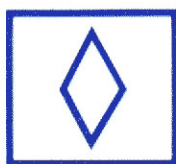
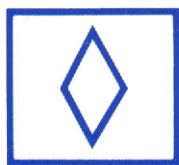


Campagnolo[®]



FLUID-DYNAMIC WHEELS



Campagnolo[®]

WHEN TECHNOLOGY BECOMES EMOTION

THE "DISC WHEEL" A HUNDRED-YEAR OLD IDEA.

The idea to replace the traditional spoked wheel by a disc wheel is approximately one hundred years old.

From a November 21, 1896 issue of *Cycling*, a British magazine, can be found an advertisement from "the Disc Wheel Company Ltd." for a disc wheel announcing its discovery as "the greatest change in modern cycling".

While at the same time Archibald Sharp wrote about the advantages of the disc wheel in his book titled "Bicycles and Tricycles" (Longmans, Green 1896 London, New York - page 352).

In more recent years, the use of the disc wheel gained prominence in events conducted by The International Human-Powered Vehicle Association (IPHVA) founded by Dr. Chester Kyle in 1974. For instance, Alec Brook rode on a disc wheel bicycle to a speed of 53 km/h, while in 1977 Norman Gall on a "Torpedo" bicycle with disc wheels by Gardner Martin recorded a speed of 68.637 km/h.

In 1982, the disc wheel once again became the subject of scientific research in a thesis titled "A Study of the Drag Reduction of a Two-Wheeled Human-Powered Vehicle" written by Anne E. Daugherty for the Aerospace Engineering Department of Texas A&M University. However, it was not until 1984 when Francesco Moser in Mexico City broke the world hour record using disc wheels did the product capture the attention of the cycling world. With the introduction of the first "lenticular wheel", developed by Dal Monte and a team of Italian engineers, started a whole new generation of this kind of wheel. Since that point in time, the so-called "lenticular" wheels have constantly been instrumental in rewriting the record books in both road and track time trial events.

It was then, back in late 1983 that Campagnolo first began its study of the disc wheel when the company directed its attention to the construction of special hubs used for Moser's record wheels.

And today, in 1986 Campagnolo announces the introduction of the FLUID-DYNAMIC wheel. Thus begins the second generation of the disc wheel.



THE CAMPAGNOLO FLUID-DYNAMIC WHEEL GHIBLI M 23

The lenticular wheel represents the first generation disc wheel of the 80's. It has been developed according to the principle of supporting the weight of the rider/bicycle system from the hub to the road surface, by compressing the connecting wall between the hub and the rim.

For this reason the choice of the structure is determined by the requirements of vertical and transversal rigidity. These requirements result in solutions weighing more than a conventional spoked wheel (min. of 0.7 kg to a max. of 1.5 kg per wheel).

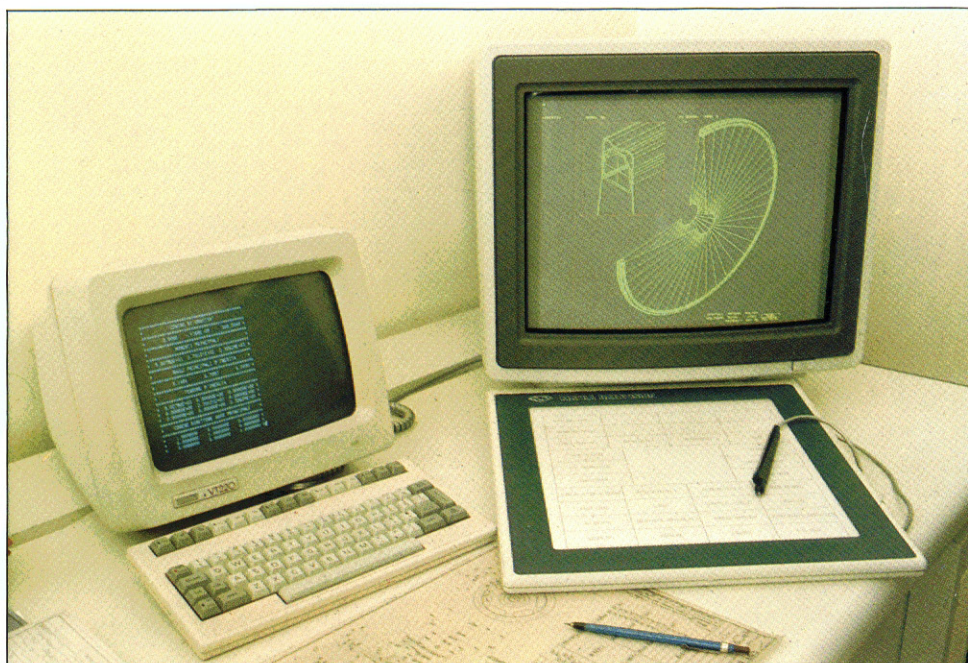
In order to define the distribution of the loads and forces involved, Campagnolo engineers utilized a computer to obtain the necessary calculations and information vital to improve the existing disc wheel.

Upon completion, this information was, through the use of CAD/CAM technology, translated

into profiles which determined the optimum requirements for the construction and mechanical characteristics to exceed all present lenticular wheels.

As a result, a new structural principle makes it possible to use tensioned fibers instead of compressed fibers, resulting in weight reduction while developing the most efficient application for fiber, ever.

The second generation disc wheels, thus, having been created by Campagnolo were appropriately named: FLUID-DYNAMIC WHEELS.



FLUID-DYNAMICS

The study of fluid movement in contact with a solid body has defined the principle that turbulent behavior of fluid threads in contact with a solid body causes a higher resistance to forward motion compared to the behavior of laminar threads.

This is due to the creation of more fluid movement around the body; movement that obviously requires energy dispersion.

Therefore when the body moves, it must give part of its motive energy to the fluid in order to compensate for the turbulence.

Turbulence is created when the angle of deviation of threads, in regards directional flow, exceeds 10 degrees.

In a spoked wheel, every spoke produces turbulence, since the deviation of the threads reaches 90 degrees.

The Campagnolo FLUID-DYNAMIC WHEEL solves this problem by creating a smooth sliding surface with an angle of deviation always less than 10 degrees.

The advantages in terms of power required to keep a determinate speed, with all the other variables fixed, is clearly described by the curves in diagram 1.

LIGHTNESS

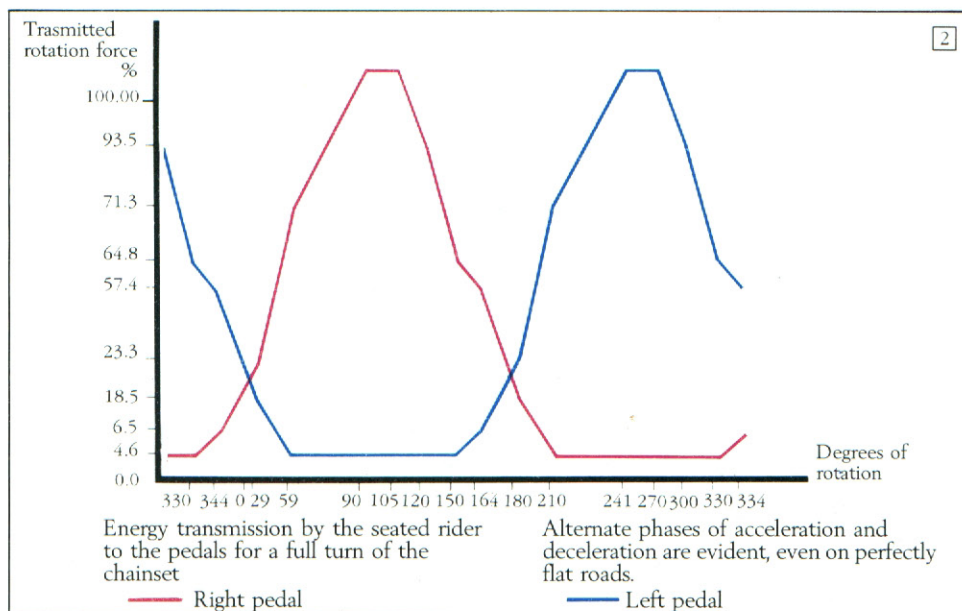
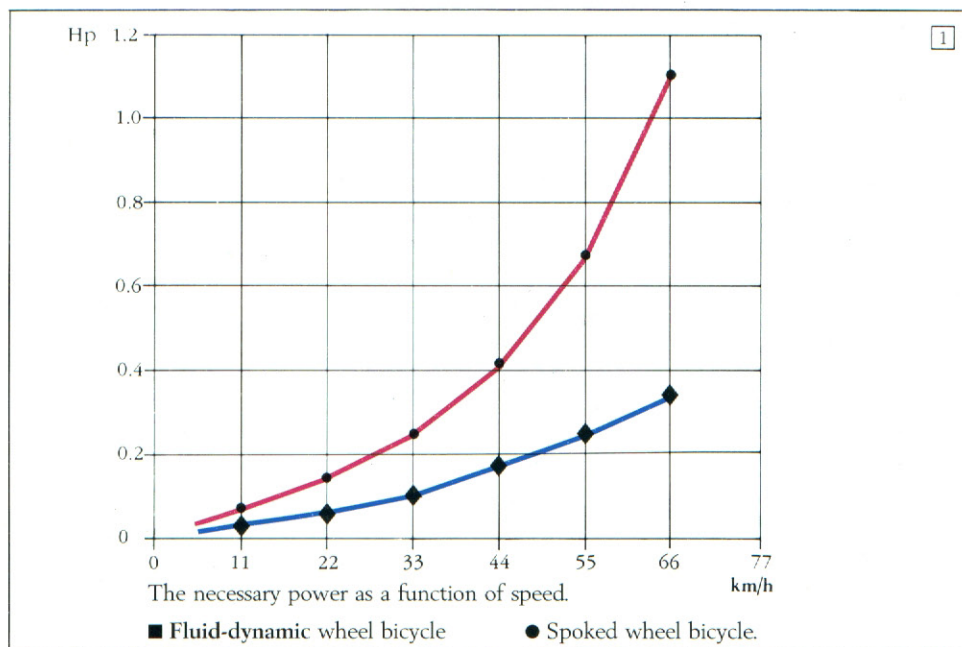
A pair of lenticular wheels of the first generation on average weigh approximately 3.6 kg.

This translates into about 1.8 kg more than a pair of spoked wheels in static conditions (at rest). In dynamic conditions, i.e. when racing, the weight of each wheel virtually doubles the total energy to be applied to the system. Once because it requires energy to move the rider/bicycle system; and again, because it requires some additional energy to make the wheel rotate on the hub.

Practically, it's as if the wheel was twice as heavy.

Therefore the difference between a pair of lenticular wheels and a pair of spoked wheels virtually becomes 3.6 kg.

All this negatively affects the athlete's performance. Indeed, the speed of a bicycle, with a fixed gear ratio depends upon the cadence; the riders ability to accelerate



and maintain his "spinning" technique.

Yet in every complete rotation, one can find both an active and inactive phase.

Therefore, the propulsion of the bicycle has a sinusoidal trend, as shown in diagram 2.

Thus the athlete must produce rhythmic and symmetrically alternate accelerations.

Since rhythmic accelerations are necessary to ensure a constant speed, it's apparent that continuously accelerating on a bicycle equipped with heavier lenticular wheels requires greater effort.

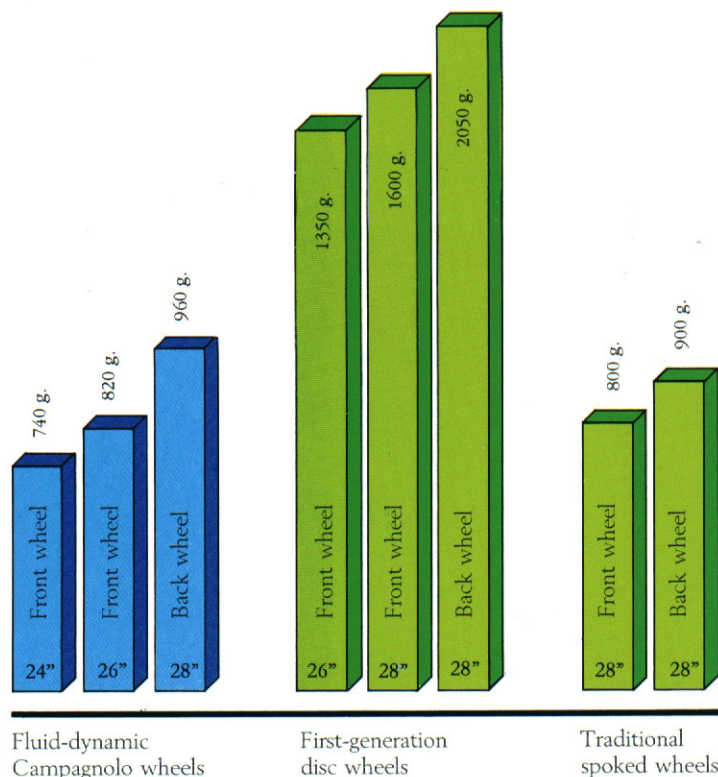
The advantage Campagnolo offers the athlete is a patented manufacturing process which permits the use of the super light materials

that maintain the reliability and dependability of the material.

As a result of this new technology, Campagnolo makes it possible to create the FLUID-DYNAMIC GIBLI M 23 disc wheel weighing only ≈ 970 gr. (28" rear wheel without quick release). This is virtually the same weight as a traditional spoked wheel. (Diagram 3).

The result is a significant energy gain due to superior behavioral characteristics of the FLUID-DYNAMIC WHEEL when compared to any spoked wheel. Also, due to extreme lightness of the product a time trialist or triathlete will appreciate the advantage offered by the GIBLI M 23 disc, even when it becomes necessary to attack those inclines on the race course.

3



Comparison of weights
Weights are for a wheel with hub and 32 spokes without quick-release.

has already spent a fair amount of energy during the swim.

Knowing that after the cycling segment there is still the run; the comfort advantage offered only by the GIBLI M 23 becomes critical in ultimately conserving valuable energy reserves for the run.

And it is here in the cycling portion that the triathlete can realize the greatest gain in the overall time because of the mechanical advantage offered by Campagnolo.

COMFORT

The structural model developed through CAD research technology and patented by Campagnolo for the FLUID-DYNAMIC wheel, gives the system vertical elasticity almost equal to that of a spoked wheel; and definitely offers greater elasticity than any of the current disc wheels available.

At the same time the transversal rigidity is equal to even the best rims available for spoked wheels, ensuring safety with the FLUID-DYNAMIC wheel without any reduction of comfort. (Diagram 5).

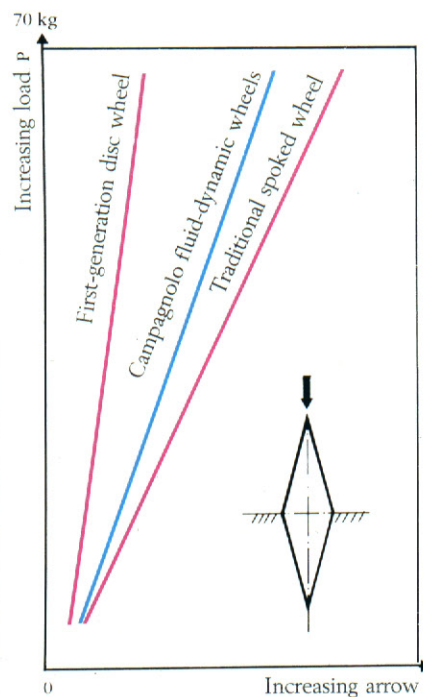
These characteristics are essential in enabling the athlete to give the best possible performance, particularly in the time trial event.

In this type of race, any reduction of fatigue (due to "road shock") can result in precious time gained over your competitor.

Campagnolo market research reports that comfort is essential for the triathlete, as well as the time trialist.

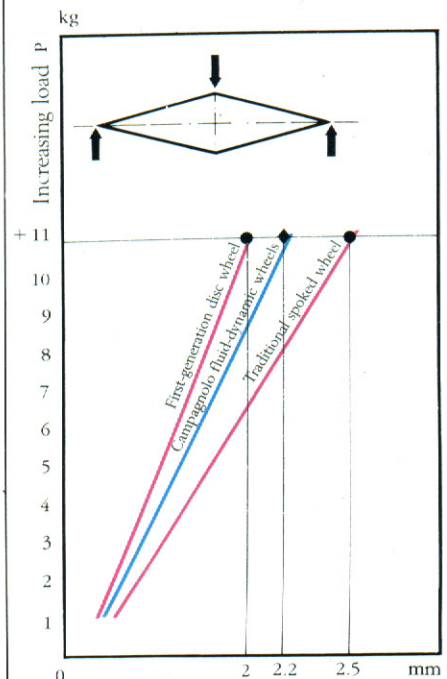
In the triathlon, the athlete

4



Comparison between vertical elasticities.

5



Comparison between transverse rigidities.



MANAGEABILITY

With the introduction of the FLUID-DYNAMIC disc wheel, Campagnolo has effectively solved two inherent problems concerning the manageability of the disc wheel: braking and steering.

Braking while using the GHIBLI M 23 disc wheel is equal to a spoked wheel.

The circumference of this new second-generation disc is formed from an extremely hard aluminium alloy rim which is 13 mm wide (same as spoked wheel).

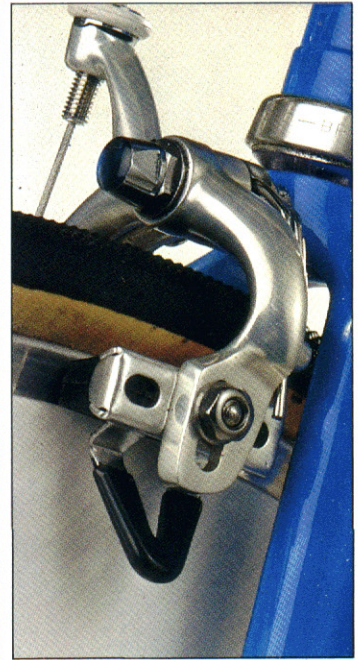
The manageability factor of the disc wheel, particularly when steering the bicycle is linked to two main factors: weight, which affects the gyroscopic effect; and profile, which affects lift.

The principle of gyroscopic effect states, when the axis of a spinning disc is altered, the disc goes back to its former axis with a force increasing proportionally to the weight of the body.

Because of this law, in fast turns, heavy lenticular wheels understeer, when compared to spoked wheels. (Diagram 6).

Unlike the lenticular wheels, Campagnolo's FLUID-DYNAMIC GHIBLI M 23 wheels have a reduced gyroscopic effect, resulting in superior manageability in fast turns.

In order to further improve manageability, Campagnolo



researchers and engineers have developed a front wheel "camber" which remarkably reduces the fluid-dynamic effects of understeering due to the lift created on the front wheel when cornering.

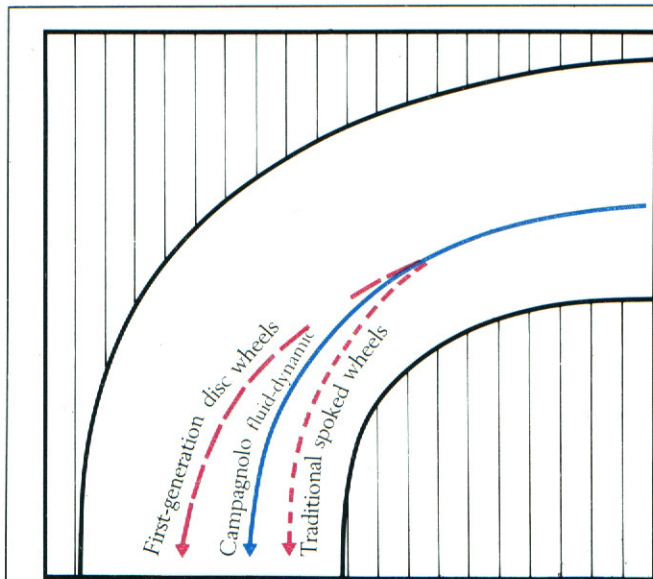
Indeed, if the front wheel surface (which is in the inner side of the turn) is angled compared to its former direction of movement, the fluid threads bring about an area of reduction of flow which, in turn produces a pressure against the wheel surface causing its rotation outward.

The camber developed by Campagnolo for GHIBLI M23 takes into consideration the most

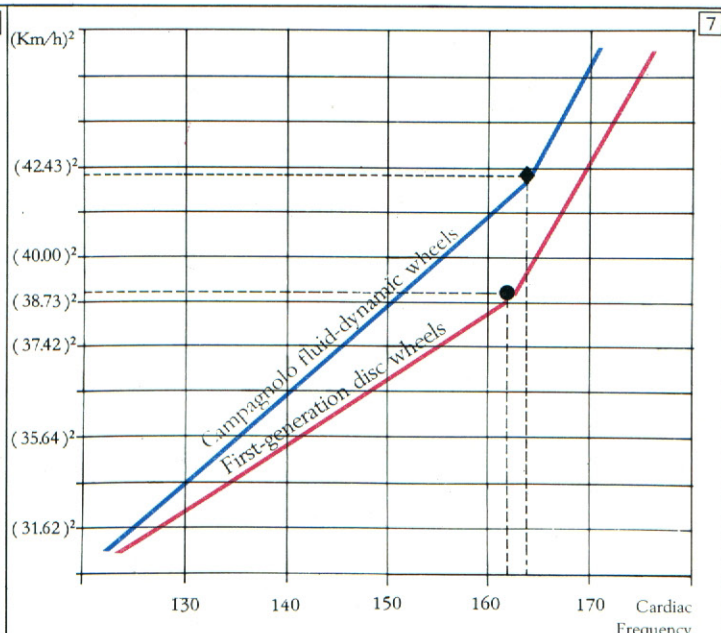
frequent steering angles and compensates for them.

In this way Campagnolo engineering has made it possible that the front wheel surface is parallel to its former direction of movement. As a result, fluid threads have a laminar motion that does not disturb the movement of the bicycle.





Ridability when cornering.
The particular camber and the weight
have been developed to allow fast
cornering.



Determination of the threshold level.
This test was carried out on the track.

EXCEPTIONAL PERFORMANCES

Proof of this new technology patented by Campagnolo for the GIBLI M 23 disc wheel has been confirmed by specific tests to determine the threshold level (the maximum level of continuous effort which still enables the lactic acid to be reabsorbed).

These tests have shown how,

with the same threshold level, the athlete with the FLUID-DYNAMIC advantage reach speeds of 4% to 6% higher than those using other disc wheels. (Diagram 7).

In addition, tests conducted during many races have confirmed that athletes obtained better results than ever before when equipped with the new Campagnolo FLUID-DYNAMIC disc wheel.

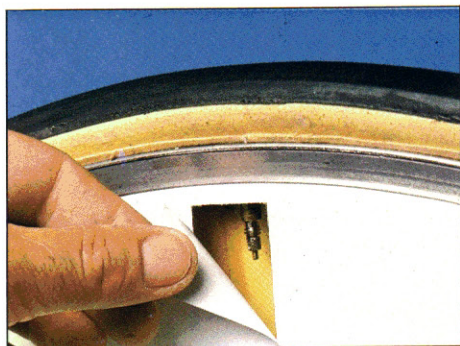
CODE	TYPE	RIM CROSS SECTION Ø	WEIGHT ≈ g	HUB SPACING mm	THREAD	FREE- WHEEL OR SPROCKET SPACING mm
0131705	ROAD BACK WHEEL 28" (700 C)	18	960	126,5	IT. 35x24P'	36
0131702	ROAD FRONT WHEEL 28" (700 C)	18	870	100	—	—
0131701	ROAD FRONT WHEEL 26" (650 C)	18	820	100	—	—
0131700	ROAD FRONT WHEEL 24" (600 C)	18	740	100	—	—
0131719	TRACK BACK WHEEL 28" (700 C)	18	960	120	IT. 35x24P'	24
0131717	TRACK FRONT WHEEL 28" (700 C)	18	870	100	—	—
0131714	TRACK FRONT WHEEL 26" (650 C)	18	820	100	—	—
0131711	TRACK FRONT WHEEL 24" (600 C)	18	740	100	—	—

KHAMSIN, THE FLUID-DYNAMIC WHEEL FOR EVERYONE

The same technique of fibers in tension, with a different material, is applied to the structure of the KHAMSIN FLUID-DYNAMIC wheels.

Campagnolo KHAMSIN wheels represent the state of the art for disc wheels. Designed for less demanding competitive purposes, they use all the principles applied to "second generation" disc wheels.

The hubs have the same components as Campagnolo Record hubs.



KHAMSIN wheels, like the GHIBLI M 23 wheels, are supplied with the hubs fully adjusted, while the quick release must be installed.

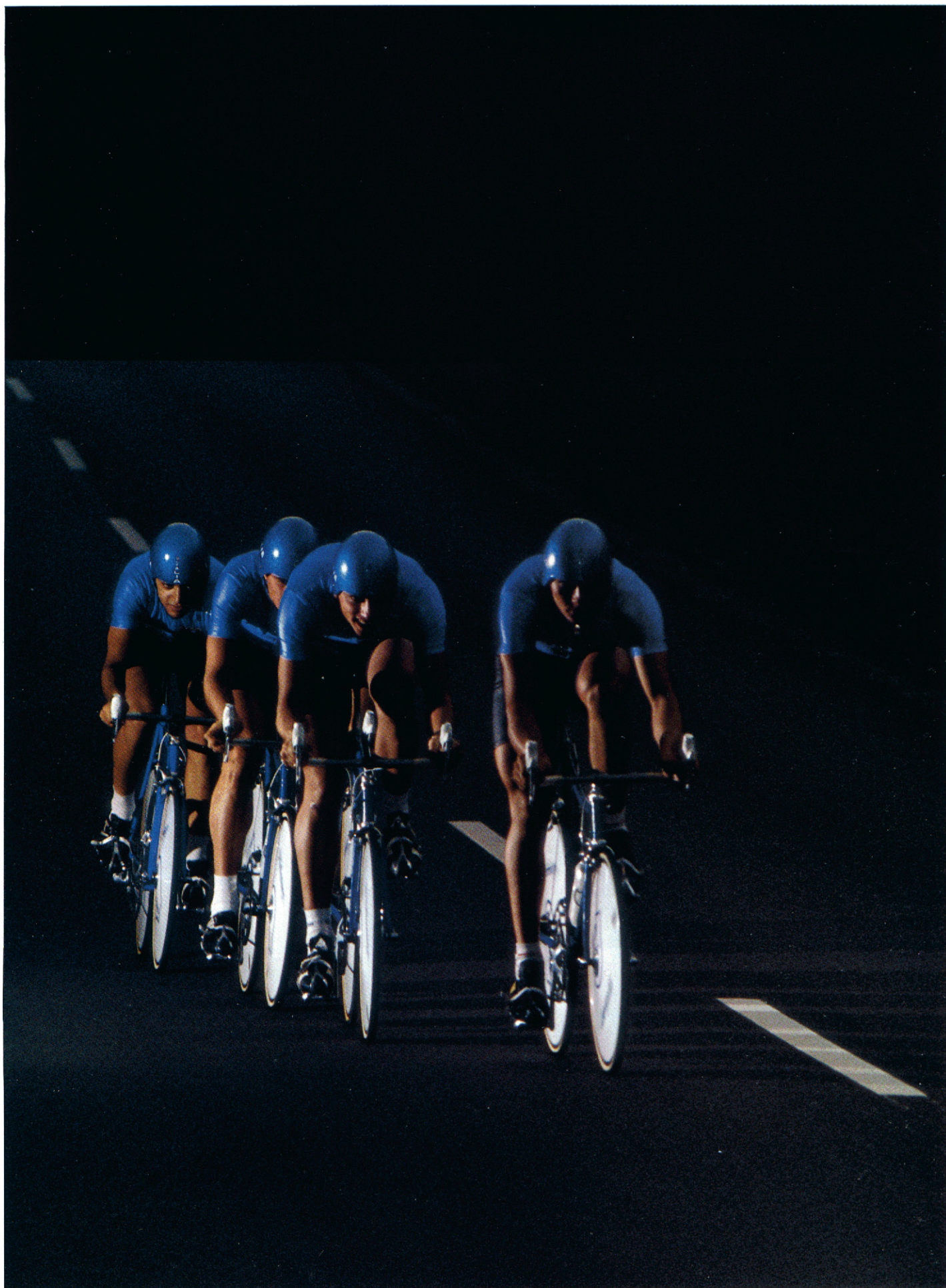
The side of the FLUID-DYNAMIC wheel has a small indentation below the valve hole which serves as a valve housing and which allows a pump extension tube to be connected to the valve.

Once the tubular has been

inflated, the housing should be covered with one of the white self-adhesive patches that are supplied with the wheel.

KHAMSIN disc wheels are particularly suited for individual races (time trials and triathlons).





AN ITALIAN TEAM ON BICYCLES EQUIPPED WITH CAMPAGNOLO GHIBLI M 23 FLUID-DYNAMIC WHEELS

Campagnolo[®]

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