# GE 23 TON SWITCH ENGINE

## HISTORY

This switch engine was built in 1941 by General Electric. It passed through many hands, and ended up at a refinery near San Francisco Bay.

Through the years, the switch engine was updated by removing the 1941 Cummins diesel engine and replacing it with a Cummins NHC 250 engine built in 1974. Many modifications were made to the engine to adapt it to the switcher. At some point in its life, due to a poor design, the bell housing cracked, and the engine was idled.

It sat up at the refinery for many years, and in 2016, the engine was donated to the Santa Clara River Valley Railroad Historical Society. Because it had been idle for so long, mud dauber wasps had taken up residence and turned the cab into a mess. The electrical and engine compartments were also a mess with cobwebs and dirt.

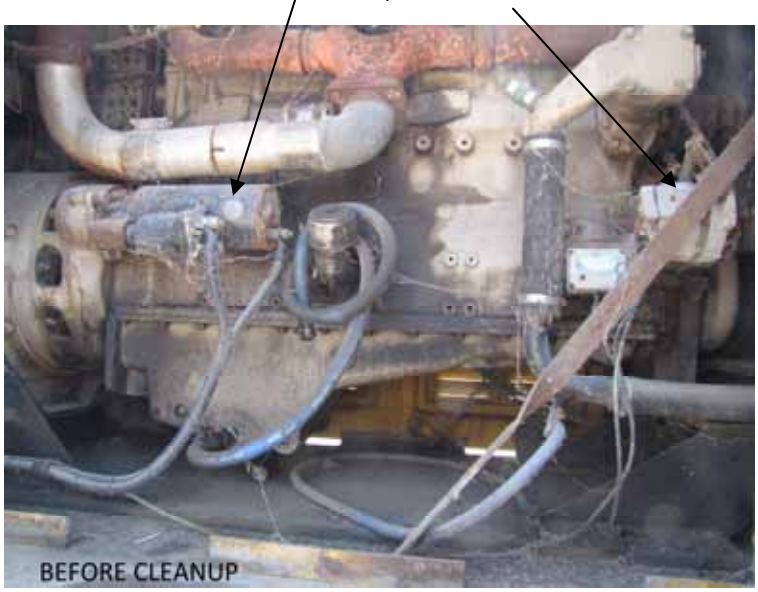
CONTROL PANEL

COMPRESSOR, MAIN SWITCH & GENERATOR

OLD 8 VOLT BATTERIES

LEFT HAND SIDE FILTERS,AIR CLEANER


RIGHT HAND STARTER, ALTERNATOR




We had a work party clean out all the mud dauber nests and remove the rusted floorboards. We also cleaned out a lot of the cobwebs.

DETERMINING THE ENGINE CONDITION

One of our first tasks was to remove the valve covers from the engine and see what shape they were in. Much to our surprise the rocker arms and pushrods were in good shape. We had half expected to see a pile of rust or sludge in there.

We removed the injectors and sent them to be cleaned and adjusted. We also poured some oil and transmission fluid into the cylinders to help loosen them. We also removed the starter and had it overhauled

OVERHAULED STARTER


What we did was all well and good, but we had to face the biggest problem which was the cracked bell housing. Our analysis of the problem was that the diesel engine was supported at the front, but relied on the bell housing to provide support for the rear of the engine. The bell housing was cast iron,

and was not designed to handle that kind of stress, and eventually cracked on both sides, rendering the engine inoperable.
We designed an adjustable support for the rear of the engine, and installed it temporarily for a fit check. The results were very encouraging, as the cracks in the bell housing closed up!
We also found a 9/16 inch hole in the back of the engine (arrow) to which we can bolt the brackets.
We put a wrench on the back of the generator, and we were able to turn the engine. It did take a bit of effort, but we realized we were not only turning the engine crankshaft, but also the generator rotor!

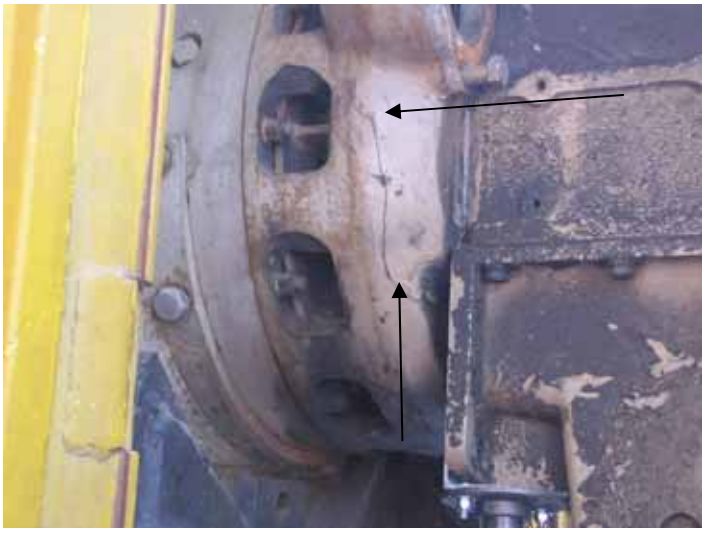
HAND BRAKE
In the meantime, we attended to another problem brought on by the inactivity of the engine and the close proximity to San Francisco Bay. The hand brake next to the battery box was frozen with rust. We moved the pawl and wire brushed the area around the gear. We then built a dam around the gear with plumber's putty and filled it with penetrating oil. We wire brushed the underside of the shaft and the plate holding the end of the shaft. We also applied penetrating oil at both places. Our plan is to let it soak for a while then try to move the hand brake. We will also try jacking the shaft from the bottom to break it loose. If all else fails, we may have to use a torch.

JACK

After dealing with the hand brake, we squirted the door latches on both sides of the engine as well as the electrical cabinet latches with WD-40 to free them up.

BELL HOUSING REPAIR

We sent the photos of the bell housing to Lock n Stitch to get a quote on them coming here and making a permanent fix. I received a response from Lock n Stitch requesting the length of the cracks and the material thickness. We made the measurements, sent the data to them.



We received a response that they were worried that someone had welded the bell housing and painted over the welds, and it hardened the cast iron so they could not drill it. They requested that we wire brush the areas to remove the paint and send them photos so they can see if it had been welded.

We wire brushed the areas with a wire wheel and were able to get some good pictures of the bare cracks. We forwarded the pictures to Lock n Stitch for them to give us an estimate.

We got an estimate from Lock n Stitch, but it was so far outside our budget that we could not agree to their estimate.

However, before we do anything we have to secure the rear engine mounts. We will match drill 9/16 holes in the brackets to line up with the holes on the back of the engine. We will then bolt the brackets to the rear of the engine with 9/16 bolts, lock washers, and nuts for a permanent installation

Right side through bolt

Left side through bolt

We need another method of securing the cracks before we try to start the diesel engine. I have an idea for a much simpler version of what Lock n Stitch proposed. My proposal, after we get the final installation of the engine rear supports completed is the following:

1. Drill and tap 1/4-20 holes on both sides of the cracks in the bell housing.
2. Install 1/4-20 threaded screw eyes in the holes.
3. Put a 1/2 inch bolt with washers, lock washer, and nut through the screw eye pairs
4. Tighten the bolts to secure the cracks closed.

This is basically what Lock n Stitch would do, but a lot cheaper.

We plan to start on the right side, as the crack is smaller. Because of the thickness of the bell housing, we will have to use plug in electric drills rather than cordless. We downloaded advice on how to drill and tap the cast iron bell housing, and will use plenty of cutting oil both on the drill and the tap. The drilling should go fairly quickly, but tapping the holes will take a lot more time. According to the article I downloaded, we will have to back the tap out frequently to clear the chips.

It turned out that the most difficult part was drilling through 3/4 of an inch of cast iron. The actual tapping of the holes was far easier, even using the technique suggested. I believe since the taps were new, they were sharper.
Our next step is to repeat the process on the left side of the engine. Because the crack is longer, we will install 3 sets of eyebolts and 1/2 inch bolts.
Jim brought some high speed metal only drills. That along with using a powered drill made the drilling go faster. The tapping took longer because of the limited access and interference from other parts of the diesel.
We are finally done and we feel the bolts will hold the bell housing securely.

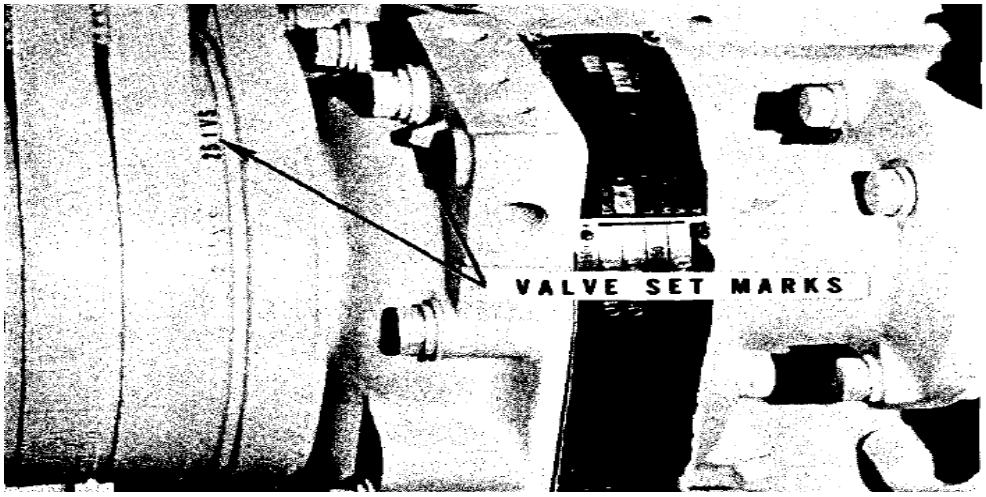
We also made an effort to turn the engine, to make sure there was nothing interfering because of the work we have done.
Below is a picture of Jim and Steve with the smiles of accomplishment.



A couple of people from the Fillmore & Western RR suggested a 50-50 mix of Marvel Mystery Oil and diesel fuel to get the hand brake loose. We will build a bigger dam around the gear and hope this works.

That will be the last thing we need to do before working on the diesel engine. To that end we have bought the following replacement parts:
Oil Filter
Fuel Filter
Air Filter
Fuel/Water Separator
Alternator
Regulator
5 Gals Diesel crankcase oil
Brake air pressure gauge
Ignition switch with keys
Two 12 volt type 31 truck batteries with 1000 cold cranking amps
Two foot long 2-1/4 inch wrench to turn the engine manually

Once we get the engine running, we can then deal with the generator, traction motor, and air compressor and all the relays and controls.
We will need a third battery to operate the relays and controls. We have been assured that the higher voltage is OK.
We also need to get the compressor checked out as well as the control valves. We will have the air gauge calibrated so we can check out the valves. We would like to get the brakes working before trying to move the engine with the generator. We want to have a positive way to stop the engine after we get it going!
GETTING THE ENGINE RUNNING
Today, since it cooled off some, we set about to Install the injectors and push rods. We got that done, but were a little confused as to whether we were missing pushrods for the injectors. We will have to do more research on that.
In the meantime, we had to look for the timing marks on the engine to set the injectors. According to the picture it was supposed to be on a pulley between two of the sheaves. Well after much looking and wire brushing, we found the mark! It was stamped into the edge of the first pulley instead of where the picture shows it.  That was only half the battle, however because we had to find the corresponding set mark on the flange. Well instead of it being a pointer, it was a stamp like a maple leaf!



We finally got the injector links back from the overhaul company and installed them. We turned the engine and wire brushed the pulley. The other 2 timing marks were located, so we are good to go to set the injectors, I had to buy a new torque wrench, because the one we had was in foot-pounds, and the injector settings were in inch-pounds. We will also have to set all the valve clearances to specification.
We also bought a push button switch to energize the starter when we are ready. It will give more control that just touching 2 wires together.
We installed the batteries and the starter. We also connected the pushbutton to the starter solenoid. We pushed the button, and the engine turned over easily! SUCCESS!

PUSHBUTTON

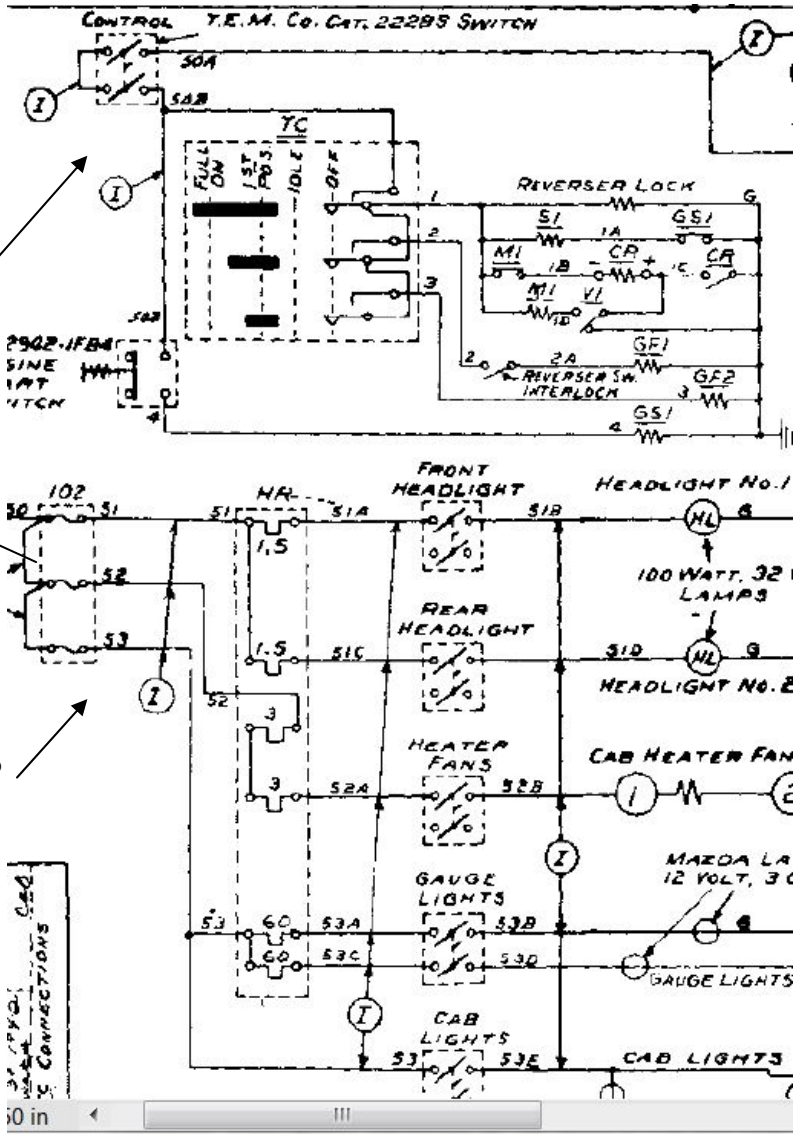
Today was a day of utter frustration. First we replaced the fuel/water filter only to discover that the new filter had different size threads than the old filter. After being unsuccessful in locating adapters, we drained the old filter and reinstalled it. We then took the filter element out of the new filter and put it in the old filter body, which was in good shape.
Next we removed the fuel filter by unscrewing it with the help of a pipe wrench. We tried installing the new filter only to discover that, even though it was the same part number, it was longer. We ended up removing the mounting bracket to screw the new filter in.

In anticipation of getting the engine running, we researched the original wiring diagram, which bears some resemblance to the way the engine is wired now. There is a series of toggle switches on the panel that are unmarked. In looking at the panel of a similar engine, we have figured out what the switch functions are. The first effort was to locate the Control Switch, which supplies power to the relays controlling the direction of the engine.

SWITCH PANEL

GE 2228S DPST SWITCH


10 AMP
FUSES




In further anticipation of getting the engine running, I went out to the electrical cabinet to check some voltages. When I threw the main switch, the voltmeter on the panel read 24 volts, which is what it should have read. I then proceeded to check the voltage on all 6 fuses, and they all read 24 volts. That is a good sign that this part of the wiring matches the diagram in the 1941 manual.

We went out and spun the engine with the starter. It almost sounded like it was ready to start. We got all the injectors adjusted, and reinstalled the air cleaner with a new filter. Surprisingly, the old filter looked in good shape, so we will keep it as a spare.

We temporarily installed a third battery to check out the electrical cabinet. We installed a big knife switch to select either 24 volts to start the engine or 36 volts to power the contactors. If everything checks out, we believe that the alternator will charge the 3 batteries.
Setting the reverser switch in the forward position, we advanced the throttle and heard the contactors operate.

## TASKS

1. Install pushrods and injectors  DONE
2. Adjust rocker arms to factory specifications DONE
3. Replace rocker arms cover gaskets and reinstall covers DONE
4. Reinstall starter DONE
5. Connect batteries to starter DONE
6. Replace air filter and reinstall air cleaner DONE
7. Replace fuel and fuel/water filters DONE
8. Replace oil filter DONE
9. Inspect all rubber hoses and replace as necessary DONE
10. Drain and refill radiator DONE
11. Drain crankcase and replace with 5 gallons of oil DONE
12. Get 5 gallons of diesel fuel and insert pickup tube into container DONE
13. Cross our fingers and try to start the engine IT STARTED!

We did cross our fingers and started the engine. It ran rough, spewing out all the oil we used to lubricate the cylinders.  We also found a few fittings that were not tight enough and leaked some fuel, but we got those fixed.
I believe this is the first time the engine has run in decades. We still have to adjust the idle on the engine to keep it running.

## TASKS

1. Install new starter key switch DONE
2. Reinstall cover over engine DONE
3. Reinstall muffler DONE
4. Adjust engine idle
5. Check throttle response
6. Check oil pressure
7. Set switch in reverse and advance throttle to see if engine will move
8. Check compressor oil DONE
9. Reinstall compressor belts
10. Replace air pressure gauge  DONE
11. Check air pressure
12. Check alternator output