Motorcycle Design
1870-1920

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MOTORCYCLE DESIGN 1870 - 1920

A THESIS SUBMITTED TO THE FACULTY OF HISTORY OF ART AND DESIGN
AND COMPLEMENTARY STUDIES IN CANDIDACY FOR BscDEGREE
BY

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FOURTH YEAR INDUSTRIAL DESIGN
JUNE 1983

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I N T R O D U C T I O N

From the dawn of time man has had the urge to travel farther and faster than his own legs could carry him. For many years this could only be accomplished with the co-operation of the horse or other animals. Animal power had its limitations though, so toodid the steam railway which opened to passenger service in the first quarter of the 19th century. The railway did get people from place to place quickly - but it was not personal transport. The bicycle proved a different matter, here at last was something that made man individually mobile yet required no costly feeding or stabling. However, the bicycle's speed and endurance were limited to the rider's own muscle power. Motor cycles were to bypass this barrier.

The word motorcycle was first used to describe a bicycle with an internal combustion engine in 1893, although the first bicycle with an engine had appeared some twenty years earlier. It was powered by steam and it was not until the advent of the petrol engine that a successful motorcycle was made. The idea spread rapidly and motorcycles soon became widely available in Europe and America and a new and popular means of transport had arrived.

Ever since its inception the motorcycle has been a source of speed and excitement, an object of aesthetic appreciation and a focus for technological innovation.

THE PIONEER YEARS

By modern standards the machines of yesterday are crude, inefficient less-than-reliable contraptions, but the pioneer machines of an infant industry gave birth to to-day super-bikes, and those old veteran machines are revered to-day by enthusiasts who seek them out and restore them to their former glory.

MAKING IT WORK:

As early as 1869 an adventurous Frenchman managed to fit a light perreaux, single cylinder steam engine to a bicycle frame and for the first time went for a spin under mechanical power (Fig. 1). In the next decade or so, various experimentors applied steam power to bicycles and tricycles.

In Phoenix Arizona, Lucius Copeland attempted to fix an auciliary engine to a Columbia high wheel bicycle. He discarded the idea as "inefficient and dangerous" and proceeded to design a light unit for his 'penny farthing' star bicycle. By 1884 the machine was ready (Fig. 2). A small boiler fed the engine which drove the rear wheel via a belt. The cycle could attain around 12 m.p.h. Copeland sought backers and formed the Northrop Manufacturing Company of Camden, New Jersey. Within three months he had a reliable three wheeler the 'Phaeton Motorcycle' on the road (Fig. 3). A two seater steam 'safety cycle' appeared in 1888, later a third wheel was added on an out rigger carrying another seat, the first germ of the sidecar idea.

But the steam cycle was a dead end line of investigation, too cumbersome to be a practical proposition. Although the world did not know it, motorized transport was awaiting the arrival of the relatively light and high speed internal combustion engine.

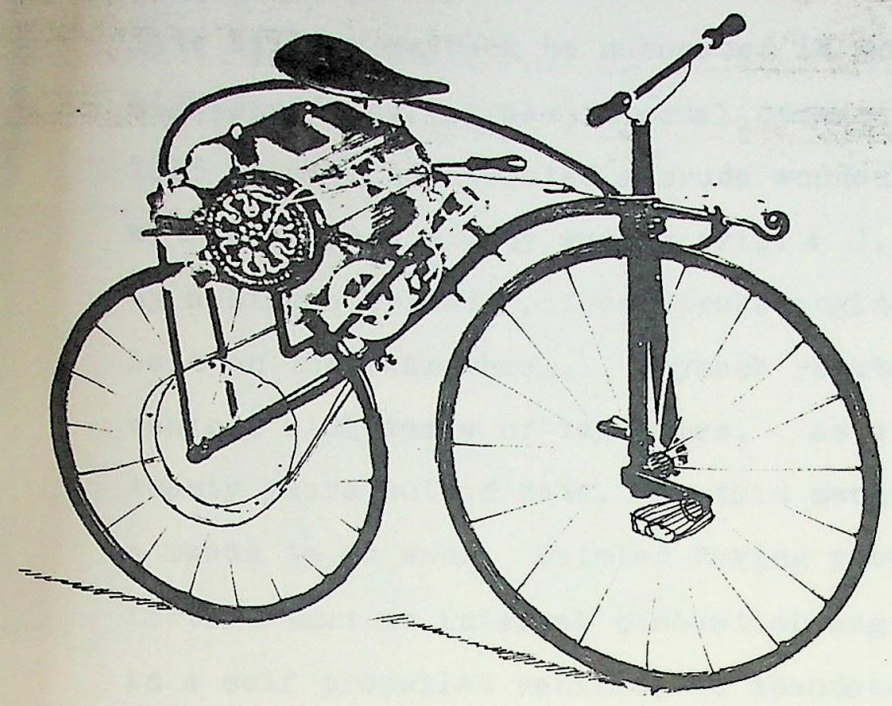

FIG 1 Pierre Michaux constructed the first known powered cycle in 1869 when he fitted a small pereaux steam engine to a boneshaker frame.

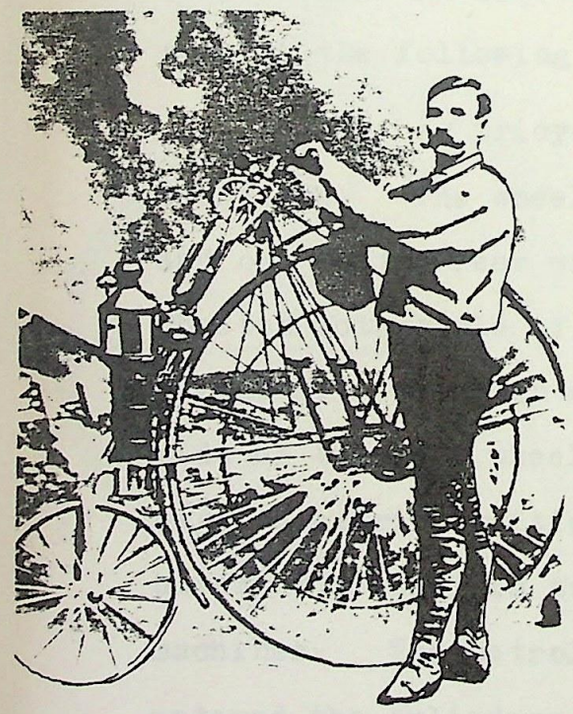

FIG 2 Credit for America first mechanically propelled two wheeler is given to L.D. Copeland, who in 1894 fitted a steam cylinder to his pennyfarthing bicycle. Contrary to pennyfarthing practice the small wheel was at the front.

By general assent Gotlieb Daimler is credited with the title "Father of the Industry". In 1883 with his associate William Maybach he succeeded in producing the first high-speed four stroke internal combustion engine. In 1885 Daimler constructed a crude wooden framed two wheeler with outrigger steady wheels (Fig. 4). It was powered by a single cylinder, four stroke engine, which drove a belt on the rear wheel. Maybach reputedly rode this vehicle a distance of ten miles. As a bicycle it was twenty years out of date, but this machine was no more than a means to an end. Daimler having proven to his own satisfaction that an internal combustion engine could be employed in a self propelled vehicle, he abandoned motorcycles and devoted his research entirely to cars.

British inventor Edward Butler was working along similar lines as Daimler at about the same time. The three wheeler he designed was much more advanced (Fig. 5). Drawings of the machine were exhibited at the Stanley Bicycle show in 1884 and the tricycle was completed and running the following year.

The Butler tricycle was a remarkable design by any standards. The wheel configuration of two in the front and one in the rear was similar to the earlier steam powered Phaeton motorcycle of Lucius Copeland. Its' four stroke engine had two cylinders mounted horizontally, one either side of the rear wheel. Advanced features of the design were, electric ignition and the earliest known spray carburettor similar in principle to the units fitted to modern machines. The petrol/air mixture was pre-heated before it entered the cylinders and water for cooling the engine was carried in the hollow rear mudguard. Before starting the engine the rider depressed a pedal which forced two small

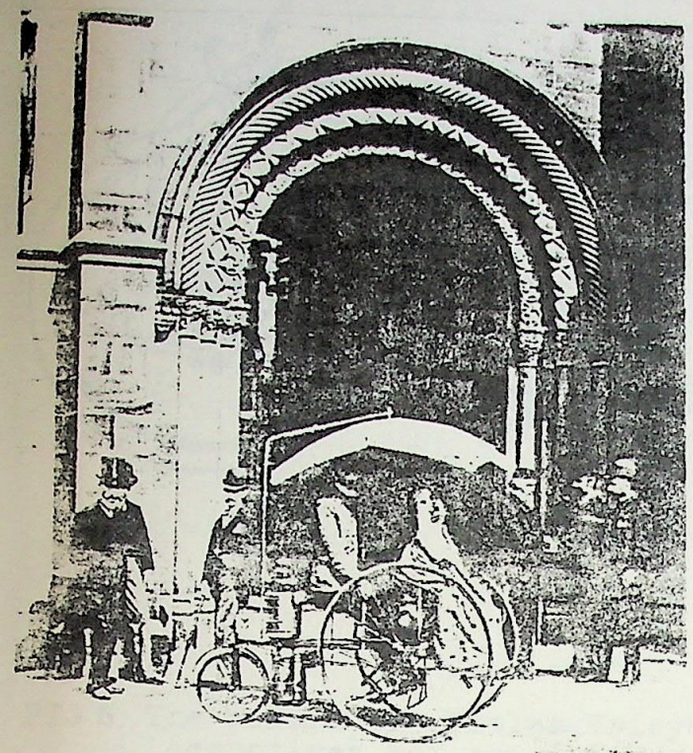

FIG 3 Copelands Phaeton motor cycle outside the 'Smithsonian Institution Washington in 1888.

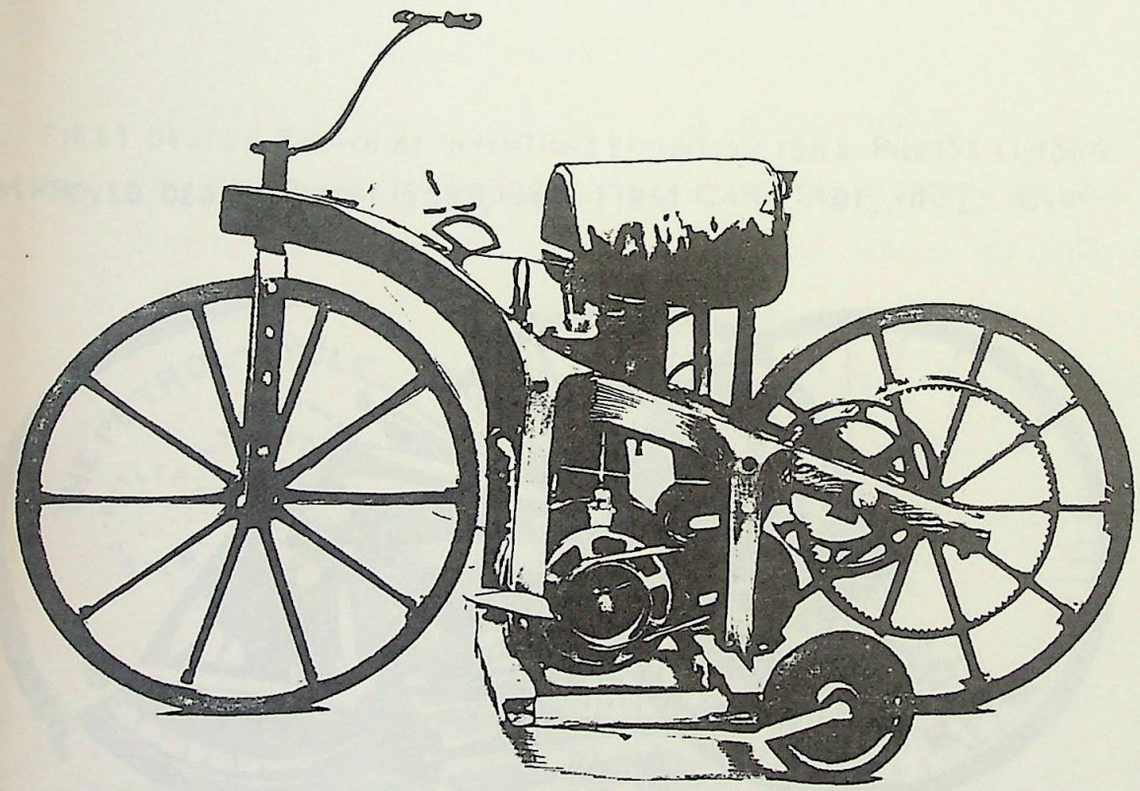

FIG 4 The machine that started it all Daimler's crude wooden wonder.

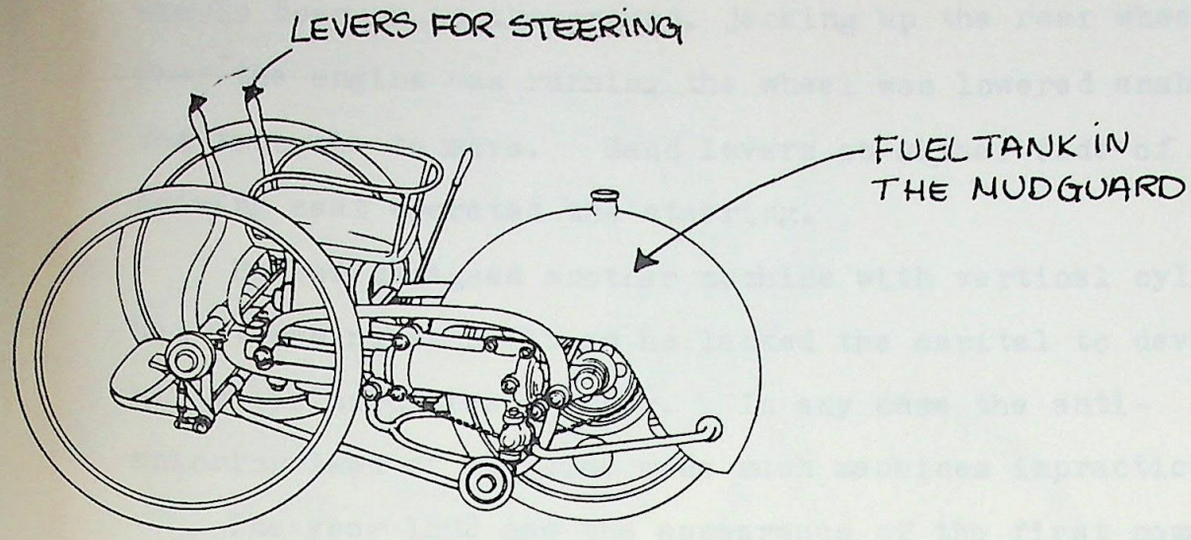

FIG 5 The remarkable Butler Tricycle- The 4mph locomotives act and a lack of finarcial backing, killed the petrol-cycle within two years of it's introduction, the prototype being broken up to recover the value of the brass and copper used in it's construction.

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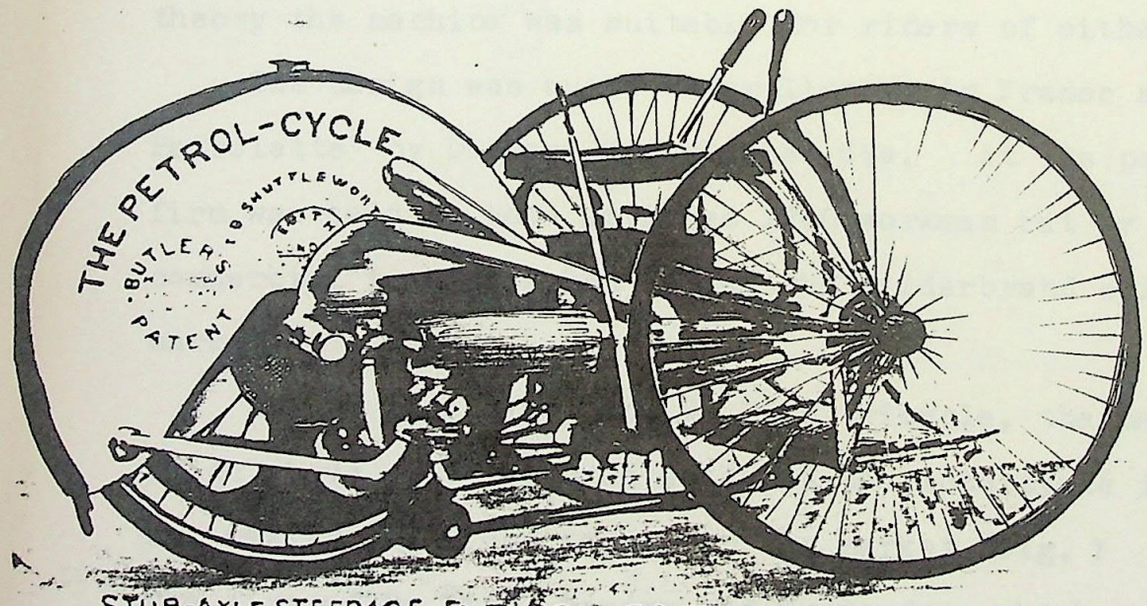

STUB-AXLE STEERAGE, FOOT-BRAKE & FOOT-CLUTCH CONTROL,
2-CYLRS, WATER-COOLED, ELECTRIC-IGNITION, JET-CARBURETTOR.

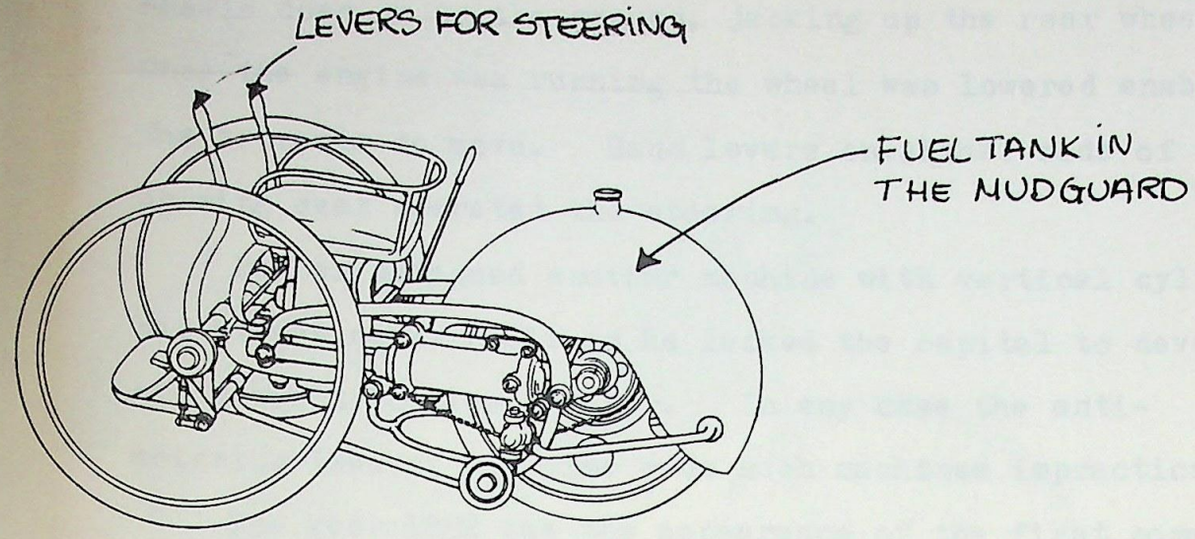

FIG 5 The remarkable Butler Tricycle- The 4mph locomotives act and a lack of financial backing, killed the petrol-cycle within two years of it's introduction, the prototype being broken up to recover the value of the brass and copper used in it's construction.

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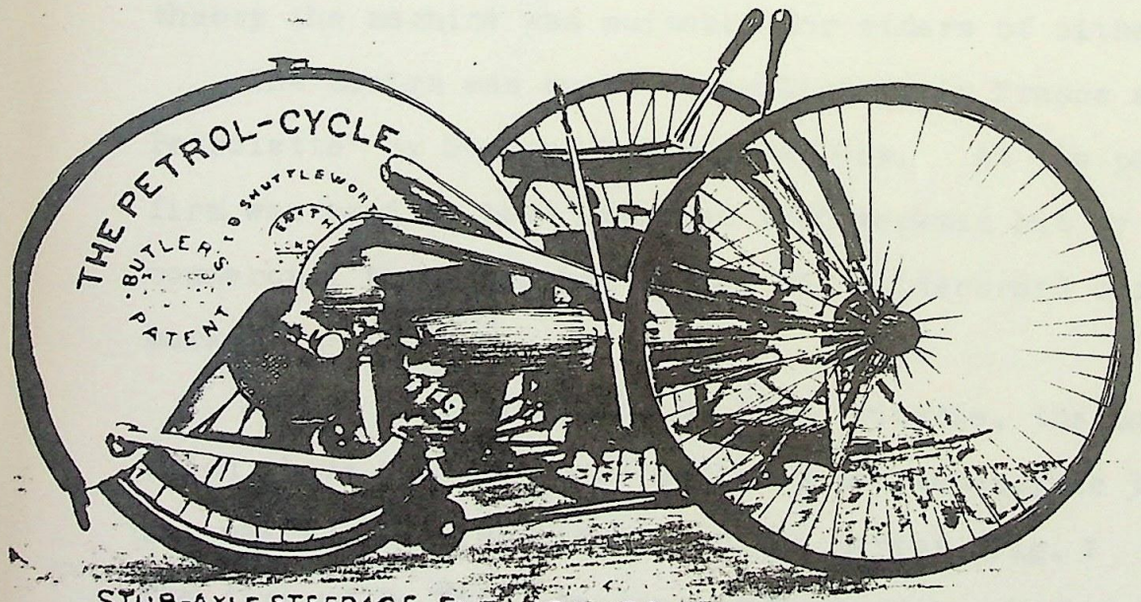


wheels down on to the ground, jacking up the rear wheel. Once the engine was running the wheel was lowered enabling the tricycle to move. Hand levers on either side of the driving seat operated the steering.

Butler designed another machine with vertical cylinders, but it was never built as he lacked the capital to develop his motor tricycles further. In any case the anti-motoring laws of the time made such machines impractical.

The year 1892 saw the appearance of the first commercially successful motorcycle, built in Munich by two German engineers, Hilderbrand and Wolfmuller (Fig. 6). They had earlier experimented with steam bicycles before turning to the internal combustion engine.

The design had a two cylinder engine, weighed 112 lbs and had a maximum speed of 28 m.p.h. The cylinders were water cooled, the water being carried in the curved tank that also served as the rear mudguard.

Two additional features of the design were a throttle control on the handlebars - this did not become standard practice for many years, and a dropped frame so that in theory the machine was suitable for riders of either sex.

The design was built under licence in France as "La Petrolette" by Duncan, Superbie et Cie. At its peak the firm was said to have employed 1200 workmen but by 1897 commercial pressures had forced the Hilderbrand off the market.

Around this time, the De Dion tricycle, the machine which above all others established the motorcycle industry, was making its first impact on the market (Fig. 7). The firm of De Dion, Bouton and Trépardous which had been founded in 1882 was an unlikely alliance between the Marquis de Dion, George Bouton a tiny mechanic and his brother-in-law Trépardous. During the 1880's the partnerships steam

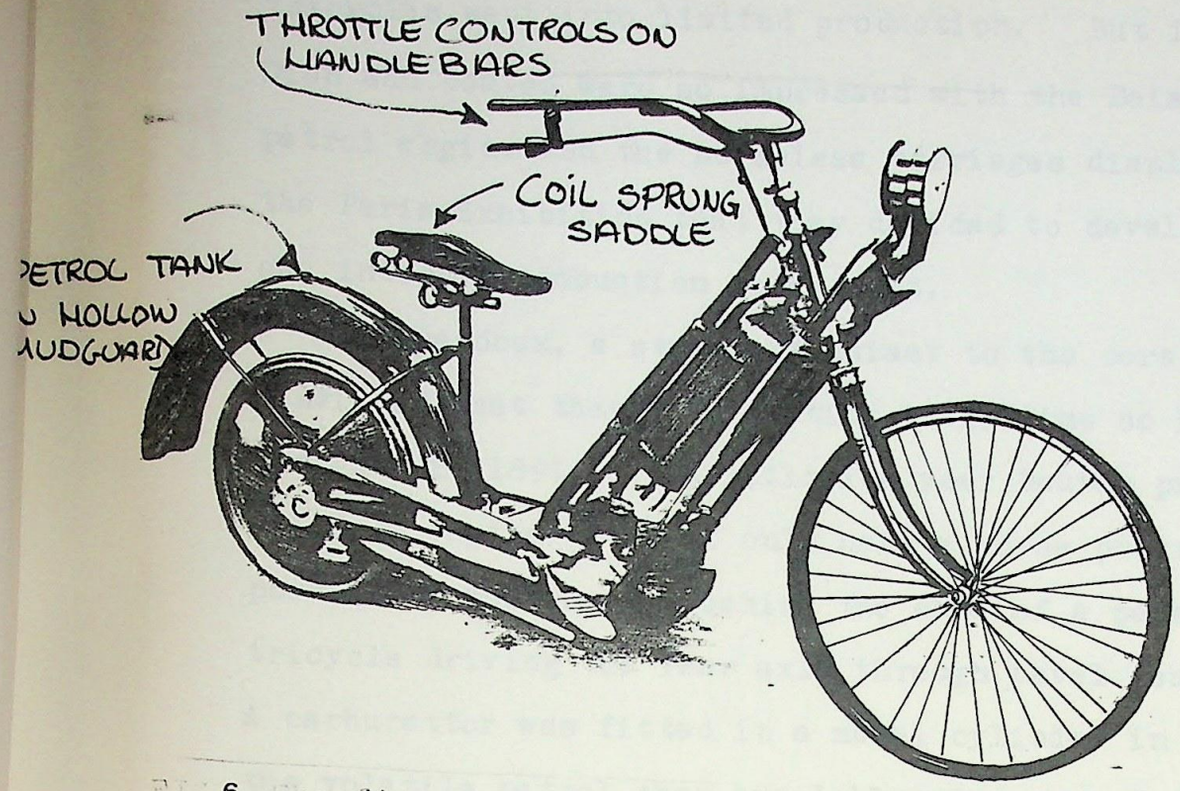


FIG 6 The first volume produced motorcycle...
the Hilderbrand and Wolfmuller.

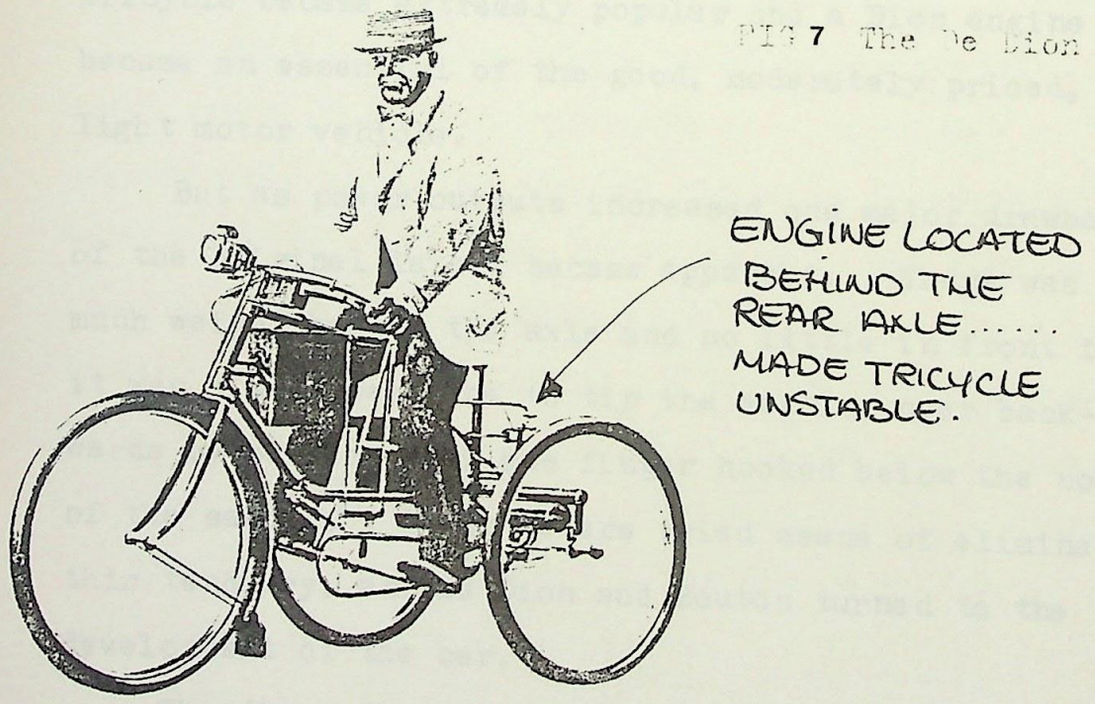
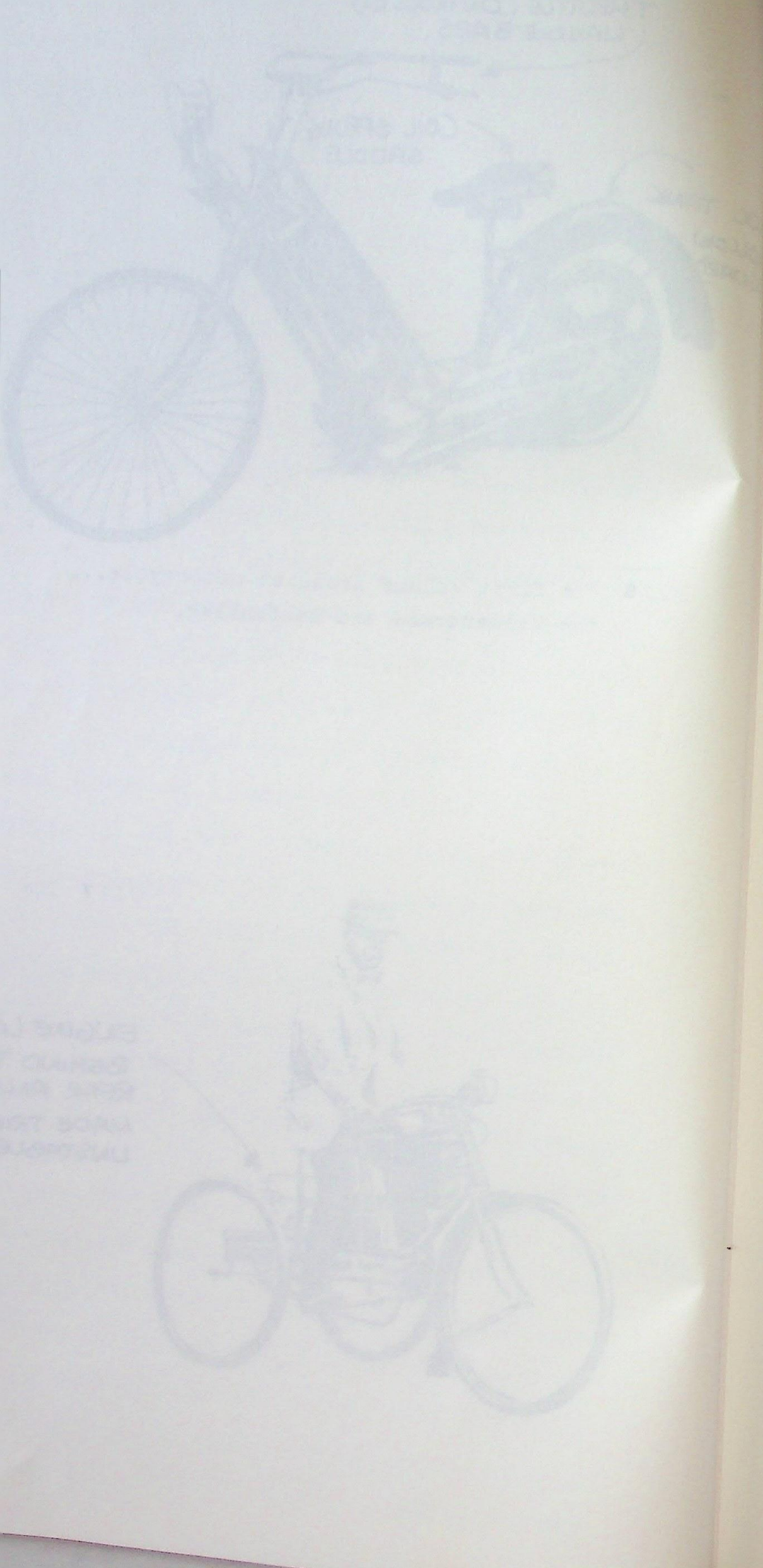


FIG 7 The De Dion tricycle.



tricycles went into limited production. But in 1889 Dion and Bouton were so impressed with the Daimler petrol engine and the horseless carriages displayed at the Paris Exhibition that they decided to develop their own internal combustion power unit.

Trepardoux, a steam enthusiast to the core, was convinced that they were wasting their time so he resigned in 1894. The following year Bouton produced a 120 cc engine rated at only half a horse power. This power unit was mounted behind the axle of a pedal tricycle driving the rear axle through bevel gearing. A carburettor was fitted in a metal cylinder in which the volatile petrol then available was persuaded to evaporate and form a combustible mixture simply by the jolting it received as the unsprung tricycle rattled along the unmade roads of the day. The speed of the tricycle could be regulated to some extent by advancing or retarding the electric ignition.

Despite the imperfections in its design the Dion tricycle became extremely popular and a Dion engine became an essential of the good, moderately priced, light motor vehicle.

But as power outputs increased one major drawback of the original layout became apparent. There was so much weight behind the axle and so little in front that it was almost possible to tip the machine over backwards by pulling with one finger hooked below the nose of the saddle. Other makers tried means of eliminating this tendancy, and De Dion and Bouton turned to the development of the car.

The first four cylinder motorcycle appeared in 1895. This was the brainchild of Colonel H.C.L. Holden, a

brilliant engineer, who later designed the Brooklands Race track (Fig. 8). There were many original ideas incorporated into the design. The inlet valves were automatic and the pedals drove the front wheel through internal gearing. The four cylinders were arranged horizontally, in two parallel pairs in line with the frame. This shaft drive from the four cylinder engine to the wheel resulted in a far smoother ride than could be obtained on the belt driven motor bicycles of the time.

Hills were a source of trouble as the angle of the incline often prevented fuel flowing to the engine, which then petered out, allowing the machine to run backwards. Descent was always made at snails' pace because of inefficient brakes. Holden's motorcycles gained a reputation for their quality of workmanship and smooth running. Holden had his factory 'The British Motor Traction Company' at Kennington, Oval., but production did not get underway seriously until 1901, by which time the design was outdated.

In Britain in the 1890's there was an overall speed limit of 4 m.p.h on the roads. Even then a mechanically propelled vehicle had to be accompanied by a man with a red flag, so progress in all aspects of motoring was almost negligible despite pioneers like Holden. Sir David Salomans , a wealthy motor enthusiast, organised a demonstration of 'horseless carriages' at Turnbridge Wells in Kent, in October 1895. Among the spectators was one man who saw the potential of the spluttering machines in the arena.

Harry John Lawson had entered the cycle trade in the 1870's and together with John Likeman had patented

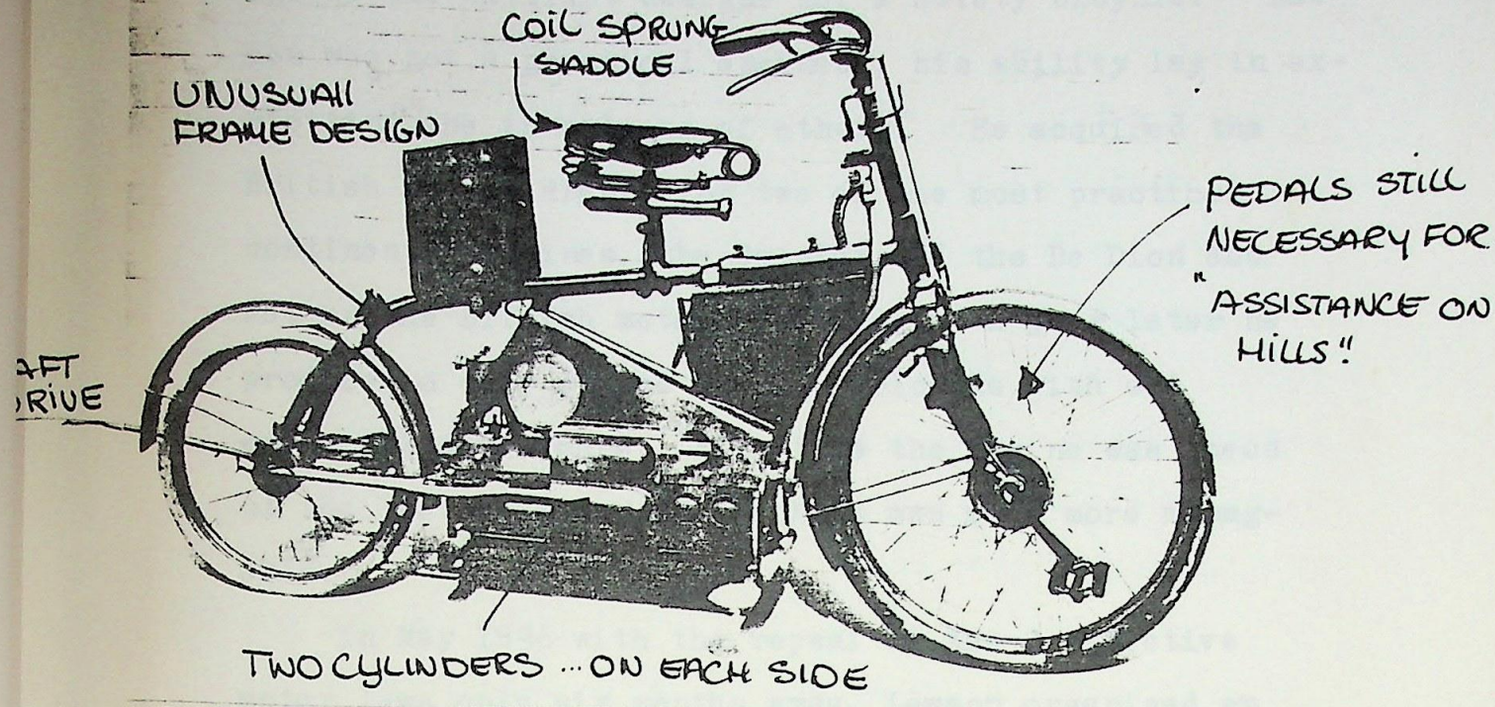
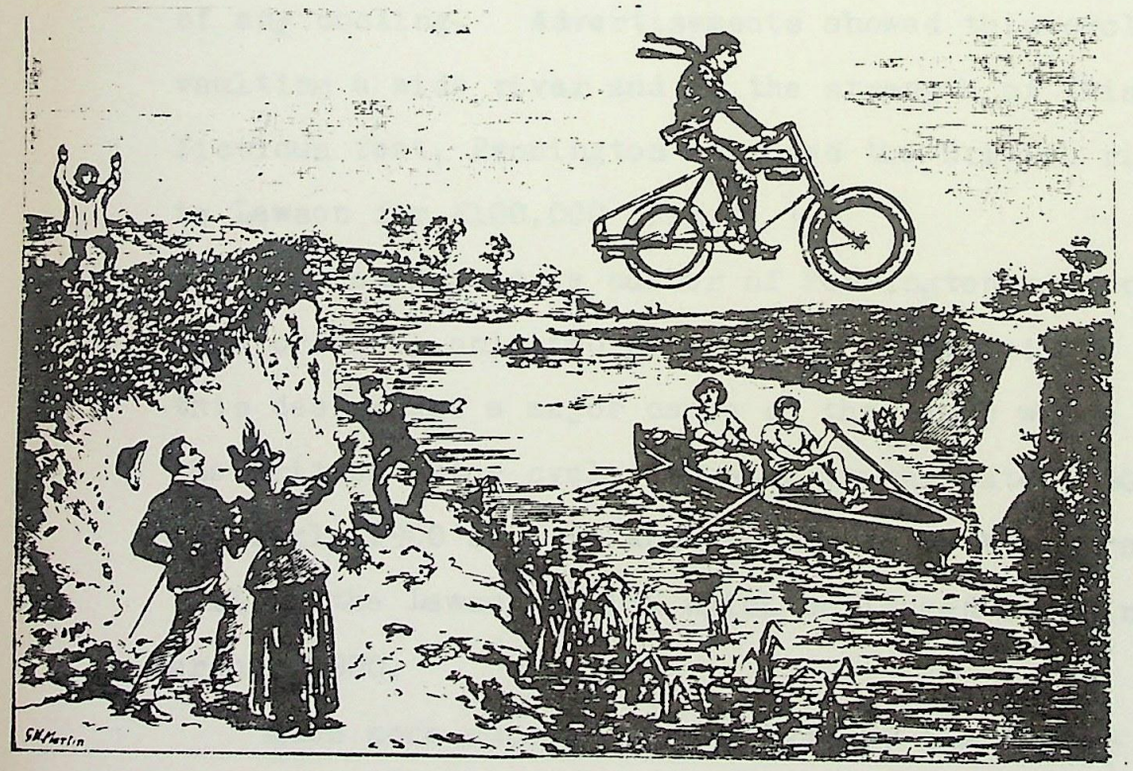


FIG 8 The first four cylinder motorcycle designed by Colonel Helden.

FIG 9 Advertisment for Pennington's motor cycle-claming the could jump a wide river.



one of the earliest designs for a safety bicycle. Lawson was not a practical engineer, his ability lay in exploiting the inventions of others. He acquired the British Patent Rights for two of the most practical continental engines, the Daimler and the De Dion and set up the British motor syndicate. A year later he produced a copy of the De Dion tricycle with one essential difference; this time the engine was ahead of the rear axle and the machine was much more manageable.

In May 1896 with the repeal of the Restrictive motor laws only six months away, Lawson organised an exhibition at London's Imperial Institute at which both cars and motorcycles were demonstrated.

At this point a swindler named Edward Joel Pennington breezed on to the scene from America, where he was known as "Airship Pennington" after a dubious 'flying machine' project. Pennington had designed a crude "moto-cycle" with long drainpipe cylinders devoid of any cooling. Advertisements showed this cycle vaulting a wide river and on the strength of this fictious feat, Pennington unloaded the British rights to Lawson for £100,000 (Fig. 9).

Although a large number of Pennington moto-cycles were ordered, only two were built. The failure of this design was a major cause of the slump which hit the British motor cycle industry in the late 1890's and early 1900's. It also proved to be the first nail in the Lawson Empire which collapsed in ruins around 1900.

Much more success was enjoyed by the Werner brothers, Michael and Eugene, two Russian emigrés living in Paris. They had already tried and failed to

make their fortune from phonographs and typewriters, when in 1897 they turned to the motor cycle. They designed the Werner 'Motorcyclette', it had a ¾ h.p air cooled engine mounted in front of the handlebars ... driving the front wheel by belt (Fig. 10). The engine was intended as "added power" rather than the sole propulsive medium - on hills the rider had to give - "light pedal assistance". The top heavy layout of the Werner was less than ideal on the atrocious roads of the day. Motorcycling journalist B. H. Davis recalled the first one he ever saw?

"It side slipped on the grease on Euston Road, lept on top of its owner, pummelled him severely and catching fire burnt itself to scrap" (Taken from 'Historic Motorcycles' by David Burgess Wise).

In spite of such stories Werner enjoyed a fair amount of popularity.

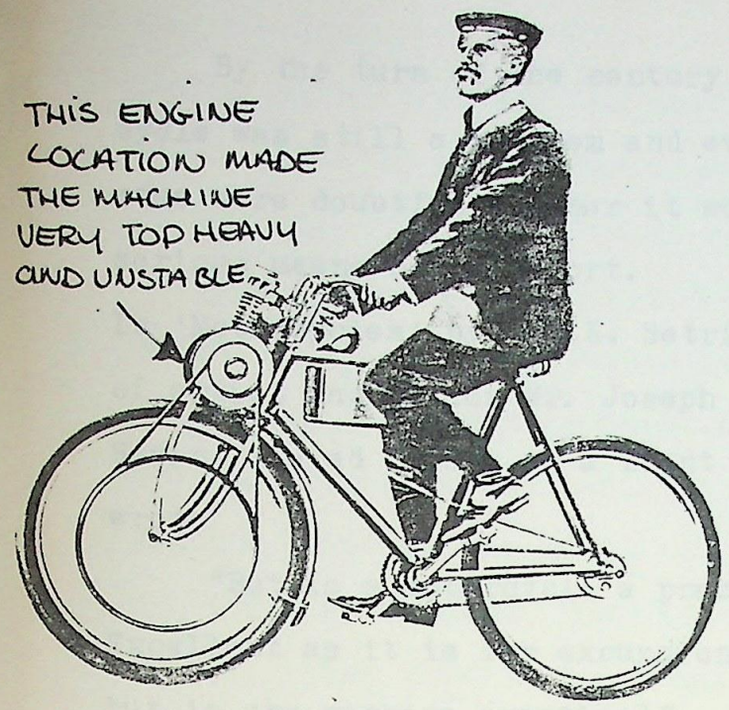
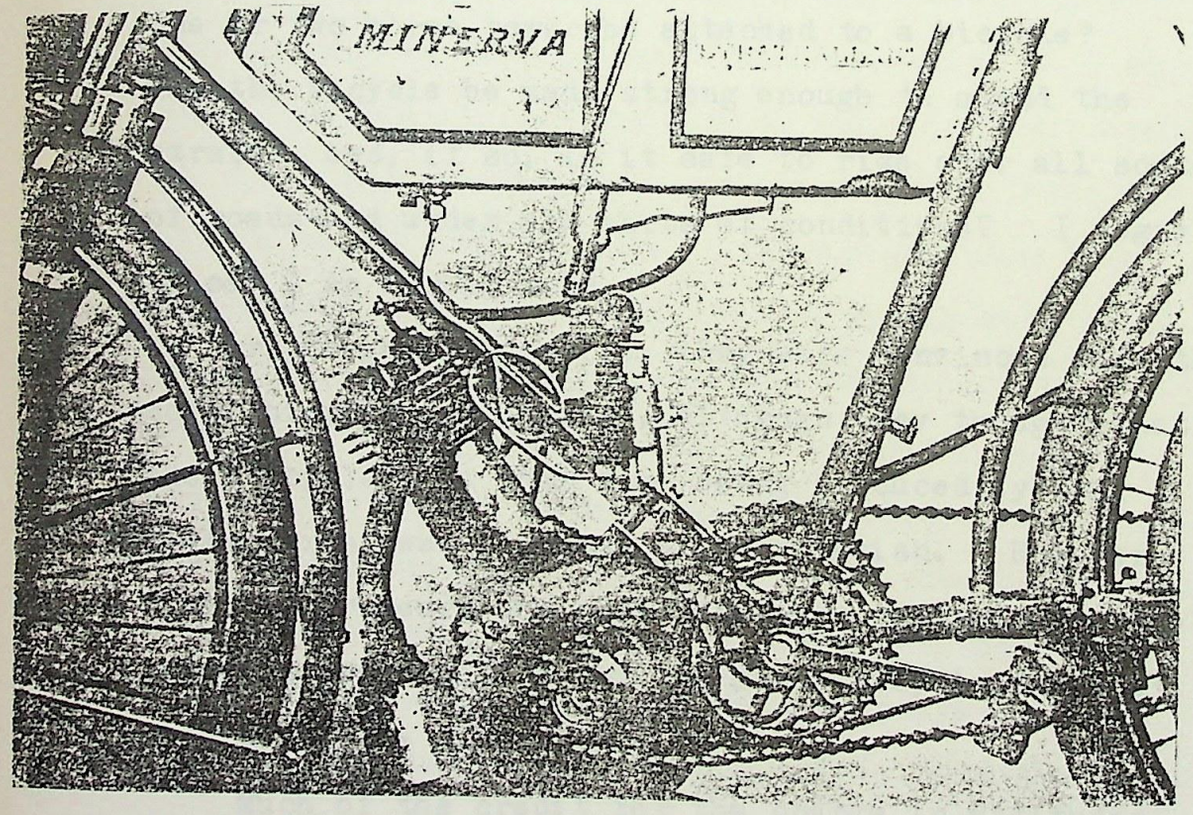


FIG The original Werner.

FIG One of the popular clip-on engine units, the Minerva built in Antwerp by Sylvian de Jong to the design of H.Luthi and E.Zurcher.



THE 1900'S

By the turn of the century the future of the motor cycle was still a problem and even its keenest advocates were doubtful whether it would ever become a serious means of transport.
In 'Motorcycles' by L.J.K. Setright we find the opinion of artist and author Mr. Joseph Pennell on the subject. Having toured France on a front wheel drive Werner he wrote

"But is a motorcycle a practical touring machine? Excellent as it is for excursions, I am afraid not, ... but is the machine practical? Is it a rival to the ordinary cycle for touring? .... I think not ...

But is the system right? I am afraid not for touring. I do not in this matter refer to the Werner especially, which seems to me to be the only Bicycle at all practicable, all others that I have seen have some fatal or absurd defect. But can a motor of say one or two horse power be attached to a bicycle? Can the bicycle be made strong enough to stand the strain? and, if so, is it safe to ride over all sorts of roads and under all sorts of conditions? I regret to say I am afraid not".
As for the general public, they were convinced that the motor bicycle was a freak, although they thought that the tricycle - at that time being produced by over fifty firms, was a practical proposition. However within four years the positions were reversed - the tricycle was obsolete and the motor bicycle was the machine of the future.

Much of the credit for the change in attitudes can be given to the continental "clip on" engine units

designed to clamp on to the frame of a strongly built Bicycle (Fig.11) driving the rear wheel by belt. The pedal bicycle was the obvious ready made article on to which to attach the engine to relieve the rider of effort. As cycle frames and engine units were cheap and readily available they enabled any cycle smith to become a motorcycle manufacturer overnight, providing just the stimulus the struggling industry needed. However by their very popularity these designs revealed the basic inability of the pedal cycle frame to absorb the extra stress imposed by the engine. The vibration and bumping were very severe, and the frames had not any kind of springing. The front forks were rigid and frequently snapped. It soon became apparent that the motorcycle should be designed as a complete entity.

The first positive step in this direction was taken by Werner who towards the end of 1901 introduced an entirely new model (Fig. 13). Where to put the engine had always been a problem, (Fig. 12) and Werner solved it .... the engine was bolted vertically in the middle of the frame in the position taken up by the pedals in a bicycle. This might seem like an obvious location to-day, but as pedals were still considered essential for starting and assisting the engine on hills, space had to be found for both. On the new Werner the pedals were moved back, emphasising their auxiliary function. The extra tube beneath the fuel tank braced the frame. Other features of the design included a foot operated rear brake and hand pump lubrication, relieving the driver from the need to dismount every 10 - 15 miles to administer fresh oil. Werner had succeeded in producing a machine in which

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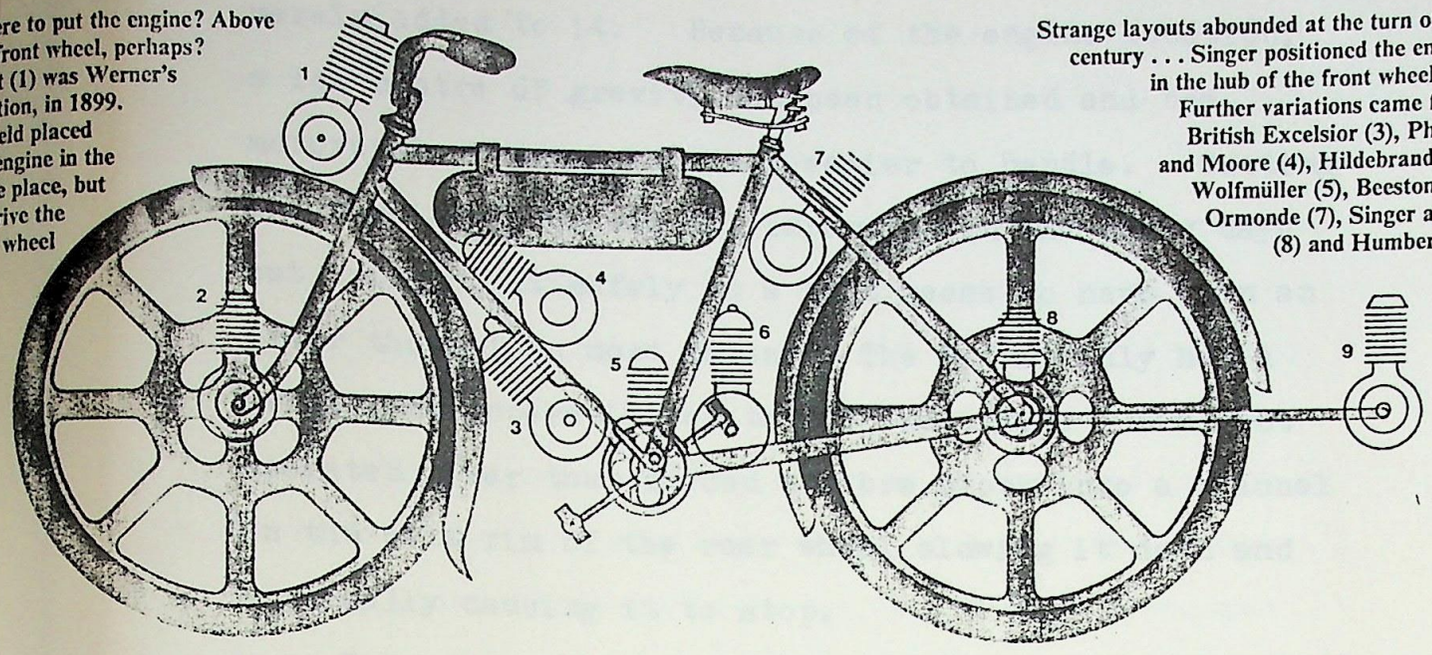


Strange layouts abounded at the turn of the century . . . Singer positioned the engine in the hub of the front wheel (2). Further variations came from British Excelsior (3), Phelon and Moore (4), Hildebrand and Wolfmüller (5), Beeston (6), Ormonde (7), Singer again (8) and Humber (9).

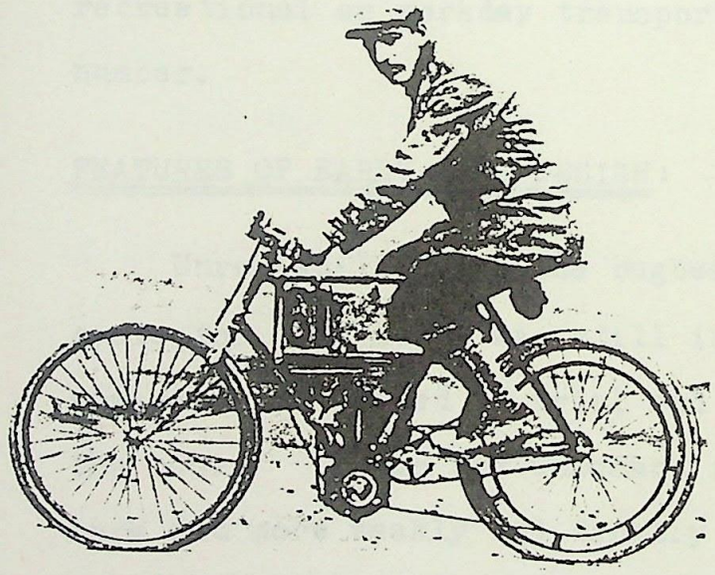


FIG 13 The New Werner.

the engine was incorporated into the frame rather than merely added to it. Because of the engine location, a low centre of gravity had been obtained and the motorcycle became safer and easier to handle. Getting the machine to go was all important in the early days but bringing it safely to a halt seems to have been an after thought in most cases. The Werner only had a crude brake operating on to the front tyre and a foot operated lever that forced a fibre block into a channel on the belt rim of the rear wheel slowing it down and eventually causing it to stop.

From the point of view of engine location a practical design had been established. The Werner with its new found stability, rigidity and performance provided the crystaline form that was to be multiplied and mirrored a thousand times as motor bicycles entered a decade in which they passed from being the experimental plaything of a lunatic minority to becoming the recreational or workday transport of a considerable number.

FEATURES OF EARLY BIKE DESIGN:

Unreliability was the bugbear of the early motor cycle for metallurgy was still in its infancy and engineers proceeded by trial and error rather than by the book. It was not uncommon for a valve to function more and more weakly and finally to fail to open at all as its operating cam reverted to circular form.

TYRES:

Early prototype bikes had solid tyres wired on to the wheel, the joint being effected by welding. The first pneumatic tyres, invented by J. B. Dunlop in 1888,

were made of canvas and rubber and had beaded edges that interlocked with an inturned wheel rim. Motorcycles were fitted with this form of tyre, but its life was short on the stoney nail strewn roads of the time. They were likely to become detached should a sudden puncture occur. Manufacturers experimented with all types of tyre fastening in the form of hooks, studs and perforations before developing the wire suspension variety. The wheel diameter varied from 22 to 28 inches and the tyres that they carried were never more than 2 inches across. These slender tyres inflated to fairly high pressures to sustain the additional weight of the engine, as well as that of the bicycle and the rider, could not be relied upon to give anything positive in the line of grip on the roads.

This problem was overcome by advances in tyre design, reducing the wheel diameter and increasing the tyre width.

FUEL:

Fuel was not expensive, costing ninepence or a shilling a gallon in England. The carburation (mixing of petrol and air) of the day, being the imperfect kind that it was, ment that the petrol was more volatile than would be necessary to-day. But it was difficult to get, there was no question of refilling at some convenient garage or filling station because such places did not exist. One of the difficulties with the distribution of fuel was that the railways were reluctant to handle it.

LIGHTS:

A good reliable light was a necessity, but early

owners had to be content with oil or acetylene bicycle lamps which did not readily withstand the greater draughts and extra vibrations to which they were submitted. Lucas and other firms produced more suitable lamps after the turn of the century but the light was poor and tiresome to ride by for any length.
Gas was provided by a carbide and water mixture and illumination was increased by mirror reflectors, but it was a smelly troublesome business and motorcyclists gratefully put these lamps aside as dynamos light became available in the 1920's.

"CARRYING A PASSENGER"

Motorcycles were still comparatively expensive, prices ranging on average from £30 - £60 and already there was growing opinion that they were becoming too fast (around 30 m.p.h.)

One of the results of the increased power output was that the motorcyclist could consider carrying a passenger. At first it seemed that the tricycle would be the most suitable in this respect.
In 1898 Pennington designed a machine called the 'Olimpia Tandem' which was constructed by Humber and had a coach built passenger seat mounted between the front wheels (Fig. 15). The rear part of the machine was conventional motorcycle with the engine outrigged behind the back wheel.

Another solution was for the motorcyclist to hitch a light trailer behind his machine (Fig. 16). This location was the least favourable from the passenger's point of view. On the atrocious roads of the day the unfortunate passenger would be sprayed with exhaust fumes, oil, mud and dust, while the connection between cycle and trailer was unreliable and often broke.

J. Van Hooydonk maker of the Phoenix motorcycle, designed a forecar attachment to replace the front wheel, and convert a bicycle into a two seater tricycle. This Phoenix "Trimo" attachment was widely copied and other makers, notably Excelsior and Mills and Fulford (who had previously built trailers) were soon producing competitive designs. (FIG 17)

The brief vogue enjoyed by these conversions was brought to an end by the advent of the sidecar, in-

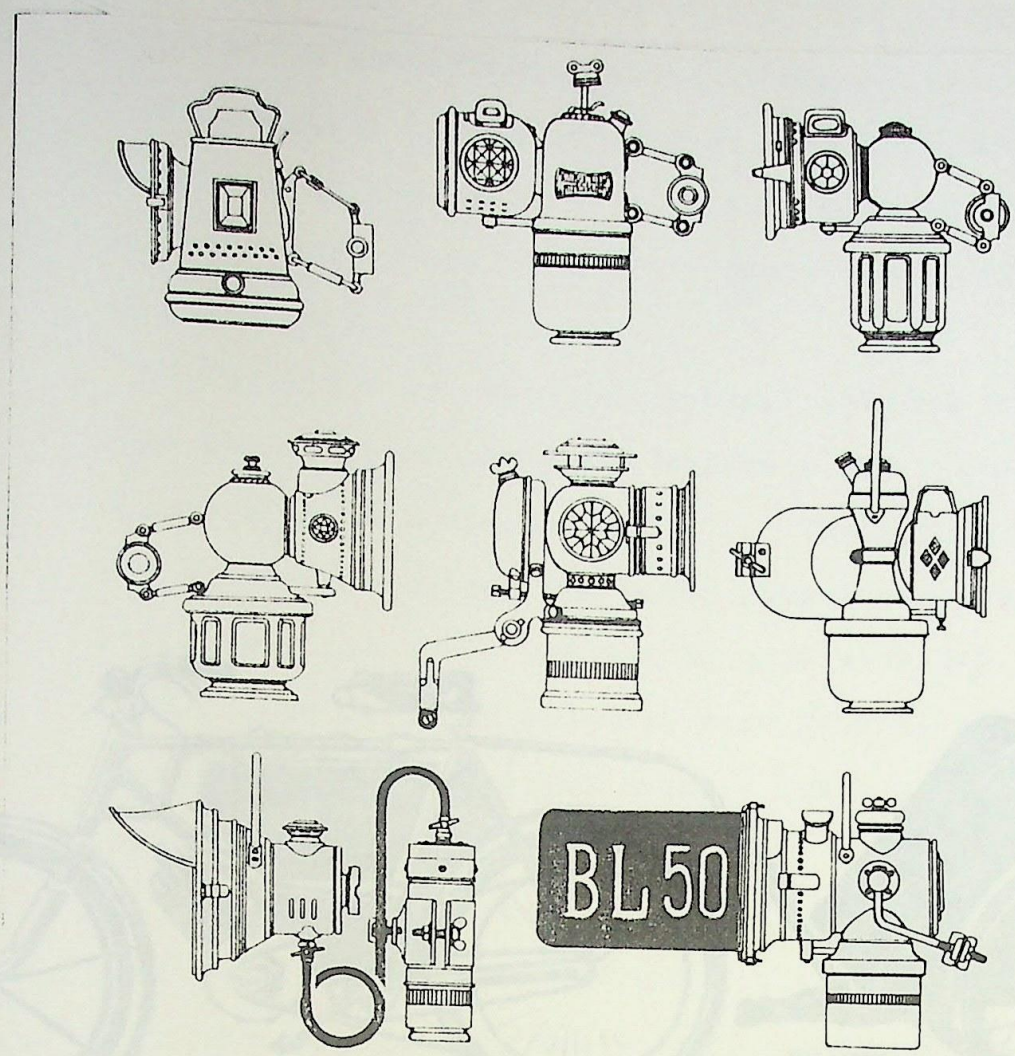


FIG 14 Various gas and oil powered lamps used by early motorcyclists.

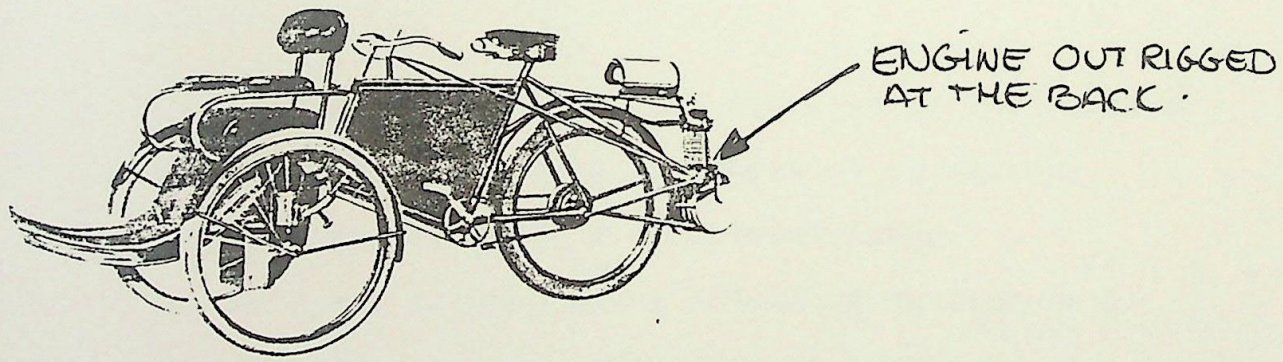


FIG 15 The Humber Olympia Tandem of 1895 designed by Pennington.

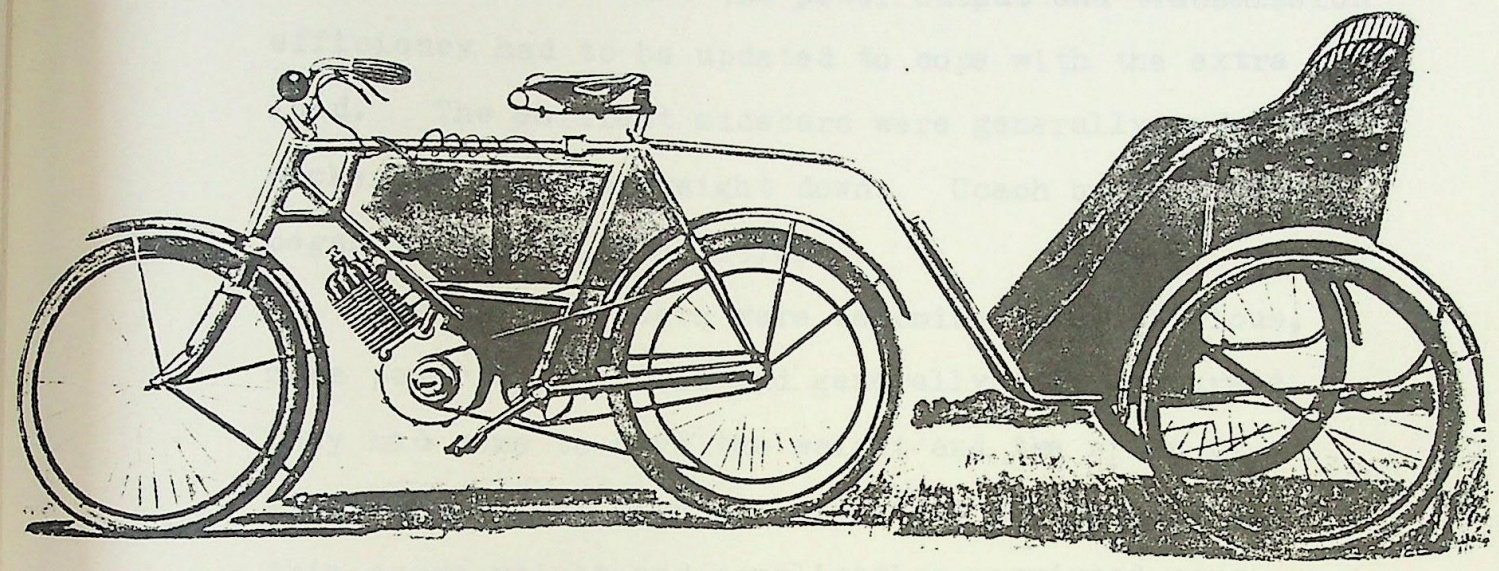


FIG 16 Clip-on wickerwork trailer turned this MMC engined Coventry Eagle into transport for two.

vented in 1902 by Mills and Fulford who simply took one wheel off a trailer and bolted it alongside a motor-cycle (Fig. 18). Other makers soon followed their lead, and by 1903 several "sociable attachments" were on the market. By 1911 the sidecar was firmly established.

The Mills and Fulford designs included features like steerable or castoring sidecars and a one - either side twin sidecar outfit. The popularity of the sidecar ment that the power output and transmission efficiency had to be updated to cope with the extra load. The earliest sidecars were generally made of wicker to keep the weight down. Coach built models began to appear after 1910.

Meanwhile tricars were becoming more luxurious, more powerful, heavier and generally more lethargic. They had come to have the weight and the price of a light weight car without its social standing. All this extra weight and complication convinced some designers that a return to simplicity was overdue and a spate of ultra-light machines were released on to the market.

A new kind of lightweight appeared in 1905 with a layout that has continually reappeared in various guises during the history of motorcycling.

This was an open frame low-slung machine with weather guarding - the type later to become known as the scooter. One of the earliest examples was the 1905 Brown Midget Bicar with steel armoured wooden frame which was followed a couple of years later with a design by W.C. Johnson of Colemans Hatch Sussex. In Italy in 1908 the £38 Laviosa Autoclettee was shown

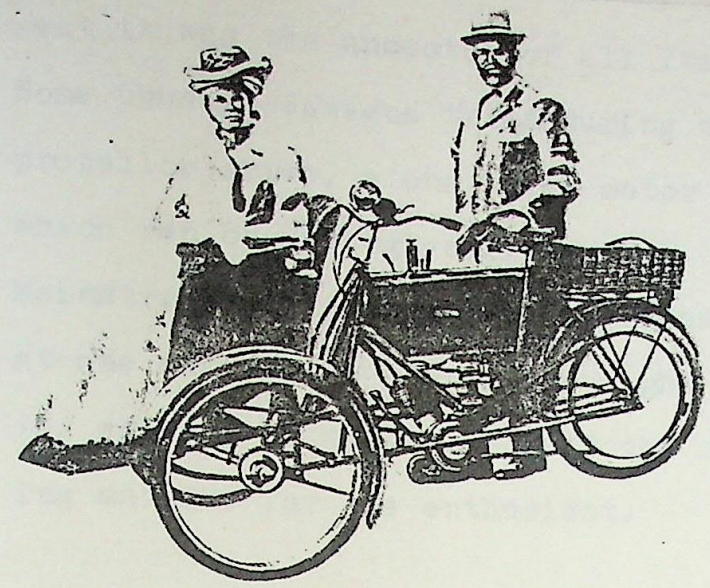


FIG 17 The 1902 Phoenix Trimo designed by J.Van Hooydonk.

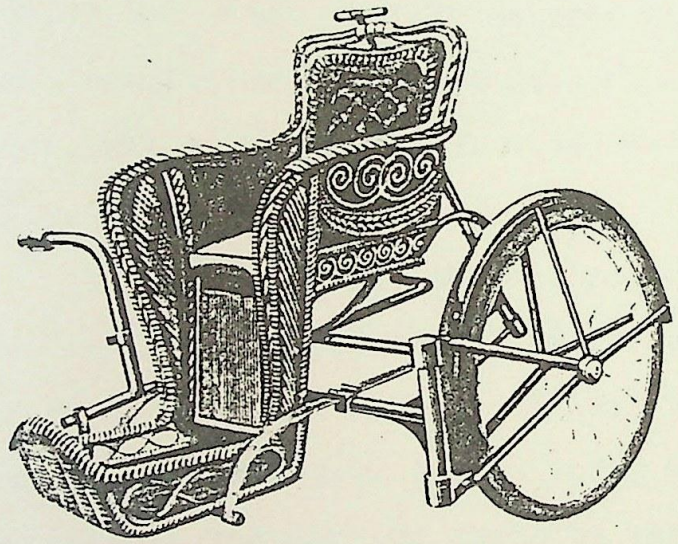


FIG 18 One of the first sidecars was this Rococo wickerwork Mills & Fullford sociable attachment of 1903.

at Turin; with its small wheels, open frame and bucket seat it was the ancestor of all Italian scooters.
Some unusual designs tried during this period included propellor drive, a one wheel motor cycle and an engine which ran on nitroglycerine
Mainstream design was rapidly becoming polarised with, at one end of the scale, the light runabout designed for economy of upkeep and, at the other end, the sporting machine for the enthusiast.

MULTI-CYLINDER ENGINE

Naturally, the sporting riders were always looking for an increase in power and speed and at first designers uprated the power output by raising the swept volume of the engine. But this meant that the big single cylinder engines eventually reached a size where they suffered from excessive vibration, so the industry began to take a second look at multi-cylinder power units, originally killed off by the clip-on boom and the new Werner type of frame, into which a vertical single fitted so neatly.

The advantages of the multi-cylinders were more even torque and increased flexibility of running. The most popular type was the vee-twin which fitted naturally into a diamond cycle frame.

One of the first British manufacturers to fit a vee twin was Princeps of Northampton, whose 1903 4 h.p model had a variable gear with handlebar control (Fig. 19).

In the same year the Eclipse Motor & Cycle Co., of Birmingham built the '90 degree vee twin XL-ALL (Fig. 20). The Company claimed that in a case of partial breakdown or if the rider wanted to economise on petrol, the machine could be run on one cylinder only.

Far smoother than the Vee-twin, but difficult to house within a bicycle frame was the flat twin. Joseph Barter of Bristol pioneered the type in 1902, and he sold his design to the Douglas Brothers of Kingswood. A defect of the design was the excessively long wheel base (due to the engine legnth) which made the bicycle very liable to skid.

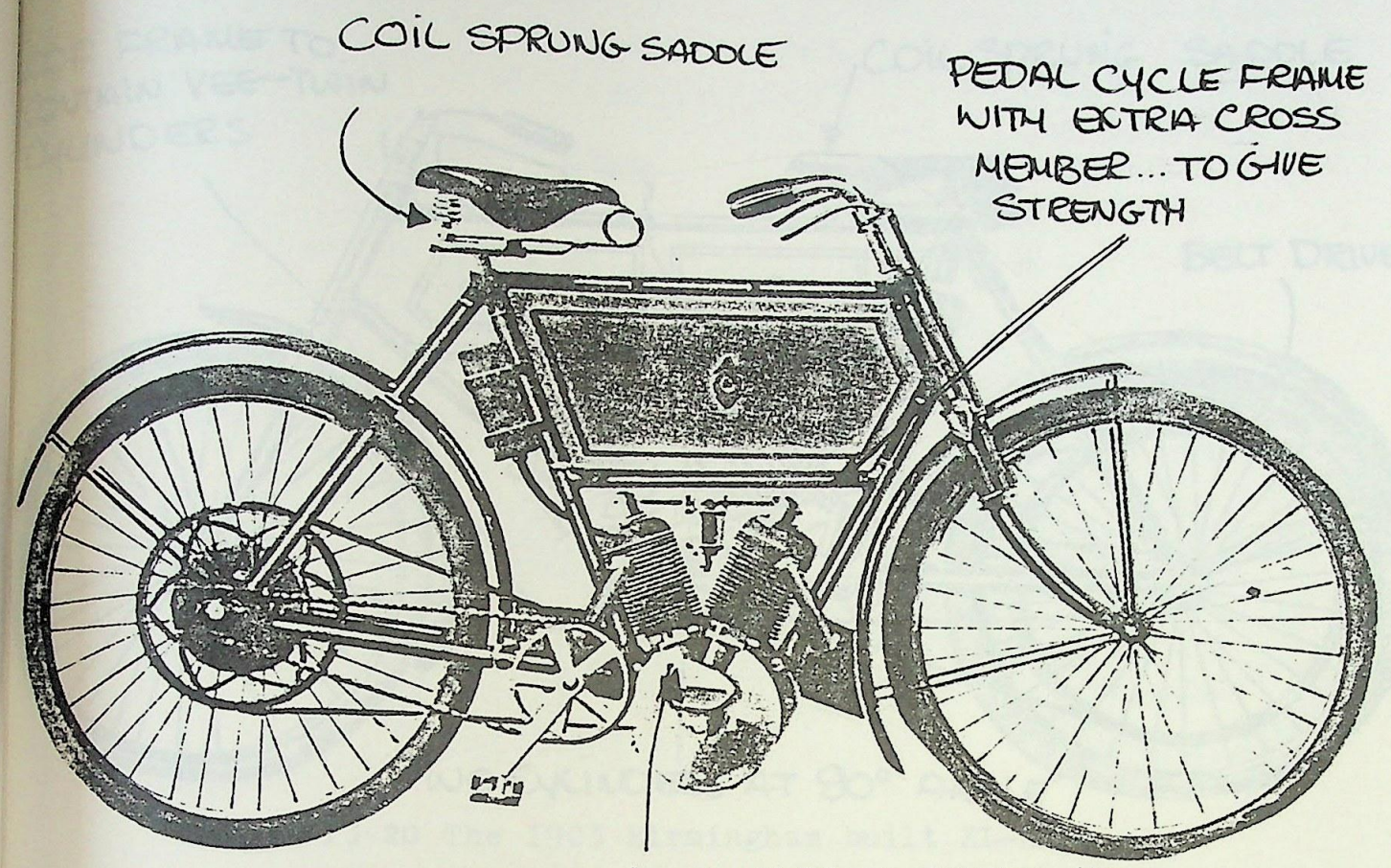


FIG 19 The 1903 Princeps Vee-Twin model.

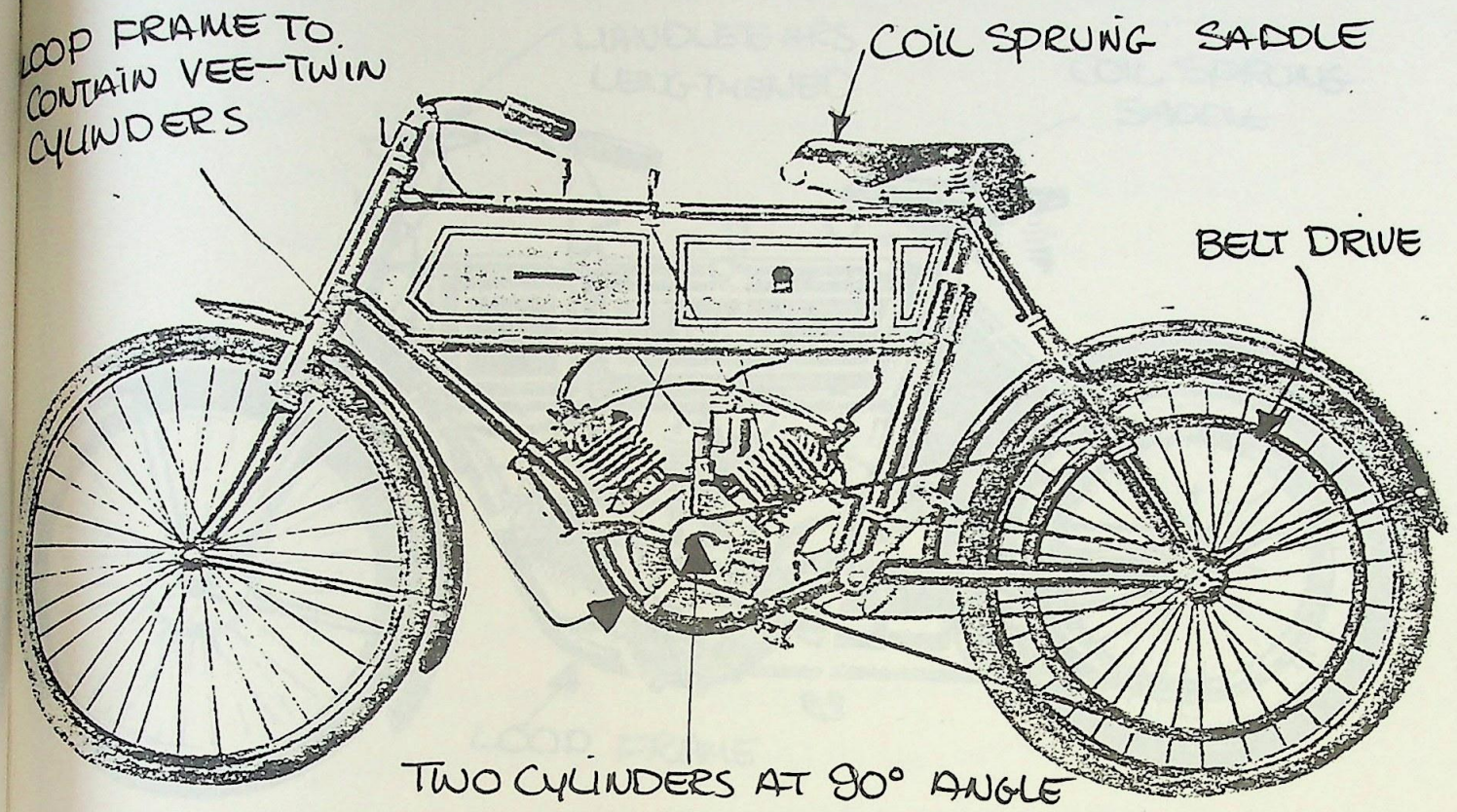


FIG 20 The 1903 Birmingham built XL-All.

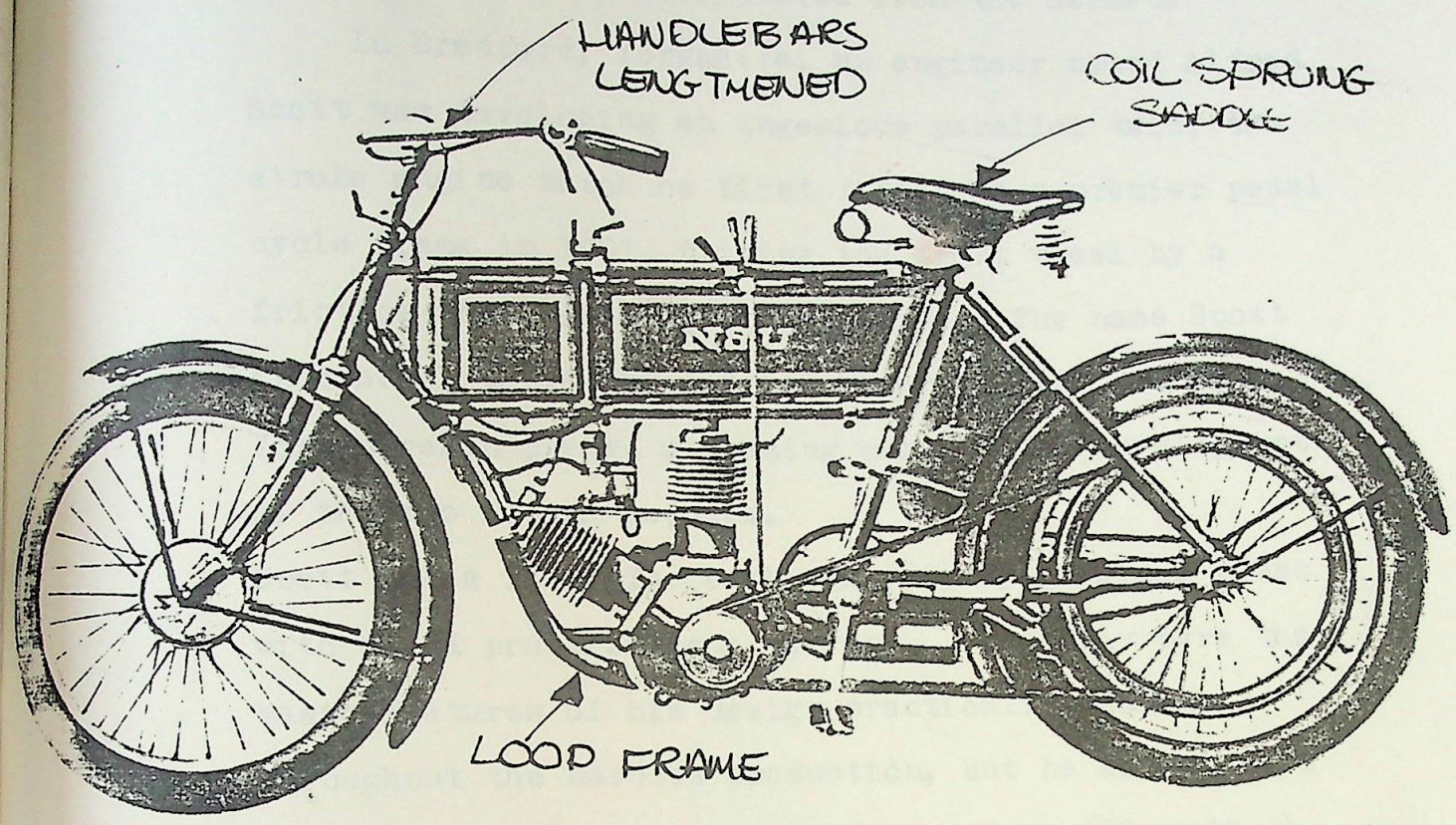


FIG 21 In 1906 NSU (Neckarsulmer Fahrzeuge Werke) of Germany built this Vee-twin model with the engine inclined forward for better cooling of the cylinders.

One type which did not catch on to any great extent was the vertical twin, which in its early form had all the vibratory disadvantages of the single together with the complications of the twin. Bercley of Brussels and Werner built units of this type around 1905. After a brief vogue they disappeared from the market.

In Bradford, Yorkshire, an engineer named Alfred Scott was developing an ingenious parallel twin, two stroke engine which he first fitted to a premier pedal cycle frame in 1901,. driving the front wheel by a friction wheel rubbing on the tyre. The name Scott is central to the history of motorcycling. This Yorkshireman played a leading part in the development of the two stroke machine.

Scott had a flair for combining highly original ideas with sound practical engineering. Not only were the basic features of his design practically unchanged throughout the marques production, but he anticipated technical trends by up to half a century (Fig. 22).

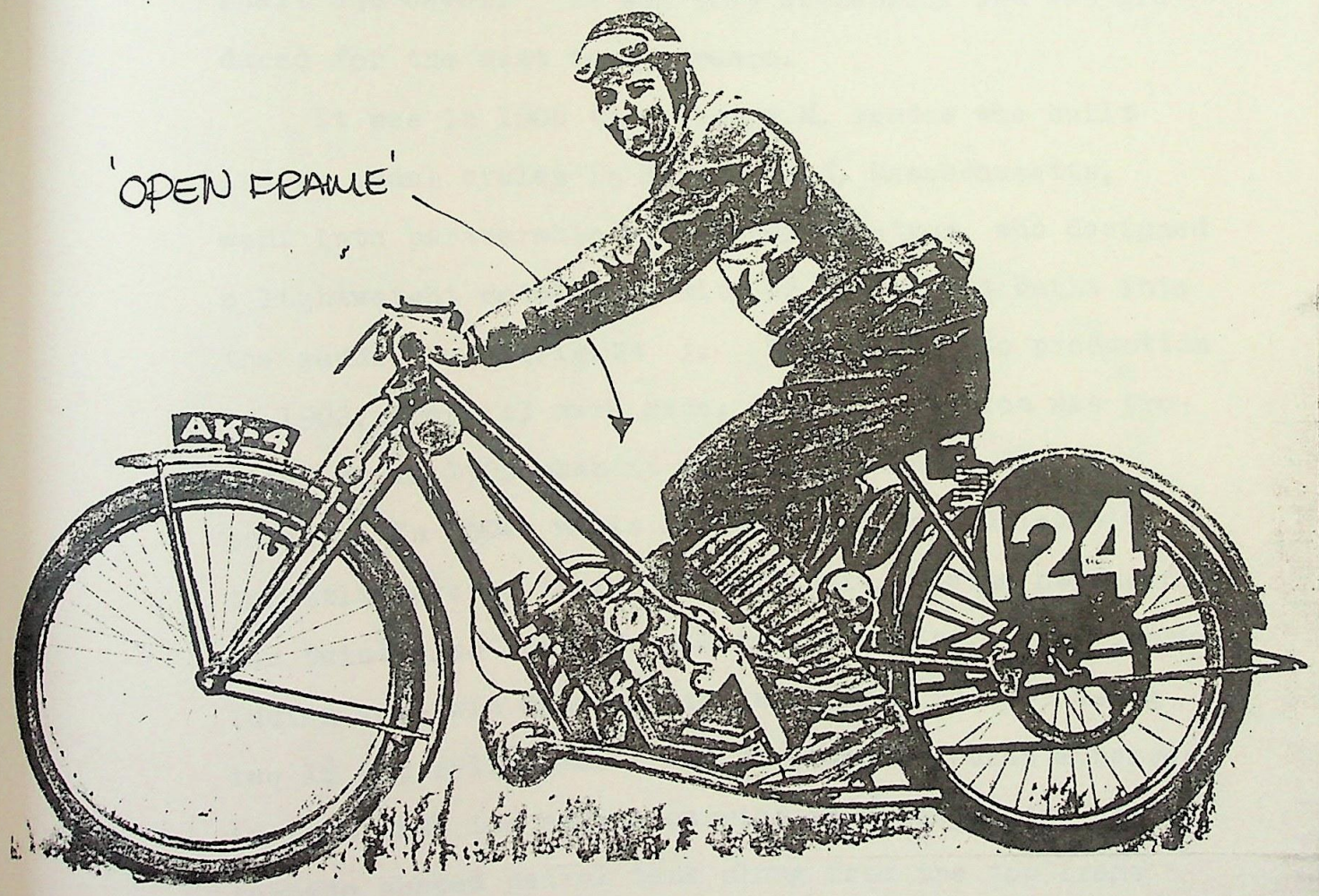
One of the mainstays of present day Japanese two-stroke production.- the 180 degree parallel twin, was used by Scott back at the turn of the century. Even to-day water cooling of such an engine is something of a racing sophistication, yet Scott engines had water cooled heads from the very beginning and by 1914 were completely water cooled.

Now practically universal, telescopic front forks became popular shortly before World War Two, Scott had them before the First World War.

Scott was very aware of the importance of frame stiffness and the lowest possible centre of gravity.

The legendary road holding of his machines owed much to the triangulated, straight tube, open frame in

FIG 22 A 1913 parallel-twin two-stroke Scott.



which the engine was an integral, low slung member. This triangulated frame was to become the marques hallmark.

The ultimate in smoothness was the in-line four cylinder. Initially this meant a dangerously long and hence skid prone wheel base, but one solution to the problem was devised by Charles Binks of Nottingham, who pioneered the four cylinder in Britain. His 1903 model could be had with the engine set either longitudinally or transversely. But the heyday of the transverse four was many years in the future.

Late in 1904, the first example of what was to become one of the most famous 'four-in-line' motor cycles was revealed to the public (Fig. **23**). Built by the Belgian armaments firm, Fabrique Nationale d'Armes de Guerre of Herstal Liege, the new FN model had 363 cc engine designed by Paul Kelecom. Transmission was by shaft and bevel. It was very successful and was produced for the next twenty years.

It was in 1900 that George M. Hendee who built Indian pedal cycles in Springfield, Massachusetts, went into partnership with Oscar Hedstrom, who designed a lightweight motorcycle with $1\frac{3}{4}$ h.p engine built into the saddle tube (Fig. **24**). This went into production in 1902, when 143 were made, and this version was produced until 1905 when it was replaced by a $2\frac{1}{4}$ h.p model. In 1904, while European riders fiddled with throttle levers, their transatlantic cousins had handlebar twistgrips for controlling the engine. The famous Indian vee-twin models were introduced in 1905 using two $1\frac{3}{4}$ h.p cylinders. The archetypal Indian appeared in 1909 with its engine carried in a loop frame and a torpedo shaped petrol tank slung from the top frame

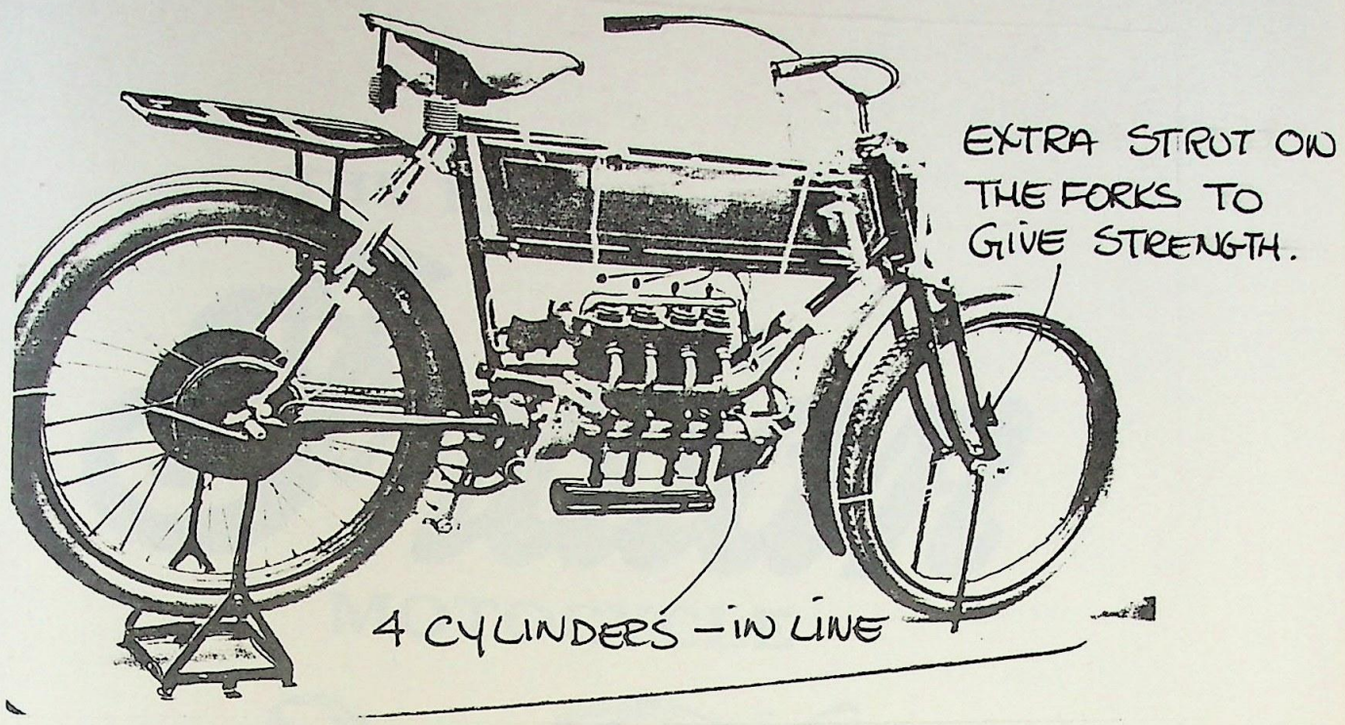


FIG 23 The best known of the early four cylinder models models was the shaft-driven FN built in Belgium to the design of Paul Kelecom.

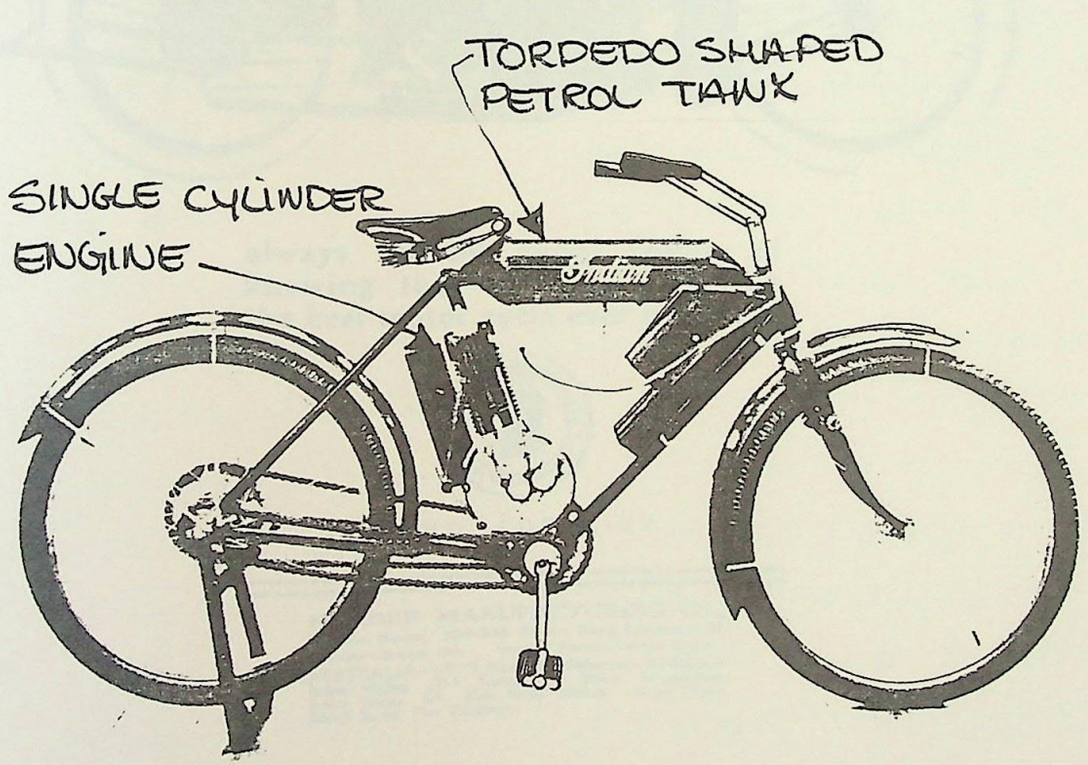


FIG 24 The original version of the Indian built from I90I until I909.

tube. Indian were virtually unique in promoting a virorous export policy, their British depot being in the hands of Billy Wells, who had previously sold Vindec motorcycles. He encouraged the entry of Indians in competitions of all kinds, and in 1911 an Indian machine was the first foreign bike to humiliate the British industry by scoring a 1-2-3 victory in the senior TT in the Isle of Man.

What was to become Indian's biggest rival, the Harley Davidson began in a backyard shed in 1903 when William Harley and Arthur Davidson put together a light 2 h.p single cylinder model (Fig. 25) which was progressively developed until 1909 when Harley built their first Vee twin of 6 h.p.

Since cars were so cheap in America, from a very early date manufacturers tended to emphasise the sporting side of motor cycling. The big-twin became the most distinctive and long lived American type.

Meanwhile in Britain the number of motorcyclists had grown from 29,000 in 1905 to over 80,000 in 1907, and the greater number of motorcycles in use meant that design imperfections were becoming more apparent and less tolerated. Also, the type of motorcyclist was changing - the dedicated enthusiast of the early days was being replaced by a rider who expected reliability and a reasonable performance from his mount.

One of the most popular motorcycles of the 1907-9 period was the 476 cc $3\frac{1}{2}$ h.p Triumph. In 1895 M. J. Schulte, a young German, came over to Coventry to demonstrate a Hilderbrand and Wolfmuller motor bicycle, liked the country and stayed. He joined the Triumph Cycle Company where he became a director, a post he retained for over 30 years.

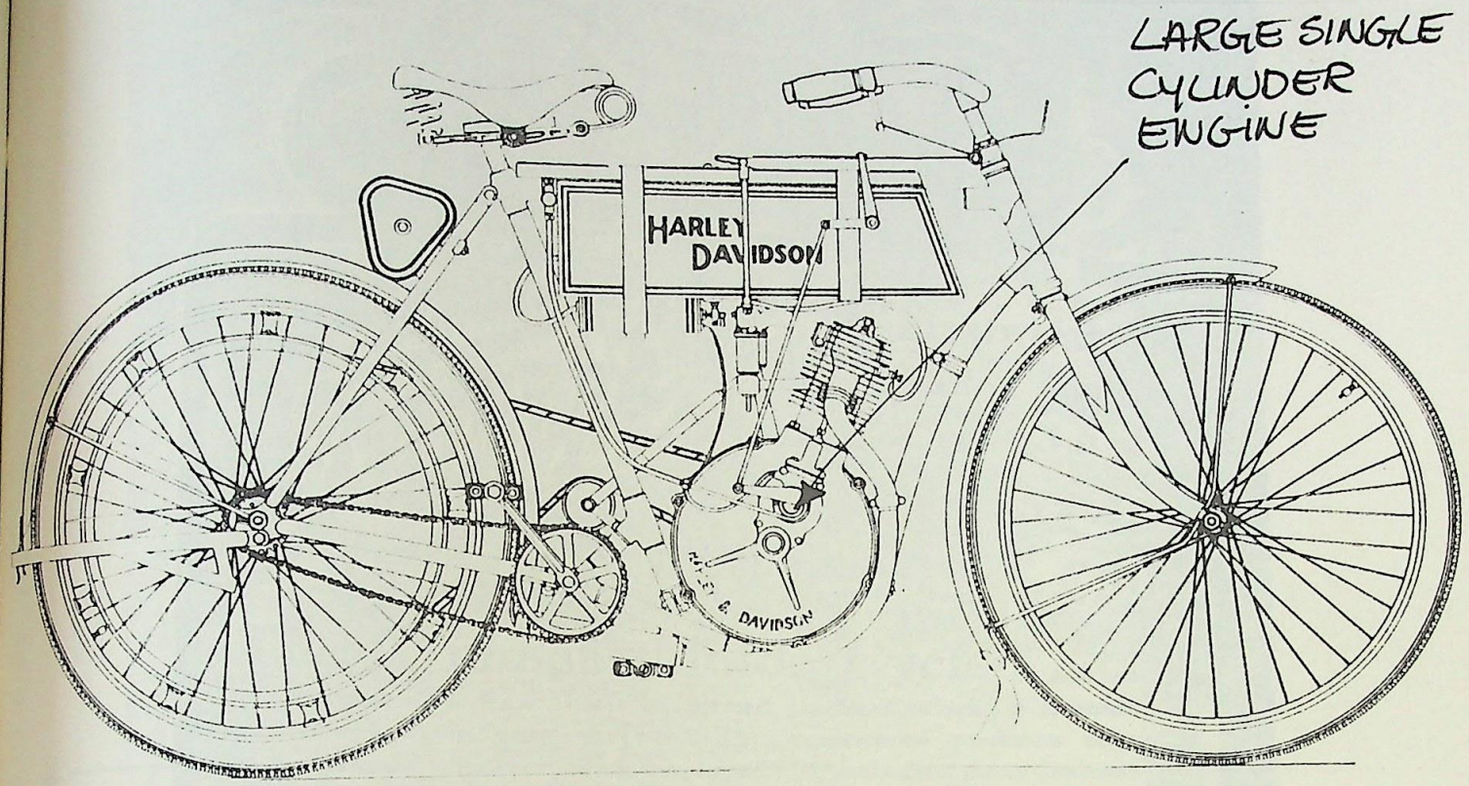


FIG 25 3hp Harley Davidson produced in 1903.

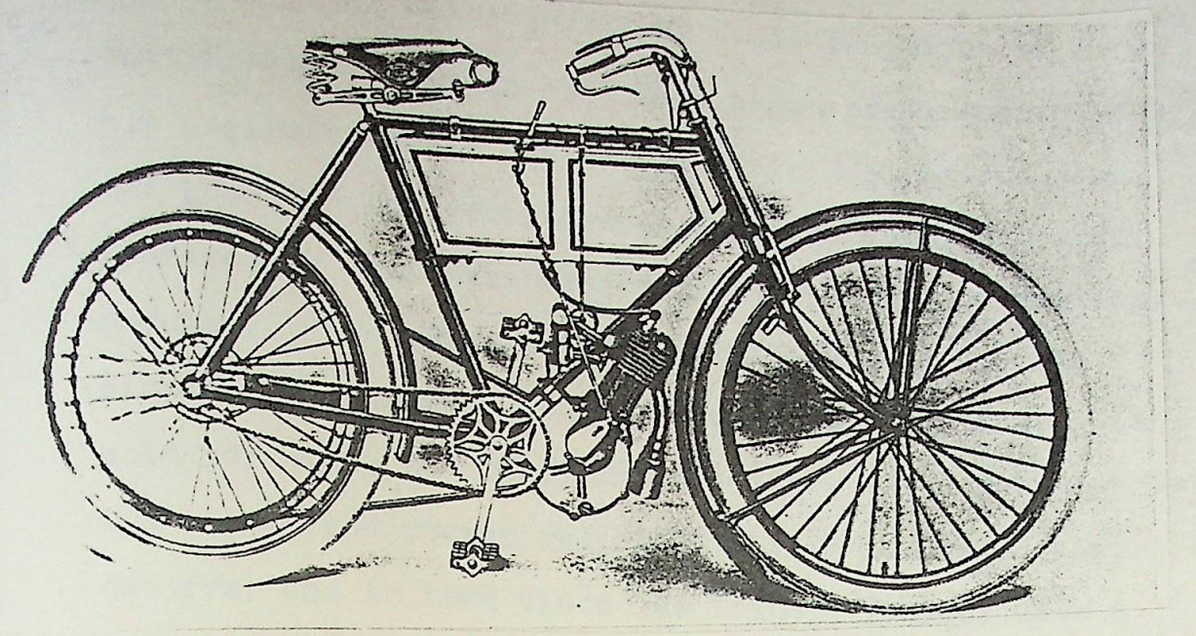


FIG 26 Triumph's first - introduced in 1902.

In 1903 Triumph began building motorcycles, at first with Jap power units (built by J. A. Prestwich in Nottingham). But in 1906 they began production of a 3 h.p engine of their own design. Initial models were not good and lost compression rapidly, but the Company profited by their mistakes and later models became very popular. The essence of Triumph's success was its simplicity of upkeep and its robust construction. It sold for £48 - not cheap for the time, but a good sporting record and proven reliability were powerful sales factors, and in 1908 alone the Triumph Company made a profit of £22,048.

It was the development of reliable machines on the lines of the Triumph which really established the Brtiish motorcycle industry as world leaders. A high percentage of the bikes produced were exported. In 1905, only 3,250 machines were produced and 688 exported, but the figures rose rapidly and, by 1910, a third of the output of 10,000 machines went overseas.

On the Continent things were different. Although France had set the pace at the beginning of the century, the number of motorcycles in use dropped noticeably between 1906 and 1909, when a low figure of 26,465 was recorded (in the same year 75,000 motorcycles were estimated to be in use in Britain). By 1912 the number of machines in use in France had risen to 37,000 but the average size of the motorcycles was smaller than their British counterparts. Also the Franch lightweight machines were devoid of some of the features demanded by the British motorcyclist, such as clutches or variable gears, because it was claimed that the low weight of the machines rendered them unnecessary.

One factor common to all the motorcycle markets was that the rider was demanding more from his machine in terms of comfort and reliability.

Vibration had been a bugbear of the early days. While speeds were low, lack of any form of springing was of minor consequence, but as engines began to gain power so frame breakages became more common. The addition of struts to the front fork blades proved not to be the answer and gradually front springing became essential. The introduction in 1906 of spring forks had done much to alleviate this problem.
The BAT ('Better After Tests') machines had a fully-sprung frame as early as 1903 and it was also one of the first makes to dispense entirely with pedals, relying solely on the engine power.

TRANSMISSION:

The single speed belt transmission was popular for quite a long time, the first move towards variable gearing came with the invention of the adjustable engine pully. The idea was that by closing the pulley the belt would operate at a greater radius, thereby raising the overall ratio. Alternatively, opening the pulley would lower the ratio.

This type of gearchanging could not be done on the move. On reaching the foot of a hill the rider had to dismount, remove the driving belt, adjust the pulley and refit the belt. Because the belt, correctly tensioned for the high gear, would be too slack for the low gear, it was necessary for the riders to carry two belts of different lengths, one for each gear.

One of the more advanced forms of the variable pulley was to be found on the Zenith Gradua Bikes. On these machines the gear could be varied without stopping.

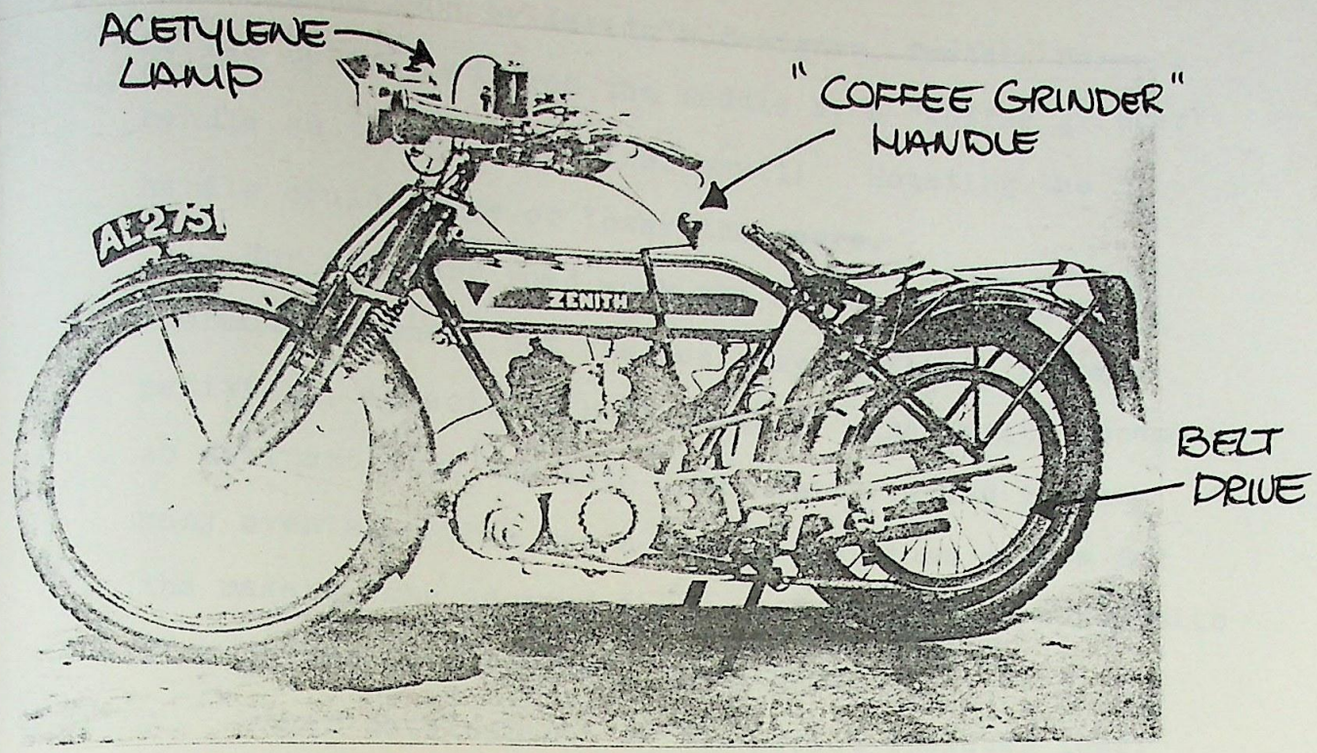
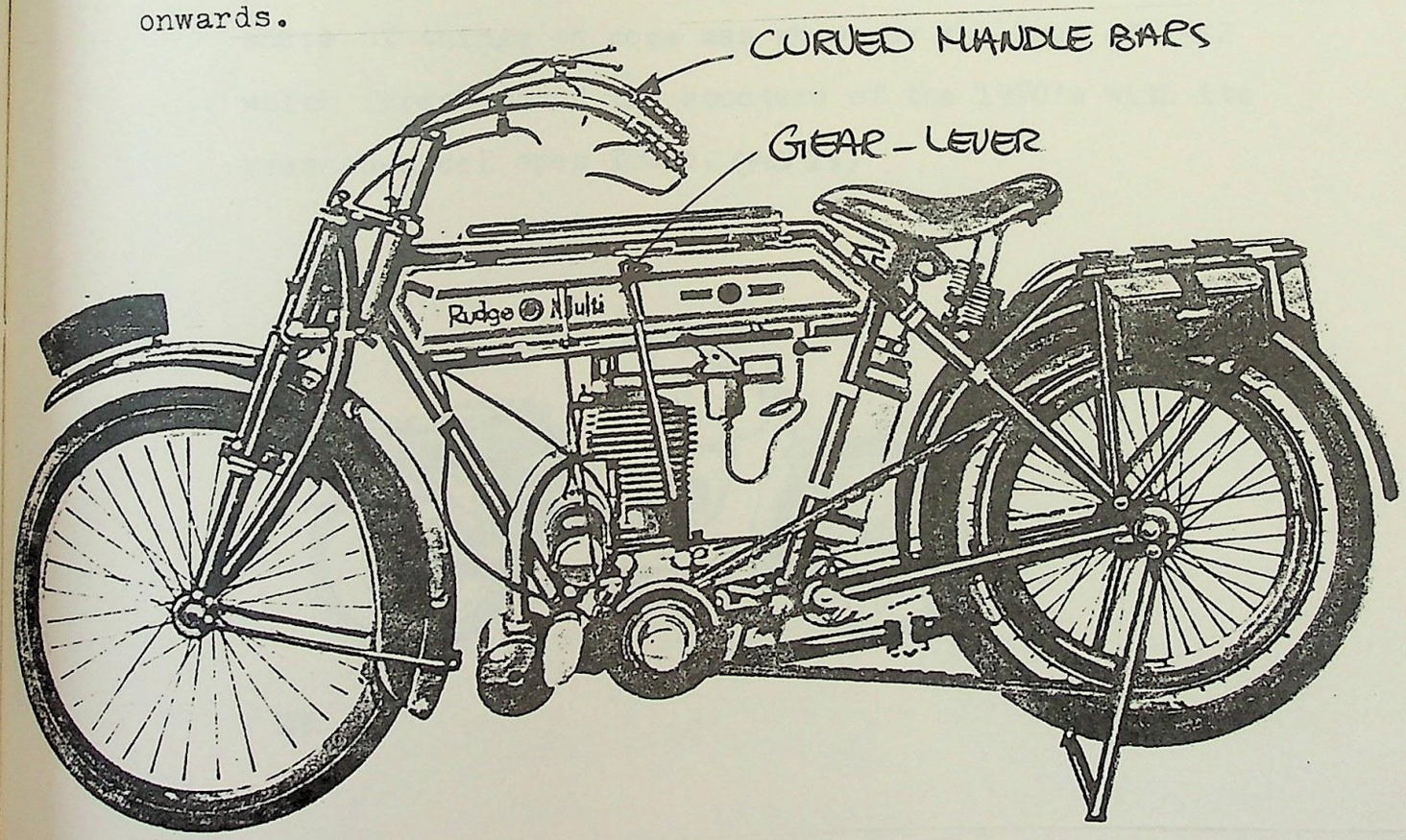


FIG 26 The Zenith Gradua had variable transmission in 1908.

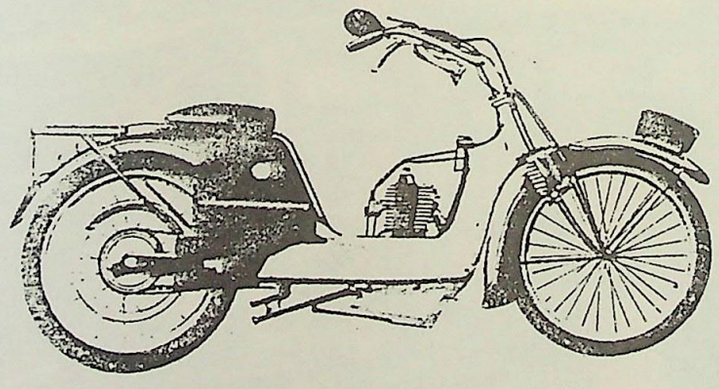
FIG 27 One of the most successful variable transmission machines was the Ruge Multi, produced from 1911 onwards.



Invented in 1908 by Zenith's designer, Freddie Barnes, it was controlled from the saddle by a "coffee grinder" handle on top of a vertical shaft. Rotating the handle could raise or lower the gears.

For ordinary road work the Gradua gear was an enormous advance, but the real pay-off came in competitions, especially hill climbs. The Zenith became so dominant thst the Auto Cycle Union barred it from many events. This was a boom rather than a blow for the makers, who adopted the word "barred" and a symbolic five barred gate as their trade mark.

Other developments of the period included lower frames, sometimes with rear springing - the Sharpe designed ASL had pneumatic suspension fore and aft, better tyres and improved lighting. Acetylene lamps had replaced the glowworm oil lights of the pioneer days. Experiments were being made with electric lighting and Indian were the leaders in this field, with electric lighting and starting in 1914. The shape of things to come was shown by the Swan of 1912 which foreshadowed the scooters of the 1920's with its pressed-steel open frame. (FIG 28)



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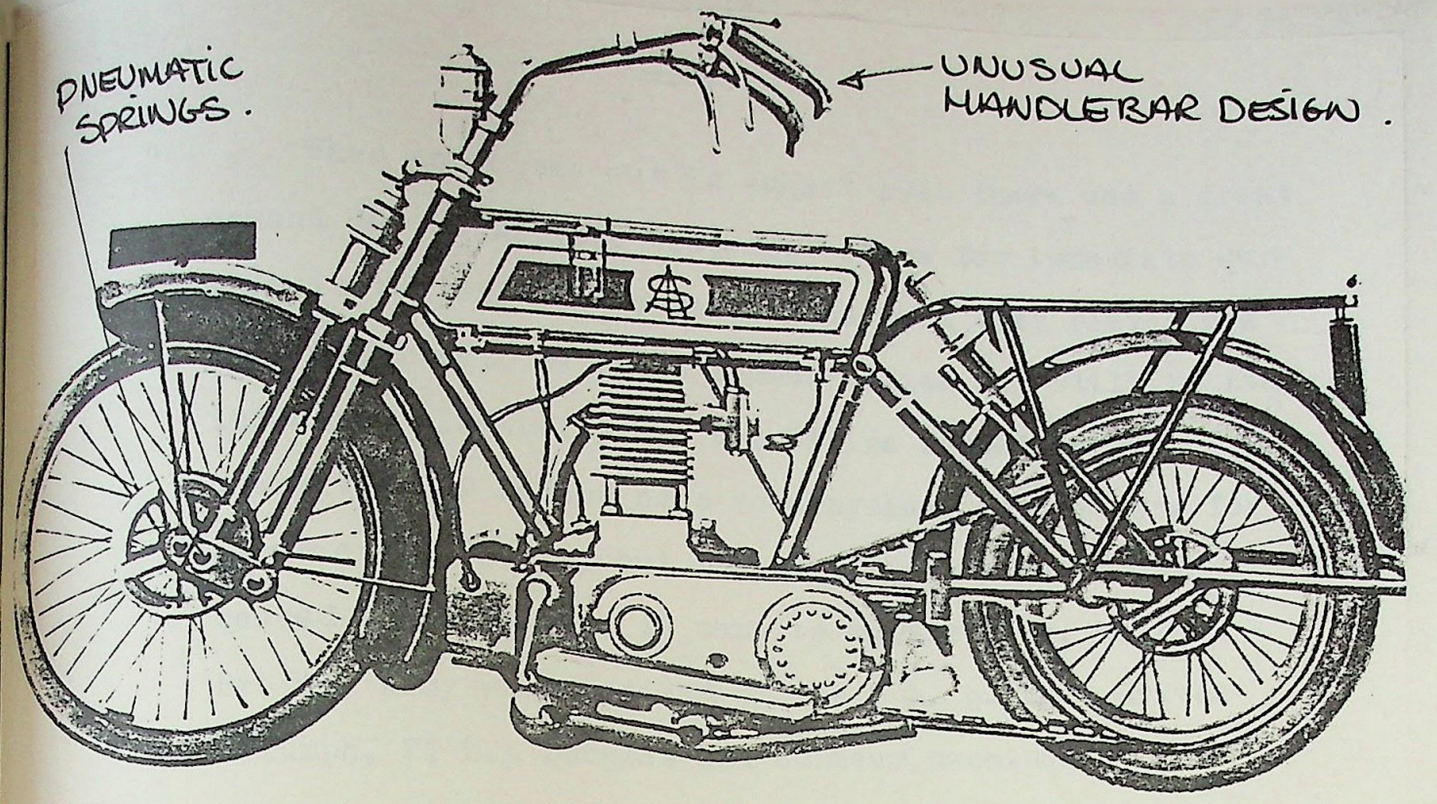
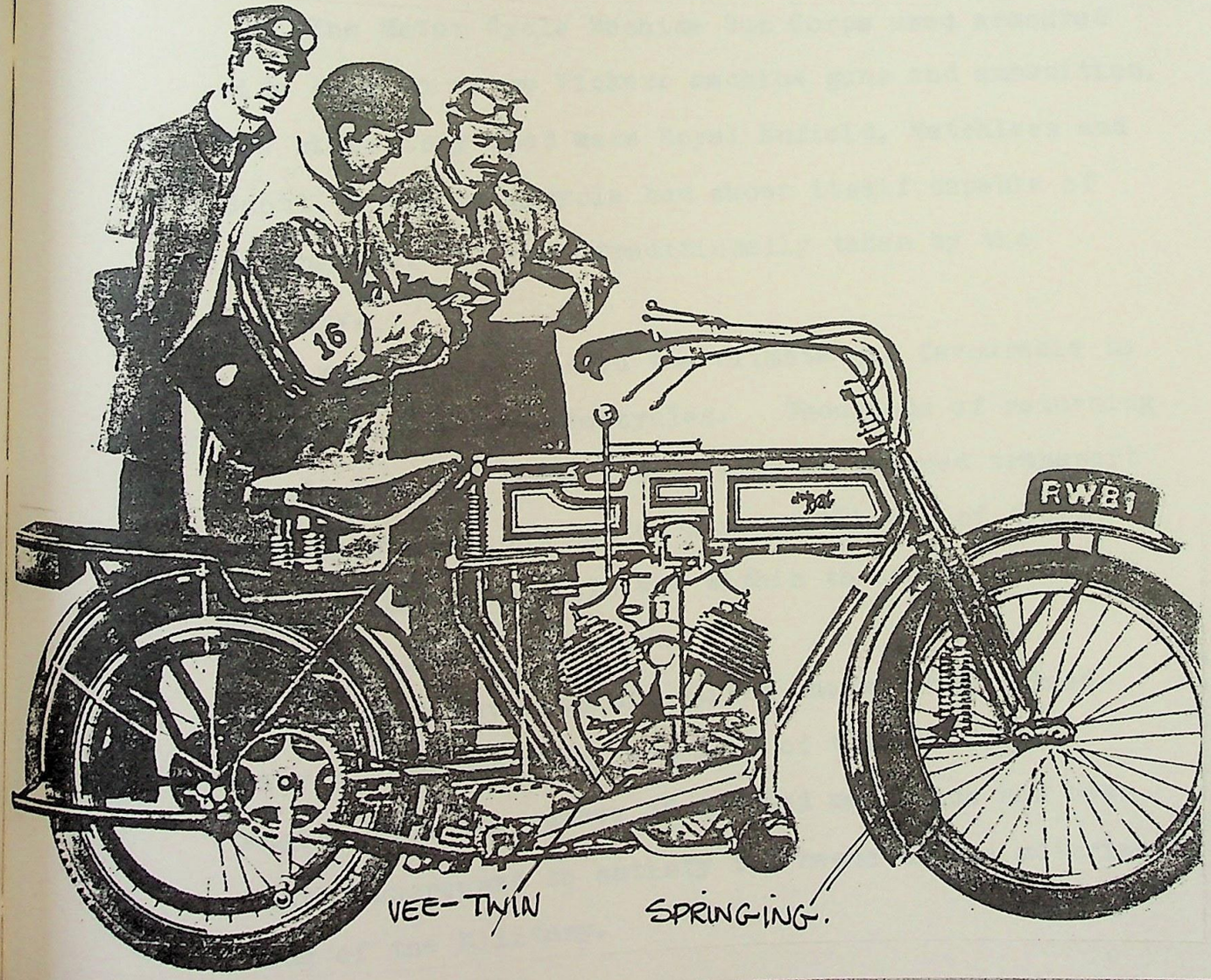


FIG 29 Designed by Sharpe the ASL had pneumatic springs fore and aft.

FIG 30 Another early spring-frame was the BAT (Best After Tests) designed by S.A.Tessier.



W A R

When war broke out in August 1914 there was a great demand for motorcycle despatch riders for immediate service in the British Forces. The part they played was very important, as radio communication was still in its infancy. Initially the War Office bought large quantities of second hand motorcycles, advertising for experienced riders, but the number of makes in use caused problems when it came to maintenance, so the British Army standardised on the 4 h. p. belt driven Triumph, $2\frac{3}{4}$ h.p Douglas and Sunbeam machines.

The Germans used mainly NSU and Wanderer Bikes, the Franch René Gillets, the Austrians Punchs and the Italians Bianchis. Britain supplied Rover and Premier machines to the Czar of Russia.

The Motor Cycle Machine Gun Corps used armoured side cars to carry Vickers machine guns and ammunition. The bikes they used were Royal Enfield, Matchless and Scott. The motorcycle had shown itself capable of taking over the role traditionally taken by the cavelry.

When the war ended the climate was favourable to the sales of new motorcycles. Thousands of returning servicemen had their first taste of powered transport during the war and wanted a motor vehicle of their own and the motorcycle was within the reach of a wide section of the population.

Engine developments during the war had solved many of the technical problems of the air cooled engine, and the number of trained mechanics had been vastly increased to satisfy the needs of the motorised wing of the Military.

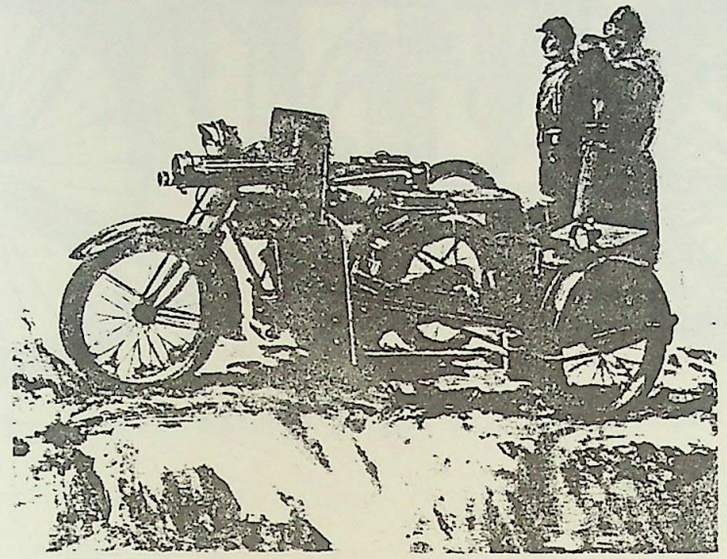


FIG 31 The Vickers-Clyno motor machine gun outfit

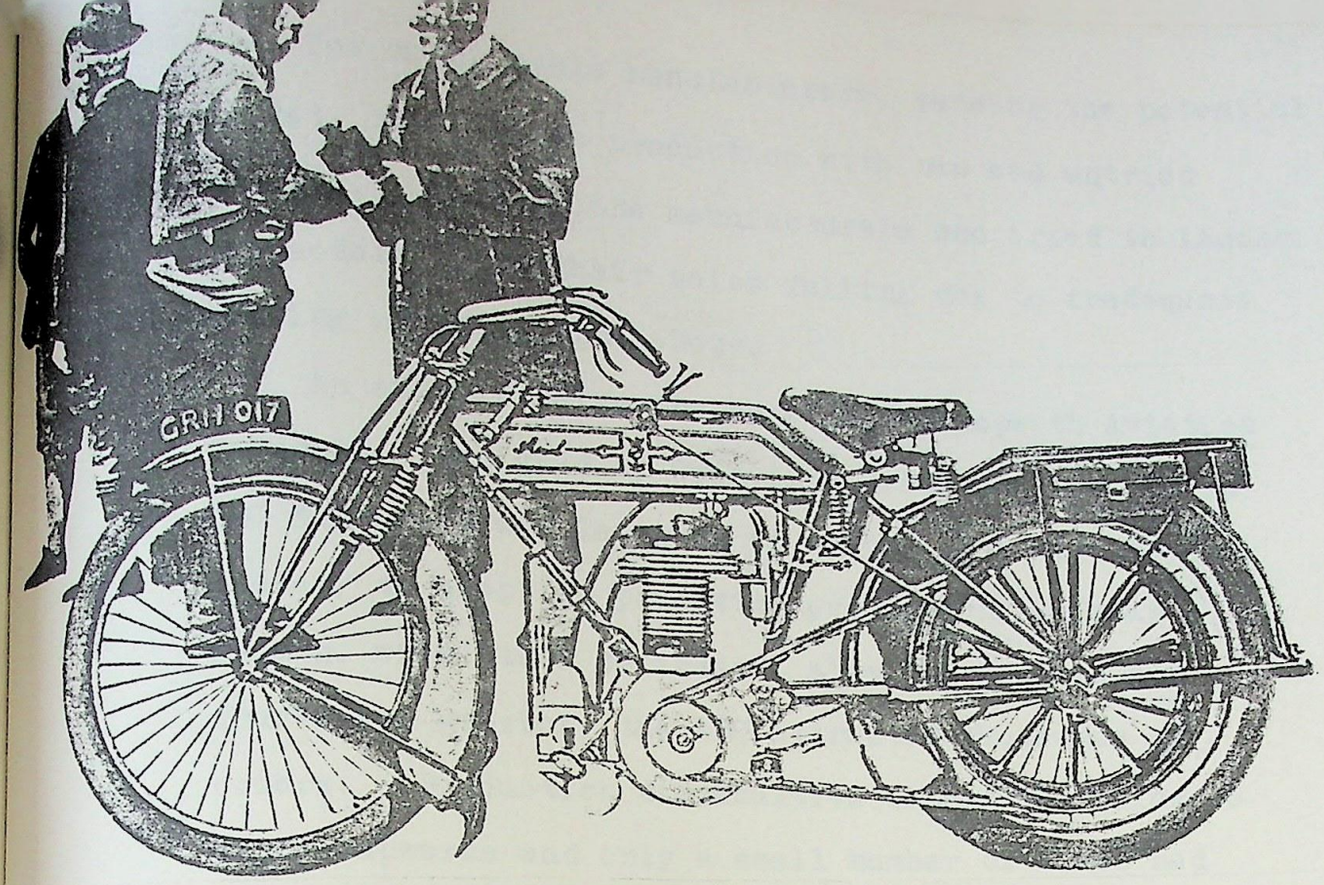
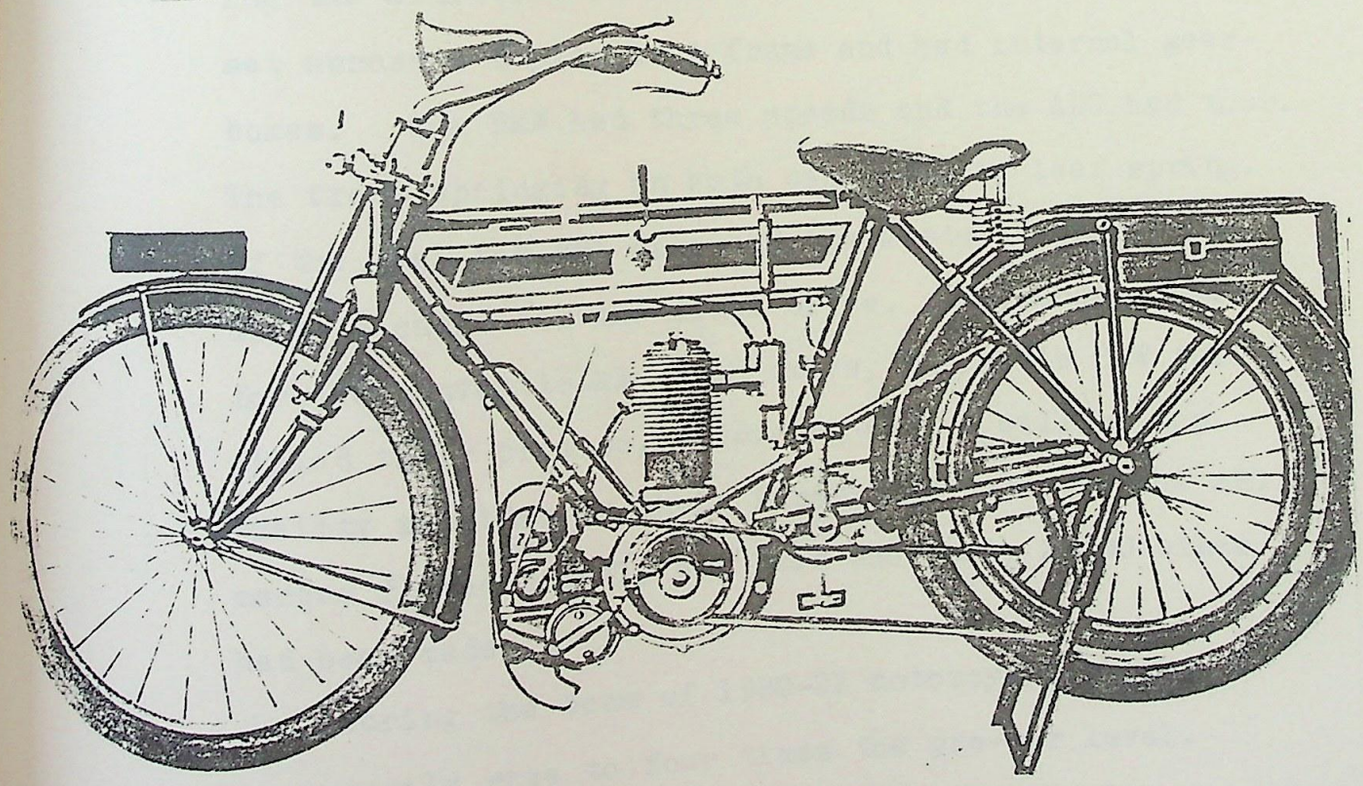


FIG 32 Ariels 3½hp model with a White & Poppe power unit.

FIG 33 The 3½hp Triumph which became the standard despatch riders' machine in the First World war.



The motor cycle manufacturers, sensing the potential market, rushed into production with new and untried designs. Many of the manufacturers who tried to launch new models found their sales falling due to inadequate costing of parts and labour.

An example being the case of the Sopwith Aviation Company. Designed by Granville Bradshaw, the 398 cc ABC Flat-Twin was launched to enable this aircraft factory to adapt to peacetime production. Fully sprung, with steel cylinders, aluminum pistons and four-speed gearbox, the ABC attracted thousands of orders. Production difficulties caused the price to rocket upwards and only a small number of bikes had been built when the cash ran out.

Similar in layout to the ABC was the first German BMW marketed in 1923, three years later than the British bike.

Both machines were launched to employ aircraft factories that would have otherwise stood idle following the armistice in 1918. Both bikes had the cylinders set across a duplex loop frame and had internal gearboxes. The BMW had three speeds and the ABC had four. The front springing in both cases was by leaf spring. Of the two, the BMW bike had the better transmission using a shaft for the final drive. Bradshaws opted for the conventional chain drive, and while BMW fulfilled their promise, producing half a million top quality machines in their first half century, the ABC marque flared briefly and died when only 2,000 bikes had been made.

During the boom of 1920-21 motorcycle prices temporarily rose to four times the pre-war level. Even so, English production in each of those years was

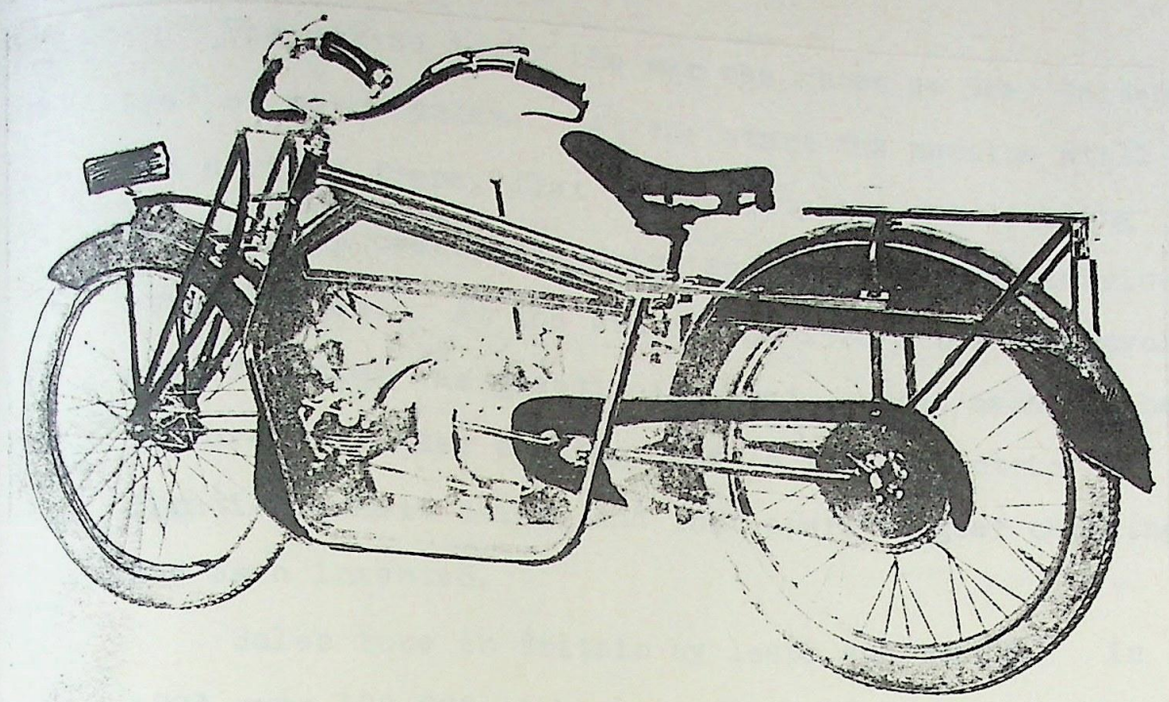


FIG 34 The ABC flat-twin designed by Granville Bradshaw.

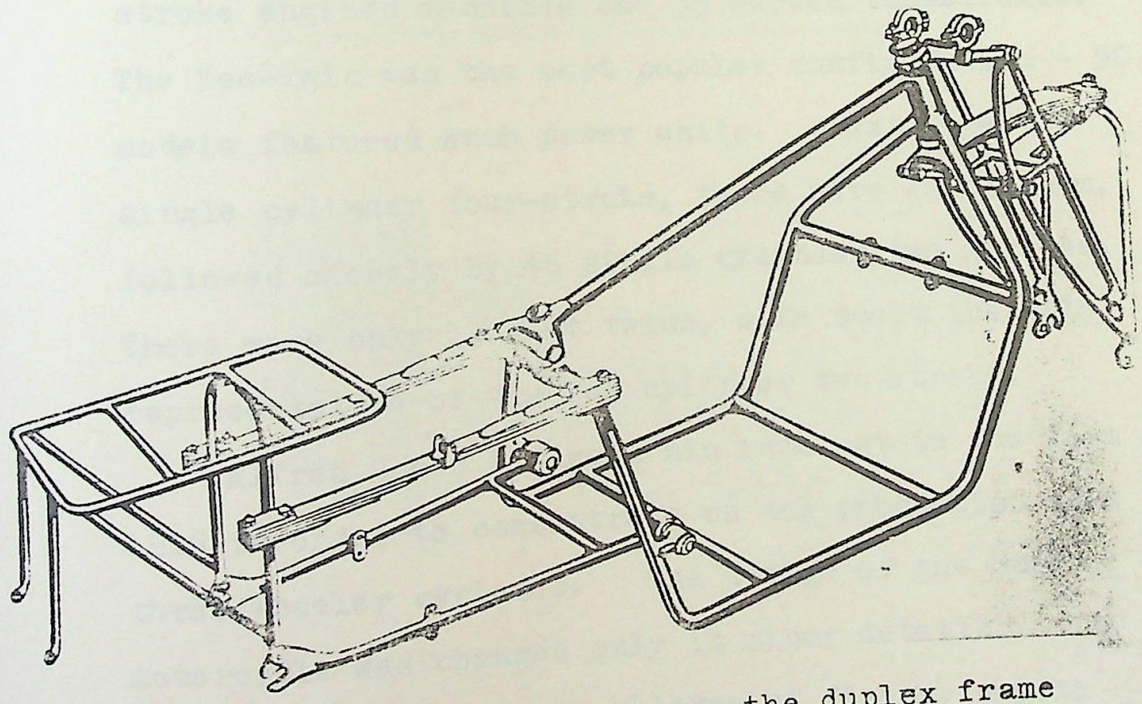


FIG 35 Leaf sprung front and rear, the duplex frame was wide enough to protect the cylinder heads and encompass the footboards.

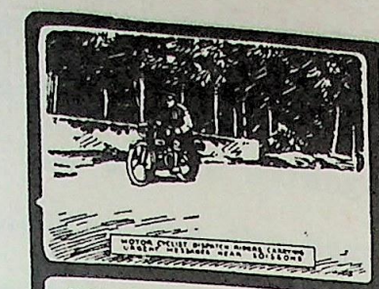
75,000, 5,000 more than the 1914 total, and it continued to rise steadily.

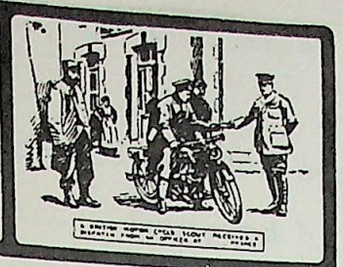
The period after the war was known as the 'Golden Age' of motorcycles. At the start the machine still had a rigid frame, flat tank, acetylene gas lighting and,in many cases,belt drive and hand operated lubrication system. At the end of the 1920's the motorcycle specification was greatly improved. Most machines had improved cylinder cooling, saddle tank, electric lighting, chain drive, and foot operated gear changing had been invented.

Sales rose in Britain by leaps and bounds. In 1923 over 100,000 machines left the factories and the figures continued to rise until 1927, when 163,024 motorcycles were made.

The variety of engine types used in the 1920's was quite considerable. At the 1920 Olympia Show there were 96 exhibitors. 61 of them showed four-stroke engined machines and 35 showed two-strokes. The Vee-Twin was the most popular configuration - 50 models featured such power units. Next came the single cylinder four-stroke, there were 48 of them, followed closely by 46 single cylinder two strokes. There were only 11 flat twins, with Scott the sole representative of the two cylinder two stroke.

Alfred Scott had sold his interest in the firm in 1919 in order to concentrate on the production of a three wheeler cyclecar. The design of the Scott motorcycle was changed only in minor details. It was renowned for its excellence of finish, smooth running and outstanding performance. But the company suffered from under capitalisation. In 1926 they introduced a new model - The Flying Squirrel. Of more



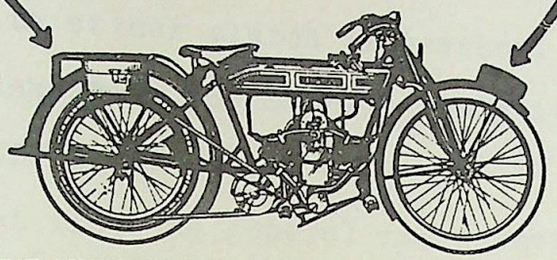


THIS · IS · THE · LITTLE · 2¾ HP

Douglas

THAT HAS MADE MOTOR CYCLE HISTORY

PRICE MODEL "V" £48



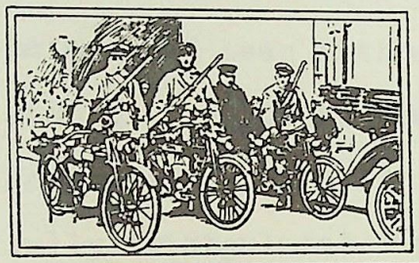
PRICE MODEL "W" £54

WHAT DISPATCH RIDERS THINK OF THE "DOUGLAS."

Corporal A. J. SPROSTON, whose Diary appeared in the "Daily Mail," says: "You have reason to congratulate yourselves on the excellence of your machine."

Lance-Corporal SHARPE says: "The 'Douglas' is the only machine we can safely ride." "It may interest you to know that all fellows I saw with machines smashed had them replaced with 'Douglas' 'S.'"

Supplied to the War Office, Belgian Government, The Australian Expeditionary Forces.



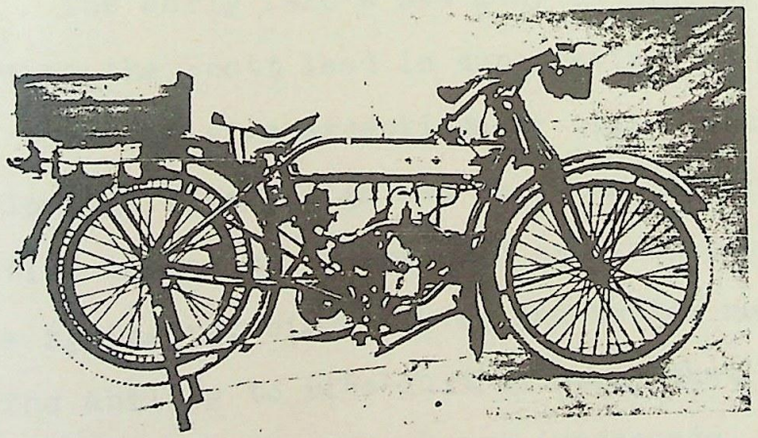
DOUGLAS BROS., Kingswood, BRISTOL.

'Phone 4527.

Telegrams: "Douglas, Kingswood, Glos."

LONDON: 39 Newman Street, W.

PARIS: 14 Rue Boudon, Levallois.



conventional appearance than its predecessors, the Flying Squirrel was a worthy upholder of the Scott tradition.

One of the strangest motorcycles ever to reach production was the Megola. Designed by Fritz Cockerell, and built in Munich, the Megola had a five cylinder rotary engine in the front wheel and a fully sprung frame with a comfortable seat complete with back rest. But Cockerell omitted to equip the Megola with either clutch or gearbox. So the rider had to push start the machine and switch it off at every traffic hold-up.

Apart from the general improvements in engine and transmission design, the shape of the motorcycle was undergoing change. The frame which up to the outbreak of the war had been little better than a strengthened push bike unit, had received little attention. Scott had differed from the herd, offering a strong fully triangulated duplex frame, with the engine playing a vital role in bracing the whole unit. The early 1920's saw many manufacturers following the Scott lead in duplicating the major frame tubes to give exceptionally rigid construction.

Spring frame design was becoming neater and more effective backed up by improved saddles, often with double springing, bigger tyres and better mudguards.

The ability to ride further meant that the quaint old slab-shaped petrol tank was inadequate. The solution came from the racing world in the shape of the bulbous saddle tank, which straddled the top tube of the frame and gave almost double fuel capacity. Some makers like Sunbeam clung desperately to the flat tank but by the end of the 1920's the saddle tank was

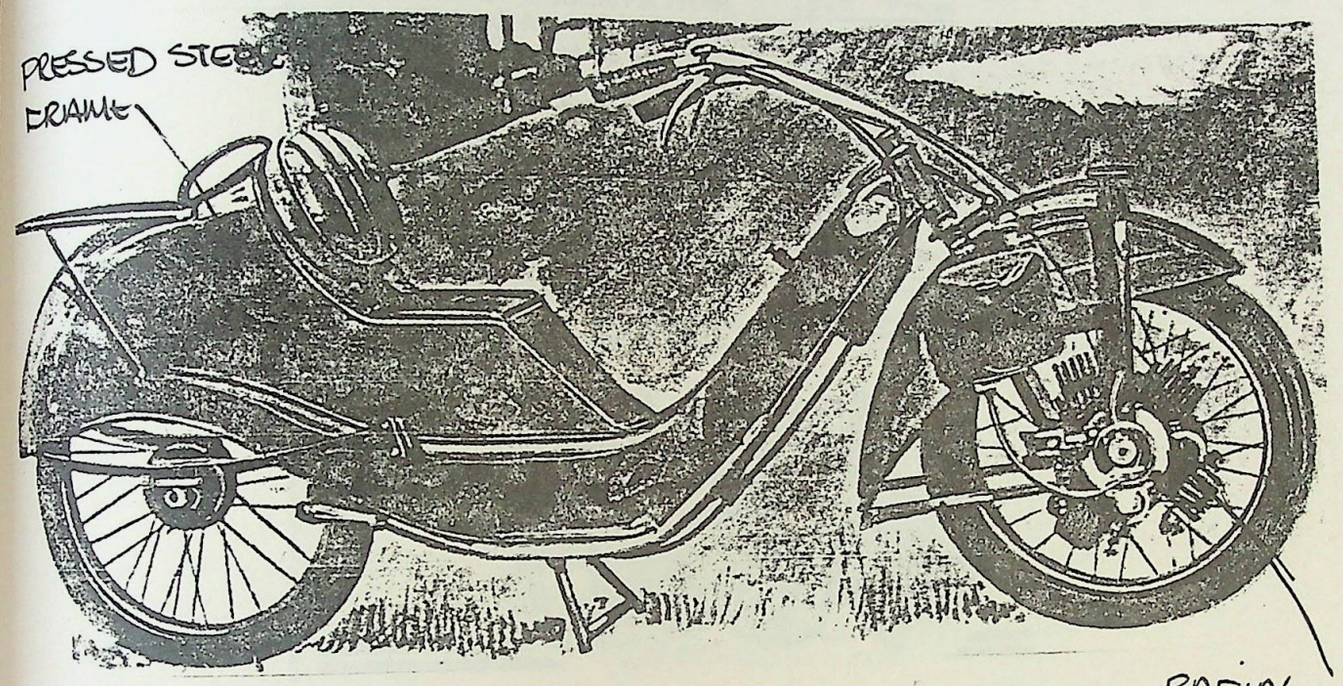


FIG 36 The five cylinder Megola designed by Fritz Cockerell in I92I.

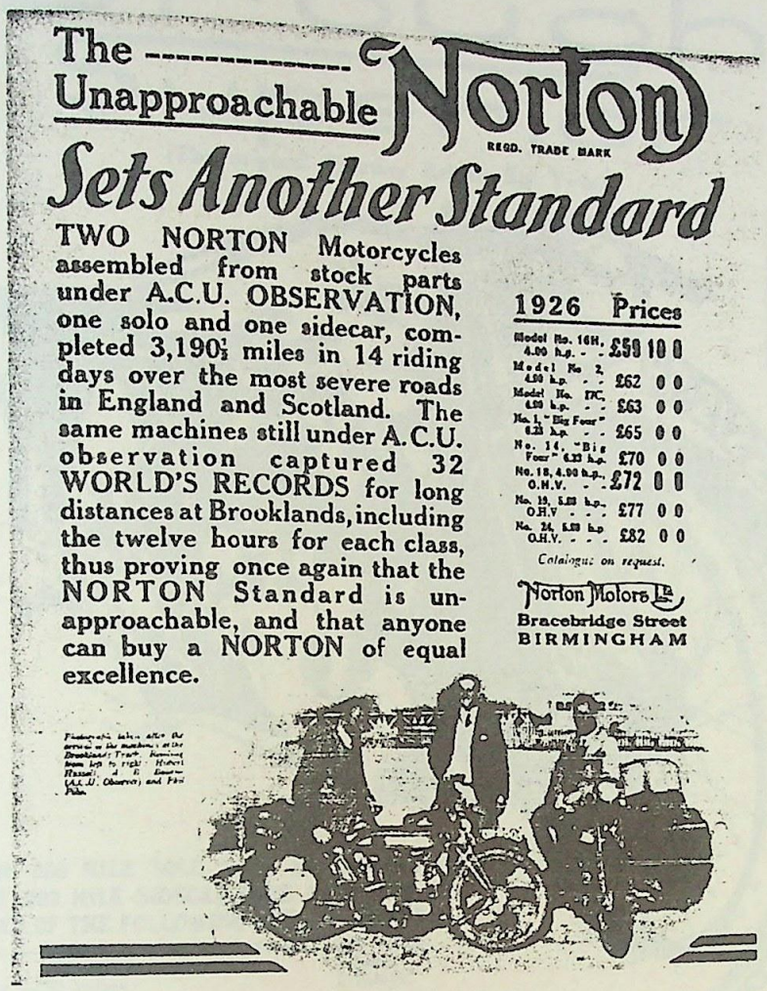


FIG 37 This advertisment appeared in late 1925.

Road holding was much improved as new frame designs brought the saddle position - and the centre of gravity - lower, and as far as performance was concerned the motorcycle of the late 1920's was not to be bettered for 20 years.

With the dawn of a new decade, so the era of the entrepeneur - engineer was ending, bringing to a close what was perhaps motorcycles finest decade.

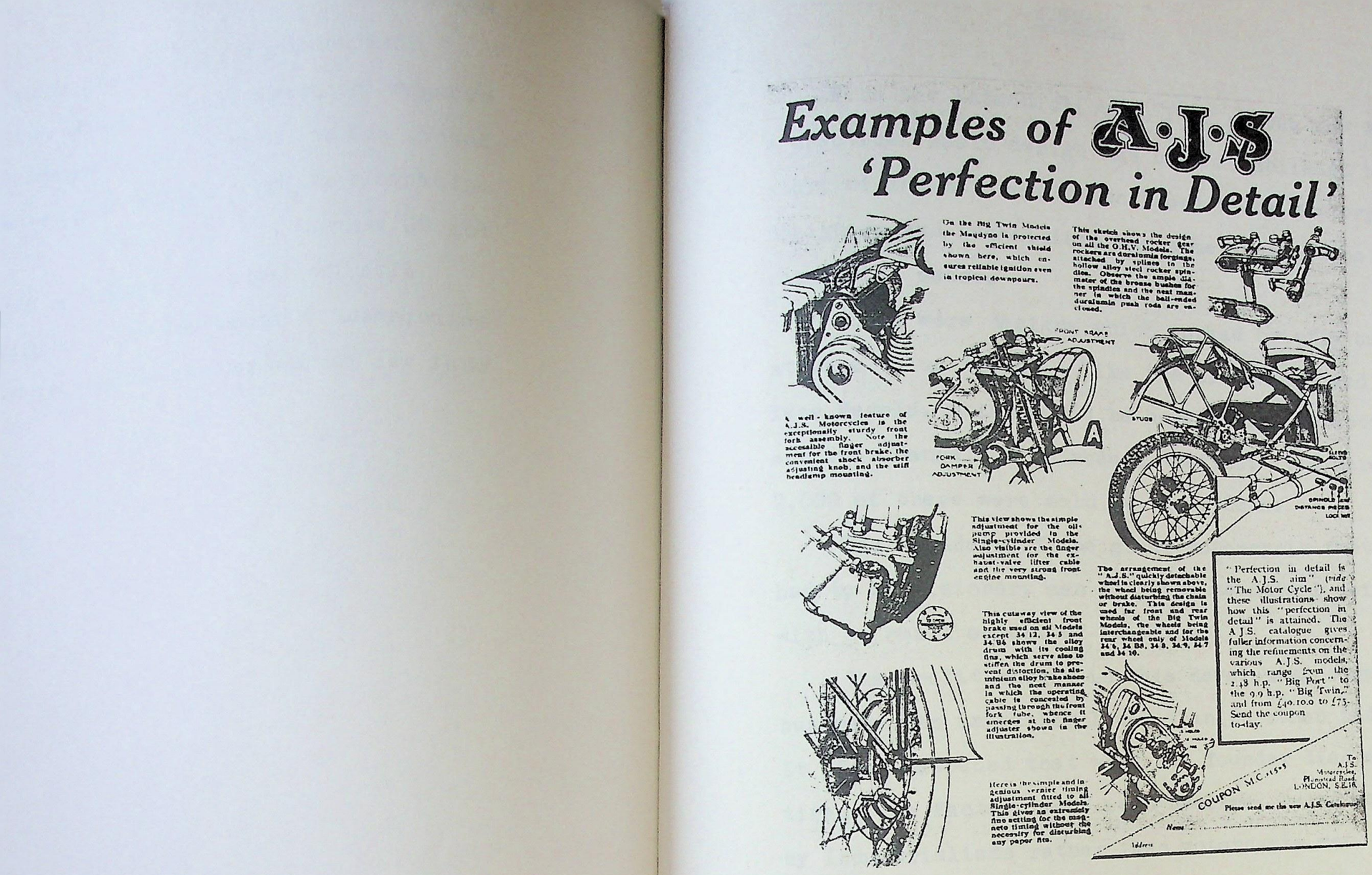


FIG This advertisment highlights some of the design features of the A.J.S machines.

SUMMARY

With the introduction in 1902 of the new Werner, a practical basic design had been established but the story of the motorcycle continued to be a story of designers and technicians who sometimes had no commercial sense.

There were designs which worked briefly but look strange to us to-day - like the clutchless and gearless Megola, which would be hopelessly impractical, and even dangerous in modern traffic; yet more than 2,000 of these were sold in the 1920's.

The founders of the great motorcycle factories had to be visionary men of great technical ability, with no small amount of idealism.

The profit margin in this developing competitive business was unusually lower than in other industries. It often happened that when the founder died or retired, the factory went into decline, being managed by Industrialists rather than motorcycle men. An example of this was the Indian factory of Massachusetts. In 1912, Indian was one of the largest motorcycle factories in the world, employing about 3,000 people in three shifts. When founder George Hendee retired in the mid 1920's the factory began a long slow decline and was finally bought in 1959 by Associated Motorcycles Ltd. of London.

The motorcycle industry, like any other, is also subject to factors outside its control. A great many factories went under during the Great Depression of the 1930's. After each of the two world wars, motorcycles were in such short supply that small companies sprung up in almost every country.

The saddest story of all is the decline of the British Motorcycle Industry, for decades the world's leader. It is not possible to stay in the motorcycle business on any sizeable scale unless a wide range of models is offered. In the face of Japanese competition, British factories gave up the mass-production of small machines.

The motorcycle factories who survived the Great Depression were those which were large and strong and which already had a network of dealers and customers dependant on a good name for service and spare parts.

The day of the committed idealist who could start his own factory on a shoe-string was in the past.

Throughout the history of the motorcycle, men with dreams have founded factories. Many companies had but brief glory before some disaster caused their demise, but others survived, their products keeping pace with the changing demands of the public.

Yet even those companies that went to the wall wrote some part in the story of the Motorcycle.

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