(自行車/脚踏車的发展史)

THE EVOLUTION OF BICYCLE

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FOREWORD

"The Evolution of Bicycle" is adapted from a few reference book and compiled by us. It is, in fact, part of our marketing project report.

It describes, briefly, the development of the mechanical device of bicycle, analyses the changes, and the material developments and improvements for the bicycle. We have also brought in the most recent technological innovation — the concept of "Aerodynamics and the Bicycle".

We will welcome and appreciate any suggestion for this article.

THE EVOLUTION OF BICYCLE
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(I) EARLY DEVELOPMENT (18TH CENTURY TO EARLY 1900s)

Like other wheeled vehicles, the bicycle was drawn by horses. Scholars and historians do generally agree that it was a device named the "Celerifere" by its creator, Monsieur de Sivrac, in 1791 that is led more or less directly to the bicycle. The "Celerifere" consisted of two wheels mounted in line and connected by forks to a wooden bar, or "spine", on which was mounted a padded saddle.

The "Celerifere" was improved in Germany and then became popular as a sport in England where it was named the "Hobby Horse" (Exhibit-1, Figure 1). Together with the latter invention, called "Dandy-Horse" (Exhibit-1, Figure 2), these three inventions were, and in fact, using, the same simple idea of a seat upon two wheels propelled by the two feet pushing on the ground. The rider ran along with the machine, pushing alternately with one foot and then the other. On smooth level ground, these machines provided a significant advantage to the rider, especially the "Hobby Horse" and "Dandy Horse". Under favourable conditions, the "Hobby Horse" can travel about 55 miles in a day. While, the swiftness of "Dandy Horse", with which a person well practised can travel, is almost beyond belief; 8, 9 and 10 miles may, it is asserted, be passed over within the hour on good level ground.

Until 1840, in which a Scottish Blacksmith, Kirkpatrick Macmillan, invented and built the first known pedal-driven cycle (Exhibit-1, figure 3). In the absence of some form of gearing in the early days, the only way to get the cycle to go faster - to travel farther for every turn of the pedals - was to increase the diameter of the driving wheel.

For example, the French bicycle or Boneshaker popularly favored during the 1860s, had a driving wheel of about 36 inches in diameter and a rear wheel of about 30 inches. (Exhibit-1, Figure 4)

Over the succeeding 5 years, there was a constant trend in the direction of ever-bigger driving wheels, and, by the middle of the 1870s, standard models, called "Ordinaries" (Exhibit-1, Figure 5), had front wheels of between 42 and 60 inches in diameter, and the rear wheel was as small as one third of the driving wheel or less. But, there were some serious problems associated with these "Ordinaries".

First, on the simplest level, they were hard to mount. With the large racing high wheelers, the rider required an assistant to get onto his machine and start the race. Second, they favored certain types of physiques almost to the exclusion of other people. The Ordinary was built with the large and long-legged male rider in mind; all others were at a disadvantage. Finally, and most important, was that they were extremely dangerous to ride, especially on the public roads. In order to position the rider for maximum efficiency in pedaling, designers tended to place the saddle, so that most of the rider's weight was centered over the driving wheel. In any case in which a sudden stop or upset occurred - any stone or pothole in the road, frequently it had the effect of sending the rider over the handle-bar, and thus, serious injuries were often.

Because of the problems encountered with the high-wheel bicycles, inventors, designers attempted to modify the design to make them safer and accessible to a broader group of riders.

It was in the second half of the 1870s that the term "safety" bicycle began to be heard. Initial modifications of these bicycles involved compromising the size of the driving wheel somewhat, down to the 48-50 inch range, and throwing the center of gravity definitely backward. This, along with an increase in the size and weight of the trailing wheel and increase in tyre width, did achieve a considerable improvement in stability - at a significant reduction in performance. (See Exhibit-1, Figure 6 & 7 - "Xtra-Ordinary" and "Kangaroo" bicycle).

The first "Rear-driving Safety" bicycle was invented by Mr. H. J. Lawson in 1879 (Exhibit-1, Figure 8). A few years later, (about 1885), John Kemp Starley, made the so called "Rover Safety" bicycle (Exhibit-1, Figure 9). It was the first design that embodied most of the salient features of the modern bicycle : equal-sized wheels, chain drive to the rear wheel, a diamond frame, and direct steering.

It was the principle of gearing that allowed the size of the driving wheel to be brought down to the point at which other aspects of bicycle design could receive due consideration. Starting in the 1880s, several inventors, designers and engineers began working out systems of variable gearing, but with the Sturmay-Archer three-speed hub was the simplest - which made bicycle easier and cheaper to manufacture.

When the success for a simple rider was assured, attempts were soon made to make a bicycle for two riders, for example, the "Rucker" Tandem bicycle in 1884 (Exhibit-1, Figure 10).

The Ravat horizontal bicycle (Exhibit-1, Figure 11) was invented in 1935 to increase efficiency of muscle usage as the normal upright position.

(Exhibit-1, Figure 12 shows the Captain Dan Henry's "Recumbent" bicycle, invented in 1969, and Figure 13 shows the modern rear-driving bicycle.)

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(II) RECENT DEVELOPMENT (SINCE 20TH CENTURY)

Many improvements have occurred to the bicycle, and its components in the course of a 200 year history. However, the development of the bicycle was inextricably tied up in the development of mechanical and engineering technology in general.

The first most notable improvement to the modern bicycle was the invention of the derailleur which made cycling a much more comfortable exercise.

The second historical innovation came about through the introduction of new metals which made possible lighter weight bicycles.

Besides the development of mechanical device of bicycle as mentioned above, much of the energy devoted to improving the bicycle over the past century has taken the form of seeking new or improved materials. The earliest bicycles were made largely of wood and iron. Wood quickly proved to lack the strength necessary for a high performance bicycle building materials. Thus, bicycles soon became almost entirely iron machines. As steel making technology developed, iron was increasingly supplanted by steel in bicycle building.

The single most important development in bicycle materials technology since 1900 has been the emergence of aluminium and its alloy as affordable items of commerce. As stronger and stronger aluminium alloys have been developed, they have been used increasingly to replace steel in the bicycle.

Over the decades, a number of different materials have been tried out and most rejected (such as plastics, resins, rare metals), for one reason or another.

In recent years, experimentation with non-standard materials for higher performance bicycle frames has concentrated on aluminum alloys, on titanium, and on various fiber-resin.

As an indication of a typical 19th to beginning of 20th century bicycle was 18 kg (40pounds). By 1965, the weight was reduced to 9 kg (20pounds) - i.e. 50% decreased in weight !

Recently, the industry also attempted to reduce weight by changing the bicycle's specifications, as in the case with Shimano's 10mm pitch system for track bicycles.

Today, another breakthrough of historical dimensions has revolutionized the bicycle industry - the aerodynamic bicycle. The term "Aerodynamically Efficient" is used to describe that acceleration can be achieved in a shorter period of time with less energy loss (i.e. accelerating performance of bicycle improved).

This whole innovation is dealing with another area in need of much improvement for the bicycle effectiveness - i.e. "air resistance".

Air resistance is the drag an object exhibits when moving through air. Although some devices for the reduction of air resistance to the bicycle had been attempted with in the early development, these devices were not quite successful during that times. (See Exhibit-2).

Air resistance is, now still the biggest obstacle that stands the way of the bicycle's process with road resistance having already been dealth with by making progressively lighter components.

The aerodynamic tests and research has been done by most of the world's top bicycle parts makers eg. Shimano in Japan, through its wind tunnel tests, related research and outside field testings of both the conventional bicycle and the aerodynamic bicycle, has come out with its whole range of the aerodynamic system components.

How are the aerodynamic components used to reduce the air resistance ? Basically these components are so designed for decreasing the following forms of air resistance.

a. <u>Decreasing shape resistance</u>

Shape resistance is a form of air resistance relative to the shape of an object. An ideal shape is one that allows an air stream to flow smoothly and continuously from one end to the other. (See Exhibit 3-1, & 3-2). The reason why a streamlined shape is ideally aerodynamic is because the air stream runs smoothly across it from front to rear without any air pressure build up occurring at the rear.

b. Decreasing viscosity resistance

Viscosity resistance is also known as surface friction resistance. When an object trys to go through viscous gases, friction, which occurs between the gas and the object, causes resistance. An airplane's wings and body are designed with a completely smooth, streamlined surface is not so much for the asthetic aspect but for decreasing viscous resistance as much as possible. Therefore, the aerodynamic system components of bicycle use, whenever possible, a super high level finishing treatment which can be seen in the buff almite finish. (See Exhibit-4.1 & 4.2).

c. Decreasing induced resistance

Most objects have edges. When an air stream hits this area, an eddying flow builds up and resistance occurs. To decrease induced resistance, it is necessary to eliminate all protrusions and corners by rounding them off into streamlined shapes. For example, the inner cable's end and head part's fairing cover, which are part of the aerodynamic program, were designed to reduce induced resistance.

d. Decreasing frontal area resistance

Frontal area represents the square meter total of the bicycle facing into the wind. Increase or decrease in air resistance is in direct proportion to frontal area surface. For example, the front derailleur of Shimano's aerodynamic components, was designed with a lateral link mechanism to decrease frontal area.

(Exhibit-5, shows some of the Shimano's aerodynamic components, and Exhibit-6, shows the comparison between fully equipped aerodynamic bicycle and conventional bicycle.)

The introduction of aerodynamic components will make a big impact on the history of the bicycle's development.

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CONCLUSION

Years ago, the bicycle was basically a utilitarian good. People used it to go to school or to work when cars were few and relatively expensive. It was the cheapest form of transportation. However, at present, bicycles are catered more for fun and leisure, for sports and occasionally for transportation purposes. Furthermore consumers' preference for style and colour changes as time passed, for example, the handle changes, more sophisticated chainwheels and shifting lever as well as other changes in the dimensions of a bicycle.

Today, there are many brands that exist in the market. Some of the well-known brands, locally as well as internationally, are Raleigh, Colnago, BMX, Kuwahara, Chopper and Hock Swee Leong's Motioncraft.

EXHIBIT 1

FIG. 1 - HOBBY HOUSE

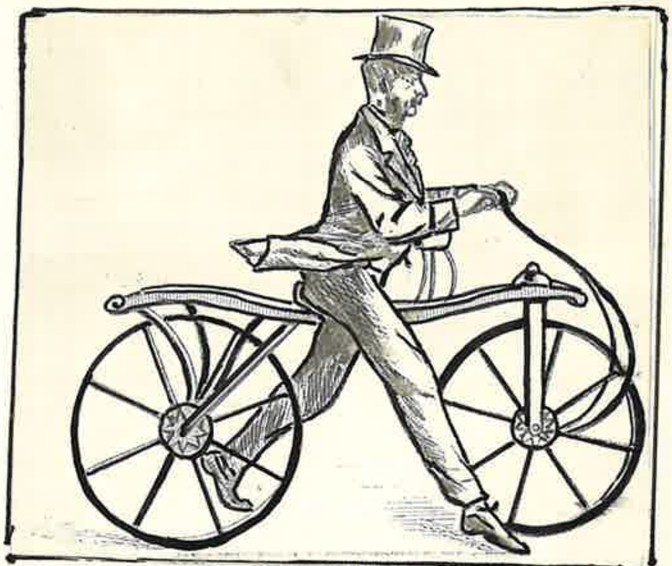


FIG. 2 - DANDY HOUSE

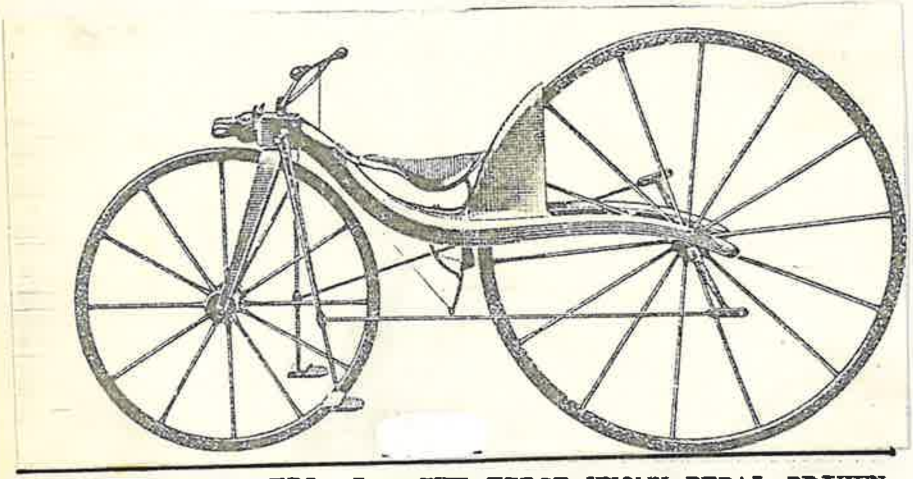


FIG. 3 - THE FIRST KNOWN PEDAL-DRIVEN

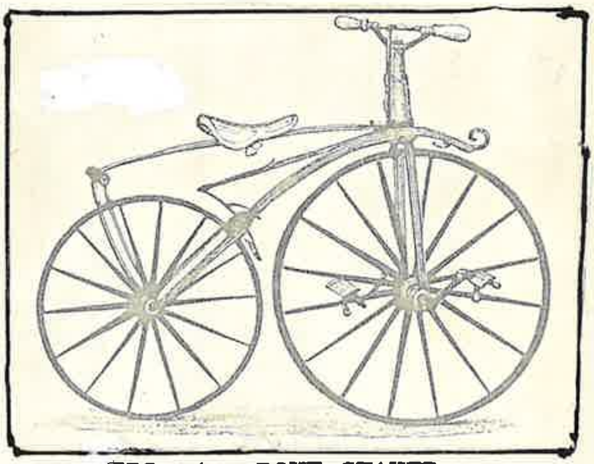


FIG. 4 - BONE-SHAKER

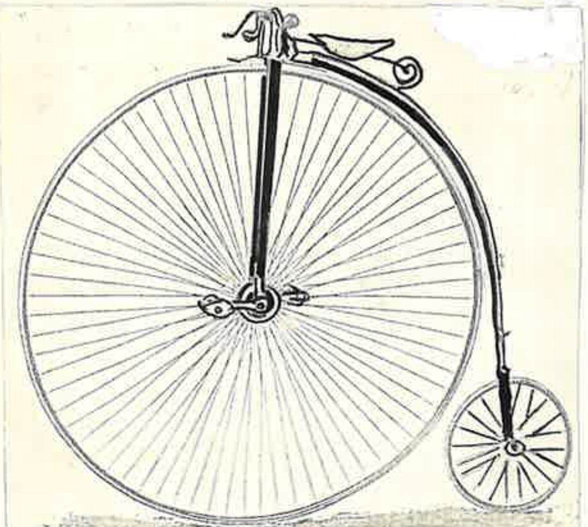


FIG. 5 - THE ORDINARY BICYLE

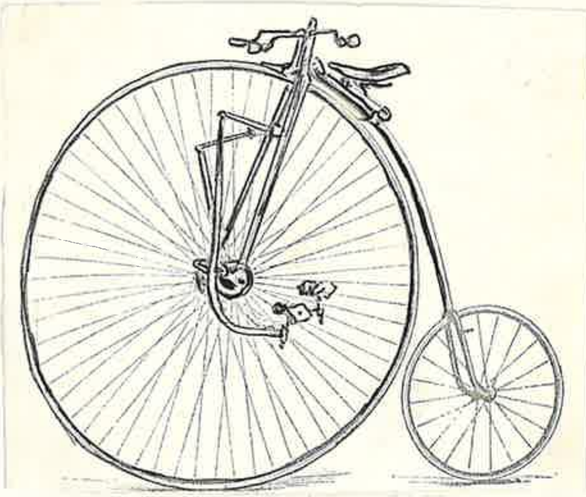


FIG. 6 - THE XTRAORDINARY

FIG. 7 - THE "KANGAROO"

Fig. 126

FIG. 8 - THE FIRST REAR-DRIVING BIKE

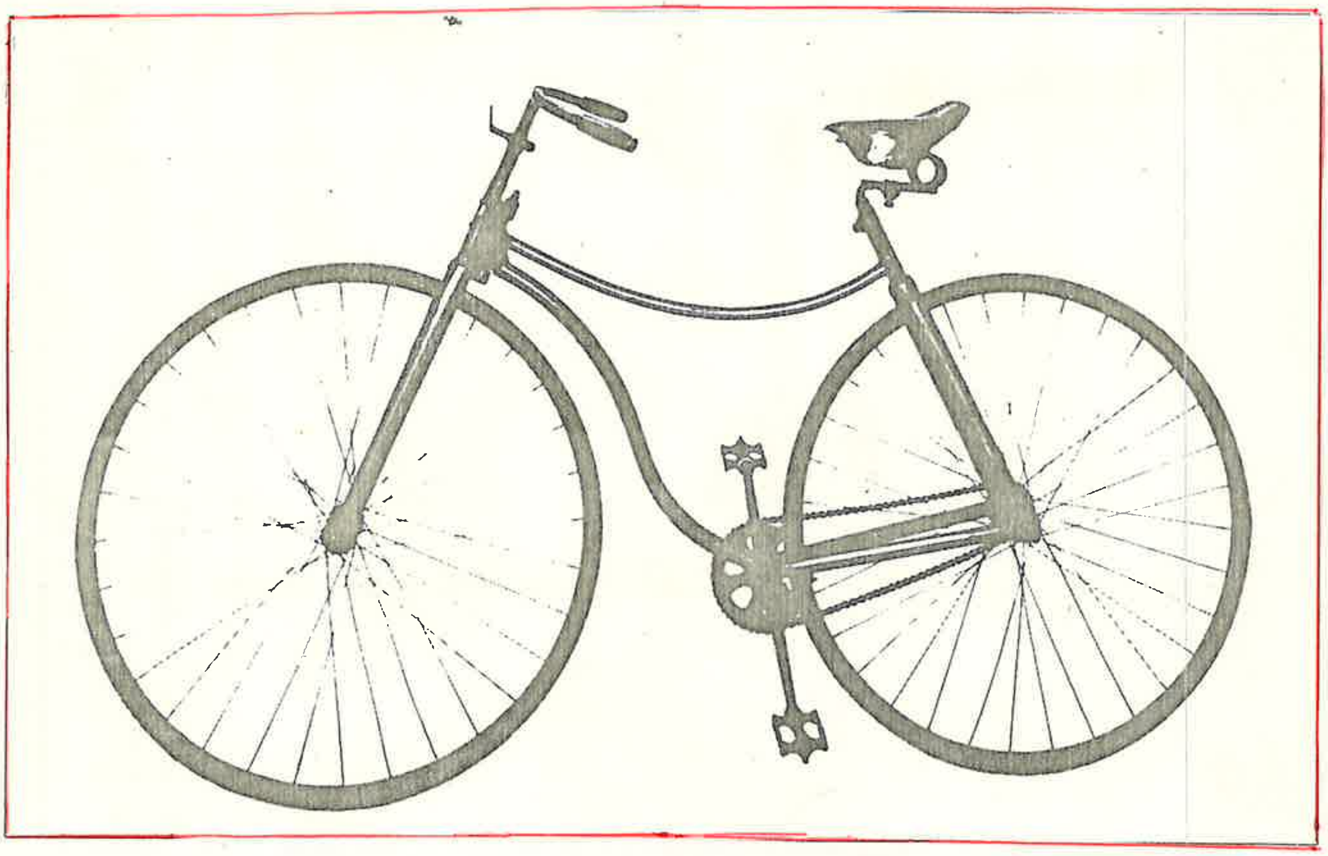


FIGURE 9 - JOHN KEMP STARLEY - "ROVER SAFETY BICYCLE"

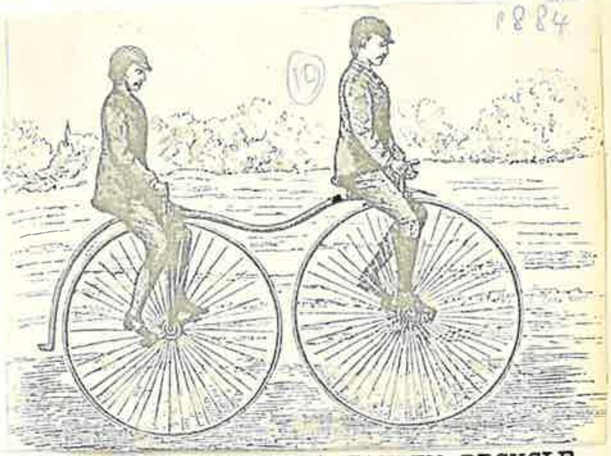


FIG. 10 - 'RUCKER' TANDEM BICYCLE FOR 2 RIDERS

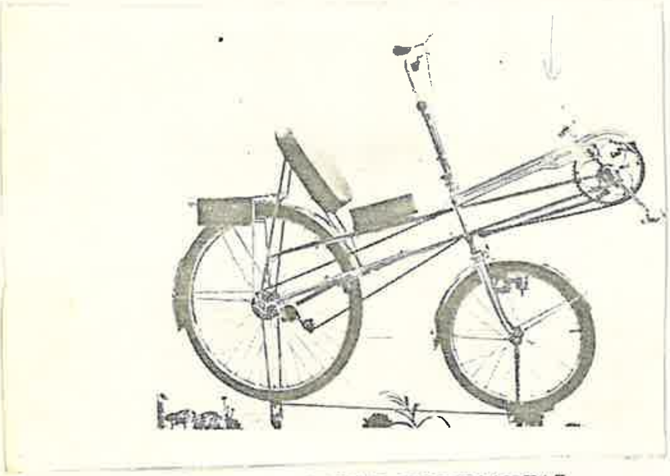


FIG. 11 - THE RAVAT HORIZONTAL BICYCLE, 1935.

FIG. 12 - CAPTAIN DAN HENRY'S RECUMBENT BICYCLE, 1965

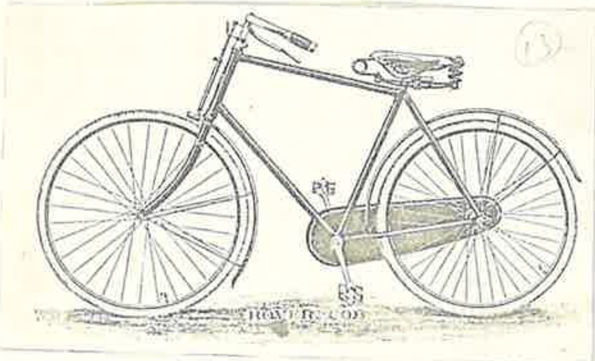


FIG. 13 - THE MODERN REAR-DRIVING BICYCLE.

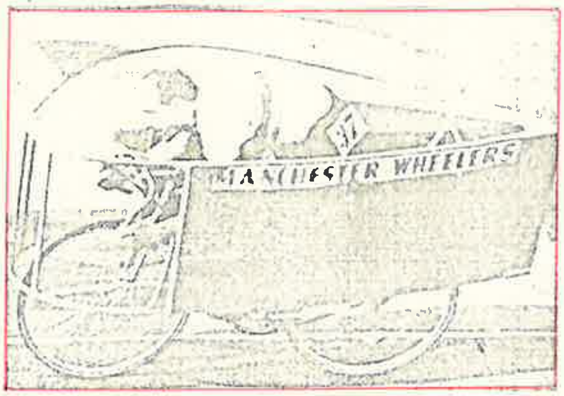


FIG. 1

FIG. 2

FIG. 3

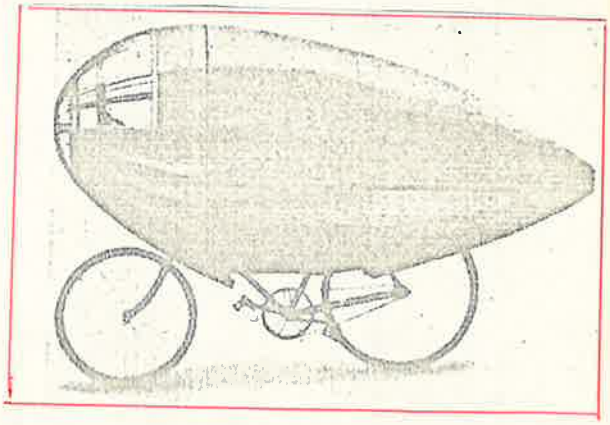


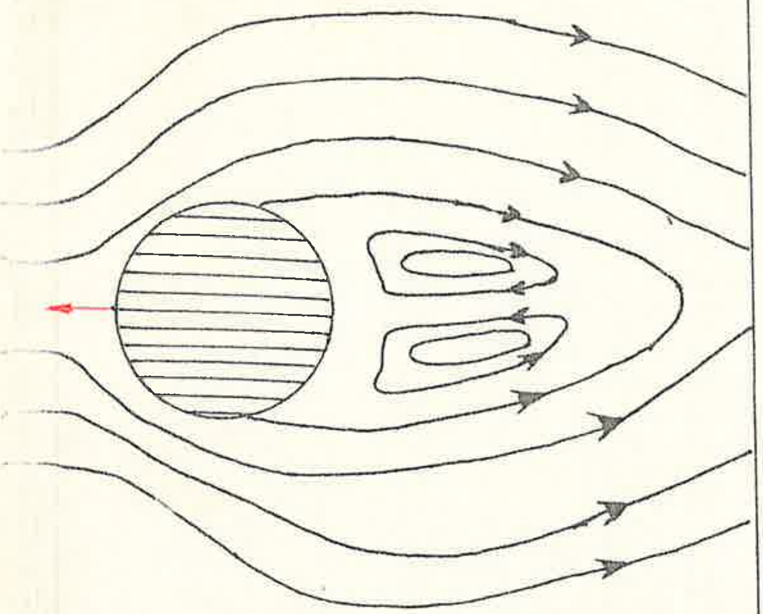
FIG. 4

SOME PAST ATTEMPTS AT STREAMLINING BICYCLES.

EXHIBIT 2

EXHIBIT 3 - 1

Wind stream which is directed toward a cyclindrical object disturbs air flow



SHAPE RESISTANCE

EXHIBIT 3 - 2

Smooth wind stream with streamlined object

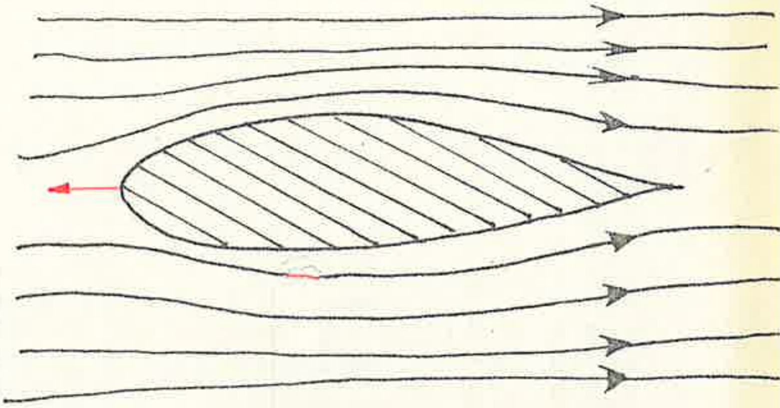
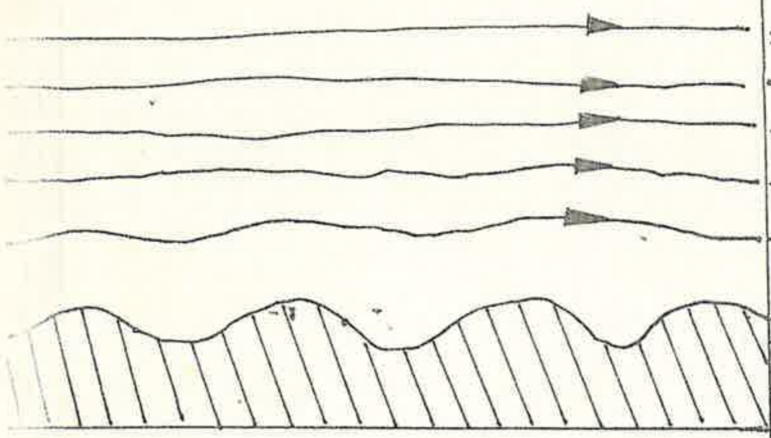


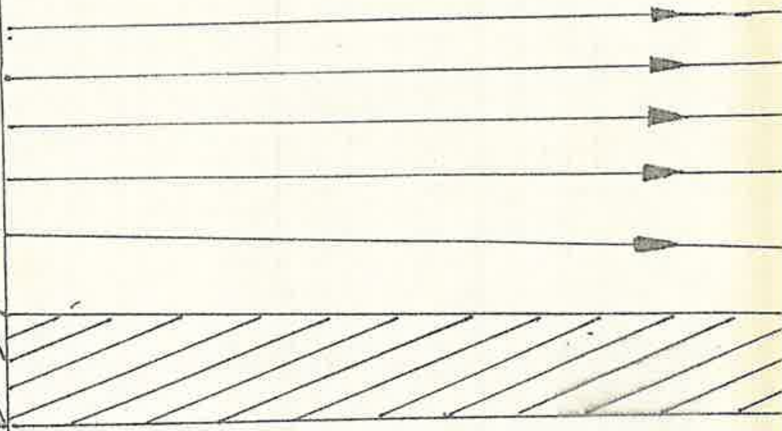
EXHIBIT 4 - 1



Air disturbance resulting from friction resistance

VISCOSITY RESISTANCE

EXHIBIT 4 - 2



Smooth air stream due to surface finishing

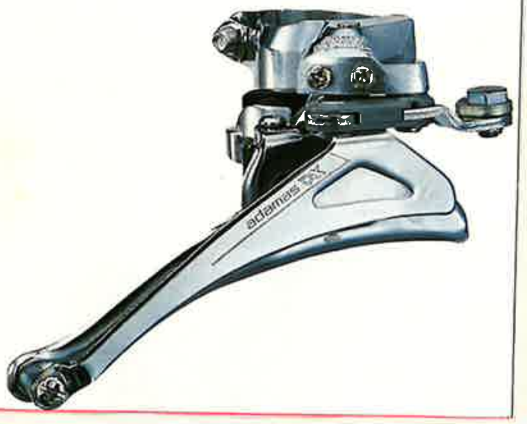
EXHIBIT 5 - SHIMANO'S AERODYNAMIC COMPONENTS

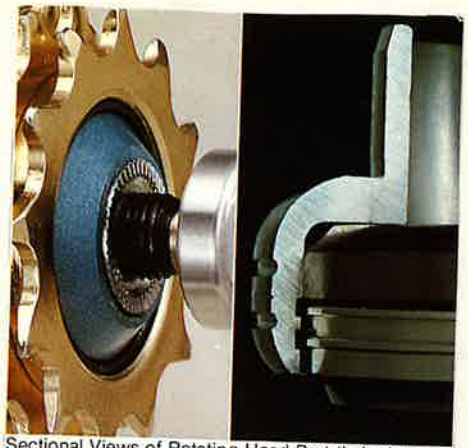
SHIMANO ADAMAS AX Front Derailleur

Model FD-AD10

SPECIFICATIONS

Capacity • 14T. or less
Weight • 3.9 oz. (111g.)
Material • Light Alloy (Body)
Steel • Chromium Finish (Chain Guide)
Inlet Diameter • 1-1/8" (28.6mm.)
Features • Aerodynamic Design/New Trap-Ease Mechanism/Indent Guide Mechanism/Inner End Guide





Sectional Views of Rotating Head Part (Labyrinth seal) and Freehub Aerodynamic Sealed Cap.

Front Hub Section

Front Hub

AIR RESISTANCE DECREASED 0.65%

The special construction of the hub allowed us to shorten the dimension between the lock nuts without altering the flange dimensions compared with the conventional hub's 100mm (3.94").
As a consequence, "frontal area" was reduced. The hub body itself is designed to aerodynamic specifications along with the quick release lever which eliminates the ordinarily protruding nut and hub cone.
The quick release shaft lock nut was also reduced in size. "Frontal area" resistance of both hub and quick release sections has been reduced considerably.

DURA-ACE AX Shifting Lever

Model SL-7310 (Brazed-on A Type)
SL-7311 (Brazed-on B Type)
SL-7321 (Brazed-on B Type for Oval Tube)

SPECIFICATIONS

Weight • 1.8 oz. (50g.) (SL-7310)
2.4 oz. (69g.) (SL-7311)
2.4 oz. (69g.) (SL-7321)
Material • Light Alloy • Anodized Finish
Type • Friction Type
Attachment Position • Down Tube
Lever Clamp Diameter • SL-7310; 1-1/8" (28.6mm.)
SL-7311; 1-1/8" (28.6mm.)
SL-7321; 1-1/4" (31.8mm)
Features • Aerodynamic Design/Sealed Mechanism/Light Weight/With Fairing Cover/Hexagon Release

SL-7310

SL-7310 Brazed-on Parts A Type

SL-7311 Brazed-on Parts B Type

SL-7311

EXHIBIT 5 (CON'T)

A Drive Chain and Shifting Section 1) Gear Crank 2) Pedals 3) Front Derailleur 4) Rear Derailleur 5) Freehub 6) Bottle
B Front Hub Section 7) Front Hub
C Handle Section 8) Handle Bar, Brake Lever, and Handle Stem 9) Front Brake Arch 10) Shifting Lever
D Seat Section 11) Seat Pillar 12) Rear Brake Arch

* Aerodynamic component is superimposed over cut-out shape of conventional component to show streamlined effect for great saving.

3) Front Derailleur
AIR RESISTANCE DECREASED 0.65%

By changing the direction of the link assembly, which used to stand at right angles against the wind, to a lateral link assembly we succeeded in reducing "frontal area" resistance. We also incorporated a "shape" resistant design to further reduce air resistance.

4) Rear Derailleur
AIR RESISTANCE DECREASED 0.82%

The tension spring, which used to protrude from the pulley, has now been built into the pulley itself to decrease "frontal area" resistance. This in addition to the whole shifting body mechanism designed to aerodynamic specifications eliminating all sharp edges and protrusions. And we eliminated the outer cable, so that air resistance could be reduced even more.

EXHIBIT 6

aerodynamic bicycle

conventional bicycle