Owner's Manual
All fired Up Racing
Blown Alcohol 8.0 second Drag Boat. 1050 HP. 145 mph
Feb 2015

King Wick and Bob Brazil campaign a 555 Cu. In. blown alcohol (methanol) Pro Eliminator (PE) 8.0 second open cockpit 1050 HP Drag Boat. Most of their racing occurs in Oregon. In past years, Bob won the World Championship in Phoenix, Arizona in his 9.0 second hydroplane.

King owns a controls engineering company called Alduras that designs automation and control systems for industrial & marine applications. Frequently, these are Programmable Logic Controller applications on ships: commercial ships, Navy ships, Coast Guard ships, etc.

Bob has been campaigning drag boats for a couple decades or more. He started out in the slower classes and has worked his way up to the fastest open cockpit drag boat class in the world: PE. This hydroplane runs the quarter mile in 8.0 seconds from a dead stop. Just like drag racing on asphalt, there is a 'Christmas Tree' set of lights at the starting line to tell the driver when he can launch. This boat runs about 145 mph at the top end of the ¼ mile track.

Above is a photo of Bob's first launch in an 8 second Blown Methanol PE boat.
Everything was a guess on this first launch: fuel, air, timing, weight distribution, propeller, and so on. As you can see, all those unknowns didn't stop Bob from going out and slamming the throttle: the boat launched beautifully straight but got a little high. We have since changed weight distribution to get flat launches: I slid the motor further forward in the boat by shortening the driveshaft to

its absolute minimum and we moved the (heavy) batteries into the port forward sponsons since the hydroplane wants to twist to the starboard during the launch.

The PE drag boat class is an 'indexed' class. That is, the driver runs against an 8.0 second index. The challenge is to run the quarter mile in *exactly* 8.0 seconds. If you run too fast (under 8.0 seconds), that is called a 'breakout' and is a disqualification: you lose. And if the driver leaves the starting line before the green light (too early), that is called a 'red light' and is also a disqualification: you lose. So the challenge is to break the starting line beam (a photo eye on the 'track' at the starting line) exactly at 0.00 seconds and to arrive at the end of the ¼ mile track photo eye beam exactly at 8.00 seconds. The boat that runs closes to 8.00 seconds without a breakout or red light is the winner of that particular two boat heat (a side-by-side race).

Bob and King are brothers-in-law. King started attending the boat drags and immediately saw the possibilities for improving the driver's experience by adding a PLC. He subsequently built and tuned Bob's motors and drivetrains: King owns the hull, Bob does the paintwork (nice, IMHO) and performs the driving while King builds most of the mechanical/electrical systems and is the crew chief.

Robert Poteet and Al Wick complete the regular drag boat crew on race days. Rob is an accomplished mechanic and knowledgeable engine consultant. Rob is also a brother-in-law of both King and Bob: this is a family project to go fast and have fun. Al Wick is King's brother – the whole family is hooked!

Kicking Up a Pretty Rooster Tail, Laying Flat near the End of a Pass

It requires approximately 1000 HP to run the ¼ mile in 8.0 seconds. The current motor was machined and assembled by Jim Andrew, Jim's Country Auto & Machine of Castle Rock, WA. Jim has been the crew chief for Jay Brookhart's 7.0 second Pro Mod dragboat for many years and may very likely be the most knowledgeable methanol fuel-powered engine designer on the West Coast. Jim is happy to share his knowledge and experience with his customers and fellow racers and has therefore been instrumental in promoting the drag boat sport to a wider audience.

The current motor was tuned on a centrifugal dynamometer at Walt Austin's shop near Seattle, WA. On its first pull, it put out over 1050 HP. That was actually a bit overkill for the 8.0 second class so Jim Andrew and King spent the rest of the day re-tuning the fuel system for even fuel distribution and approximately 930 HP at full throttle: about perfect for a hydroplane in the 8.0 second class.

Specifications:

- 555 Cu. In. Tall Deck Dart Big M block (chevy big block design).
  Sonny Bryant Billet Steel Crankshaft, 4.25"stroke, with Chrysler size rod journals
  Bill Miller Engineering 426 Forging Aluminum Rods
  Brodix BB-3 heads
  Enderle Bird Catcher mechanical fuel injection
  110 GPM Enderle fuel pump
  Littlefield Tall Deck 6-71 Blower Intake Manifold
  Littlefield 6-71 Blower
  Solid Copper Clark Head Gaskets
  Olson 12 Qt Kickout Oil Pan with Stroker Clearance
  Comp Series Jessel Rocker Arms
  Crower Roller Lifters
  Custom Cam Grind
  Keith Black Camshaft Gear Drive
  Meziere TS400 Starter (plus spare)
  Braided stainless 16 AN fuel feed hoses
  1050 HP at 7000 RPM, measured on a centrifugal dynamometer
- Lenco clutch.
  CO_2 operated.
- Lenco 2 speed CS2 transmission with Sprag Replacement Module (spragless).
  CO_2 operated
- MSD ProMag 44 magneto
  Dunn Offset Mag Drive with Billet Mag Clamp
- Peterson HTD wet sump oil pump
  We use an external belt-driven wet sump oil pump so we can prime the oil system using an electric drill in the pits. This allows us to circulate pre-heated oil throughout the block without running the motor.
- Unique 18V starter system
  There are two batteries on board: a 12V battery and a 6V battery. They are run in series to provide 18V to the starter. The 18V is necessary to provide the ideal

high starting RPM for the magneto and methanol. We tap off the 12V battery to provide 12V power to everything else: the PLC, the ignition electronics, etc. An alternator charges the 12V battery to provide reliable voltage/current throughout the run. The 6V and 12V batteries are charged in the pits after each pass.

These big alcohol blown motors eat starters like candy. It was common to go through a couple new starters per race. We have since upgraded to the expensive but very reliable Meziere brand starters to quit fighting this problem. This was an expensive lesson to learn: I viewed starters as commodity items that were very similar so at the beginning I just bought a good quality $250 racing starter and kept a spare. But as soon as I had gone through a couple of those, it became quite apparent that the ultra-high-quality Meziere starter was a much better value. Not to mention that thrashing in the pits between rounds to toss in another starter got real old in a hurry. And if your starter chewed up the teeth on your flex plate, the race was essentially over for the weekend (that meant pulling the motor).

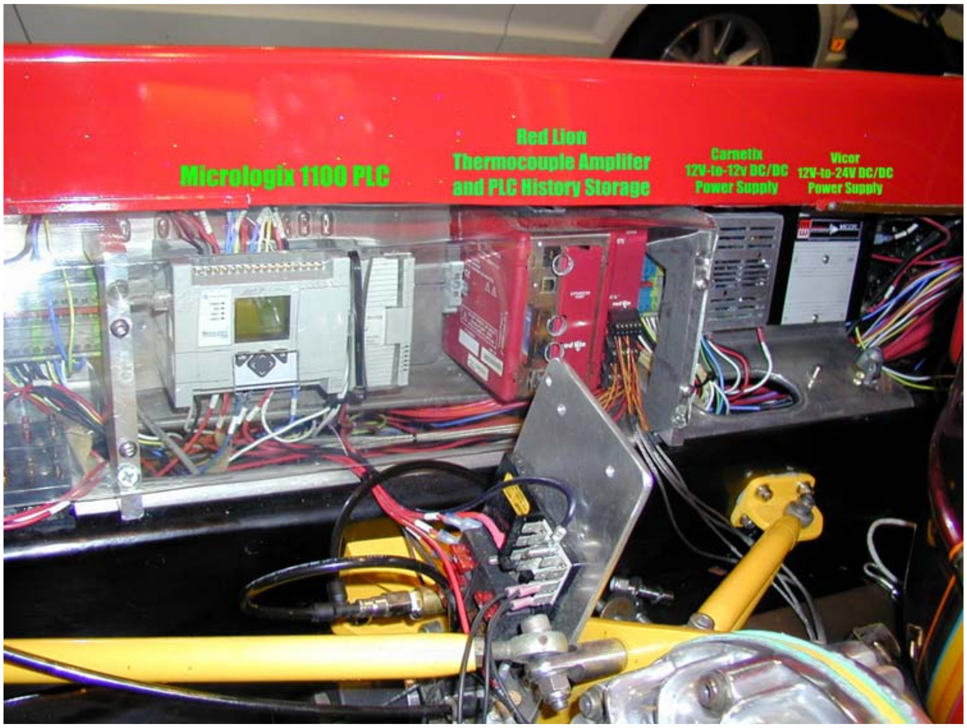
- Allen Bradley Micrologix 1100 Programmable Logic Controller.
- Red Lion Data Station to historically store PLC data and exhaust thermocouple data.
- Buffalo WLI-TX4_G54 Wifi access point and Ethernet converter to allow easy access to historical data.
- MSD 7531 Progammable Ignition Controller to gather ignition history information.
- Innovate LC-1 Wideband O2 sensor amplifier
- Type K thermocouples at each exhaust port. Sensed by Red Lion Data Station.
- Vicor 12-to-24VDC converter to provide 24V power to Red Lion Data Station.
- CarNetix CNC-P1290 12V-to-12VDC converter to provide filtered 12V power to Allen Bradley Micrologix 1100 PLC.

The Allen Bradley Micrologix 1100 PLC serves the following functions:

1) Operates the transmission air shifter solenoid. The PLC times when the transmission shifts from 1st gear to 2nd gear (air is applied to go into second gear). This timer value is the primary fine tuning key to the elapsed time of the race: the later you shift, the faster the elapsed time. Exactly like your car: if you want to go fast, you 'wind it out' before you shift: if you shift early, the car or boat 'dogs' down and runs slower.
2) Operates the clutch air solenoid. The PLC provides input to the driver to indicate when the drivetrain is ready for the driver to stomp on the throttle. This indicator lamp occurs when the PLC engages the clutch. If the driver fails to wait for this indicator to light and stomps on the accelerator too early, the transmission will not be in gear and severe damage may occur to the motor or transmission.
3) Operates the magneto kill solenoid in case of low oil pressure and while starting the engine. Methanol fueled engines can be very difficult to 'light off' (start). For a magneto it is best to let the starter motor turn over the engine for awhile before enabling the magneto, then switch the magneto on to provide spark. When the PLC sees the starter switch, it shorts out the magneto for the first 500 mS, then

enables (quits shorting out) the magneto. This helps extend the life of the starter by not 'kicking back' from spark that occurs too early.

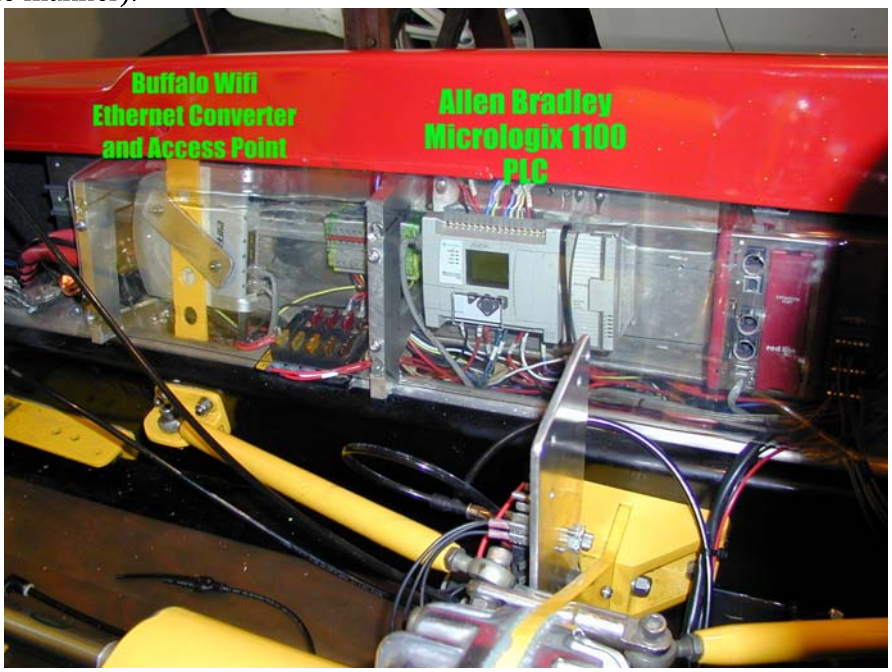
4) Operates the clutch air purge solenoid. In order to disable the clutch, air must be purged from the clutch system. A separate air valve is used to purge air from the clutch pneumatic plumbing.
5) Operates the priming fuel pump. A separate high pressure (fuel injection style) electric fuel pump pumps a small, measured volume of methanol into the hat when the driver presses the priming pushbutton (located below the driver's seat). The driver has the option to simply press and hold the priming button to operate the fuel pump manually, or, to provide a measured amount of fuel, can press the button repeatedly: each quick press runs the priming pump for ½ second per press. A pressure sensor at the hat waits for fuel pressure to be seen at the hat before the first ½ second timer starts: this ensures that the time it takes to fill the priming hose does not skew the measured volume.
6) Clears launch history of MSD 7531 Ignition controller.
7) Resets time zero of MSD 7531 Ignition controller history when the clutch engages.



Location of PLC, Red Lion Data Station and DC/DC Power Supplies

DC/DC power supplies are used to filter the (noisy) power coming from the battery and alternator. We want to ensure the PLC and Red Lion History Recorder get clean power at all times. The 44 Amp Magneto is a horrendous noise generator so filtering and ground structure are absolutely paramount to keep the electronics running smoothly.

For any PLC types reading this document, note the mounting of the PLC: it is screwed directly to a mounting plate, not mounted on DIN rail. It's not possible to tell from the photo, but that PLC mounting plate is a separate plate that is rubber vibration mounted to the main support plate. This was a valuable lesson to learn: the boat launches so hard that the first PLC lasted less than 5 seconds before it vibrated to death. By mounting this new PLC securely to a plate, then attaching that plate with rubber mounts to the main plate, we've seen much improved reliability of the PLC. I started doing the same thing in all my professional controls designs too (we had seen multiple intermittent failures machinery PLC failures that magically disappeared when we started mounting our PLCs in the same manner).



Wifi Access Point Provides Convenient Method to Read Historical Data

Operation


Dashboard Controls Visible from Driver's Seat

Controls Visible on Port Side of Driver's Seat

Master Disconnect

The Master Disconnect disconnects all power from all circuits in the boat. The main power cables to the starter solenoid have power whenever the batteries are connected so be aware the solenoid is always hot.

Ignition

Turns on the ignition system and provides power to the Safety Tether. Turning off the ignition switch shuts off the Ignition Input of the MSD 7531 Ignition Controller plus it shuts off power to the MSD 8134 Kill Solenoid (shorts out the magneto); either scenario will kill the engine using separate mechanisms. The Ignition switch must be on in order to clear the 7531 history (performed only in the pits by pit crew).

Safety Tether

Shuts off power to the MSD 8134 Kill Solenoid (shorts out the magneto). This is wired in series with the PLC output that also shuts off power to the MSD 8134 Kill Solenoid if oil pressure is lost or shuts off power to the Kill Solenoid for the first 500mS the starter button is pressed. Note the MSD 8134 Kill Solenoid is Normally Closed: it must have power in order for the engine to run. The Kill Solenoid gets hot when enabled (enabled all time after the starter button has been pressed until the safety tether is removed or the ignition switch is turned off).

Priming Pushbutton

Pumps methanol directly into the hat from a separate, small high pressure fuel injection style pump. Has two modes of operation:

1) Press and hold. Runs the priming fuel pump as long as the Pushbutton is held in. This mode is intended to be used in the pits when the motor is first fired up when one person can watch fuel delivery in the hat while another person presses this button.
2) Repeated momentary presses. For each momentary press of this button, the PLC will put 500mS of priming fuel into the system: for example, press the button quickly five times in a row to put 2.5 seconds of priming fuel into the hat. This mode is intended to be used by the driver on the water: momentarily press the Priming Pushbutton three quick times to cause the system to put priming fuel in the hat for exactly 1.5 seconds. This mode is intended to eliminate any chance of fouling the motor with excess priming fuel (we need to learn by experiment how many presses work best in various weather conditions).

Water Pump

Directly controls the water pump. Pumps lake water through the motor. Should be on at all times while boat is in the water.

Bilge Pump

Directly controls the bilge pump. Pumps aft water into an overboard bulkhead connector.

Fuel Shut-Off

A mechanical fuel shut-off cable runs from the Enderle fuel shut-off valve to the dash. Press the center button and pull the outside knob all the way out to supply main fuel to the engine.

Steering Wheel Pushbutton

Used in conjunction with the FWD/NEUTRAL/RACE selector switch. Whenever the FWD/NEUTRAL/RACE selector switch is pressed, the Steering Wheel Pushbutton must be pressed for the new selector switch setting to take effect. For example, if the driver has just put in the water at the ramp, the driver will put the selector switch into FWD (which will have no immediate effect). Once the Steering Wheel PB is pressed, the clutch will engage (in whichever gear the transmission was already in).

This delay of the selector switch position is always true. So, for example, when the driver is proceeding back to the ramp after a race, the driver will put the selector switch in FWD and then press the Steering Wheel PB to begin forward (in second gear). As the driver approaches the ramp, he will put the selector switch in NEUTRAL but nothing will change. Once he is ready to actually go in neutral, he will press the Steering Wheel PB. The system operates this way for safety: turning to change the selector switch is awkward, however pressing the steering wheel PB is natural and allows the driver's focus to be on the forward momentum of the boat.

FWD/NEUTRAL/RACE Selector Switch

- In the FWD position, the clutch is engaged once the steering wheel PB is pressed. The clutch is engaged by putting 150 PSI CO2 to the clutch cylinder.
- In the NEUTRAL position, the clutch is disengaged once the steering wheel PB is pressed. To fully disengage the clutch, the 150 PSI air to the clutch is turned off, and in addition this also enables the 'clutch air purge' valve that opens the clutch pneumatic system (for a second) to fully bleed clutch air pressure to ambient pressure (zero).
- In the RACE position, the clutch is engaged shortly after the steering wheel PB is pressed. When the clutch is engaged, a dash indicator lamp indicates the clutch is engaged and it is therefore OK for the driver to stomp on the accelerator. In the RACE position, the driver should NEVER stomp on the accelerator until the dash indicator lamp indicates the clutch has engaged or severe damage may occur to the motor and/or clutch.
- Changing the position of the selector switch NEVER directly changes anything: the steering wheel PB must be pressed before the new setting takes effect.

Special Transmission Considerations

The air-shifted Lenco clutch and transmission present some unique challenges. The primary challenge is related to the sequence required to properly shift the transmission: the transmission shifts into second gear once 250 PSI CO2 is applied to the transmission. At the same time, special air diodes on the transmission Sprag Replacement Module (SRM or spragless) transfer 100 PSI CO2 from the first gear side to the second gear side of the SRM at the output of the transmission. The SRM is designed so that 100 PSI CO2 must be applied to one and only one side of the SRM at all times (a first gear side and a second gear side): it is the job of the air diodes to ensure only one side gets 100 PSI air at a time. Of note: the clutch engages once 150 PSI CO2 is applied to the clutch. So there are 3 separate CO2 pressures (250, 150, 100 PSI) used in the system that must be coordinated.

The difficulty with the transmission shifting lies in the mechanical bleed button at the air input of the transmission: it must be manually pressed to bleed the air pressure to force the transmission back into first gear (assuming the transmission has been placed in second gear at some point by applying 250 PSI CO2). So once the system is in second gear on the water, we leave the transmission permanently in second gear: its just too much trouble for the driver to reach around back to the transmission and manually bleed the transmission while simultaneously somehow indicating to the PLC that he is doing so. That means that any trip from the end of the track back to the ramp will be in second gear – and there is simply no good, clean, reliable fix for that situation.

So the PLC code is written to maintain 250 PSI air to the transmission at all times once the transmission shifts into second gear (the transmission only shifts into second gear in RACE mode). Bleeding of transmission air is intended to only occur back in the pits. When the Master Disconnect switch is turned off, the PLC is turned off. The next time the Master Disconnect is turned on, the air valves are set for their 1st gear/clutch disengaged positions: no air to either the transmission or clutch. When the Master Disconnect is re-enabled, the air can be manually bled from the system using the manual bleed valve on the transmission and the bleeding sequence for the clutch should be initiated to bleed all air (Ignition Switch on, NEUTRAL selector switch, press steering wheel PB).

Historical Data

There are 3 separate systems maintaining and producing historical data during a pass:

1) The PLC generates real-time data during a pass that is read by the Red Lion Data Station.
2) The Red Lion Data Station reads the PLC real-time data and reads the real time exhaust temperatures from each of the eight cylinders. The real time data is stored once per second in Compact Flash memory on the Data Station. This data is available for download after the end of a pass.
3) The MSD 7531 gathers real-time ignition data during each pass: the number of times each cylinder fires, the RPM throughout the run, and the exact time the clutch/transmission shift.

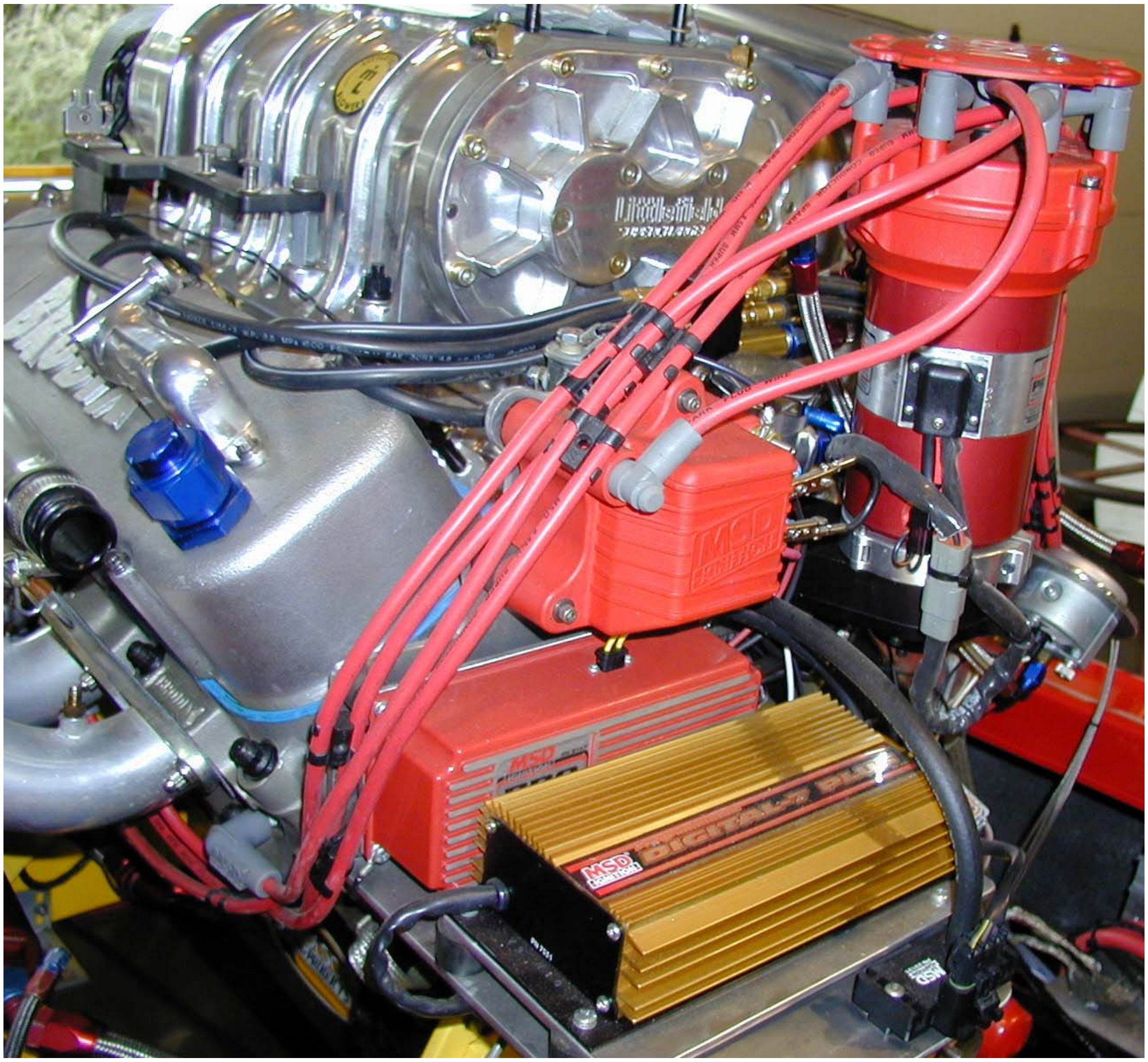
The pit crew is responsible for resetting the history before each new pass. ***With the Ignition Switch on, the motor not running, and the FWD/NEUTRAL/RACE selector switch in NEUTRAL, the steering wheel PB must be pressed three times within a second AND the selector switch must be set to RACE.*** If all the preceding occurs, the prior RPM history will be erased from the MSD 7531 so the data from the next pass can be obtained. ***The dash light will illuminate for a second to indicate the above sequence was successfully accomplished.***

At the Holding Rope Waiting to Drive to the Start of the Track

This is what it looks like on race day. These are all 8.0 second boats waiting to fire up and travel down to the starting line. That's the All Fired Up boat second from the end.

Note there are basically two kinds of Drag Boat hull designs: a hydroplane (closest boat) and a flatbottom (second boat). Flats (flatbottoms) launch faster at the beginning of the track but slow down a bit at the top end of the track as they suck down onto the water. Conversely, hydroplanes launch slower than flats but tend to ride on top of the water as the race progresses so they get higher MPH readings at the top end of the track. The All Fired Up boat is a hydroplane: the Kurtis 501 hull design tends to launch flat, stay stable, and provides a consistent experience for the driver.

This is a somewhat dangerous situation as each driver leaves the holding ramp from the launch ramp. Each driver leaves one-by-one on the honor system: they nod at each other to agree who goes next. The danger here comes from the holding rope: notice the driver in the foreground (hey Pete!) grabbing on to the holding rope. Pete (boat 202) would be the first to leave in this situation: he would nod to the 010 flatbottom (Gary) on his right that he is ready to go. The driver of flatbottom boat 010 would then grab the rope and reach as high as possible to raise the rope in the air so the rope will clear the engine of boat 202 as it drives past the rope. Notice the front of each engine has a rope deflector tube to encourage the rope to slide over the top of the engine. But sometimes mixups occur and people forget to raise the rope or the rope unexplainably gets caught somewhere on the engine in spite of the boat's rope deflector. And that can get ugly because the leaving boat starts towing the start line rope with him until it snaps back with a potentially huge amount of force.



The 44 AMP MSD Magneto Ignition System

Note the 'roach clips' (alligator clips) across the ignition coil. With a magneto, spark is potentially generated any time the motor is rotated. So as a safety precaution and in spite of all the careful design to ensure spark cannot be generated accidentally, we put a shorting strap across the coil whenever we work on the motor in the pits. That shorting strap is only removed once we all agree we're ready to start the motor.

The running engine is extremely loud. There are no mufflers and this is a huge engine: 555 cu.in. We make a habit of warning any passerby that we are about to start the engine and we all wear substantial ear protection when the engine is running.

The reason we use such a massive magneto is due to the nature of methanol. It takes approximately twice the volume of methanol to achieve the same energy as gasoline: there is simply a lot of fuel to ignite when you run methanol and that requires significantly more spark energy than gasoline. Its imperative that the fuel fully burn during each cycle: if the fuel is left in its liquid state inside the cylinder, the cylinder will 'hydraulic': liquid cannot expand like gas so when the piston comes up to compress the gas and finds a liquid instead of a gas, the compressed liquid will find an escape path by simply breaking the weakest link in its path (maybe the cylinder wall, maybe the head gasket, who knows). So the 44 Amp magneto is 'cheap' insurance to avoid engine damage in the case of a misfire.

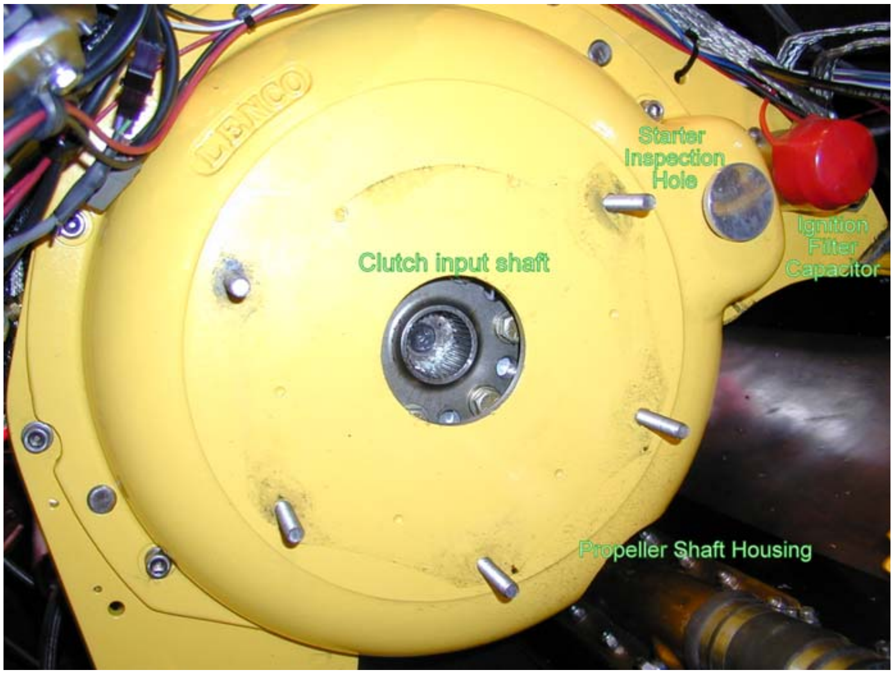
The MSD Digital 7 Ignition Controller is basically just a history-gathering device: it keeps a history of the engine RPM for the full pass so we can analyze engine behavior when we get back in the pits. It's a great way to begin to understand 'prop burn': the 'slipping' of the prop as it tries to grab the water at the beginning of the pass.

The ignition system includes a 'chip' to limit the maximum RPM of the motor. If the motor exceeds a preset RPM, the ignition system randomly drops cylinders (doesn't provide spark when its turn occurs) to limit the RPM. For a methanol motor it can be dicey to drop spark intentionally, but the alternative is an over-rev'ed motor and the potential of a basket full of garbage engine parts.

Note the 6-71 Littlefield supercharger (blower). This is considered to be a small blower for an engine that makes this many horsepower: at least that's what many engine builders will say. But that is the advantage of building this motor with the aid of a dynamometer: my original 8-71 blower simply produces too much boost to reliably tune the engine. This blower was tuned to this engine to make around 930 HP on each pass: a bigger blower would insist on making more HP and, strangely, that is one of the most difficult problems to solve. If you have a motor that naturally wants to put out more HP than you need for your timed class, its almost impossible to get that motor to run consistent from one pass to the next. As you spin a blower down to reduce its boost, its air distribution characteristics change radically: the distribution of air to each cylinder no longer stays equal. And then you have some cylinders doing considerably less work than other cylinders. But if you build a motor that puts out exactly the right amount of HP for your class, you can easily make small changes to the motor to compensate for varying weather and track conditions, but without changing the equal fuel and air distribution you've worked so hard to achieve.

Coupler from Output of Transmission to V-Drive

This photo shows how the output of the transmission couples to the V-Drive. The transmission essentially connects directly to the V-Drive with no shaft. Hence the motor's mounting angle must align perfectly to the V-Drive.

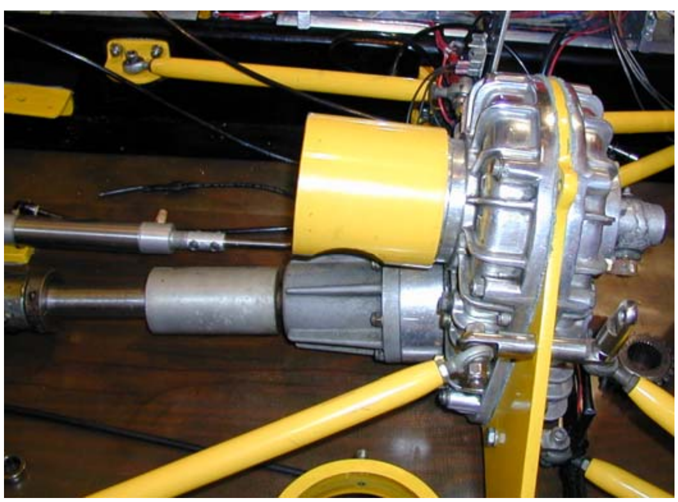


The Bell Housing Where it Connects to the Lenco Clutch

Note the input spline for the clutch has a thrust washer to prevent the clutch input shaft from moving in the spline. Lenco requires a specific tolerance to ensure the clutch shaft rides properly in the spline.

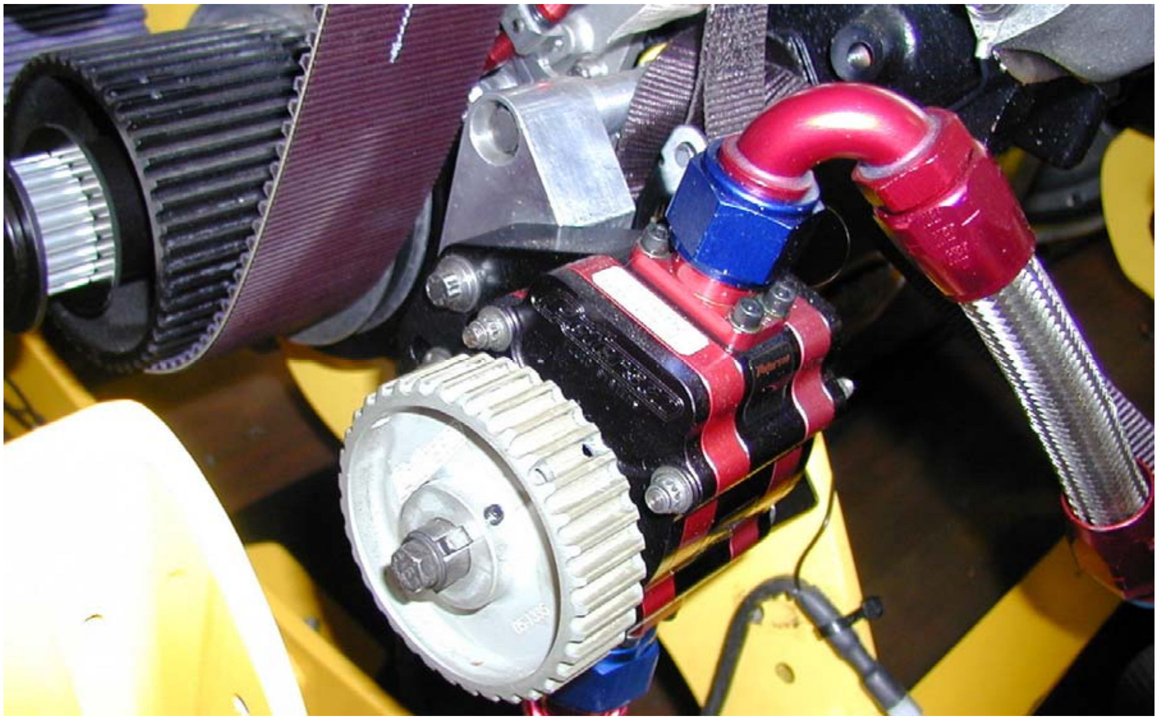
Also note the inspection plug for the starter gear. This plug allows you to properly measure the exact tolerance with which the starter gear meshes with the ring gear. This is a very important measurement to ensure the long term life of those pesky starters.

Also note the large filter capacitor for the electrical system. This is recommended by MSD to ensure the ignition system does not see any significant voltage drop when the magneto is first generating spark.



The Industry Standard Casale V-Drive

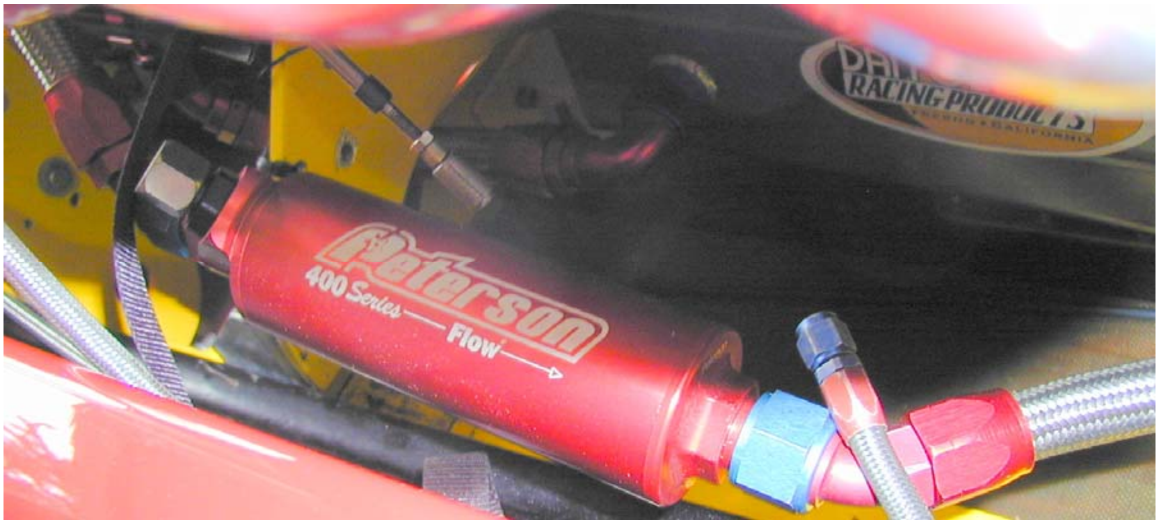
The engine in a drag boat is backwards: the normal front of the engine is at the stern of the boat and the output of the motor points toward the bow. The V-Drive takes the motor output and, in a V shape, sends the drive power back toward the stern through the propeller shaft (note the prop shaft at the lowest part of the V-Drive).



The Wet Sump External Oil Pump

On most engines, the oil pump is located inside the oil pan at the lowest part of the motor. However, in our case, I wanted to be able to circulate full oil pressure throughout the motor without running the motor. So I opted to install this belt drive wet sump oil pump. With the Gilmer belt removed (as shown here), we can attach an electric drill to the inout shaft of this oil pump to circulate oil. Not shown are the multiple oil heater coils, one in the engine block, and one on each side of the oil pan.

When the motor is in the pits, we preheat the oil using the oil heater coils attached to portable generators. Once the oil has reached temperature, we circulate the oil throughout the engine multiple times. This assures that when we finally start the engine, everything is fully warmed up and pre-lubricated. This is simply too radical a motor to start up cold and take the chance of chewing up cold bearings.

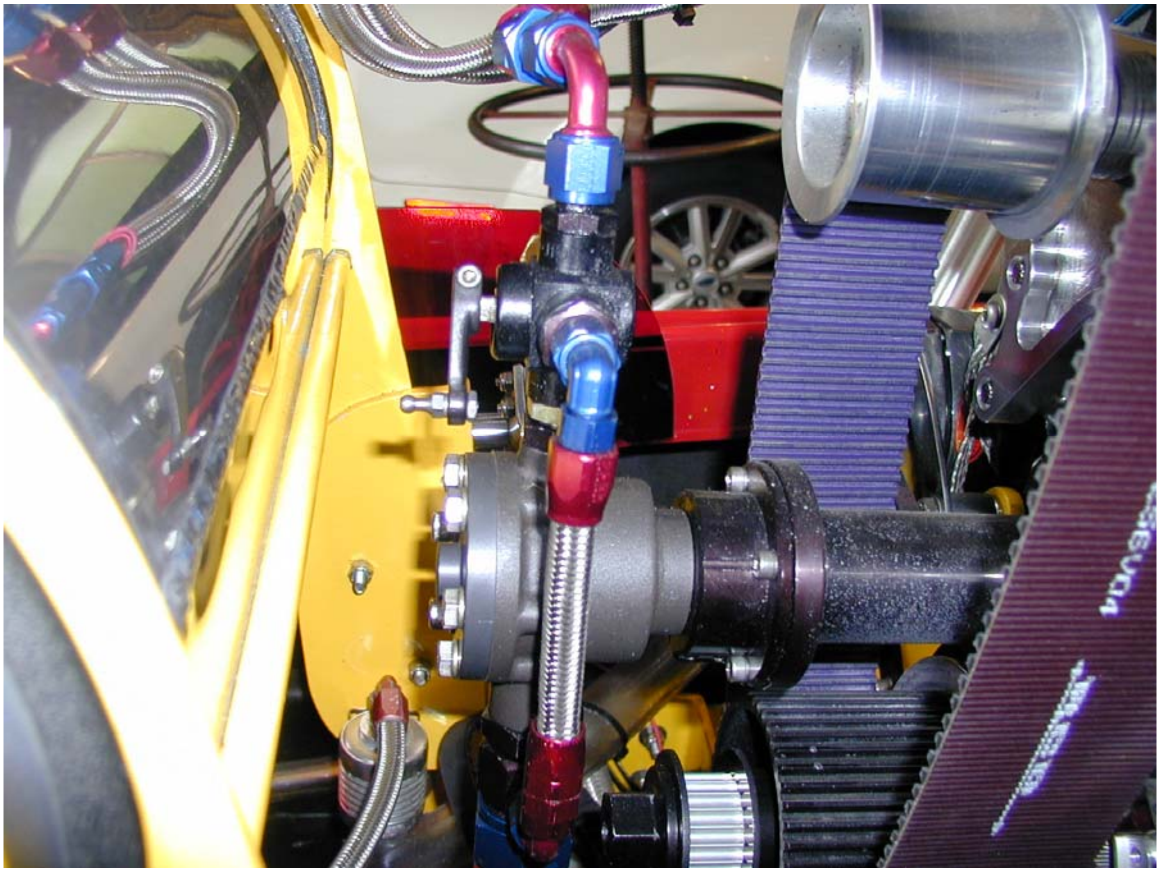


Inline Oil Filter

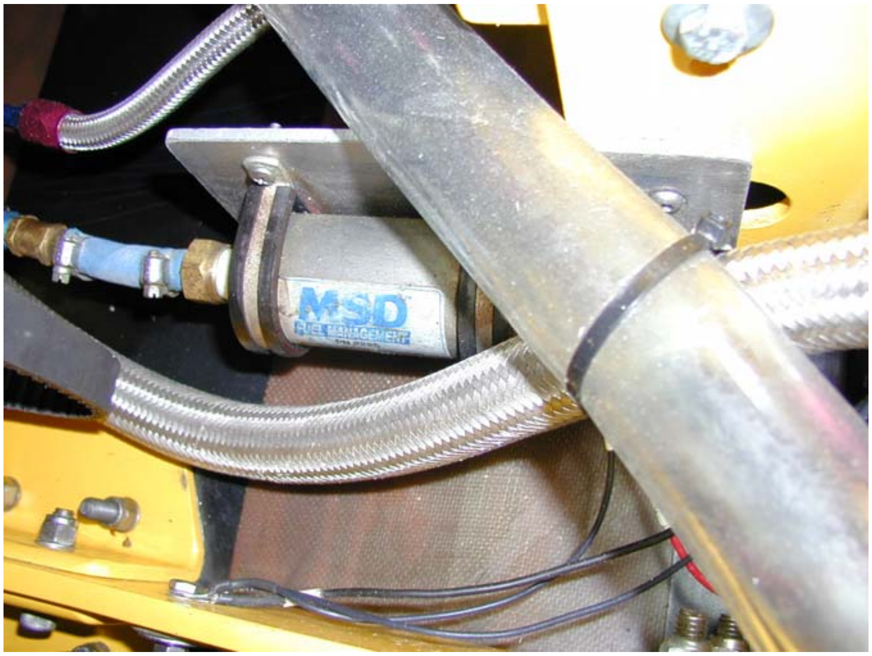
The Inline Oil Filter ensures maximum flow but still offers a very fine mesh filter to filter out very small particulates.

Meziere Racing Starter

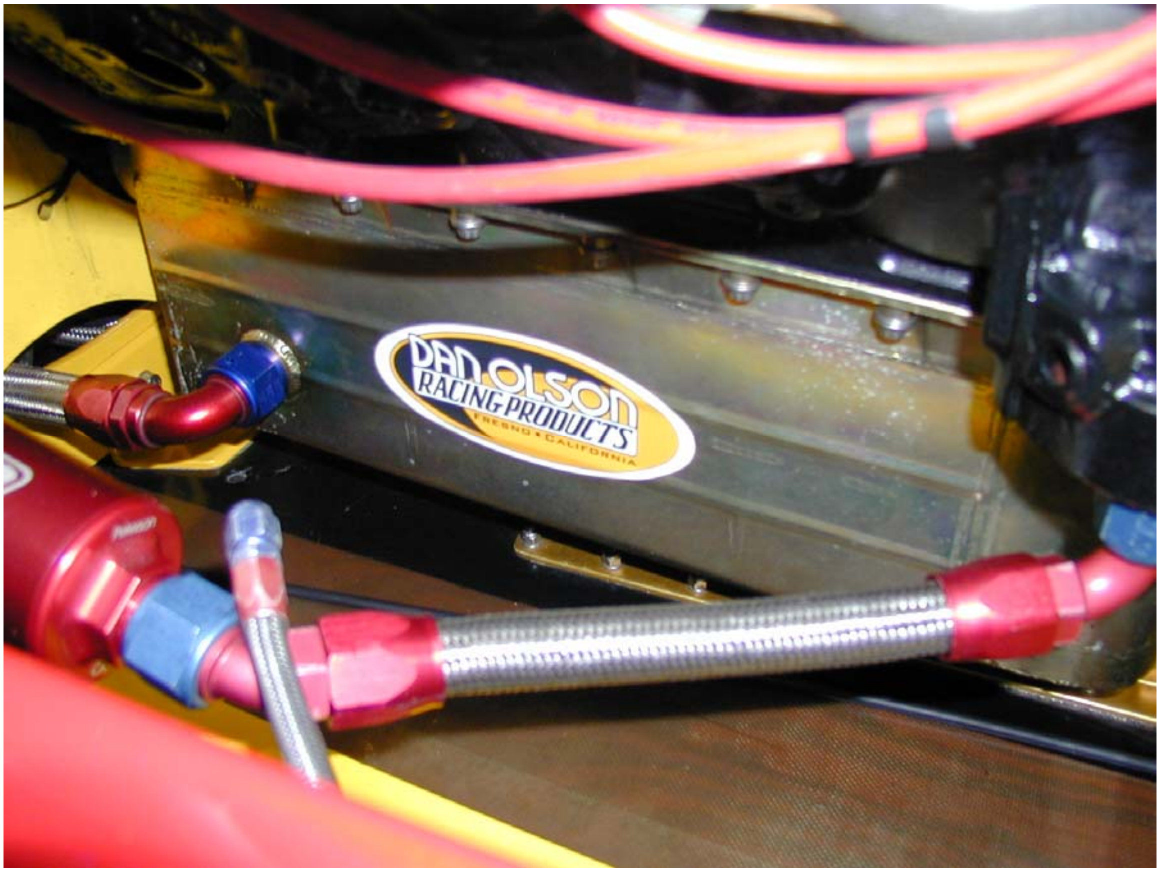
We apply 18V to the starter motor (12 V to the solenoid coils, 18V to the contacts) to turn over the methanol 555 cu.in engine fast enough to get consistent light-offs.



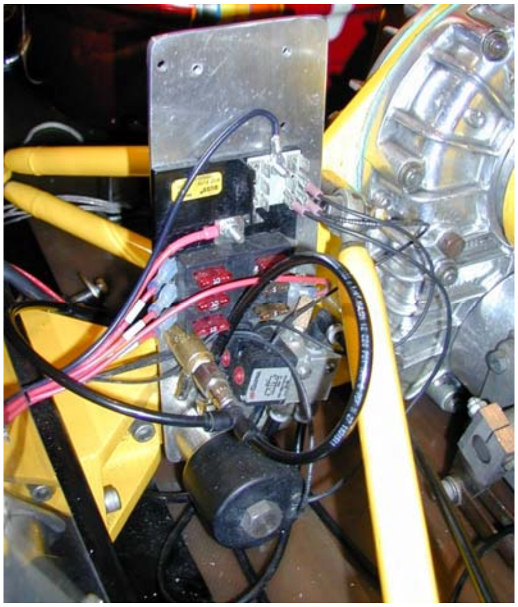
The 110 GPH Camshaft Driven Enderle Fuel Pump and Fuel Shutoff Valve



The Priming Fuel Pump (Fuel Injection Style High Pressure Pump)



The 13 Qt Oil Pan and Wet Sump Input/Output Hose Connections



The Air Valves for the Clutch, Transmission, and Clutch Purge

Note the lower large air valve rated to handle the 250 PSI CO2 required to shift the transmission.

The 6V Battery (Aft) and the 12V Battery (Foreward) Located in Port Sponson

Running an 18V starter system has worked out great. The only thing that gets 18V is the starter. Everything else runs on 12V.

The trick in making an 18V starter work was figuring out how to wire it so it worked reliably. It turned out to be real simple. I guess I should document it someday ☺.

The + (positive) terminal of the 6V battery is connected directly to the starter power contact. The – (negative) terminal of the 6V battery is connected to one of the two large terminals of a Ford style fender mount starter solenoid: this same terminal is also connected to the starter's coil connection. The + (positive) side of the 12V battery is connected to the other of the two large terminals of the Ford style fender mount starter solenoid. The – (negative) side of the 12V battery is connected to chassis ground. The starter button is connected to the coil connection of the Ford style fender mount starter solenoid.

So when the starter button is pressed, the Ford style fender mount solenoid gets energized by the starter button. That in turn closes the Ford solenoid's contacts which sends 12 V to the starter coil while simultaneously sending 18V to the starter contacts.
Basically, the Ford solenoid just simply shorts the + terminal of the 12 V battery to the – terminal of the 6V battery so the starter sees 18V. And even though the + terminal of the 6V battery is directly connected to the starter all the time, its remarkably safe because the negative terminal of the 6V battery is floating until the Ford solenoid closes: so there's no voltage at the starter contacts until the Ford solenoid closes. Clever, huh?