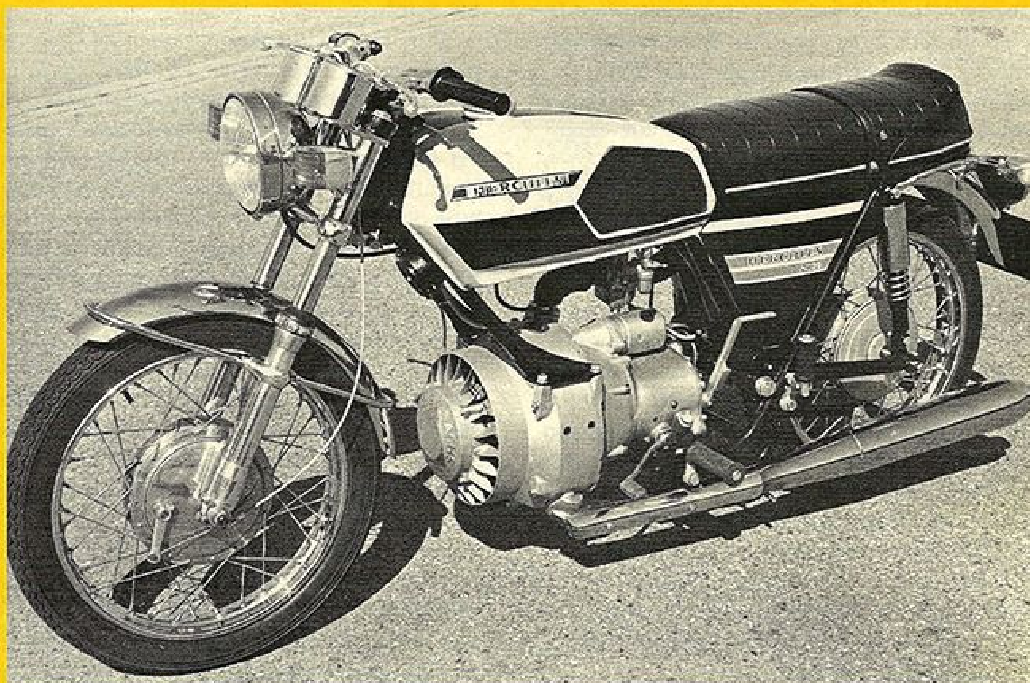
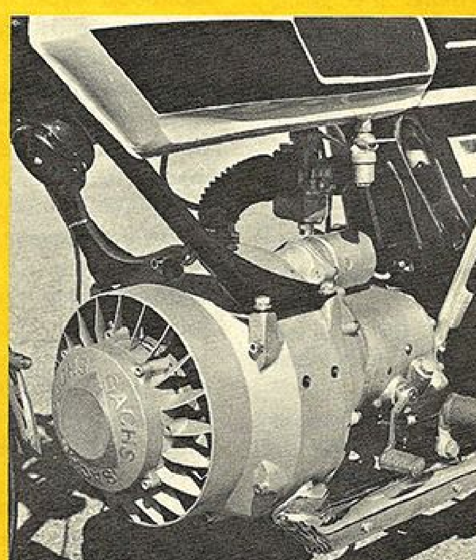


Volker Rauch Photos



THE HERCULES 2000

Felix Wankel's Revolutionary Engine Makes Its Motorcycling Debut.

HERCULES 2000

have as restricted an aspiration period as does the piston-port, two-stroke engine, which also fires once for every crankshaft revolution. As usual, the theorists have had to sit by and blush while the engineers work out the bugs besetting the new design. As Hercules and Sachs enter the scene, the major problems are mostly behind them.

The worst of these was the difficulty in maintaining a proper seal of the Wankel chambers. A rotor not only must have side seals to maintain chamber compression, but must also have spring-loaded apex seals to maintain a compression seal between each of the three sections created by the rotor. The apex seals have a function similar to that of piston rings, only on a much more marked scale. Seal velocity on the chamber wall is rapid, as are side loadings on the tips, and the temperatures on the portion of the wall where combustion occurs are much hotter than those encountered by a conventional piston ring. NSU used a wide apex seal made of graphite, which would crack if ignition timing was off, and so switched to cast iron apex tips, running on a cemented carbide rotor housing, with some success. Toyo Kogyo, builders of the Mazda, still use graphite but impregnate it with aluminum to increase resistance to cracking. Running on a chromed housing surface, it seems quite reliable.

Nonetheless, the most reliable Wankel engines are that way because power output has been held far under theoretical limits. The KM914, accordingly, is also modest in its output, at 23 bhp for 300cc, or 76 bhp per liter; matched against a 600cc machine, with which it is supposedly equivalent, that figure is halved to 38 bhp per liter. In comparison, the 325-cc Honda sohc Twin produces about 33 bhp, or 103 bhp per liter. The 100-bhp Mazda car, powered by a two-rotor Wankel, displaces about 500cc per chamber or 1000cc total, for a specific power output of 100 bhp per liter, or, FIA style, about 50 bhp per corrected liter. So, as you might guess, the Hercules 2000 is not exactly a fireball.

Nonetheless, it is a remarkable motorcycle to ride, and has a wide power band—wider than a four-stroke of equivalent (uncorrected) displacement normally has.

The Hercules has an electric starter, with a supplemental kick starter. At idle, it sounds like a two-stroke (like a two-stroke it must run on a gasoline/oil mixture, in a 50:1 ratio). Put it under load and accelerate, and the note coming from the single exhaust port acquires the more exciting overtones of a four-stroke Multi. The engine pulls practically from idle to its 6500-rpm peak with little change in effect; you cannot tell when it is lugging, or when it is about to run out of rpm. Roll off the throttle and the braking effect from engine compression is extremely strong, like that of a four-stroke. It is as smooth as grease at any rpm above idle.

Paradoxically, the Wankel engine's primary virtue, compactness in relation to high specific power output, is lost on the Hercules. This is because the engine must be air-cooled, and therefore is encumbered with finning and the gigantic shrouding for the axial fan. In this respect, the Wankel is much more suitable for automobiles, which have room to carry and enclose a water cooling system away from view. On the Hercules, the effect is like sitting behind the opposed cylinders of a BMW Twin; the shrouding bulges out just ahead of the feet.

As a total motorcycle, we rate the Hercules 2000 as a conservative sort of European touring bike. Surprisingly attractive in a Teutonic way, it is built solidly. The seating is comfortable and the handling is slow and graceful, due to a longish wheelbase. The exhaust pipe, forced by porting position considerations to run straight down before turning back to the rear of the machine, looks too close to the ground for comfort.

It is hardly a sporting machine, nor does it have sporting performance. But it is flexible, smooth, comfortable and would undoubtedly prove a pleasure on extended journeys.

What is the future of the Wankel design in motorcycling? To an extent, we must be influenced by our reactions to the Hercules 2000, which, by virtue of being first, must be the butt of many objections as well as compliments.

In its favor, the rotary combustion engine has much going for it. It is flexible, and it is smooth running. It possesses the four-stroke attribute of compression braking, with a theoretical potential of twice the power output per (uncorrected) liter. As advance ignition timing is less of a factor in firing the Wankel, it may run on low-grade gasolines which you would hesitate to put in most conventional engines.

The Wankel is also a paragon of simplicity, and possesses fewer parts than most engines. It should therefore be inexpensive to produce.

For example, the Sachs KM914 engine consists of rotor housing, rotor and seals, drive shaft and gearing, Bosch ignition, Bing carburetor and cooling fan. There are no valves, only two open ports which are phased by the rotor itself; they do not even have to be covered during part of the aspiration cycle, and so have a distinct timing advantage over the aspiration cycle of a two-stroke or a four-stroke. There is positive gas expansion for two-thirds of a complete Wankel cycle of 360 degrees, compared to that of a four-stroke—one-fourth of a 720-degree cycle.

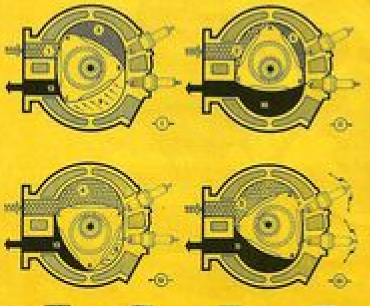
So the Wankel engine potentially may be very light for its power output. An American company, Curtiss-Wright, has made a two-rotor version producing 185 bhp at 5000 rpm with the remarkably light weight of 237 lb.

On the negative side is compactness, or lack of it. A Wankel is compact in an automobile, but not necessarily so on a motorbike. The problems with aircooling a Wankel are critical, and the bulky housing of the KM914 is witness to that fact. The main engine body of the KM914 could be slimmed down if it were watercooled, but then the bulk would have to reappear somewhere else on the cycle as a radiator system, which must raise the center of gravity and increase weight at the same time.

Undoubtedly, research will improve the reliability of the rotary combustion engine at higher specific outputs, so that these engines may someday be used to power the sporting, high-performance type of motorcycle. Actually, the housing for the first rotor produces most of the bulk, and the addition of a second or third rotor, to double or triple the power output, would add only a few inches to the engine's length.

As the displacement increases, exhaust emission becomes a problem, and may become subject to governmental regulation. The Wankel is a relatively "dirty" engine compared to the four-stroke. But as it is less finicky about what it burns, it may take advantage of low-by-product fuels which may be developed. More thorough fuel burning is promoted on one Wankel engined car—the Mazda—by having two spark plugs per chamber; one plug serves as an "afterburner," firing a short interval after the first one.

Other improvements will come along, particularly with all the big automotive money going into Wankel development. The rotary combustion engine is relatively new and untried, and so looks like a lame duck. But, in retrospect, the reciprocating piston four-strokes and two-strokes were rather rude beasts in their early years, too. Look at them now. ◘



1-2-3-4 INTAKE 5-6 COMPRESSION 7-8-9 COMBUSTION 10-11-12-13 EXHAUST

This is a schematic of a rotor chamber of the experimental Mercedes C-111 car. Like the Mazda car, it uses a second plug, firing a short interval after the first, to promote more complete combustion. In this series of drawings, we may see how the Wankel's three-sided rotor carries out the four-stroke cycle.

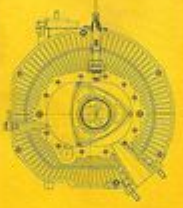
1) As rotor face BC has just passed the combustion point, face AB is compressing a fuel charge, while face AC is finishing the exhaust phase at the C end and beginning an intake phase at the A end.

2) Intake is in full swing on face AC, while firing will soon commence on the compressed charge of face AB. Exhaust has just begun on face BC.

3) The engine fires along face AB, while continuing the exhaust cycle on face BC. Intake continues along face AC.

4) Expansion takes place along face AB, while the exhaust phase nears its conclusion on face BC. When the apex of the rotor at C passes the intake port, the intake phase along face AC is concluded and compression begins.

Note that all phases of the four-stroke cycle have been performed, although rotor apex A has moved clockwise through only 120 degrees, one-third of a revolution.



Motorrad Photo

A cross-section of the Sachs KM914 engine reveals its typical Wankel configuration. Rotor turns eccentrically on a geared crankshaft. Fuel is fired by a single spark plug. Intake from a conventional Bing carburetor is ducted down to the circular intake port at lower left. Additional oil is injected from a narrow nozzle in the left side of the chamber to aid lubrication and cooling. In the rotor position, firing has just occurred and expansion is taking place. In the lower right part of the chamber, exhaust is in progress. In the left part of the chamber, intake is practically completed.