version of the Safety bicycle which still had the larger rear wheel. The frame consisted of a single column at the front with, at the top part, a bar joined which ran back, holding the saddle above the rear wheel and another bar from the bottom of the front column which held the cogged driving wheel and connected again with the forks to the rear wheel hub. The steering was direct without any levers or links. Saddle and handle bar heights were adjustable.

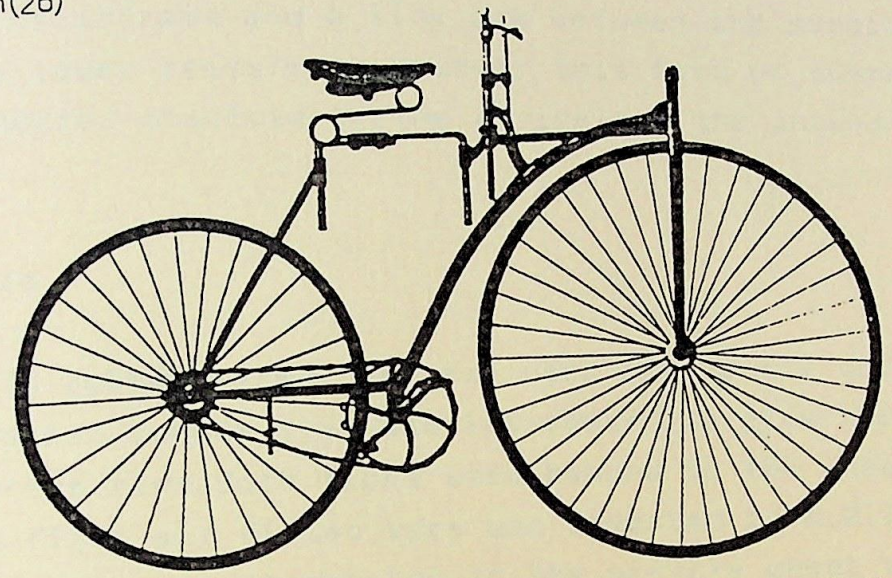
Diagram(25)



The True Safety

Another and perhaps the most famous Safety was produced by John Kempt Starley. Originally his machine was quite similar to the B.S.A. machine, having a larger front and a frame which dipped down as in the Ordinary cycles. Initially the steering was controlled by links and rods, but was soon changed to the newer direct steering method on the improved version, while still retaining the basic shape of the earlier model.

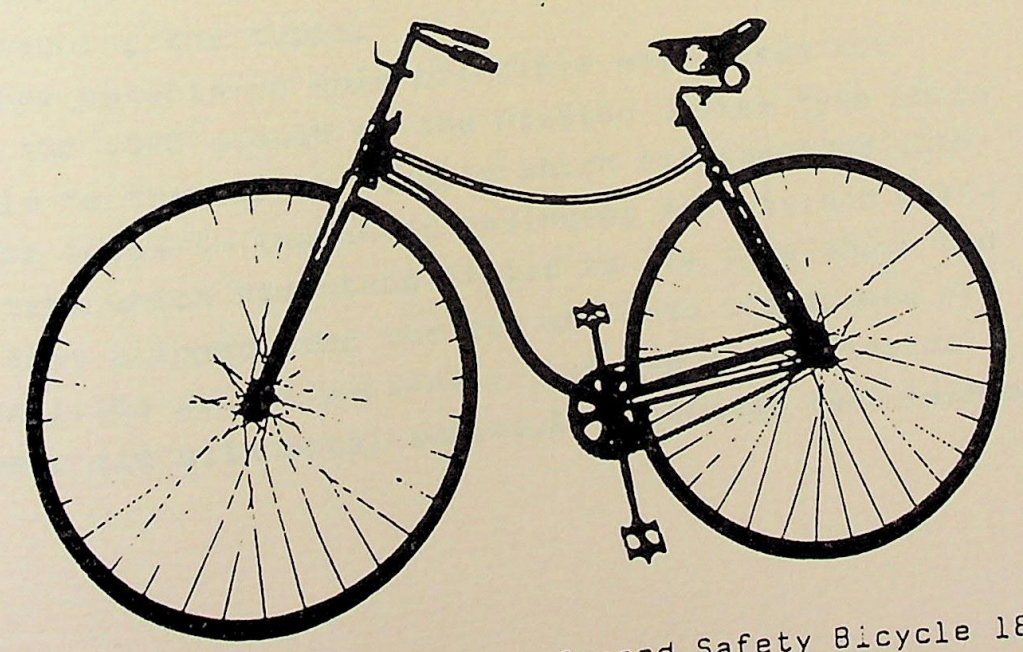
Diagram(26)



Starleys Safety

Starley produced another model in 1885, and this time the "Safety" was born.

Diagram(27)



Second Safety Bicycle 1885

### The Whippet

Another significant machine that appeared at this time was the "Whippet". It had a tube frame, direct steering and chain drive but its uniqueness was in the construction of the frame. The frame of the machine was sprung, but the position of the saddle handlebars and pedals was not altered as they were constructed on a separate rigid frame. The machine had flexible joints and springs, a coiled one stretching from the front driving and cogged wheel to the crossframe and a link arm between the saddle tube and the lower crossframe. However this form of suspension was rendered obsolete by the arrival of the pneumatic tyre.

### The Tyre

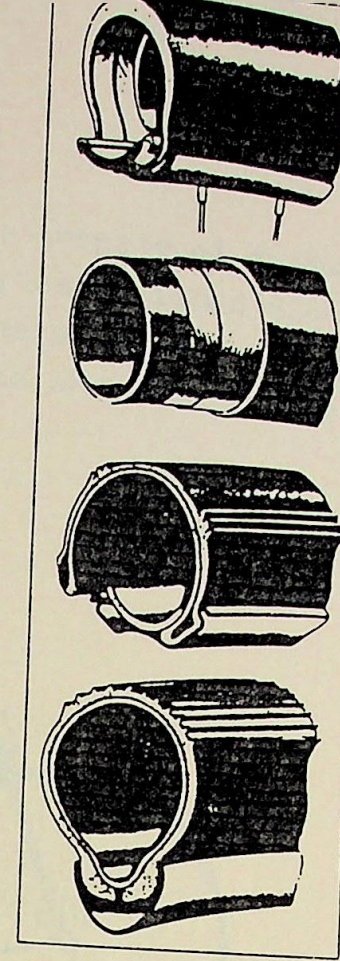
Solid rubber tyres had been used previously and later the cushion rubber tyre was introduced to give the cyclist a smoother ride. Both types were bonded to the wheel rim.

The first air filled tyre was invented by R.W. Thomassen in 1845, but was not adapted to the bicycle wheel until 1889 when John Boyd Dunlop fitted the tube with an outer covering which was secured to the wheel by cement and binding. Dunlop soon formed a company to manufacture the tyre and joined the brothers André and Edouard Michelin of France in the 1890's to perfect the method of attaching and detaching the tyres.

Other patents on this principle were taken out during the 1890's, such as the Preston Davies tyre which was held to the rim by staples which corresponded with wires or loops in the outer casing; or the Leyland pneumatic tyre which had studs fitted to the tyre, which had hooks that clipped over the rim and onto the spokes of the wheel. The Wright protector tyre was fitted inside the wheel rim with metal scales, in a lobster tail fashion;

apparently rendering punctures impossible but this and other very impractical tyres soon disappeared leaving the by now conventional tyres to Dunlop and Michelin.

Diagram(28) Right; Four early pneumatic tyres: the original Dunlop invention, a cross ply development, the Clincher-which was the first attempt to key the cover to its rim with air pressure, and a tubeless design.



#### Gears

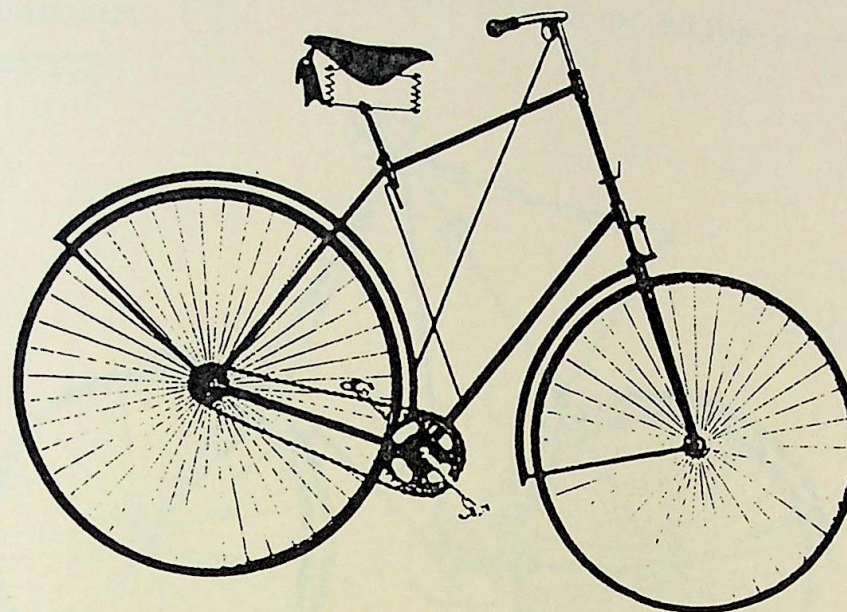
After the invention of the pneumatic tyre came the invention of the gear. In 1887, the Sparbook bicycle had two gears but this involved two driving chains: and it wasn't until 1896 that W. Reilly invented the first suitable gearing but was still only used to a limited extent.

#### The Crypto Geared Facile

Meanwhile there had been more advances in the design of the bicycle itself; although there were as always the few die-hards who continued to manufacture the chainless Ordinaries. One such example was the Crypto geared facile. It was reminiscent of the Ordinaries still produced in 1888, with lever pedals to drive the larger front wheel. Crypto stuck out to the last with their machine, and developed it further until it had gearing in the front hub with front wheel cranks and pedals, refusing to accept defeat against the by now well and truly established Safety. They continued manufacturing the Crypto until 1896, when it became entirely obsolete and the last of the front-wheel drive bicycles.

By the end of the 1880's however, inspite of a few individualists, the Safety was firmly established along with the arrival of the diamond frame which was developed by Humber, which was a stronger design and made mass production easier.

Diagram(29)



The Humber

#### The Shaft Driven Bicycle

Naturally more novelty inventions followed along with the "Shaft Driven" bicycles, developed by Wilkinsons, which had gearing and a turning rod shaft with an internally toothed pedal wheel. However these shaft-driven machines never caught on with the public because of their added weight and cost and soon faded.

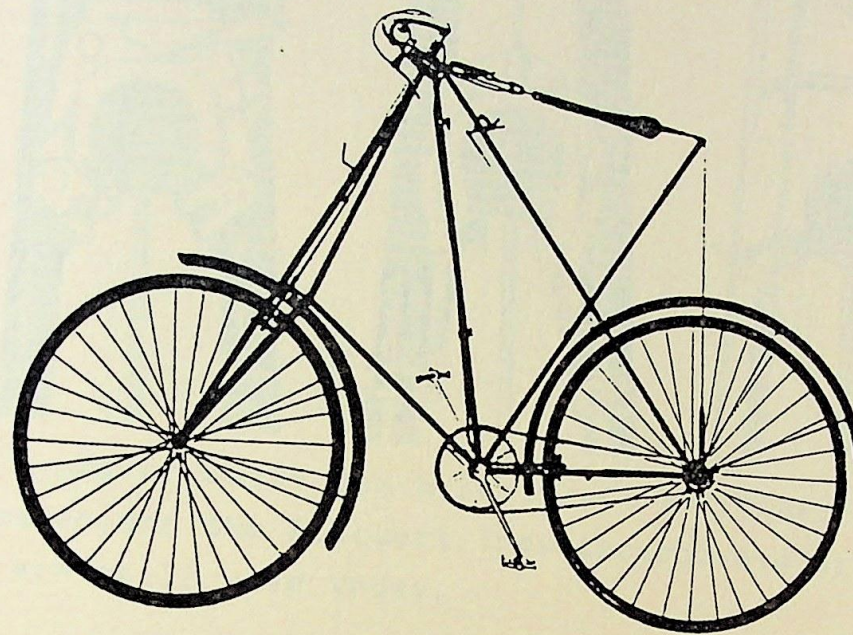
#### The Dursley Pedersen

By the mid-1890's all manufacturers had adopted the diamond frame principle and another cycle boom was revived along with the lowering of prices by mass production.

Perhaps one of the few bicycles not to be mass produced was the Dursley Pedersen, desined specifically for a smaller, wealthier more specialist market. It was scien-

tifically designed after the design of a Danish inventor Mikael Pedersen. Because of the arrangement of the tubes of the frame on the cantilever principle, the components of the frame could be thinner and smaller than on the conventional safety machine. It also had an odd hammock saddle made of silk cord suspended between the seat pillar and the steering head, which could be adjusted for tightness or looseness.

Diagram(30)



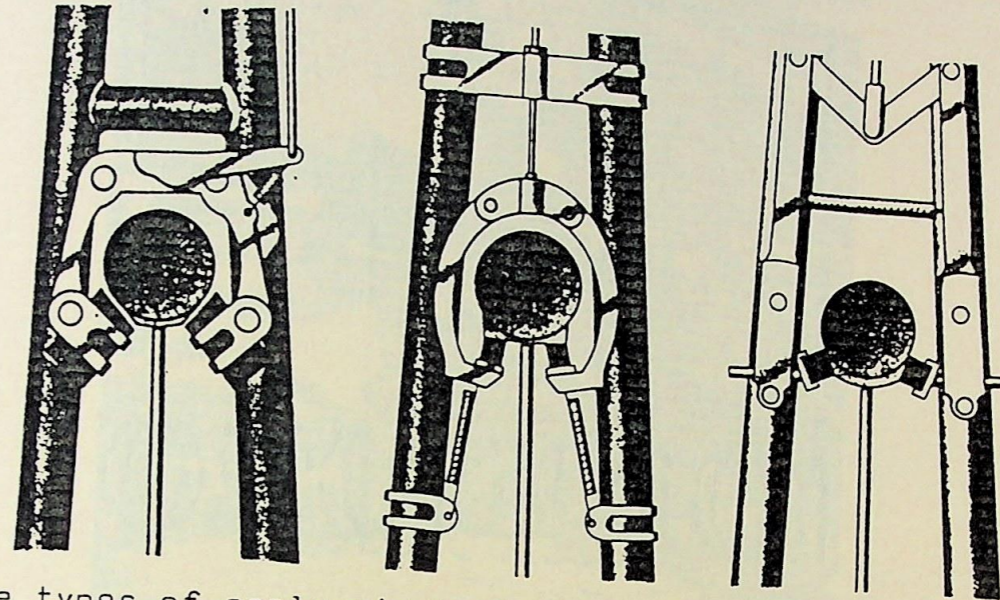
Dursley Pedersen bicycle

By the 1890's large firms had established their reputations and names such as Raleigh, B.S.A., Humber, Rudge-Whitworth, Triumph, Swift, Bayliss, Thomas and Rover were all large manufacturers of commercial machines. In 1895 the sum total of bicycle sales for that year by these companies was 800,000.

## Brakes

The Wilkinson Sword Co. went on to produce the first free wheel and back pedalling rim brake which engaged a small clutch on the rear wheel and also the quick detachable hub.

Diagram(31)

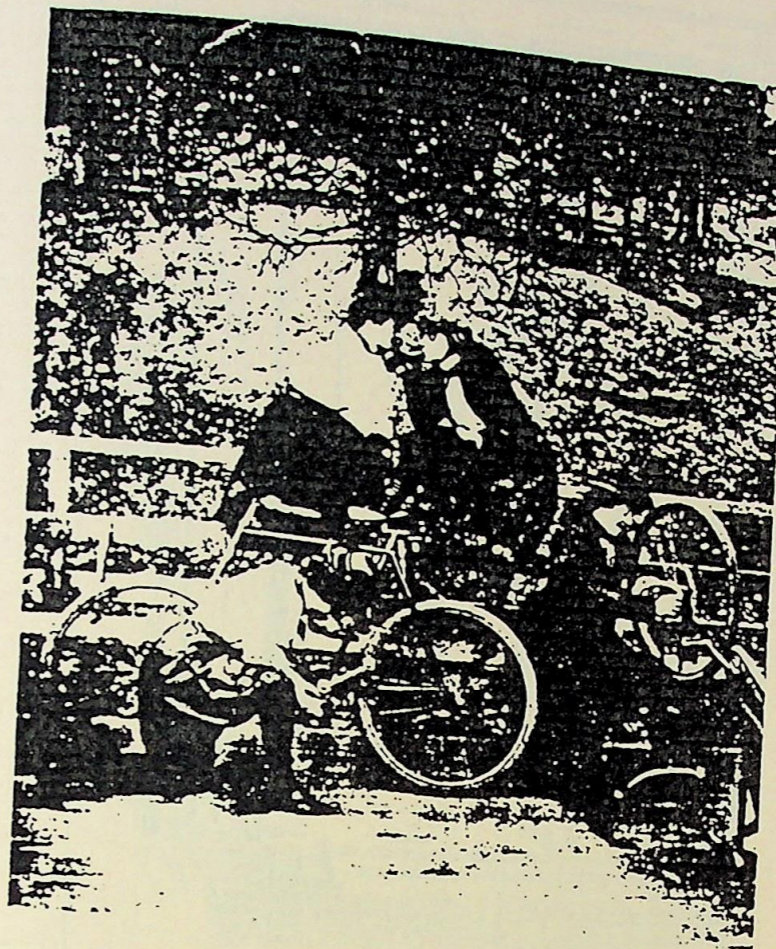


Three types of early rim brakes. left to right: the Dunois, the Bowden, and the Floquart. They incorporate principles which are still used today.

## The Scorchers

Manufacturers began to concentrate more on ladies cycles as the population of lady cyclists began to soar with the invention of the Safety. These ladies cycles were fitted with mud guards to the chain and nets over the back wheel to avoid any nasty accidents of having the long dresses becoming entangled with the spokes or chains. Cycling was no longer a male dominated hobby and women were no longer confined to the more sedate "Sociables" or "Tricycles", on which they were expected to be accompanied by a male companion. "Rational" dress became the craze which included Plus-fours, Bloomers and leggings.

These "ladies" were soon nick-named "Scorchers", pursuing their hobby on Safetys especially designed for the female sex, without the customary crossbar and an additional lower strengthening bar to the frame.



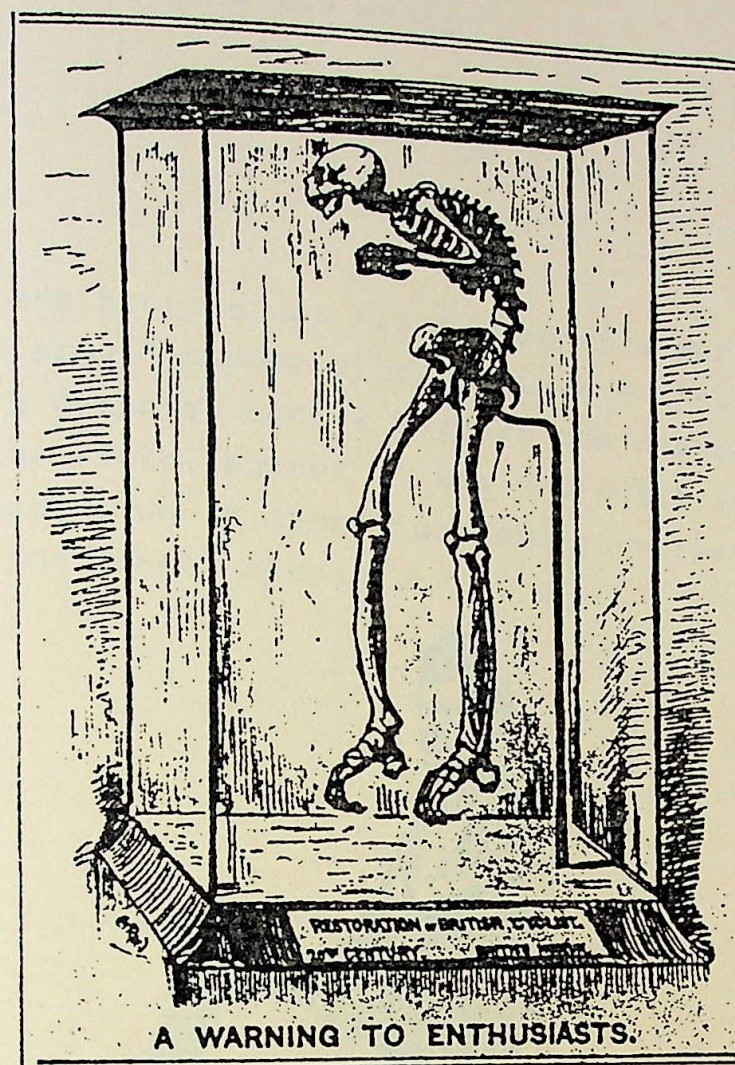
"A short halt by the roadside for a quick smoke and slight repairs". A photograph illustrating everything that the reactionaries disapproved of and feared!

Public opinion had by the 1890's more or less accepted "rational" dress and even females riding cycles, although doctors still maintained, without any medical foundation that cycling "distorted the female pelvis, with perhaps, in after life, resulting distress."+

It was not until the early 1900's however, that female cycling was fully accepted and what had been a hobby for some became a cheap and useful mode of transport for all.



Diagram(33)



A grim warning to the 20th century cyclist!  
Punch Magazine, 1889

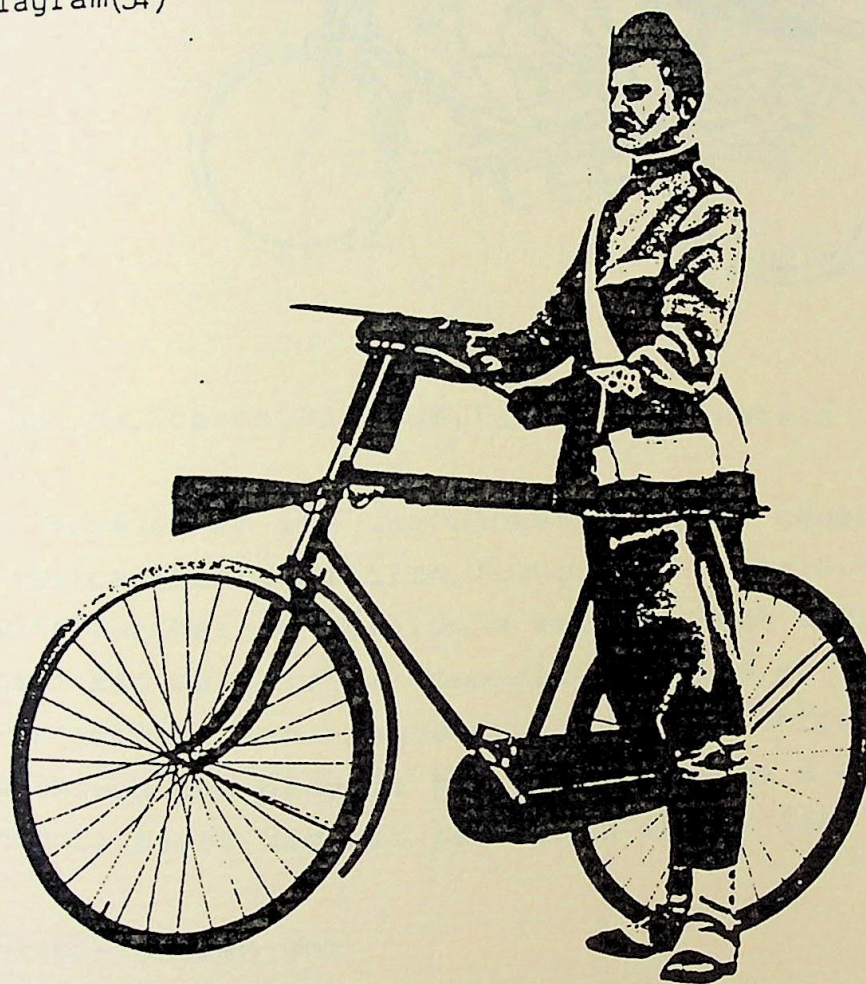
Along with the new improvements of the bicycle came the various indispensable accessories which no self respecting cyclist would be seen without. These included new form fitting padded and sprung saddles, rim brakes, rubber pedals and roller chains. The dynamo replaced the old acetylene and oil burning lamps, although the Lucas acetylene lamp was still being sold in 1940! Most bikes were still fitted with horns or other warning devices, and most cycle clubs employed a bugler to warn other road users of their arrival. By the turn of the century these eccentricities had passed away and most machines were fitted with a simple bell on the handlebars.

## THE BICYCLE AS A WAR HORSE

Italy 1875

In 1875 the bicycle was first used as a war horse by the Italian army. A number of cyclists and their machines were used as despatch riders between the commanders and troops in the field. However it was not until 1885 that this idea caught on in other European countries, with the arrival of the Safety bicycle.

Diagram(34)



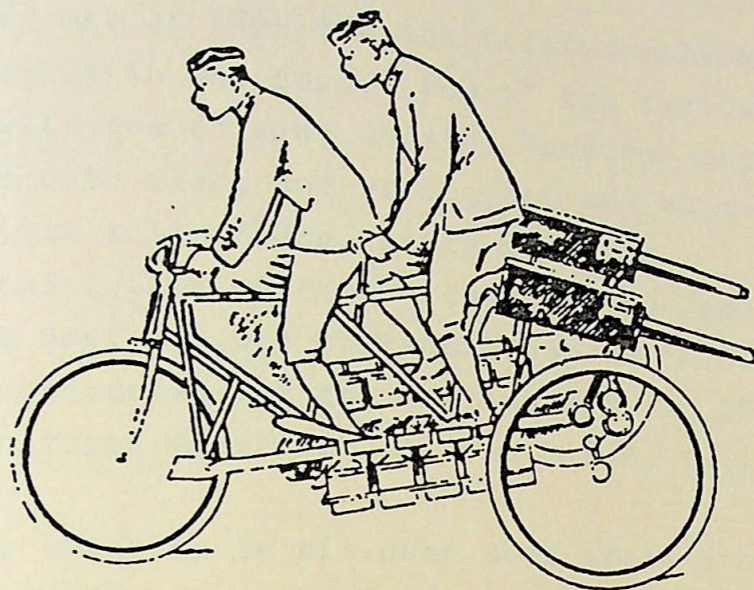
Italian Military bicycle

Britain 1900

By 1900 the British Army proudly boasted having over 360 "mounted" members; having replaced horses for bicycles. By 1919, these "mounted" troops had grown into the Army

Cyclists Corps, towing small trailers laden with tools, machine guns and telegraph cables behind their trusted "mounts". They could even scale a 16 foot high wall in three minutes with their overloaded machines, without a single mishap.

Diagram(35)



America, France, Belgium, Turkey and Austria

Because of its usefulness, the idea caught on in America, France, Belgium, Turkey and Austria. The Austrians went further to develop a machine that could fold in half and be carried knap-sack fashion on the back of the soldier, and France followed suit. Until now, however, although the bicycle had been tried by a number of countries, it had not performed in war time conditions.

Greco-Turkish War

The first recorded use of the bicycle as a mode of transport for war was during the Greco-Turkish war in 1897. The bicycle used was a "Villiers", described as being ".....of a dull green tint" and that the ".....lugubrious looking bicycle bore the battle and the breeze wonderfully well, and the maker ought to secure splendid advertisement out of it; for the tyres which pass unpunctured through

the terrors of mimosa scrub, a devastating sun in August, may fairly well be recommended for "strong roadster" work in the country lanes of England!

### The Boer War

The Boer War of 1899 saw the first consistent use of the bicycle in war fare. A few of the cyclists were equipped with the folding Dursley Pedersen machines, which were both light and strong, but the majority were equipped with solid frame Safety machines.

The machine that continued the Dursley-Pedersens success during the Boer War, was Wilkinson Swords "B.S.A." Territorial Bicycle constructed for the British Army in 1908; complete with three speed hub and two B.S.A. rolling lever brakes.

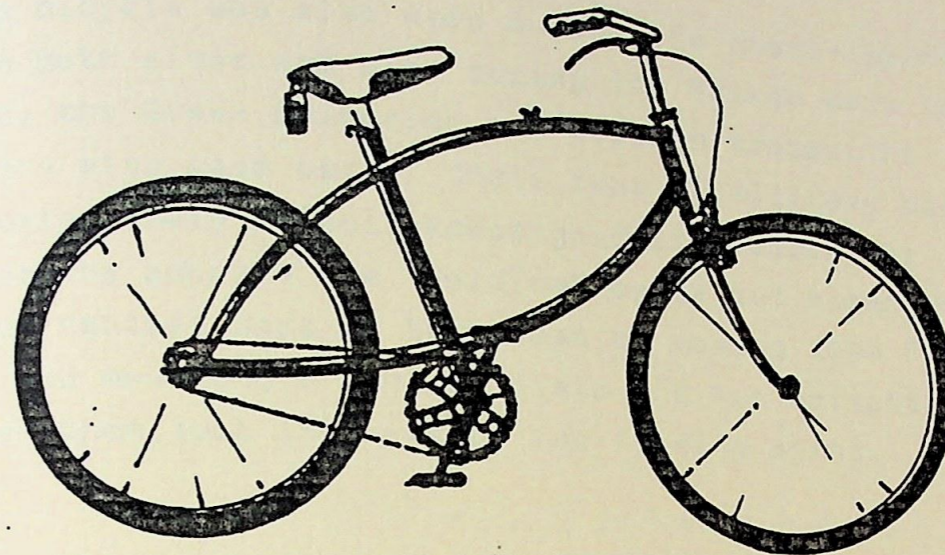
However the bicycle did pose some small problems for the British Army. The conventional manner of hand saluting was changed to either moving the eyes to the left or to the right, so that the cyclist did not have to remove one hand from the handle-bar. Weapons had to be strapped onto the bicycle, and swords were suitably strapped to the front handle-bars and forks.

The problem of arming the cyclists appealed to some inventors and one inventive genius produced what became known as the "handle-bar pepper-box six shot revolver". This ingenious gun had a folding trigger housed inside the grip of the handle-bar, retained by a spring clip. When under attack, the cyclist had only to press the stud on the top of the grip with his thumb while still holding the grip and pull out the revolver whose trigger sprung down into firing position.

Bicycles continued to be used in the British army where two sorts of machines were used; either the "trade cycles" or "folding cycles"!

The "Trade" cycles were Safetys painted green (khaki); and the folding cycles were specifically designed folding bicycles made to military specifications, used mainly by airborne troops.

Diagram(36)



Folding B.S.A. Military

#### Ireland

In the Irish Army between the two World Wars, there was an entire cavalry regiment mounted solely on these "Trade" cycles.

#### France

The "Folding" cycle was adopted by the French Army, a welcome change to the military Ordinary cycles in use since the 1880's. The French folding cycle had the saddle mounted over the back wheel with the pedals just in front of the rear wheel with a short chain. The frame consisted of two bars which folded in the centre. This machine was designed to be carried on the back of the soldier and had two straps, similar to knapsack straps, which passed

over the shoulder. The French continued to use their "folding" cycle until 1940.

#### The Russo-Japanese and the Balkan Wars

The bicycle was also used during the Russo-Japanese War on both sides and also during the Balkan Wars in 1912 by the Greek, Bulgarian and Serbian troops. The Italians also made use of their type of military bicycle during their Tripoli campaign. During World War II the Germans adopted the "Folding" cycle, but strengthened the two central bars of the frame by moving them farther apart and mounting a central plate and two uprights between them, just in front of the folding point.

#### Japan

The Japanese conquered Singapore by riding through what was considered impenetrable jungle. Each soldier was armed with not only his rifle and bag of rice but also firecrackers to create the impression that their force was greater in size than it actually was. It worked and the British forces withdrew and Malaya and Singapore fell to the enemy.

#### Viet Minh

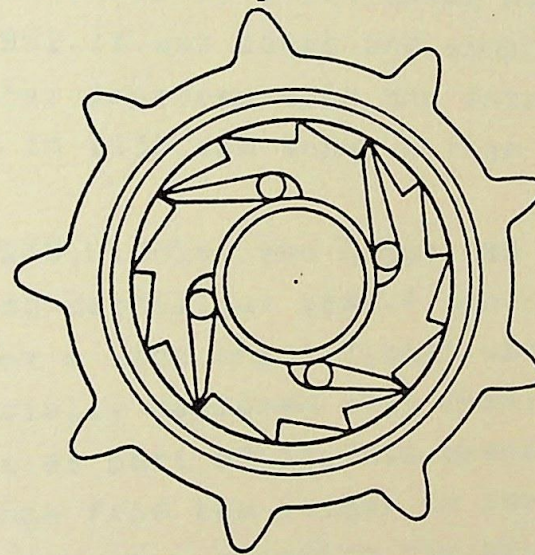
The Viet Minh defeated the French Army in Indo-China using French made Peugeot bicycles.

### The Safety bicycle

The safety bicycle had by now spread through all levels of society and was proving a cheap and effective means of transport for countless numbers of people. It speeded up rural life, it helped doctors, policemen, post men and others and gave the working man a cheap form of transport to and from work enabling him to live farther from it.

The various refinements and improvements made to the Safety bicycle came thick and fast in the years leading up to World War I, and affected every part of the machine and improved either safety or efficiency. By the turn of the century the free wheel, pneumatic tyre and back pedalling rim brake were firmly established and gears had made their appearance.

Diagram(37)

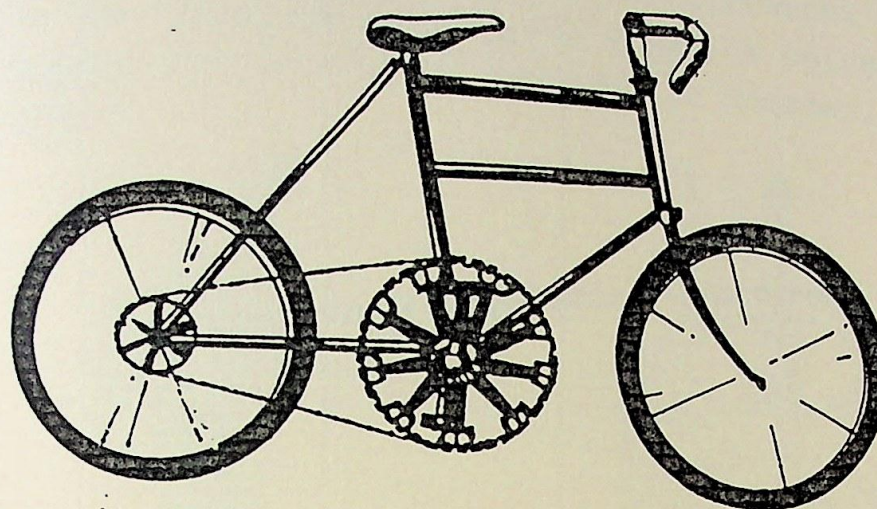


The free wheel, standard item on bicycles by the end of the nineteenth century.

### Gears

Rudimentary gears had been designed in the 1890's and were used on bicycles such as the Chater Lea Pacing

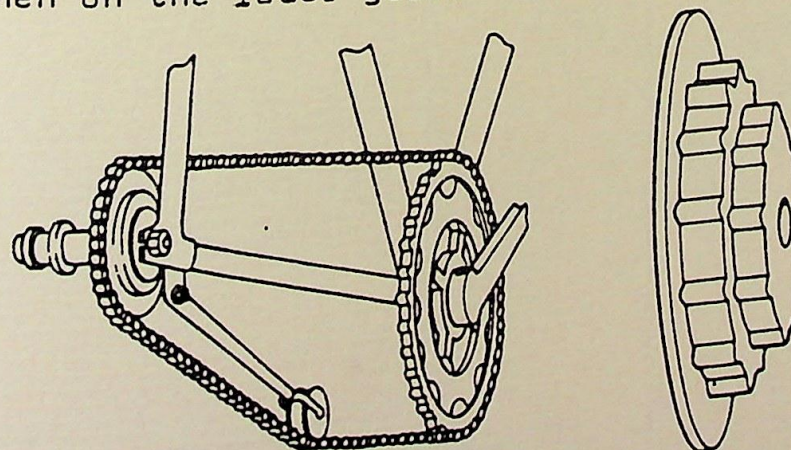
machine for racing cyclists by using a twenty inch  
cogged wheel.  
Diagram(38)



Chater Lea Pacing machine

The most important and still used system of gearing was the Sturmey-Archer-three speed hub manufactured by Raleigh in 1902. It was cheap and simple to manufacture and was later improved with the introduction of the four speed type in 1938 and today a five speed type is available.

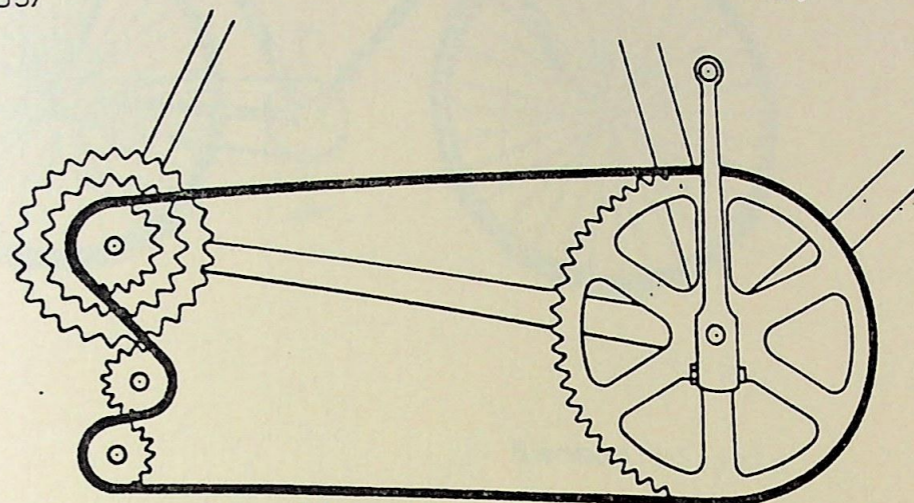
However, in 1900, Lindley and Biggs had invented a type of two speed derailleur gear. A specially shaped chain passed over a wide wheel fitted with pedals at the front and a specially designed rear wheel with two sizes of cogged wheels as part of it. This special chain allowed the gear to change from the larger to the smaller or vice versa rear hub thus altering the gear ratio. A sprung lever with a pulley was also fitted to take up the slack when on the lower gear.





In 1909, the derailleur gear was invented in France. A free wheel hub was fitted with from one to six interchangeable cogged sprocket wheels of different diameters to give the required gearing, and a device which allowed the chain to be "derailed" from one to another.

Diagram(39)



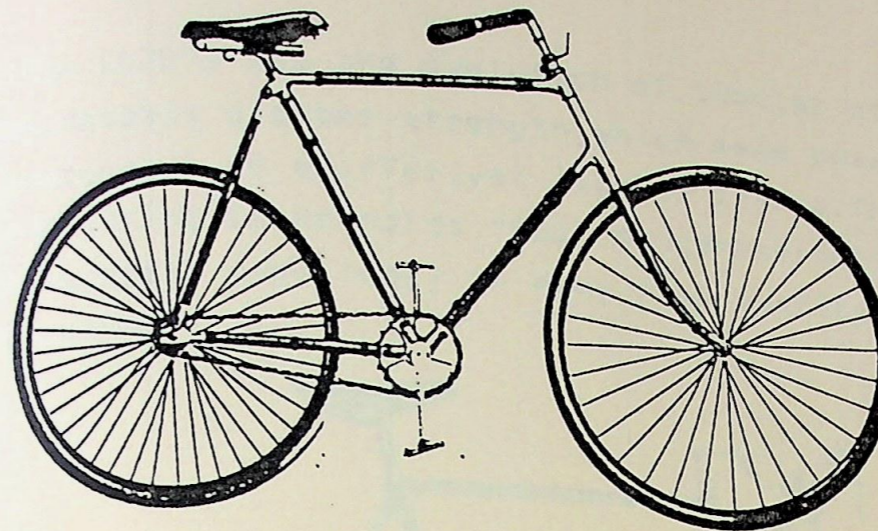
Derailleur system of gearing

#### Brakes

The first wooden block brakes and spoon brakes used on the earlier bicycles gave way to the various sorts of rim brakes. These included the Clipper rim brake, the Stirrup rim brake, the contracting brake (activated by levers and rods) and the now important Bowden Cable or hub type brakes worked by furious back pedalling by the cyclist.

#### The Bamboo bicycle

There was very little change in the design of the bicycle in spite of efforts of a few. In 1895 the Bamboo bicycle company launched their safety which was a conventional machine which replaced straight tube framing but not the joints, with poles of male bamboo (which is more solid than the female variety), claiming that it was "better" than steel. However there was no great demand for these bamboo cycles and they soon died out.



Bamboo bicycle

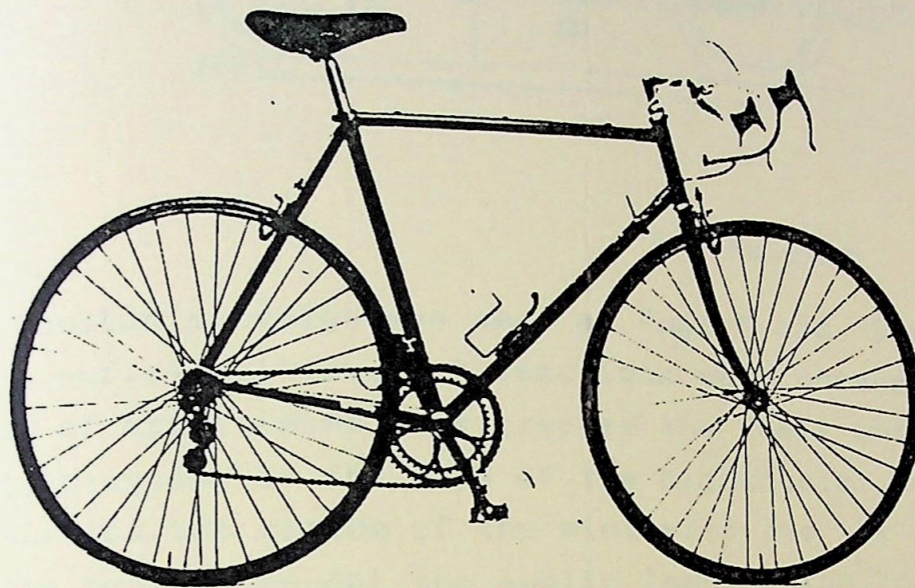
By 1900 the first era of experimental design was over. The great majority of bicycles in use were safety machines, plus a few tandems and tricycles. For the next sixty years this basic configuration remained the same. It was a period not of basic modification but of refinements in detail and steady improvements in manufacturing techniques, materials, components and accessory design.

Up to the 1920's, a typical bicycle had a diamond frame design of steel tubes brazed into iron sockets or "lugs". It may have had stirrup brakes operated by handlebar levers or coaster hub brakes activated by back pedaling. The frame was finished in hard stove enamel, usually black. The handlebars, wheel rims and small components were nickel plated. Saddles varied from the hard racing type to the broad "anatomical" saddle to combat soreness.

After the 1920's

The 1920's saw the evolution of tubular steel of considerably greater strength, which made possible the construction of stiffer, yet lighter frames. The best known tubing is Reynolds "531" manganese-molybdenum tubing, still used today in many high quality cycles.

Diagram(41)

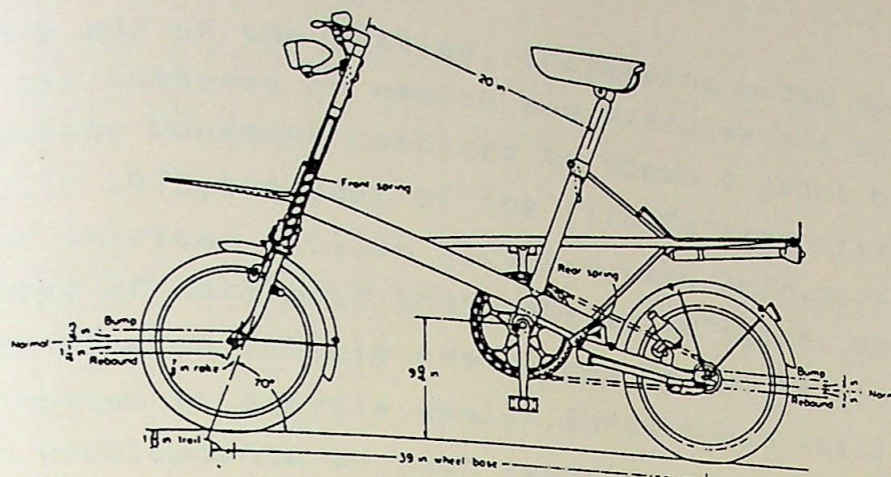


Trek's double butted, chrome molybdenum and manganese molybdenum steel alloy bicycle.

The Moulton bicycle

Despite these continual refinements, no radically new bicycle design appeared in this century until 1962, when Alex Moulton resurrected the cross frame design, which had been tried as early as 1886. The design logic of the Moulton bicycle flowed from the idea of a load-carrying, portable city bike. He integrated the frame with a baggage carrier mounted behind the seat. To achieve the low centre of gravity needed to carry heavy loads, small sixteen-inch wheels were used. These in turn dictated a suspension system to cope with the rougher ride. The cross frame and instantly adjusting saddle allowed people of varying sizes to ride the Moulton, making it the first family bicycle.

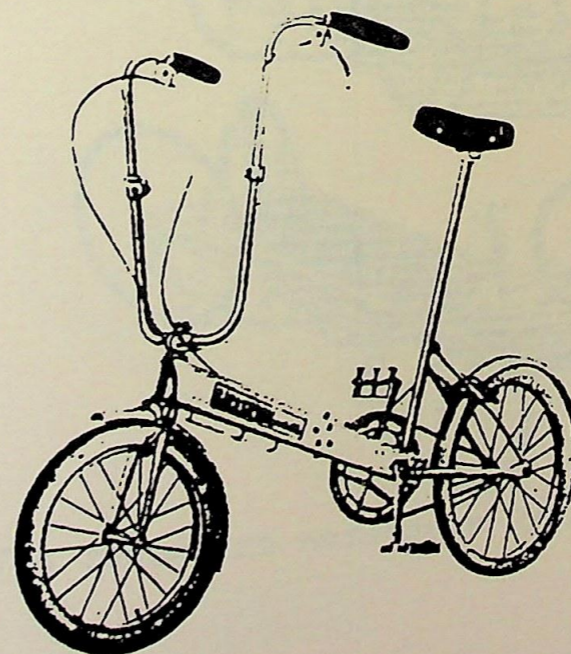
Diagram(42)



The Moulton

Moulton's design was seen as "ugly" and "inelegant" by the purist critics. Such reactions were unconscious echoes of criticisms that greeted the small wheeled safety bicycles in the days of the highwheeler. But in the sixties, the decade of the miniskirt and the mini-car, the Moulton caught the public imagination. Today, all major manufacturers offer a small wheeled, Moulton inspired model. The most successful has been the Bickerton portable, which caters to the needs of the urban commuter and apartment dwellers and can be folded into a two foot square bag that doubles as a carrier fitted to the handlebars. Made of aluminium alloy, it weighs just twenty pounds.

Diagram(43)



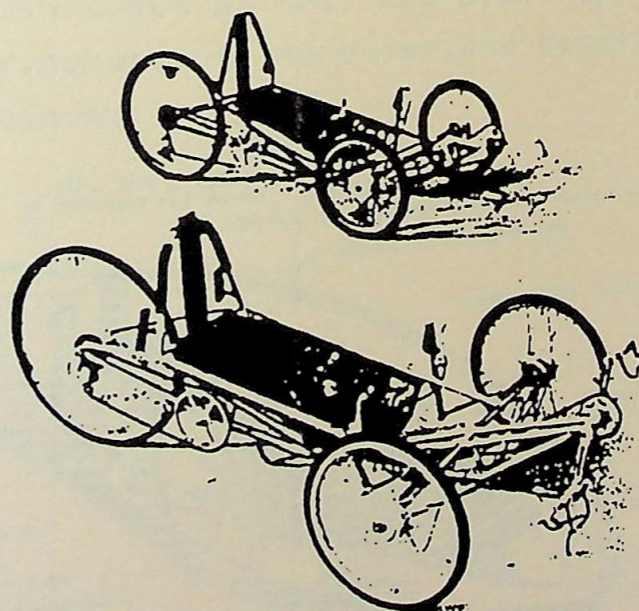
The Bickerton

At the end of the sixties, increasing urban congestion, a new interest in health and exercise, and the budding ecology movement combined to spawn a great bicycle revival. In 1973, the year of the first "energy crisis", a total of thirteen million bicycles were sold, more than the number of cars sold that year. In 1974, the International Human-Powered Vehicle Assoc. was formed to give fresh impetus to bicycle design. IHPVA speed trials have spurred developments in such areas as aerodynamics, geometry and materials.

#### The IHPVA

For top mechanical efficiency and least frontal wind resistance, the best position for a racer is lying prone or supine. The recumbent supine position favoured by IHPVA speed trial cyclists is in some respects a clear improvement on the standard geometry; it is faster, safer in collisions, more comfortable, more ergonomically efficient, has a lower centre of gravity, and carries large loads well. On the other hand it reduces both vision and visibility, critical factors in everyday city cycling.

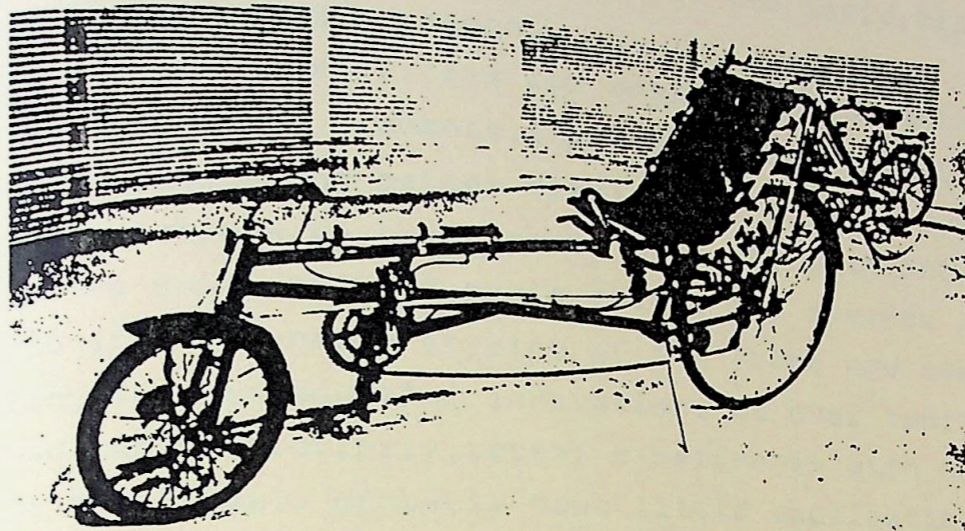
Diagram(44)



The recumbent Aerocoupe Cyclecars

A high, semi-recumbent position may offer an acceptable compromise for light traffic conditions. Recumbents are now in commercial production; the best design is a long wheel base version called the Avatar.

Diagram(45)

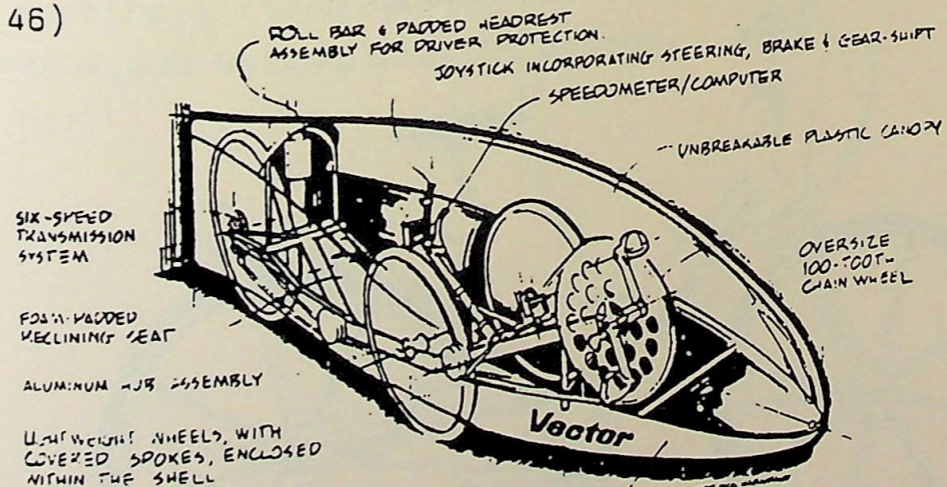


The Avatar

Fairings

Fairings—the shells that enclose speed-trial machines to reduce drag—are another IHPVA development with possible commercial applications. Although most riders are not concerned with wind resistance, they are concerned with protection from the elements. But as they are presently designed, fairings are bulky, awkward to maneuver, and dangerously susceptible to side winds.

Diagram(46)



WEIGHT	51 POUNDS
LENGTH	118 INCHES
WIDTH	25 INCHES
HEIGHT	32 INCHES
SPEED	56 MPH +

STREAMLINED, MOLDED FIBERGLAS SHELL, REINFORCED FOR RIDER PROTECTION

The Vector

While important developments with commercial applications may emerge in the future, the increased ergonomic and mechanical efficiency sought by the IHPVA speed trialists cannot be considered a high priority. With an energy expenditure comparable to 1,500 miles per gallon of petrol, the cyclist is already the most efficient mover in the world, beating even the horse and the salmon.

More important priorities for design improvements are protection from the elements, improved reliability, greater carrying capacity, and better braking and gearing systems. Recent innovations in these areas have met with only mixed results. The popularity of cycle racing has sparked recent attempts at aerodynamic styling of the frame and components resulting in such doubtful innovations as oval tubing and enclosed cables. Similarly, recent experiments with non-ferrous metals will probably have little application outside of high-quality racing and touring bicycles, due to their great expense. (Many of these new alloys were developed by the aerospace industry; in a sense, aeronautics is repaying an old debt to the bicycle.)

#### The Itera

The Swedish Itera is the first commercial bike with an engineered plastic frame. It is molded in 45% glass reinforced polyester, the pigmented frame performs the work done by several welded tubes and joints (finished and painted), on a conventional bike, as well as serving as a chain guard, battery housing, lifting handle and a housing for an anti-theft device, and weighs only 9½ pounds.

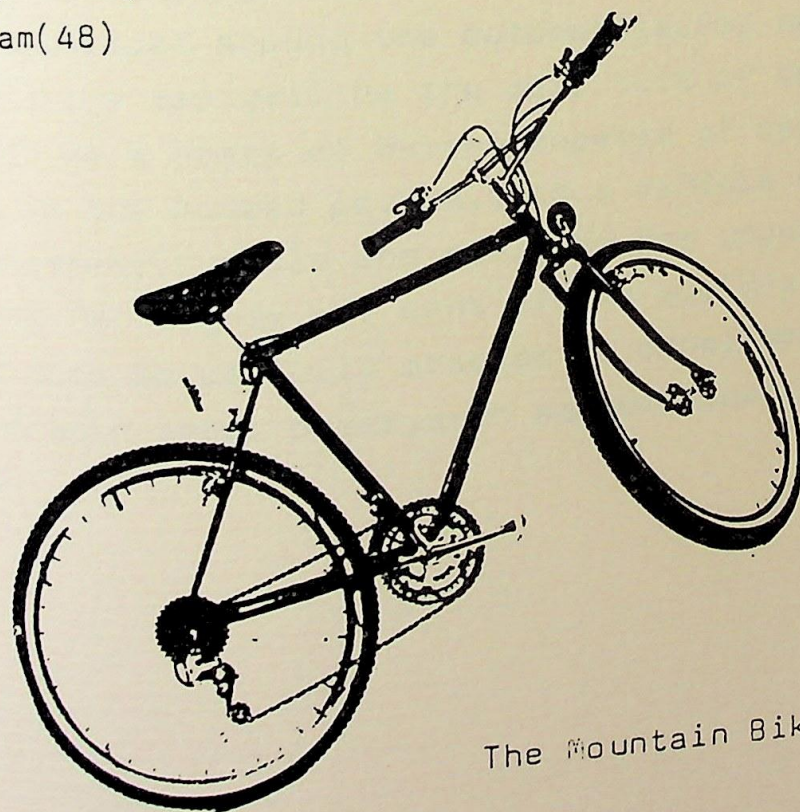
Diagram (47)



Plastics are now being used extensively in childrens bicycles, and in the hugely popular BMX bicycles, off-road machines with ballon tyres, small nylon wheels, wide handlebars, one-or tree-speed gears, and coaster brakes. The BMX is rugged enough to handle the potholes, curbs and drainage gaits that plague urban cyclists, but for some reason it has never come into wide use by adult city riders. Sadly, the design chosen for most city riding, and the one that outsells all the others, is the low-priced, shoddy facsimile of the drop handlebar, derailleur-gearred racing bicycle. The marketing of these models is an exercise in consumer exploitation. Many mechanics refuse to touch them because repair and maintainance are virtually hopeless.

If the urban possibilities for the BMX have been missed, the enormous interest generated by the "Mountain-Bikes" shown at the 1983 New York Bicycle Show is encouraging. With their long wheel base, large-diameter tubing ballon tyres, and high axle, these tough cousins to the BMX may well become the urban bicycle of the next generation. To achieve the wide range of gears needed for steep slopes, the mountain bike usually features a ten-or twelve speed derailleur. Unfortunately, such derailleurs are easily damaged and require constant maintainance.

Diagram(48)



The Mountain Bike



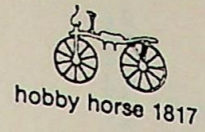
For this and other reasons, the development of an efficient and practical variable gear would be a needed and significant breakthrough in bicycle technology. Various systems of expanding, chainwheel gearing are currently on the market, i.e. the Deal Drive. All attempt to adjust automatically to encountered resistance in the same way an automobile's automatic transmission does; in other words, as one rides faster, the gears automatically shift up (or down if encountering a hill).

Perhaps the most urgently needed development design is a cheap, easily maintained, all-weather braking system. Riding conditions have changed since the 1880s, when brakes were optional, yet bicycle brakes have, on the whole, been poorly designed, sometimes scandalously so. Four types of brakes are currently in production: disk, rim, hub, and coaster brakes. Because they are lightest, rim brakes are by far the most common, but their performance drops off dangerously in wet weather. The other systems are much heavier, but perform better on wet roads.

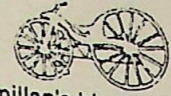
Even the development of an ideal brake would not make a perfect bicycle, for different design criteria are required for different contexts—Europe needs a different bicycle than rural India. For the former, bicycle design has to acknowledge roads and a transportation system that developed around the automobile. For many in India, the bicycle may well be the sole form of transportation, as well as a beast of burden capable of carrying loads of up to two hundred pounds. Such a vehicle would need to be extremely durable and designed for unpaved roads, which account for eighty per cent of the world's highways. It might also be usefully adapted to other needs that can be met with pedal power, such as pumps, generators, mills and plows.

Thus, it is difficult to consider the future of the bicycle without considering the systems of which it is a component. The beauty of the locomotive lies partly in the designer's conception of the vehicle and its road as one system. For all its silent, nonpolluting austerity, the bicycle cannot usher in a new ecological age without meeting, at least halfway, the conditions it has the potential to change. It has to adapt to its surroundings. Yet Austrian social critic Ivan Illich may be right in claiming that a truly humane, equitable world will conform to the scale and speed of the bicycle, enabling people to travel without haste or fear by means that do not cut us off from the earth over which we walked for so long on our own two feet.

Divergent, convergent  
and divergent phases in cycle design  
between 1860 and 1980



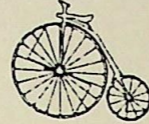
hobby horse 1817



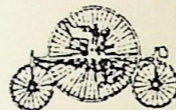
Macmillan's bicycle 1839



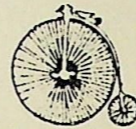
velocipede 1861



Ariel 1870



Coventry Rotary tricycle 1876



Ordinary 1871-90

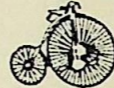


Lawson Bicycleette 1879

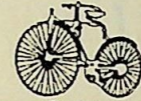
design divergence  
component innovation



Salvo tricycle 1877



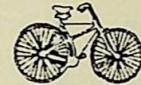
Kangaroo 1884



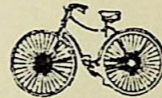
Rover Safety 1885



Crippler tricycle 1890



cross-frame safety 1887



Rover safety 1888



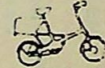
Humber safety 1890

design convergence

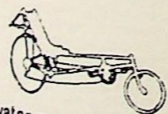


lightweight sports bicycle 1930

design divergence



Moulton bicycle 1962



Avatar recumbent 1977



shopper 1965



Chopper 1969



Vector streamliner 1976



Bickerton portable 1973



BMX 1975



Itera plastics bicycle 1981

CYCLES



two-wheeled  
unstable equilibrium

**dicycles**  
transverse equilibrium stable

longitudinal equilibrium unstable  
Ohio Dicycle

longitudinal equilibrium stable  
no example

double-steering  
adjustable safety

front drivers

geared

ungeared  
'Bone-shaker' 'Clayton' 'Ordinary'  
'Fellon's' 'Xtraordinary' 'Facile'

toothed wheel  
'Cryple' 'geared' 'Ordinary' 'Bantam'  
geared 'Facile' 'Sun and Planet'  
Merlin

chain  
'Kangaroo' 'Shellar'

**bicycles**  
longitudinal equilibrium stable  
transverse equilibrium unstable

BICYCLES

front-steering

Marrill  
&  
Cooper

geared

ungeared  
'American Star'  
rear-driving 'Facile'

toothed wheel  
'Burton' 'Clayton' 'Ternhead'  
geared 'Facile' rear-driver

Bouard Gear



one-wheeled  
unstable equilibrium

**monocycles**  
transverse equilibrium unstable

longitudinal equilibrium  
stable

longitudinal equilibrium  
unstable

side-steering

back drivers  
'Dublin' 'Olympic'

side drivers  
'Coventry Rotary'

front drivers

ungeared

single-driving  
'Bone-shaker'

double-driving  
no example

single-driving  
no example

double-driving  
'Humber'

single-driving  
'Facile'

double-driving  
Lisle's early Ladies' Tricycle

single-driving  
'Phantom' 'Clayton'  
'Trent Convertible'

double-driving

treble-driving

single-driving  
'Velocimeter'

double-driving  
'Tricycle' tandem 'Chrysemonore'

**tricycles**  
statically determinate frames

TRICYCLES

front-steering

rear drivers

ungeared

geared

direct-steering  
'Chippel' 'Merlin'

indirect-steering  
'Devon' 'Club'  
two-track tricycles 'Quadrant'  
'Nottingham Sociable'  
Singer's 'Omnicycle'

**multicycles**  
statically indeterminate frames



three-or-more-wheeled  
stable equilibrium

rear-steering

side-driving  
'Challenge'

front-driving

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