Listeroid Generator Support Chassis Project

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General notes:

This document was originally written for a fabrication engineer (Mike Brown) who had designed and constructed an engine mount for a Lister 2/25 engine and generator head with starter and cooling system. I had seen the engine and mount, and had contacted him to create a similar (but significantly extended) platform for my own 2/12 generator project. However, he had been winding down his post-retirement work, and has finally stopped taking new projects.

I include the pictures of the previous chassis/frame that was created by Mike Brown. The general concept of the system is very similar, but with extensions for much greater fuel storage, a different cooling system, extended control electrics, physical shielding/rainproofing, and "trailerization", among other updates.

All of my comments and requirements below are subject to alteration at your discretion and my comments/approval. I am not dead-set on most things, and if there is an obviously better way to do it, I'm more than interested in hearing what the method is. However, any changes would require my approval and discussion before implementation.

I have put quite a bit of thought into the various components of the system, but I have certainly missed quite a few important and obvious points. Let me know what I've not commented on.

Some of the requirements described here are self-evident, and I hope you're not insulted with the more blatant descriptions of things that you may be quite familiar with doing. However, it helps my thought process to visualize every aspect of the system and put it on paper as much as I can so that I don't miss points which are obvious to me, but might not be obvious to the reader. If I catalog everything, then it is at the reader's discretion to ignore components or comments rather than guess at what I've simply opted to not include.

The goal of the system is to be (not necessarily in order):

- simple. A reasonably mechanically inclined person should be able to configure, start, and repair the system without significant special knowledge or tools.
- semi-portable (moved once every two years or so, in conditions that may involve trailering, truck shipment, ISO container shipment, etc. in environments that I do not control nor moved by people who are particularly concerned about damage)
- fairly (but not entirely) foolproof to start and understand with a basic manual
- startable by someone who does not have any mechanical abilities (can read instructions, can press buttons, can flip switches but that's about it.)
- built to last for 40+ years with no major overhauls (other than normal engine/generator maintenance)

- safe, or at least reasonably safe from inadvertent injury possibilities
- flexible as far as environment (temperature) and fuel types (petrodiesel, biodiesel, SVO, WVO)
- managed by a single person (setup, maintenance, transport readiness)
- environmentally friendly (leakage-safe, vibration resistant, rattle-proof)
- moderately secure (prevention of trivial maliciousness)
- failsafe. If one or more components fail in the control system, it should be possible for the technical expert to easily circumvent failed subsystems and obtain power.

My goals are not:

- driven by cheapness – quality thoughts, quality parts, and quality work are the only things that last decades – everything else gets thrown out.
- driven by ego – if you have another way to do it, let's hear it! I might still want to do it my way, but I'm always interested in hearing an alternate view from someone who has more or different experiences than myself.
- driven *exclusively* by simplicity. While I chose this engine and generator design for it's simplicity, I also enjoy some amount of automation to prevent damage, reduce my effort, and increase my ability to measure/manage what is happening with the system.

I expect I'll be using this system at my home for a while as a backup power source and to get familiar with the engine, and then I'll pack it up and it will become the primary power source for my future home, as I build it in the next few years. That means I'll be running everything from power saws to water pumps to refrigerators on the system, and I can't even predict what else. After the house is finished, I'll build a generator shed out back in which the system will live for quite a few decades. It will be cold in that hut, so insulation is going to be needed for the tanks. However, there will almost certainly be occasions when it is packed up and moved for various emergencies (earthquakes, etc.) or to loan to a friend who needs temporary power in some remote spot while they build THEIR house off-grid. Therefore, support of a wide range of environmental circumstances need to be designed into the elements of the system.

I expect to be running straight vegetable oil in the fuel system at some point, which is why I have a "start" and "primary" tank arrangement. The start tank will have petrodiesel, and the primary tank(s) will have SVO or a blend. Therefore, special heating of the SVO tanks is required for winter operation. I'd like to be able to use this system down to around 10 degrees F without too much time spent with a blowtorch warming things up before starting. Electrical warming of the fuel directly before injection is critical, but so too is the pre-warming of the fuel tanks with waste heat from the engine itself. Even under normal circumstances, vegetable oil fuel needs to be at approximately 185F to prevent coking.

Equipment and component sourcing: I don't care where the pieces come from. eBay, McMaster Carr, MSC, auto parts stores, hardware stores, basements, etc. – doesn't matter to me. While I'm obviously spending quite a bit on these elements, I'm also very interested in finding equipment as surplus, used, or via other methods that involve spending less than "new", especially when the delta in cost is often an order of magnitude between new and used. I'm a big fan of eBay, and I'll be happy to order things and have them shipped right to you if there is something you think matches a requirement that you can find. I can often find things in less time on eBay than I can through normal industrial catalogs or parts sources because sellers typically try to describe things in easily-searchable terms instead of dry technical number lists or marketing-speak which so often slow down normal catalog digging.

I've already bought some components, most obviously the 12/2 (12 horse/2 cyl) Powersolutions Lister-style CS engine and an ST-10 generator head. I've also got casters, wheels and half-axles, an electrically-operated fuel valve, a tachometer with low/high output triggers, and some 12vdc relays already purchased and sitting around here in a box, mostly from previous projects. Everything else is yet unpurchased, and undecided. If you are familiar with McMaster Carr, I've put in a bunch of keywords for their products in the endnotes below as I've fished through my 2003-vintage catalog. Their website will probably give a new and corrected price and model number, but the name of the item is a pretty good start. I don't necessarily have my heart set on McMaster Carr as the source for items (as I said, I prefer eBay) but I find it's a single source for a large array of fairly difficult-to-get and high-quality parts for projects like this when other sources turn up dry. I can order things via McMaster Carr and have them shipped directly to you, so that is a possible solution for sourcing some of the "new" items that will be required, but you'll probably need to create the final ordering slip if you choose to use them as a source since for the most part I'm just offering suggestions and you're the one that has to put them together.

Steel is steel, and I'm happy with used or discarded steel as long as there is no rust pitting. The whole assembly will have to be media- or sand-blasted before powdercoating, so surface rust or paint does not worry me. Steel is expensive, so whatever method that can be used to get it at a lower cost is fine with me.

This specification covers:

- general steel fabrication
- fuel system piping
- exhaust system bending/tubing
- sheet metal bending/framing/punching
- prepping for powder coat
- general supply acquisition/sourcing to spec
- electrical system design and implementation

If you feel comfortable with the electrical system portion of the spec, that would be optimal, but if you are not interested in developing the electrical parts of the platform that is acceptable but you must make clear what sections below you would not be able to complete.

I do not need anything more than a rough diagram of how you'd consider this going together. I don't need a CAD drawing of all components and layouts, but if that's what you prefer to do and you consider it required to make a bid, then that's fine with me. I will be involved during the construction fairly often since I like to see how work is progressing, so I suspect that major problems will not go un-noticed, therefore a full pre-build diagram is not a requirement (though you may want to do it anyway.)

So, enough rambling, let's get to specifications. I'm pretty much looking for a rig very similar to that which is included in pictures below, which was for the Independence Junction building in Independence, Oregon (and can actually be seen at the site near in downtown Independence.) There are quite a few more details on my plan that I'd like to integrate, which will be obvious from reading the document. Additionally, the raw materials (gauges, electrical components, raw steel) will add to the price. I'd like to end up with a bid price on the labor for the time. Everything else is materials, and since I will be possibly be involved purchasing things I'm not so worried about the

System and Assembly Specifications:

1. Surface Integrity
   1.1. All bar-stock or tube stock should have welded ends so that it is impossible for water to gain access to internal surfaces and cause corrosion.
   1.2. No water/oil pooling areas. All trough-like areas should either have drain holes or should be avoided where possible (noted on pictures: the battery tray looks like a prime candidate for pooling, and should be examined for this type of pooling problem.) Locations like 90 degree joints which may experience small areas of standing water if wetted and should be treated with cavity filler (auto body type) after painting/powder coating in enough depth to prevent water from accumulating, then re-painted.
   1.3. Any holes drilled in tube steel will be threaded and matched with a bolt to prevent water seepage – no "thru-holes" in tube stock (though "thru-holes" may be used in non-tube steel sections.)
   1.4. Unused or accidental holes sealed with weld and ground smooth.

2. Paint/Coating/Signage
   2.1. The chassis and all steel components should be powder-coated in a diesel-resistant layer of powder coating. Wheels, axles, and other components which contain rubber or other powder-coat-process unfriendly materials may simply be painted with olive drab paint.
   2.2. The chassis and all paint-able/powder-coatable components should be olive drab, matte finish if possible
   2.3. All general printing or stenciling should be done in sans-serif font, at least 1" in height, in black lettering
   2.4. All labelling of switches, gauges, etc. should be done with black plastic signage with white etched lettering. Font should be sans-serif. Font size should be ½" high at a minimum.

3. Hardware/Wiring
   3.1. Hardware

3.1.1. All hardware should be stainless steel, grade 3, nylock where possible (allen head fastners exempted from nylock requirement)
3.1.2. SAE or Metric is fine, but there should be no mixing of types anywhere on the chassis. (engine and gen head are separately considered)
3.1.3. No Phillips-head or flat-head screws. All instances where screws might be used should be replaced by Allen-head bolts (except cable tie mounting points, see below)
3.1.4. Fasteners should not be painted or powdercoated, as they are stainless.
3.1.5. Locktite or similar material should be used where appropriate and where nylock fastners are impossible (i.e.: bolts into threaded steel plate.)

4. Metalwork

4.1.1. All steel components should be cut with either a bandsaw, plasma cutter, or water jet. No torch-cutting of components ends that are visible.
4.1.2. All ends and angles of plate steel (where not welded to another plate or component) should have at least a 1/2" radius curvature corners.
4.1.3. All steel edges should be de-burred and smoothed with a light grinding wheel for the purposes of increased handling comfort as well as adhesion of powder coating.
4.1.4. All welds should be ground or cup-brushed free of spatter and should have no pockets or bubbles.

5. Wiring

5.1.1. All wiring should be heat-resistant and diesel-resistant
5.1.2. Wiring should be loomed where more than 2 wires are run in a cluster[i]
5.1.3. All zip ties used for wiring holddown should be UV-resistant and diesel-resistant[ii]
5.1.4. All wires should be of good grade (not typical NAPA automotive grade)
5.1.5. All wiring should be routed onto equipment chassis and held in place with cable ties every 8 inches.
5.1.5.1. Cable ties should not be mounted directly on frame rails or other components, but should be mounted to cable tie mounting points.[iii]
5.1.5.2. Cable tie mounting points should be fastened in place with stainless hardware, via threaded holes in chassis. (note: flat or Phillips screws acceptable on cable tie mounts, but still needs to be stainless)
5.1.5.3. All wiring should be run in a way that prevents accidental tangling or exposure. Running cables along the inside edge or bottoms of components is ideal to prevent crushing or entanglement.
5.1.6. All major wiring component sections should have weather-proof automotive-type quick-disconnects to allow rapid disconnection of subsystems without cutting wires.
5.1.7. All wires should be crimped and soldered where a crimp-type connection is required.
5.1.8. All wire junctions (if any) should be soldered and sealed with weatherproof and diesel-proof shrink-wrap tubing.

6. Charging/Battery system
   6.1. The 12 volt system should be charged by an automotive-style alternator, connected to the flywheel opposite the main generator load via a serpentine-style belt.
   6.2. The alternator should be sourced to provide enough power for the “always on” components of the system plus additional charging, lighting, and auxiliary loads simultaneously.
   6.3. The battery should be a deep-cycle 12 volt battery (marine?)
   6.4. Battery should be protected with a plastic enclosure to prevent shorting, damage, and spillage[iv]
   6.5. The alternator should be mounted on the same sub-assembly as the generator and engine, to make minor vibrations not have any effect on belt tension.
   6.6. The alternator should have the ability to be tensioned with a typical automotive-style tensioning method (lever-and-tighten-the-bolt method) or via a bolt which increases angle and therefore tension as it is tightened.

7. Starting system
   7.1. The handle mechanism for starting should still function easily (with shield(s) removed)
   7.2. The electric starter configuration should use GM parts (preferably, from the small block family of motors) The starter engine system may be already purchased from someone who makes kits to do this – more information available mid-May.
   7.3. To start the system, the operator should:
      7.3.1. Turn the main power keyswitch to "ON" (the main power light turns green)
      7.3.2. Allow the fuel heating system to heat the start tank and fuel line (if temperature requires it) – this is an operator-timed interval, and not measured or gauged.
      7.3.3. Ensure the system is not spinning (optional: if the RPM sensor detects motion, there should be a relay engaged which prevents the starter button from causing any action)
      7.3.4. Press and hold the "start" button
      7.3.5. The fuel lever solenoids activate and set fuel levers to "run" position (default springs take fuel levers or valves to "stop" position with no power, as a failsafe)
      7.3.6. The decompression solenoids activate, opening decompression valves. (This may be unnecessary depending on starter methodology, as some starters will turn engine without decompression levers engaged.)
      7.3.7. A timer circuit is energized, with an X second delay, allowing (if applicable) decompression valves to be activated.
      7.3.8. The starter relay solenoid is energized after delay, starter engages, engine begins to spin
      7.3.9. Operator waits until flywheels are "at speed"
      7.3.10. Operator releases the start button
      7.3.11. The decompression solenoids return to "default" closed position.
      7.3.12. Engine starts
      7.3.13. If the engine fails to start, the operator waits until spin-down, and tries again.

7.3.14. Engine starts to spin up to operating speed over X seconds
7.3.15. UVPS engages (see below for UVPS engaging process)

8. Fuel System

8.1. 5 gallon starting tank fuel system (size is approximate- less than 5 gallons would probably be OK)

8.1.1. Starting fuel tank should have 12v pre-heater to liquefy fuel in extreme cold. Heater should be placed on or as near the output drain as possible to allow for faster warming start times.[v]

8.1.2. Starter tank should be close to the engine, but would optimally not be mounted on the engine itself but instead be mounted on the frame of the chassis. If this is unworkable, engine mounting would work.

8.1.3. Starter tank should have valve on the bottom of the tank where fuel exits to filter piping to facilitate removal of tank without fuel spillage

8.2. 110 gallon primary fuel system (you know, the more I think about the primary fuel tank, the less inclined I am to use 55-gallon drums and just ask you to make a steel 110 gallon tank that slides into another steel box with room for insulation that does this without retrofitting barrels)

8.2.1. 2 55 gallon steel drums, mounted opposite of cooling system, using gravity feed to engine

8.2.2. pre-heater loop in both drums via coolant circuit, run in parallel or series (see "cooling system" below) using B100-safe metal (copper?) in loops or other heat-dissipating configuration in center of drums.

8.2.3. Tank(s) should be easily remove-able when empty (quick-release valve couplers to prevent spillage and also to facilitate rapid teardown/setup)

8.2.4. Tank(s) should have a metal frame and sheet metal shielding enclosing them entirely. There should be minimally 8 inches of space on sides and top between outside of the drums/tank and sheet metal shielding. This is to allow installation of fiberglass batt insulation in cold environments. There should be a "tray" below the drums of at least 6 inches of depth to allow lower insulation to be installed. Configuration should prevent small amounts of spillage from soaking insulation on the bottom of the assembly.

8.2.5. There should exist a 6-inch deep tray below the secondary fuel tanks which will be sealed except for one outlet in a lower corner, which will have a valve and attachment nipple for a small plastic pipe. This is to allow accidental fuel spillage during fueling to leak into a controlled area below the tank(s), where it can be collected instead of merely overflowing onto the ground below. (this may not be required if a self-built tank is created. A lip around the top of the tank may be sufficient to capture any spillage around the top of the tank.)

8.2.6. Tank top(s) should be covered or filled in such a way as to prevent water accumulation in the event of direct rain exposure.

8.2.7. Tank(s) should be in a sub-chassis such that it can be quickly lowered to a mounting point in which the top is even or close to even with the main chassis frame top, and re-bolt or fasten it in place. This is for the purposes of transport, where having the tanks above the lines of the primary frame would introduce leverage, wind, or clearance problems. In this position, the tank(s) should not interfere with palette jack, forklift, or caster movement or usage, though palette jack transport may be more difficult (impossible?) with shorter jack forks due to center of gravity being too far from edge of liftable area.

8.2.8. To lift tank(s) into place, there should be a mount position on each corner of the sub-assembly for a 60" Hi-Lift jack to be used to lift set into mounting position (1, 2, or 4 jacks? With “capture” rails, may only need one jack, maybe two?)

8.2.8.1. Mounting positions for jacks should have some method of "locking" or ensuring no slippage of jack mount (even if minor jack head modification is required)

8.2.8.2. During lifting, assembly should be stabilized by "rails" or other vertical capture method such that no horizontal movement of either the generator set or tank system is required to bolt into place. Additionally, "rails" or capture method will prevent tipping of assembly during lift.

8.2.8.3. Mounting positions for jacks would optimally be on the “end” of the tank sub-assembly, to facilitate lifting in close quarters (there will almost always be room for the jack at the “end” of the unit, while the “sides” may be constricted.)

8.2.8.4. Entire radiator assembly should lift out of capture channels (or come off sideways?) for maintenance.

8.2.9. Any electrical wiring to primary fuel tank(s) for thermostat and/or gauge should use waterproof/fuelproof quick-release connectors

8.2.10. Any fuel connection should have quick disconnect connectors/valves located in such a way as to allow for removal of the tanks with minor fuel (half a gallon, or "slosh") to not leak out when tanks are disconnected

8.2.11. Quick disconnect fittings should have valves on both sides of the disconnect, so that the quick disconnect piping may also be used for draining the tanks in a controlled manner (note: a petcock or other valve arrangement would also work for this functionality, though it must have a)ability to have a plastic pipe connected, b)adequate size as to allow 55 gallons to be emptied in a reasonable time, c)be in a very guarded location to prevent accidental damage, and d)be easily accessible without disassembly of the insulation shielding, etc.)

8.2.12. Bottom of the bung on the output fuel line should be 1/2" from the bottom of the tank. Any sediment, water, or other inadvertent impurities will settle to the bottom of the tank, and should not be pulled into the engine. (Note: Sediments/water/etc drained through petcock valve installed on very bottom of tank.)

8.2.13. The top of the tank(s) should be remove-able via a clamping lid mechanism, allowing maintenance on the insides of the tanks on an infrequent basis. Bolts or clamps are acceptable, but must be fuel-tight when assembled. Semipermanent sealing methods are acceptable (PVC, etc.) to assist in liquid-tight installation.

8.2.14. Electronic fuel gauge which reads out percentage or gallons of fuel tank fill on console

8.2.15. Manual fuel gauge which is mounted in the top of the tank assembly[vi] (protected against shearing by a metal hood?)

8.3. Electrically operated fuel valve which changes from start tank to primary tank(s) which activates on fuel temperature reaching X degrees on outlet area of primary tank(s). Valve activation can be "start tank", "primary tank", or "automatic" according to a rotary switch on the console. "Automatic" setting should use thermostatic sensor to alternate between start tank and primary tank.[vii]

8.4. All fuel lines should be wrapped in Insultube or similar material for heat retention[viii]

8.5. All fuel should pass through a water removal system and fuel filter before the fuel pump

8.6. All fuel should pass through a “final” electrical heating pipe segment as close as possible to the injector pump for final pre-heat (if electrical heating system activated)

8.7. See “Fuel Pre-Heating System” in “Cooling System” section for liquid-based fuel pre-heat loops

8.8. All fuel lines should be made of heat-resistant tubing and/or braided line. Biodiesel-safe hoses should be used in all connections.

9. Cooling system

9.1. Primary cooling via cast iron house-style radiators, mounted in generally the same location as the two tanks were in Steve R's configuration. One, two or more radiators may be required.

9.2. Thermostatic valve configuration built in to allow for primary tank fuel pre-heating (FPH). Thermostatic liquid valves near should divert all coolant to FPH system if the coolant temperature is BELOW xxx degrees. As coolant temperature rises to above xxx degrees, main cooling system is utilized (but coolant should still run only through FPH system if that is adequate for cooling. In other words: as many calories as possible go into the FPH system until it is unable to cool the engine adequately, and then thermostats start leaking into the main cooling radiators as needed.) This system is NOT related to the electrically-operated (thermally regulated) valving system that determines the tank from which fuel will be used.

9.2.1. FPH system should have valve system that allows for manual deactivation of FPH cooling loop

9.3. Radiators should have a petcock valve at the bottommost portion of the assembly to allow draining. Valve should have the ability to have a press-on pipe installed to allow for controlled drainage. Valve should be in an area protected from damage during transit.

9.4. Cast-iron radiators should be mounted in a frame which can be lifted into operational position and bolted into place, but also can be moved to a "transport" position where the frame is bolted securely to the main chassis base. This should be similar in design to that which is used for the primary fuel tank configuration, such that the center of gravity of the cooling system is as close to the bottom of the entire chassis as is physically possible, given dimensions of the cooling assembly.

9.4.1. To lift radiators into place, there should be a mount position on each corner of the sub-assembly for a 60" Hi-Lift jack to be used to lift set into mounting position

9.4.2. Mounting positions for jacks should have some method of "locking" or ensuring no slippage of jack mount (even if minor jack head modification is required)

9.4.3. Lifting should be done with “guide rails" (aka: capture channels) or other vertical capture method such that no horizontal movement of either the generator set or cooling system is required to bolt into place. Additionally, "rails" or capture channel method will prevent tipping of assembly during lift. (Use of “capture” guide rails on generator side of assembly means perhaps only one jack is needed for lifting, instead of 2 or 4?)

9.4.4. Mounting positions for jacks would optimally be on the “end” of the tank sub-assembly, to facilitate lifting in close quarters (there will almost always be room for the jack at the “end” of the unit, while the “sides” may be constricted.)

9.4.5. Entire radiator assembly should lift out of capture channels (or come off sideways?) for maintenance.

9.4.6. Frame around cooling radiators should be a “box” so that during transport it is difficult to bump or ram the radiators themselves if the chassis shifts or other large items shift into the chassis. Obviously, shielding is not required on radiator sub-assembly.

10. Under-Voltage Protection Systems (UVPS)

The Problem: If the engine fails and slowly spins down the generator while under load, the generator will "de-magnetize", which is bad. Additionally, some loads that are on the generator will be damaged if they experience voltage drop to 0 over time. Having the generator immediately turn "off" in the case of voltage drop would be ideal so that both the loads and the generator will be disconnected during spin-down for whatever reason.
The solution I came up with (but would welcome suggestions on):

10.1. If the engine is operating above 648 RPM (via the RPM sensor) for X seconds (adjustable) the RPM sensor should engage the UVPS system.

10.2. A sensor on one leg of the generator detects when voltage drops below XXX volts (adjustable?)

10.2.1. A relay shuts down the engine in the event of a low-voltage situation

10.2.2. A relay that disconnects generator load in the event of a low-voltage situation (this relay can also function as a start-up delay trigger, so that during engine start there is no load on the generator)

10.3. A switch should exist that allows override of the UVPS for manual testing ("Auto", "Override")

10.4. A series of lights on the console that indicates status of UVPS ("UVPS Active - Low Voltage", "UVPS Active - Good", "UVPS - Override")

10.5. Other things to consider: the UVPS needs to be deactivated during engine spin-up, after starting. This could be accomplished with a delay-on-make relay of some type.

10.6. **** more thought required here.

11. **Chassis/base**

- 11.1. Dimensions (dimensions are maximums, not minimums)
  - 11.1.1. Height should be no higher than 7’ 8” assembled (not on casters or axles but with fuel/cooling sub-assemblies raised) and no higher than 5’ 8” in transport position (with axles installed and fuel/cooling assemblies lowered)
  - 11.1.2. Width should be no wider than 5’ 6” assembled (not on axles) and no wider than 6’ 6” including wheels and axles in transport condition
  - 11.1.3. Length should be no longer than 15’ 0” with both cooling and fuel sub-assemblies in place, and no longer than 18’ 0” with tow yoke installed
- 11.2. Chassis should have side access holes at least 2” high for forklift (i.e: forklift-able from all four sides)
- 11.3. Chassis should be standard palette-jack friendly from lengthwise dimension (not necessarily from width-wise dimension)
- 11.4. Main skids for chassis should have angled and enclosed ends (see images below) made of I-beam material. These angles allow for minor attack/takeoff angle issues when trailering.
- 11.5. Mobility
  - 11.5.1. Casters
    - 11.5.1.1. Casters should be mounted inside of bottom frame rails.
    - 11.5.1.2. Casters should be easily remove-able
    - 11.5.1.3. Caster mounts should not interfere with palette jack usage
    - 11.5.1.4. Casters should be 360 degree swivel
    - 11.5.1.5. Casters should have on-board stowage points in the chassis when removed
  - 11.5.2. Trailer Wheels
    - 11.5.2.1. Half-axles installed on both sides, near center of gravity (unloaded with coolant and fuel.)
    - 11.5.2.2. Half-axles should be easily remove-able for generator use (bolts are acceptable)
    - 11.5.2.3. Clearance with axles installed should be at least 10” under bottom-most part of chassis
  - 11.5.3. Ramps for trailer configuration
    - 11.5.3.1. Two ramps should be included which are capable of handling one trailer wheel each (est. 1700 pounds each wheel)
    - 11.5.3.2. Ramps should be at least 8' long and suitable for use on vertical lifts of up to 3' with appropriate push vehicle
    - 11.5.3.3. Ramps should have slight (1/2”?) lips on each side to "channel" the tires to prevent wheel drop-off during backing
    - 11.5.3.4. Ramps would optimally bolt under chassis during non-use, but that is optional if too difficult
    - 11.5.3.5. Ramp surfaces either diamond-plate, extruded grip walkplate, or grid mesh is acceptable for weight savings and grip improvement.
- 11.6. Both the generator head assembly and the engine should be removable with a standard "cherry-picker" engine shop crane. The implication of this is that the units should be able to be lifted several inches and moved out of the chassis horizontally instead of lifted several feet vertically to clear the upper frame rails.

This may mean that one or more sides of the upper frame rail is bolted (not welded) into place for horizontal access. (this may be solved already by the whole upper frame being remove-able? Not sure, but it still may make sense for one upper side rail to be removable to allow for easy engine work without too much leaning.)

11.7. Shielding

11.7.1. All sides of the main chassis system (including top and bottom) should include shielding plates which prevent access by anything larger than a 1/2" dowel during operation. Ideally, these plates would prevent no access at all. The control panel assembly will have it's own box and protection enclosure, which can be closed and locked and should be accessible without removing main shielding. The fuel system also has shielding for insulation purposes, and the cooling system will have no shielding for obvious reasons.

11.7.2. The top shield plate should have an angle that prevents water collection, and should create a drip environment that does not lead water towards internal components. While this is not intended to be a permanent environmental protection, it will be the case that in a "lean-to" or other primitive primary shelter there is significant water exposure to the main platform, and so drip-proofing the top is required.

11.7.3. The bottom shield plate should be at an angle or have construction that forces all drippings from the upper engine area to a single low point in one corner, which should have a nipple attachment for a plastic pipe drain to an external oil pan OR the shield should have a central low point and hole under which a simple oil pan can be placed to collect spillage or leakage during operation and maintenance. The bottom shield should be easily remove-able with all components in place (ramps may need be removed to access bottom shield, if that is where they are stored). The bottom shield need not lock in place.

11.7.4. The top and four side shields should have the ability to lock in place. Flush-mount locks are preferable with matched keys, though some type of hasp/padlock system might work (though is cosmetically less attractive.) The locks should not be part of the fastening system, so that it is possible to leave the shields in a "locked" or "unlocked" state while installed.

11.7.5. Top shielding may require two plate components to allow removal/installation around exhaust piping without disconnecting exhaust system.

11.8. Chassis should have in each corner a "receptor" for a Hi-Lift jack mechanism. This is to allow for easy lifting of the whole platform with four Hi-Lift jacks to install wheels for trailer wheel installation. These "receptors" should have the ability to "capture" the Hi-Lift jack, so that the jacks do not slip out during uneven raising situations (even if this requires modifying the Hi-Lifts with a drop-in ball-spring clevis pin assembly or something similar.)[ix] There need to be eight (8) total receptors – two for each corner. This is because it may be the case that jack levering is impossible due to side clearances from obstruction such as a wall.

11.9. There should be storage inside the shielding for four 60" Hi-Lift jacks, fully assembled or completely disassembled (doesn't matter)

11.10. Trailer Yoke

11.10.1. trailer yoke for 2" ball AND pintle hitch (switchable via any method including bolts, but no welding or cutting should be required to switch between types of mount)

11.10.2. Swivel-down, screw-type "foot" on yoke to allow off-vehicle balancing of trailer weight

11.10.3. Yoke should be easily remove-able via clevis pins (should not require bolts for yoke removal)

11.10.4. Yoke should collapse into bar or tube stock as much as possible (i.e.: not a big, welded triangle that is difficult to store somewhere. Bolts are fine for this teardown option.)

11.10.5. Yoke (and trailer wheels) should be configured to put less than 150 pounds on the ball/pintle in static configuration (empty of fuel/coolant)

11.10.6. Yoke should allow clearance for at least 75 degree turning angles before hitting a bumper (assuming bumper is parallel with chassis "axle" line and is 5 inches in front of the center of the ball - make sure this includes the fuel or cooling tanks in stowed position during design!)

11.10.7. Safety chains for weight capacity should be included on yoke assembly and should mount (clevis pins) to welded mount points on chassis, perhaps near or integral with other yoke mount points. Not sure what tow chain weight ratings should be, as an overage of weight of the trailer itself (2x? 5x?)

11.11. Vibration dampening

11.11.1. Engine and/or generator sub-assembly should be mounted on vibration-dampening mounts within chassis[x]

11.11.2. Chassis should have a least 1.5” of rubber vibration dampening/”walk-prevention” material[xi] on the bottom of the chassis skids. This can be “horse stall” rubber padding made of compressed shredded tires, or other material. Material should be bolted to the bottom of the skids (drill those holes before assembly or you’ll be unhappy.) Bolt heads should not touch the floor, and should be recessed or otherwise not touching the ground, as any contact would defeat the vibration-control capabilities of the padding. This may require counter-sinking a larger hole in the padding material around the bolt-head/washer.

11.11.3. Chassis must not have audible rattles during normal operation of engine/generator system. All components must bolt down or have “positive engaging” fastening systems that prevent rattles during engine vibration of main chassis. Notably, this includes the shielding, the fuel tank sub-assembly and cooling tank sub-assembly, and the motor/generator sub-assembly. No metallic “clanking”, rattles, or clicking noises should be evident at a distance of 15 feet or greater at full or partial engine load.

11.12. Toolboxes

11.12.1. There should exist two (or more) toolboxes for miscellaneous equipment, spares, and tools, inside shielding and with separate lock mechanisms. Toolboxes should be watertight and airtight, suitable for storage of paper media in high humidity. 7.62mmX1500rd, 4mmX32rd, 81mmX6rd, 20mmx50rd ammo cans would be possible options and are all acceptable, but must have airtight seal. Upright or lateral mounting is acceptable.

12. Exhaust system
   12.1. Similar to that which is shown in the pictures, except that the system should mount to either the left or the right side of the frame by bolting the exhaust support bracket on the different side (pipes should work in either left or right exit direction, so the support bracket should be a clamp to allow for sliding the pipes through. Flanges should be left/right symmetrical.)
   12.2. Flanges just above the shielding line on the engine frame (about 2? 3? feet outwards from the block) so that quick breakdown for transport is easier and/or an alternate system can be attached without significant re-work of any components attached to the engine inside the shielding. Flange interconnect point should be even with shielding.
   12.3. Stick with the dual-stack design - seems to be fine. Use mufflers as supplied with engine.
   12.4. Considering the vibration of the engine versus the stability of the exhaust mounting bracket, it may be necessary for a flexible coupler at some point to prevent stress and fracture of flanges or pipes.
   12.5. Bottom of vertical exhaust pipes should have a water trap (as shown in pictures) to prevent condensation from draining into engine. Trap should be filled with non-rusting material (epoxy?) to prevent rust-through problems.

13. Generator mounting
   13.1. Generator will have a serpentine belt pulley installed (supplied by me) which will then wrap around the flywheel. Generator assembly must have the ability to slide back and forth in relation to fixed engine mounting location up to 3” with adjustment screws (stainless) for proper belt tensioning.
   13.2. Generator must be installed on same vibration-dampened sub-frame as engine.
   13.3. Center of generator pulley must be aligned exactly with center of flywheel. It may be optimal to create notched bolt mounting holes for the generator to allow for small adjustments in lateral alignment before tightening bolts on engine mount.

14. Electrical sub-panel
   14.1. Panel should be accessible with shielding removed or in place
   14.2. Panel should be lockable (same keys as shielding)
   14.3. Panel should have (retractable? Foldable?) rain shield to prevent water from entering panel or plugs during normal light rain/dew conditions (maybe recess the whole panel in the chassis a bit?)
   14.4. Panel should have main breakers for three circuits:
      14.4.1. Leg 1 110V (? AMPS)
      14.4.2. Leg 2 110V (? AMPS)
      14.4.3. 220V (? AMPS)
      14.4.4. Breakers should be magnetic style, and not thermal household breakers[xii]

- 14.5. Primary output from generator (both legs) should be attached to a “main” switch, which is in turn connected to a solenoid to control power to main loads.
  - 14.5.1. Switch should be suitable for frequent use (not a limited-use “breaker” style switch which may become mechanically problematic due to small duty cycle rating.)
  - 14.5.2. Switch should be suitable for large load inrush
  - 14.5.3. Two switches are acceptable (one for each leg) if that is the configuration that makes the most sense
- 14.6. Output from breaker panel should be:
  - 14.6.1. Two hard-wired connection boxes, one for each leg (blank faceplate)
  - 14.6.2. Two four-outlet, 110v grounded plug boxes – one for each leg (8 outlets, total)
  - 14.6.3. One 220 volt NEMA twist-lock outlet (50 AMP?)

15. Lighting system

- 15.1. Console should have low-level lighting fixtures above all switches. Console lights may include backlights for gauges that support backlighting.
- 15.2. Lighting for console should be optionally activated (i.e. not always on, excepting illuminated switch)
- 15.3. there should be a switch on the main console that is illuminated (backlit) with main system power (just the switch is fine; don't need to illuminate the inscription, but I don't want to use a console light that is "always on" for this purpose)
  - 15.3.1. "off" is no lights
  - 15.3.2. "console" turns on the console lighting
    - 15.3.2.1. Console lighting can be individual lights over each functional area, or a white LED array that illuminates the whole (also illuminates console)
  - 15.3.3. "work" activates four small 12v worklights that are installed in the corners of the main chassis frame, illuminating the engine and generator. Specifically, the starter mechanism and mechanical actuators for decompression and fuel rack levers should be illuminated. (of course, this will only be useful with the shielding removed from the unit.) This is for "midnight repairs" without groping for a flashlight.

16. Console

Console can be fabricated custom, or could be a NEMA-style enclosure (see eBay for some examples) if pricing makes that more attractive.

- 16.1. Console should not be "above" main shielding, and should be below the upper frame rail line to prevent damage during transport.
- 16.2. Console should be water-resistant to prevent water entry during transport or during long exposure to outdoor storage
- 16.3. Console should be accessible with main shielding in place
- 16.4. Door to console should open flat or otherwise remain in "open" position without creating an obstruction to operator in close-quarters conditions (should swing open to be flush with chassis or otherwise be moved out of the way)
- 16.5. Door to console should lock with same key for rest of shielding

16.6. There should be a cigarette-lighter style plug (fused, 10A) on the console for auxiliary powered devices, or for trickle charging input

16.7. All wiring that feeds into the console should be through a bulkhead connection, allowing removal of entire front panel, relays, and control logic as a single unit.[xiii] Wiring can be “hard mounted” on console box, but all components should be easily removed for bench testing away from chassis. (This kind of implies all-electric gauges.) Main power to console may be excepted from single bulkhead connector, but should still be “quick-disconnect” style wiring connector.

17. Sensors and Console Meters

17.1. Fuel consumption meter (gph or similar) (if possible, but not required since possibly does not exist)
17.2. Oil temperature
17.3. Fuel temperature (primary tank, near outlet bung)
17.4. Fuel gauge (start tank)
17.5. Fuel gauge (primary tank(s))
17.6. Ambient temperature
17.7. Water temperature (engine output, one side or the other)
17.8. Engine RPM
17.9. Operational hour counter (Hobbs meter)
17.10. Generator Hertz
17.11. Leg 1 amp meter
17.12. Leg 1 volt meter
17.13. Leg 2 amp meter
17.14. Leg 2 volt meter
17.15. DC leg amp meter (excludes starter, of course)
17.16. DC volts

18. Control elements and unmanned switches

18.1. Starter motor solenoid
18.2. Shutdown (fuel rack) solenoid
18.3. Fuel tank selection valve switch (thermal, on primary tank)
18.4. Fuel tank selector valve solenoid
18.5. Breaker box solenoid
18.6. Engine RPM relay (see ‘starter system’ and ‘UVPS system’)
18.7. UVPS relay
18.8. Decompression solenoid

19. Switches

19.1. All switches and buttons should be weather-proof (outdoor or harsh condition rated)
19.2. Rotary switches should have work-glove[xiv]-friendly knobs
19.3. Fuel supply: “start tank”, “primary tank”, “auto”
19.4. Electric heater: “on”, “off”, “auto”
19.5. Starter: momentary pushbutton
19.6. Main power load: “on”, “off”, “auto” (controls breaker box solenoid)
19.7. Engine activation: "run" and "stop" (activates shutdown solenoid aka fuel rack lever)
19.8. Main power keyswitch: "on" and "off"
19.9. UVPS: "override" and "auto"
19.10. Lights: “off”, “panel”, “work” (illuminated switch)

20. Lights/Indicators

- 20.1. All lights should be weatherproof (outdoor or harsh condition rated)
- 20.2. Generator Output
  - 20.2.1. Online (current status of main panel load switch (auto or manual) is "on") green
  - 20.2.2. Offline (current status of main panel load switch (auto or manual) is "off") red
- 20.3. System Power
  - 20.3.1. On (key is in "on" position) green
- 20.4. Fuel Tank Selection
  - 20.4.1. Starter (current selection (auto or manual) is using "starter tank") green
  - 20.4.2. Main (current selection (auto or manual) is using "main tank") green
- 20.5. Electric Fuel Heaters
  - 20.5.1. On (current status of heaters (auto or manual) is energized) green
- 20.6. UVPS
  - 20.6.1. Good (at or above minimum voltage on tested leg, shutdown circuit open) green
  - 20.6.2. Low Voltage (below minimum voltage on tested leg, shutdown circuit closed) red
  - 20.6.3. Override (manual override selected, shutdown circuit open) yellow
- 20.7. Console lights (illumination)
- 20.8. Work lights (illumination)

21. Receipts

- 21.1. All receipts should be kept for any components purchased
- 21.2. All model numbers, stock numbers, or inventory information about every item in the system should be maintained and not thrown out (wrappers, boxes, etc.)
- 21.3. Types, weights, and sizes of all steel plate or bar stock and raw components should be estimated as closely as possible.

Notes to myself:

http://www.bndcom.com/rms/rms.htm

solenoids (door pull solenoids)

http://store.summitracing.com/default.asp?Ntt=door+pull+solenoid&x=0&y=0&searchinresults=false&Ntk=KeywordSearch&DDS=1&N=115&target=egnsearch.asp

dieseltherm electrics for fuel heater
http://www.diesel-therm.com/diesel-therm.htm
http://www.deltechnet.com (info@deltechnet.com)

rack puller options?
http://www.fwmurphy.com/products/engine_motor/rp75.htm
FW Murphy sensor/switch pricing:
Here are some prices from murcal.com

L100-	(Oil level guage and high/low switches)	$58.50
RP75-	Diesel rack puller (30 lbs pull)	$205.75
VS2-	Vibration Sensor	$102.25
TM4594	DC Hour meter, low current	$37.50

omniremote
http://www.surplussales.com/Omniremote/omniremote.html

lots of rotary switches, and I also like (KNB) A12 for switch knobs...
http://www.surplussales.com/Switches/Switches.html

current sensing relays, transducers
McMaster Carr, #108, p. 629 (eg: 6583K32)

Possible tachometer candidates:

Monarch ACT 3/12 with relays
http://omnicontrols.com/lists/MonarchTacho.html $495

Phares PE-5 http://www.phareselectronics.com/products/tach.htm at $425 (single alarm, 12vdc)

Dynalco MTH-103D tach with trip
http://www.govconsys.com/mth103d.htm

Dynalco SW-200B over/under speed relay system

Newport Q2000H with alarms (note: needs board for over/under)
http://www.newportus.com/Products/FreqRate/Q2_9000H.htm
Used!
http://www.plccenter.com/productdetail.aspx?PartNum=Q2000H&Manufacturer=NEWPORT

Bunch of ‘em: http://measurebetter.com/panel/dfrm.htm

Simpson Hawk HK40? 12vdc option with relays

Murphy SD35HL – perfect, no longer made, but worth follow-up

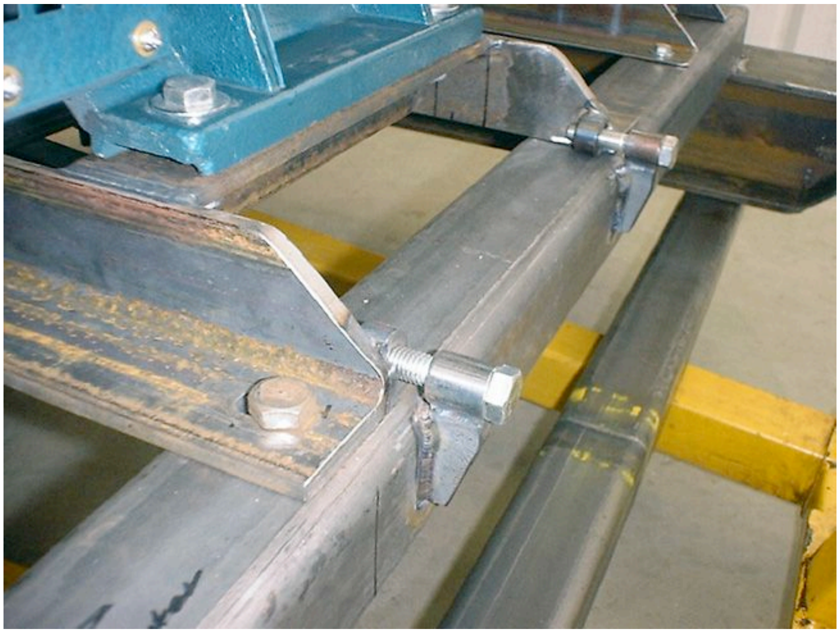
Abtek TR3 http://abtekcontrols.com/Principals/Abtek/motion2.htm

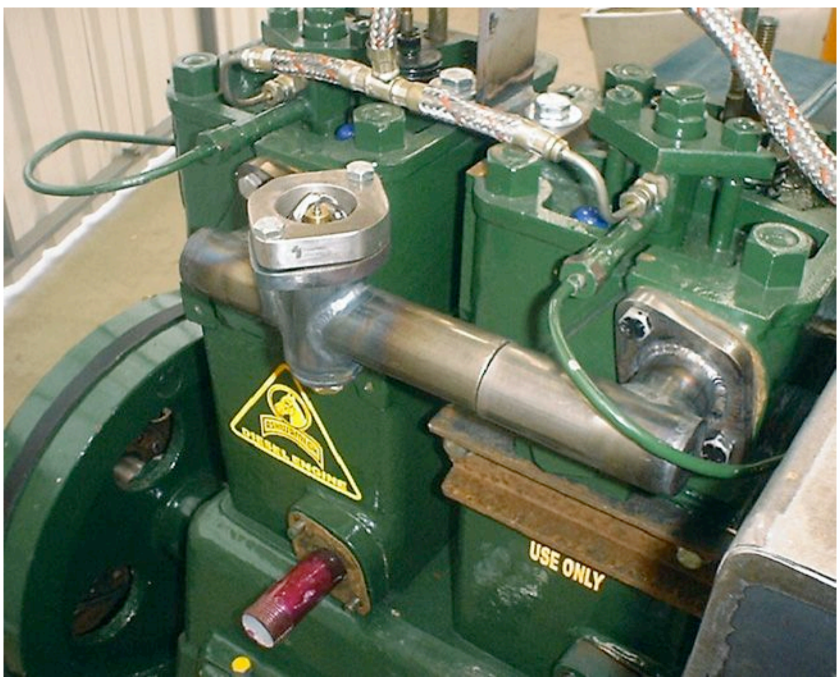
Timer relays, mechanical “delay on make”
McMaster Carr, p.802 “Single Function Timing Relays” 7268K12
Multifunction Timing Relays (plug or panel mount) 6964K2

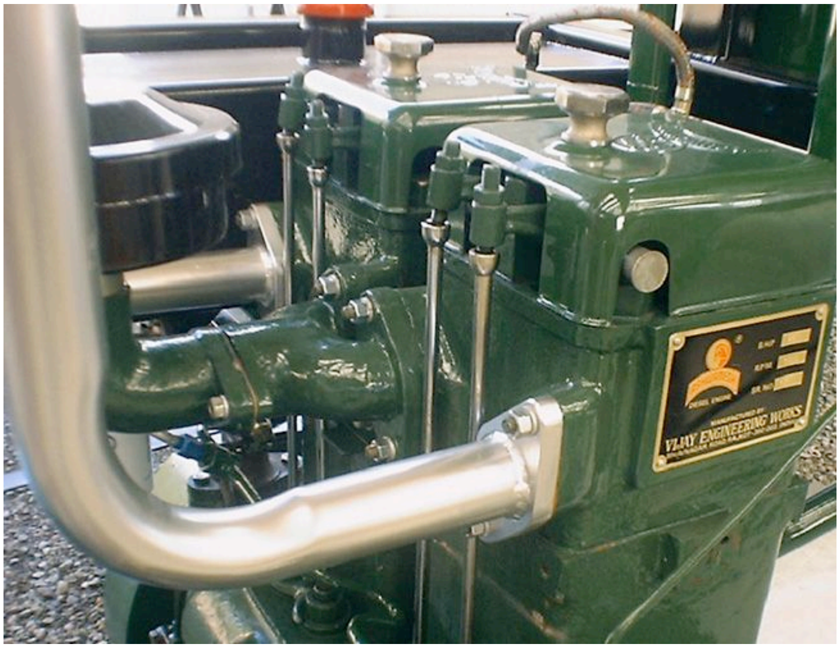
2006-04-04
what is the method for starting gear? Mike Monieth has a kit for building starting gear configurations.
http://www.listeroids.com/Parts.html
He also has serpentine pulleys.

2006-04-05
Interesting array of heaters, filters. Cheap!
http://www.fattywagons.com/fwproducts.htm

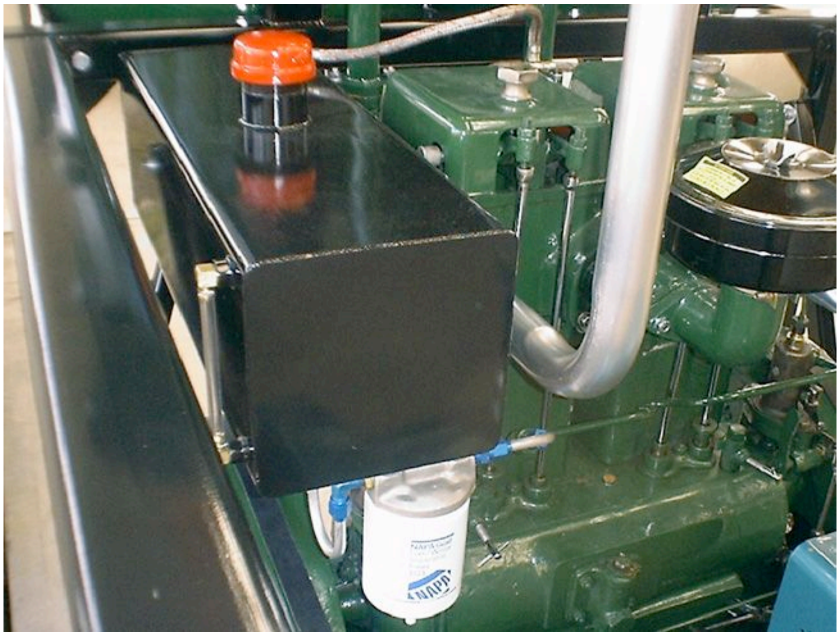
Included below are the pictures of the chassis that Mike Brown had previously built. This is the model from which I would like to work.

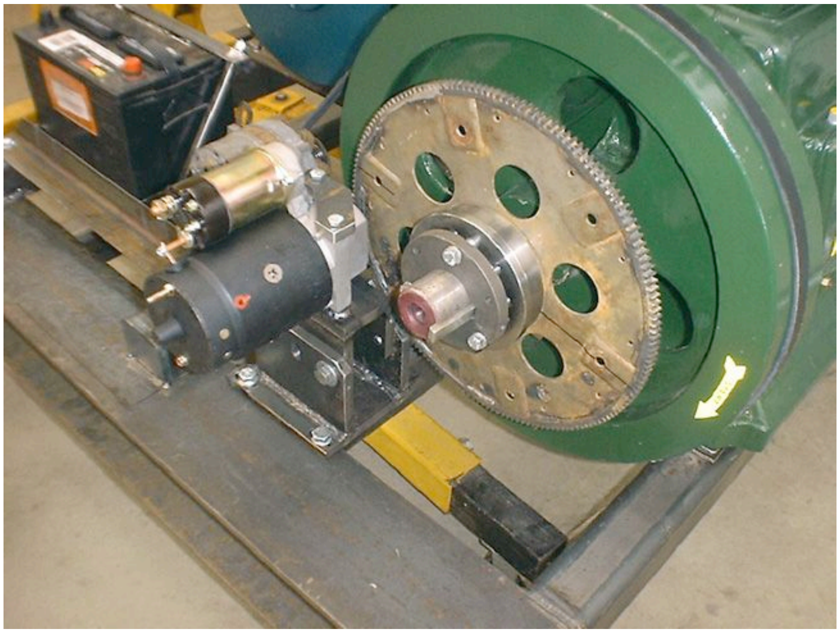


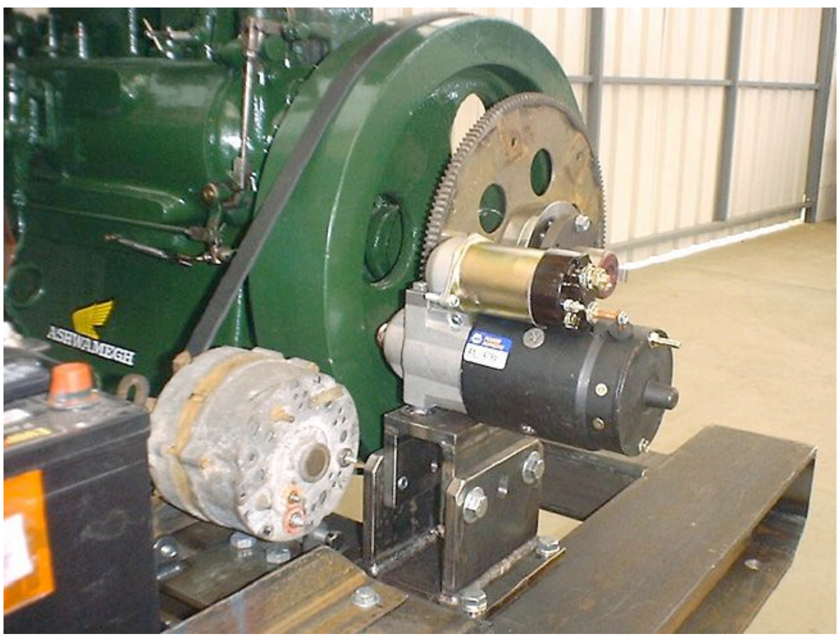

USE ONLY

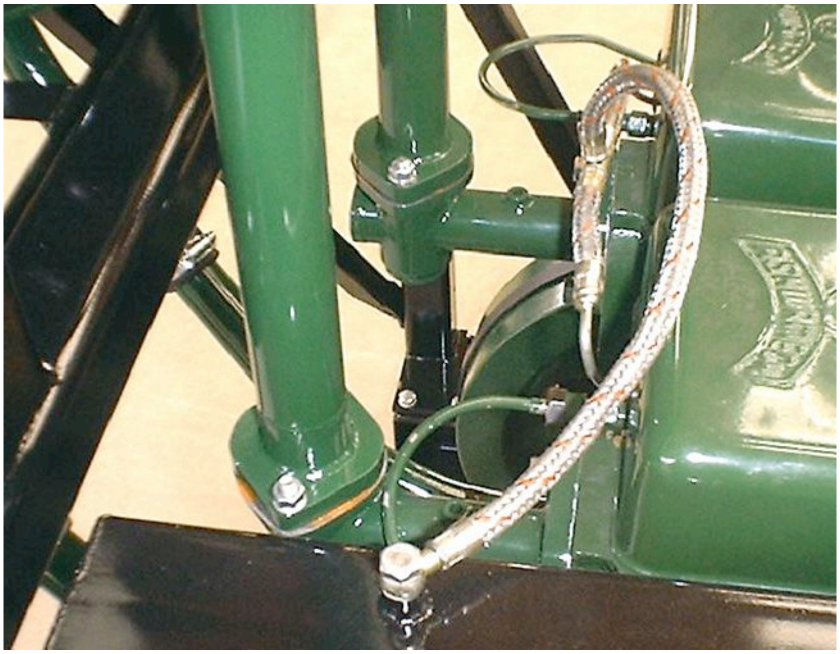

VIJAY ENGINEERING WORKS


NAPA Gold
Fuel / Water
Separator
Primary
3123
NAPA






ASHWAMEGH

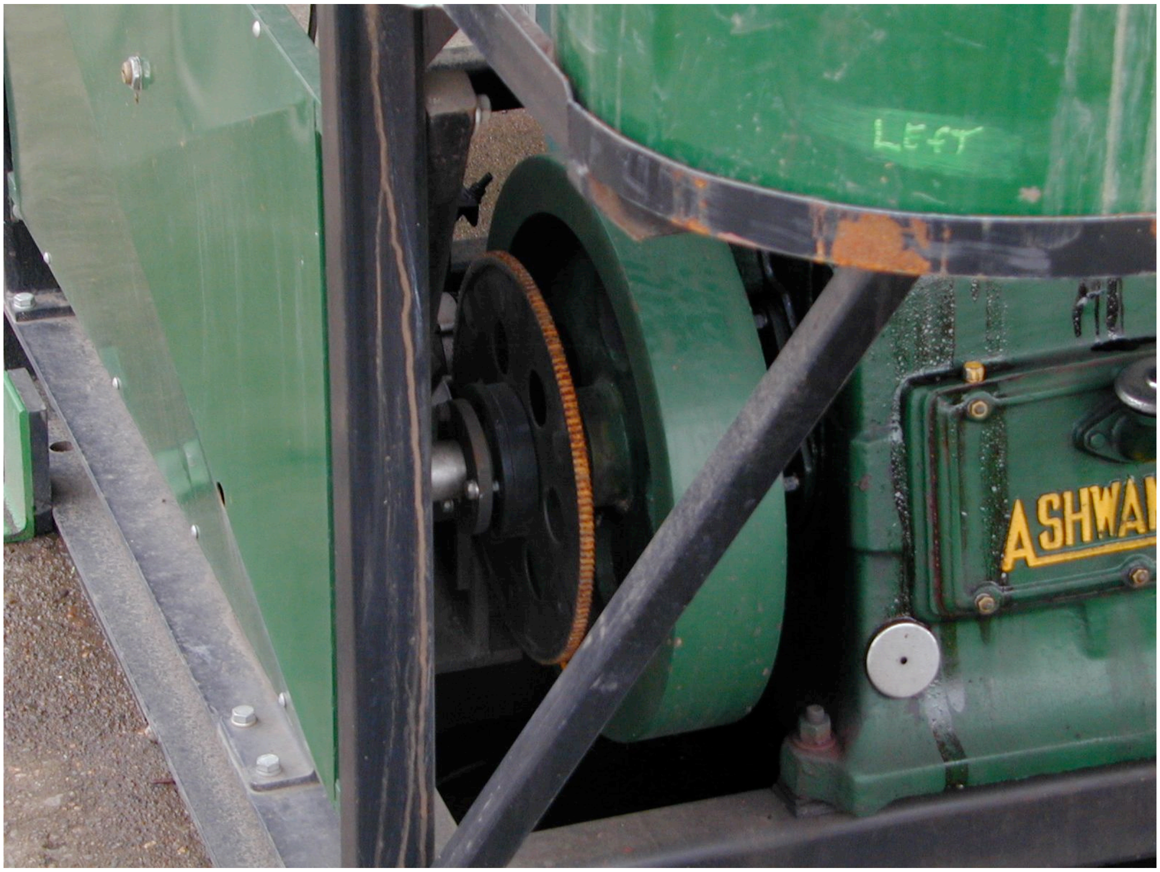



DIESEL ENGINE
B.H.P
R.P.M.
SR NO
MANUFACTURED BY
VIJAY ENGINEERING


Battery Charger


ASHWAMEGH


ASHWAMEGH



[i] McMaster Carr #108, p.669, Coated Fiberglass Sleeving (vinyl) (e.g.: 7408K29)
[ii] Wire ties should be Thomas & Betts with stainless steel lock, or similar. McMaster Carr #108, p. 719 “Nylon Cable Ties with Stainless Steel Lock, 11”, black, 100 count, 6614K55”
[iii] McMaster Carr #108, p.722, “Cable Tie Holder, 2-way, heavy-duty, ¼” screw, black 7585K11”
[iv] McMaster Carr, #108, p.750, “Battery Box”
[v] (AF-EH-3660 370W 12v DC Electric Fluid Reservoir Heater http://www.partssystems.com/shop/products.html?vendor_id=ARCTIC)
[vi] (McMaster Carr #108, p.436, either standard 55 gallon, or custom)
[vii] Both the valve and thermostatic switches are enclosed, though neither need be used if better solution is viable.
[viii] (http://www.partssystems.com/shop/products.html?vendor_id=ARCTIC or similar fuel-resistant wrap)
[ix] McMaster Carr, #108, p.3047 “Ring Grip Quick Release Pins”
[x] Engine vibration mounts, McMaster "all direction center bolt-through mounts" p.1196
[xi] Vibration control pads, McMaster p.1199 (polyurethane) but horse stall padding is probably cheaper/better

[xii] McMaster Carr, p.730, “Magnetic Circuit Breakers”, 30 amp(?), single pole, 72015K3
[xiii] McMaster Carr, Heavy Duty Pin-and-Socket connectors (6 to 48 connectors) p.661 (e.g.: 8037K61)

[xiv] McMaster Carr, p.759, “16mm Panel Cutout Plastic Switches”, rotary short lever switches, DPST-NO maintained (e.g.: 65645K35)