TILLOTSON

Diaphragm carbs for karting

Tillotson is as synonymous with the diaphragm carburettor as it is with karting. The Irish company is in the throes of producing a brand new carburettor for the 125cc engines that will be introduced into international karting in 2007, so an ideal time to find out more about their operation, the new HW carb and their preparations for a future with stricter emission controls.

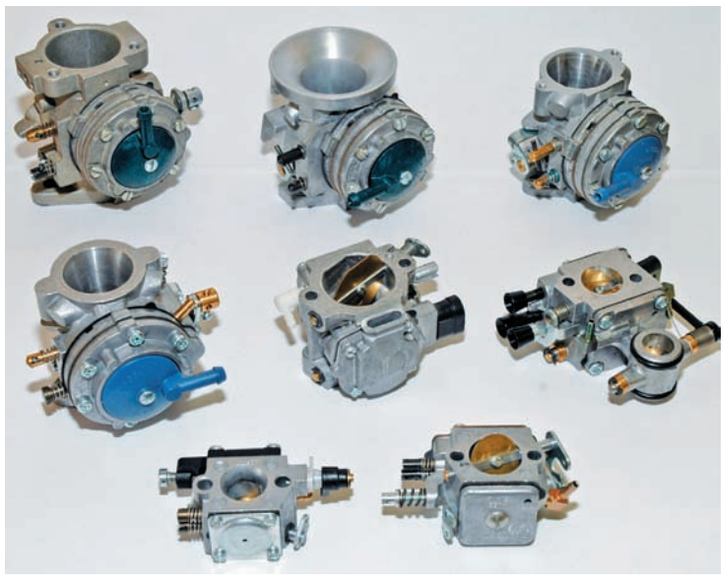
Although Tillotson today is very much an Irish company, its roots go back to Toledo, Ohio, USA and 1914 when Tillotson Manufacturing was founded by Harry Tillotson and John Willys. Willys was at the time in charge of the Willys-Overland Motor Company that would go on to produce the Jeep vehicles used in World War II. Tillotson initially produced float carburettors for Willys-Overland and the then budding automobile industry. The company prospered and grew, then when the industry matured Tillotson explored other products in their field and began to concentrate on small 2-stroke and 4-stroke engines.

In the late 1940s the development of the Tillotson diaphragm carburettor enabled engines to operate in positions other than horizontal thus boosting the already expanding small engine market. Tillotson was the first independent producer of the diaphragm carburettor with applications such as power mowers, chain saws, motor bikes, outboard motors, snowmobiles, pumps, generators and trimmers. Because of the continually growing market, the sophistication of the diaphragm carburettor evolved as unique applications were demanded. B.C. Phillips, then Chief Engineer, was granted over thirty patents on this product line.

Tillotson's success resulted in the Borg Warner Corporation purchasing it in the early 1960s who merged it with their Marvel-Schebler operations, forming the Marvel-Schebler/Tillotson Division. For the next twenty-five years Borg Warner manufactured a variety of carburettor products at three factory locations, Decatur Illinois and Blytheville Arkansas in the USA and Tralee Co. Kerry in Ireland. The Tralee plant was established in 1972, first with an assembly operation and later as a full production facility with machining and assembly. Engineering, design and R&D design were soon to follow.

In 1983 Borg-Warner Corporation decided to sell its carburettor operations which were now totally concentrated at Tralee. Thus in January 1985, Tillotson Limited was formed and once again became a self sufficient independent company reigning as the leading manufacturer of diaphragm carburettors.

Machined bodies awaiting assembly



Just some of the current range

The company employs 90 people at its facility at Tralee that has 4,830 square metres of manufacturing, engineering and office space and is self sufficient from the design and development stage through to manufacturing. Tillotson's core capability and speciality is in close tolerance machining and assembly. Machining typically takes the form of drilling, tapping, reaming, boring, milling and gun-drilling with some special finishing operations such as thermal deburring and cleaning. Machines vary from cam driven rotary index type to modern CNC. Typical tolerances are +/- 0.01mm although in the case of fuel jets the diameter is a reference only.

The assembly operations consist of conveyor lines and benches with specialised tools required to assemble the small and delicate component parts. The final product can be as small as a 3.8cm cube but consisting of over forty component parts. The function of the pump, metering and adjustment system is checked at various stages during assembly while a final flow test that simulates the

Tillotson's facility at Tralee

CNC machining line

operation of the engine is carried out before packing and shipping.

A view widely publicised some years ago was that the 2-stroke engine would die with the introduction of strict emission regulations but this is certainly not the case. Traditionally, small 2-stroke engines were branded as smelly and noisy but they do have a lot of attractions and in particular to the karting industry. Because they have no camshafts or valves the engines are cheaper to make. Two-strokes also produce more power per cc than 4-strokes and this makes them great for karting.

Next year will see the introduction and homologation of new, so called 'long life' 125cc TAG engines specifically developed for karting and sanctioned by the CIK. These new engines will require a carburettor and Tillotson are in the process of completing designs for a totally new unit specifically for this application. Prototypes have already been flow bench and track tested under stringent conditions and as a result the major design parameters have already been specified for Juniors, ICA and FA (or KF3, KF2 and KF1 as they are to be known) with the new carburettor series designated 'HW'. The new range will be butterfly type diaphragm carburettors but because of the particular application, great attention has been given to well known problem areas such as the fuel metering transition between the low speed system and the main fuel delivery system where a 'lag' or lean mixture area results in poor acceleration.

Wide open throttle position has also been addressed by bench testing and optimising the air intake, venturi profiles and shaft/shutter positioning to achieve maximum power. The carburettor body will be produced in a new single cavity high pressure die that virtually eliminates porosity making this casting comparable with gravity feed bodies and those produced by forging. Tillotson will also CNC machine for accuracy and repeatability. The intention is to produce a dedicated, race ready carburettor that will benefit from a cost standpoint being produced by a large manufacturing company.

What of the future regarding emissions, 2-stroke engines and the karting industry? Tillotson are ahead in this respect and are already manufacturing the next generation fuel systems for the latest stratified charged 2-stroke engines that meet current and forthcoming emissions legislation. Should the industry be forced to make the change, the new stratified charged 2-strokes will give increased power, lower fuel consumption, emissions reduced by as much as 70% and reduced odour from exhaust gases. Other benefits are a concentrated fuel mixture in the crankcase that lubricates the crank bearings and cylinder barrel plus a quieter engine producing more power even at lower revs with a longer service life, at least in other applications.

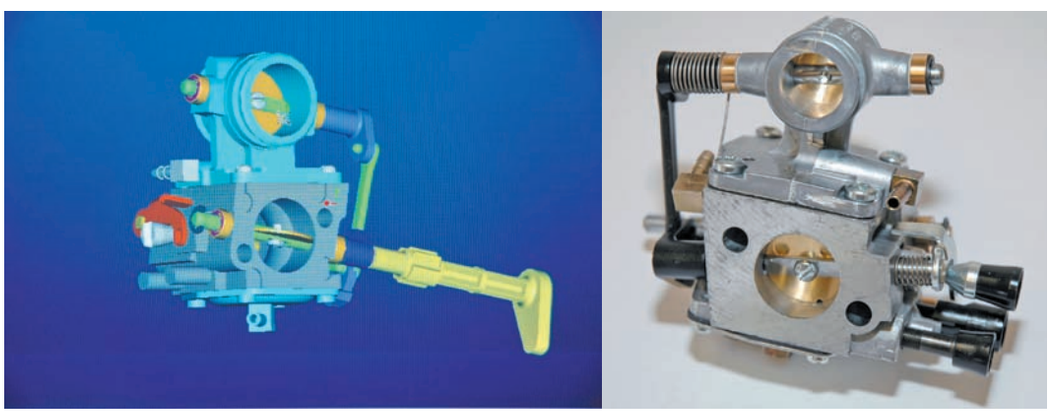
This is all achieved in the gas exchange process. Exhaust gases are extracted with clean air instead of by a mixture of air and fuel from the intake. In the current 2-stroke engine cycle any unburnt fuel is exhausted during the gas exchange cycle with some of the exhaust gas in still remaining the cylinder. The secret here is the introduction of single or multiple flushing air ducts at the appropriate location. A barrier of clean air is introduced during the cycle at a precise time and forced into the cylinder between the exhaust and the incoming fresh charge. This blanket of clean air separates the burnt gases from the fresh charge. As a result, part of the clean air charge is emitted in the exhaust and part remains in the cylinder. This process is known as dual charge or airhead engine technology.

Analysis of engine performance on a dyno

The carburettor is modified by the addition of a throttle bore required to throttle this clean air barrier. The throttle in the air bore is linked to the standard carburettor air/fuel throttle and calibrated for precise timing of the charge's introduction.

It seams the new generation airhead engines would be a natural progression if emissions legislation forces the issue. The engine remains simple in design terms, reliable with a dual barrel carburettor and the average kart owner will not be baffled by the upgrade in technology and will still be able to make adjustments. Alternative options would be to introduce electronic control of some carburettor functions/adjustments or to introduce injection. These systems are available and are reliable, but are expensive and require special skills to adjust and set.

For now it looks like we are fine with the not so humble diaphragm carburettor for some time to come yet. We can now look forward to the new generation of 'long life' 125cc engines and the new Tillotson HW carburettor for next year.



Computer generated solid model and manufactured airhead carburettor showing the secondary air throttle