**Under the Hood, March 2022**

Racing season is here and I suspect many of us spectate, or are a participant, in some form of racing. Every racing series organizer works hard to make the racing exciting to the fans. Often this involves trying to make the various vehicles similar in performance so that one marque doesn't dominate racing. For sports car racing where each marque has potentially specific advantages, the organizers try to make each marque equal to the others. Perhaps they add weight to one marque, decrease the air venturi area to another, or change the aerodynamics of another marque. Of course, the racers all want to win and will work feverishly to overcome whatever handicap the event organizers assigned. This seems to be a never-ending battle. If one marque seems to be winning too frequently, it will be saddled with additional handicaps, and the cycle continues. It gets a bit more complicated in formula racing. In formula racing the cars/engines are all pretty much the same. For instance, in Indy Car Racing there are only two engine suppliers (Chevy & Honda). Traditionally one of the biggest complaints of formula racing is that it can be a bit boring. Since the cars/engines are so similar there is little passing, and it seems that whoever jumps out ahead at the start often finishes first. Sometimes the racing finish standing comes down to who had the fastest pit stop. Now, boring racing equals reduced attendance and perhaps reduced television demand and payments. Each formula series has come up with different solutions to help create more exciting racing. In Indy Car racing all the drivers now have a Push to Pass (PTP) button. PTP allows the driver (generally) 200 seconds of additional power during each race. PTP also provides about 60 hp extra from higher turbo boost. Managing this PTP time becomes a major part of the racing strategy and if you watch Indy racing, the driver's remaining PTP seconds are routinely part of the telecast. Formula One has utilized a Kinetic Energy Recovery System (KERS) to aid in passing and provide some excitement. KERS allows the drivers to store braking energy in a large flywheel and release that energy whenever needed. It is reported that this energy can be the equivalent of 160 hp. Formula E (electric powered formula cars) is working with a different strategy. Initially the Formula E cars did not have enough battery storage for the cars to complete the full race. Each team was allowed two race cars and the drivers would change cars about mid race. This car exchange seemed to create some rather laughable results and provided some spectator interest. However, the batteries were improved and now Formula E racers can complete the entire race with the same car. Enter the series organizers with a new way to create more competition. Formula E now includes "Attack Mode". Attack Mode allows the driver about 35 KW of additional electrical energy. The time allowance of this additional energy is decided before each race and might be 4-8 minutes total. To activate (or create) the Attack Mode energy, the racers must drive off the racing line to drive over an activation zone and drive over sensors at both ends of the zone to "capture" the additional energy. Of course, to capture that energy they are slower than normal when they go off the fast racing line. It seems that some of these systems are a bit gimmicky, like reality TV, but it is all done to increase spectator interest. The next time you are watching TV racing, look for these systems.

The curious F head engine. In the early days of internal combustion engines, almost all engines were of the flathead design. Engines were relatively slow revving, and were undersquare, with small cylinder diameters and long cylinder strokes. Since the cylinder is round, it was difficult to get sufficiently sized intake and exhaust valves within the confines of the cylinder bore. Think of a large circle (representing the cylinder) and then inside that circle, draw two smaller circles (representing the two valves) and you will see that the cross-section area of the valves is limited by the cylinder bore. The flathead design somewhat solved this problem by having the valves along the side of cylinder. The cylinder head was basically a flat slab of cast iron with some formed depressions for the combustion chamber and a hole for each spark plug. Look at any flathead engine and you will recognize the simplicity. The famed Ford flathead V8, introduced in 1932 and continued until 1954, is the best-known example. Even Cadillac and Lincoln were selling flathead V12s, and Cadillac had a flathead V16 for a few years. There were two main problems with the flathead design. The intake air into the combustion chamber and the exhaust air leaving the chamber both had a very circuitous path with attendant inefficiencies. By keeping the exhaust valve in the engine block, there was also a lot of heat in the block. If you have a Craftsman lawnmower, or a different brand with a Briggs and Stratton engine, you probably have a flathead engine. Chevy was the first of the big 3 to drop the flathead engine and provide an overhead valve engine. Now the valves were located over the cylinder, but the valve operation was far more complicated. As the camshaft rotated, the cam lobes would push upward on a valve lifter, which would push upward on a push rod, which then operated a lever (rocker arm) above the cylinder and the rocker arm would push down on the valve to open it. The air path was more direct which was more efficient (meaning more horsepower). By taking the exhaust valve out the cylinder block, the design also distributed the heat of combustion to allow more efficient cooling. Even today, all of our Corvette engines (excluding the C4 ZR1 and upcoming C8 Z06) are pushrod operated overhead valve design. The C4 ZR1 was still overhead valve, but the valves were operated by overhead camshafts rather than push rods. The overhead valve design started the trend to larger cylinder bores (to allow larger valves) and shorter cylinder stokes. There was a curious hybrid engine design that combined elements of the flathead and overhead valve engines. This hybrid design was generally called a F head. The intake valve was located over the cylinder, but the exhaust valve was still in the block similar to the flathead. The F head provided the opportunity to have larger valves for better breathing, since it only had one round valve above the cylinder and could have a larger exhaust valve in that area alongside the cylinder. The F head still had the inefficiencies (and heat issues) of the flathead exhaust valve. We would see a lot of F head engines in motorcycles where it was assumed that the air flowing over the engine would be able to handle the heat of the exhaust valve in the block. It is interesting that two manufacturers continued to use the F head design until fairly recent times. Rolls Royce had a reputation for smooth and silent engines and the F head suited them well. In the early days all the complicated geometry of the overhead valve design or overhead cam design could generate noise not suitable for the typical pampered RR buyer. The RR F head engine was finally replaced by a fully overhead valve engine in 1959. Willys (later Jeep) also was a proponent of the F head design, and we find the WWII flathead 4-cylinder engine replaced with an F head engine. The Jeep F head engine would remain in production until 1971. Now the next time you hear someone talking about a F head engine, you will know what they are talking about.