The making of an Air boat Motor

By Gary Orloff

When one of my boating friends called me to tell me about a marina that was going out of business I felt obligated to call some of the guys in our chapter and see if they would want to go and check out what they were selling off. It was something to do on a sunny Saturday in mid Summer and you never know what deals we might find. It wasn't a far drive over to Andover Pa. to check things out and several of our guys were interested in going.

We all arrived that morning and were soon looking through motors of all kinds along with piles of parts both new and used. Most of the motors were newer Johnson's Mercury's and Mariners of all sizes along with several older small engines, i.e. a couple KE4's some 9.9 Johnson's Evinrude's and a small Evinrude Pal. There was plenty of marine equipment for sale too, but I'm getting off the topic of the story! After we'd had our fill of negotiating on some of the motors and parts, we headed out to lunch at a nearby restaurant and then home.

Because a couple of the guys couldn't make it that day they decided to come back the next Saturday, my good friend Jerry was one of them. He called me the next week to tell me what he'd found under a pile in one of the back rooms. All excited, he said it was an "Airboy" (airboy) outboard and a deal he couldn't refuse. For those of you not familiar with the Airboy outboards they were powered by a small 2 cycle engine with an airplane type propeller and were manufactured back in the late fifties. They didn't see much success as an alternative to a regular outboard but they were quite unique as collectables go. (The Airboy that Jerry bought is shown below!)

Jerry worked on it for a couple weeks and had it looking like it was ready to fly (no pun intended) when he brought it out to show us. The engine looked pretty enough but he

had found it had a couple bad spots on the crankshaft and probably wouldn't live very long if run hard. So now the hunt was on to find another engine to make it a good working model!

A couple weeks later Jerry attended another meet up in Michigan. While looking thru some of the parts in the host's collection one of our other members spotted a wooden propeller up on a shelf and mentioned it to Jerry.

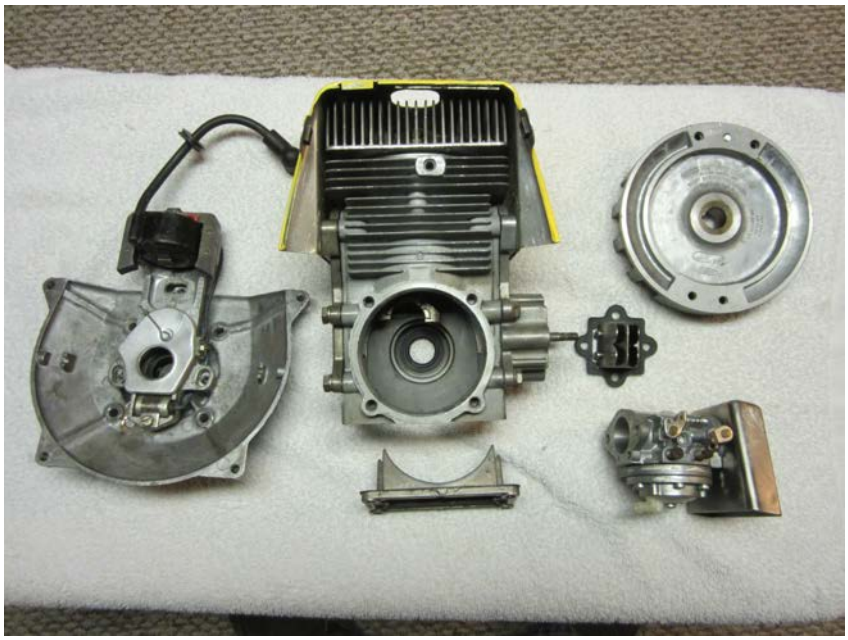
Jerry remembering what our good friend Jim always says, "never have just one" - so a price was negotiated and soon the prop was his. Once he got home and looked at his Airboy engine and prop, he realized the new one he had just purchased rotated in the wrong direction!

So now the stage has been set for this story, I hope I haven't bored you with the prelude. At our next Wednesday get-together out at Jim's, Jerry asked me if I would be interested in the prop he had just acquired, he went on to explain that it rotated the wrong direction to work on his engine. This set off a couple bells in my mind, so I told him sure I never turn down a good deal, he reminded me it turned the wrong way to work with most engines as they usually rotate CCW or left hand rotation while looking at the output shaft of the engine.

The bell I heard go off in my mind was in reference to what I remembered about a small engine we used to test in the laboratory I worked at years ago. It was a single cylinder 2 cycle Chrysler WestBend utility engine. I worked with a couple engineers developing a test stand for that engine and remembered there were two different styles we tested. One was with just the engine driving a dynamometer, the other one was a fire pump mounted on a floating ring that we floated in a tank and could control the discharge to load the engine. The test was to develop a 2cycle oil additive for the industry. What rang my memory bell was that those engines could be set up to run in either direction with a simple change of a couple parts. The neat part about 2cycle

engines is they don't care which way they rotate, if you ever played with the little Cox .020 or .049 model airplane engines you might remember they would sometimes start in the wrong direction to fly the plane. Of course the little Cox engines were glow plug fired so it wasn't uncommon for them to start the wrong way! With the Chrysler engine it was necessary to change the cam and flywheel to get them to rotate the opposite way.

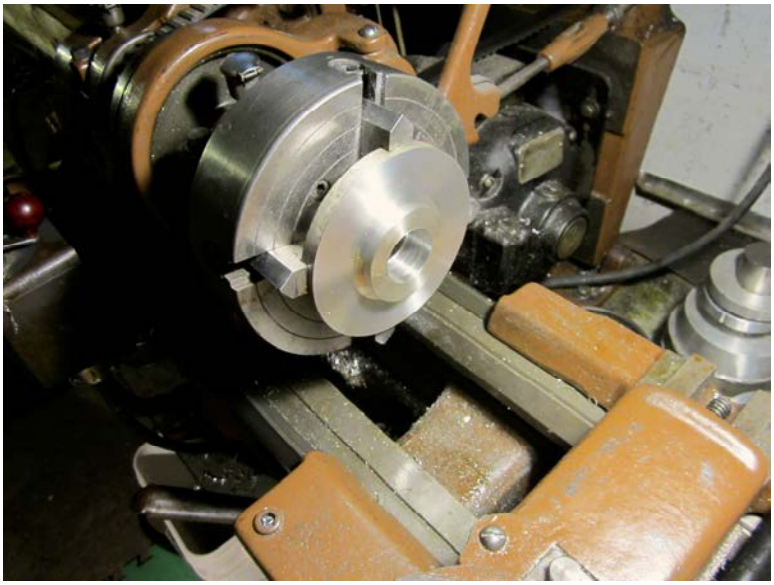
Back when I was working in the lab I had all kinds of opportunities to gather extra parts for these engines as they only ran them for one test then they were scrapped. So when Jerry told me about the propeller being a opposite rotation the idea of building an air drive outboard or ice boat engine popped into my head! Now all I had to do was look through my Chrysler engine parts to see if I had what I needed. I knew I had a complete engine that I had coupled to a water pump storied out in the barn but was pretty sure it turned the wrong direction. Upon pulling it out for inspection, my guess was correct as it turned CCW facing the shaft. Next was looking at my inventory of parts, but I first needed to make sure I knew what I needed to reverse the rotation. A quick look on the Internet showed go-carts with twin engines opposed to each other but no information on how to reverse one. So back to my parts, what I found I had squirreled away years ago was a flywheel marked CCW with an arrow to indicate direction! My next find was a points cam with an arrow on the top of it indicating the proper direction for what I needed.



Once I got the engine separated from the pump setup I was on my way. I decided to tear it down to make sure everything was in good condition, but when I removed the cowl on the flywheel side I noticed something wrong. When I turned the engine over, the magnets on the flywheel were scrapping the ignition coil laminates and one of the laminates was bent! There was no way it was going to produce a good spark like that! So I removed the flywheel and saw someone had written a note on the back cowl / magneto mount! It said " bad Brng with loctite, give away!" This was the first of my problems, next was to remove the back cowl / magneto cover and see if this information was true. Once I had it off I couldn't see anything wrong with the bearing so I decided to put it back together and try a different magneto assembly thinking maybe it

was just a bad fit! That didn't work either as it still rubbed, I pulled it apart again and this time removed the bearing and installed it in a different cowl, back together again that did the trick everything worked Ok, it was just a bad casting and fortunately I had enough extra parts to fix the problem.

After cleaning all the parts I reassembled everything, cleaned and set the points to .015 and installed the new flywheel, it turned freely and gave a nice blue spark just flipping it by hand. In between working on the engine I knew I needed to make a hub mount for the propeller and started looking for just the right pieces to build one. I had some aluminum round stock 4" in diameter that looked like it would be just right to turn a hub on my lathe.



I started by facing off one end of the 4" stock and then cut a piece about 1" thick from it. This I turned to fit the back face of the propeller which has a cavity in it about 1 7/8" dia. and about 1/2" deep, so I knew I needed part of the hub to fit into that cavity. The center of the disk was bored to 1.333 dia. for a shaft to be pressed in, then welded. I will have to take it over to my buddies machine shop to have them bore the hole in the shaft and brooch a keyway in it to fit the 3/4" shaft of the engine, but that will have to be done later.

Back to the engine. I painted the fan cowl and once dry assembled everything and installed the recoil starter, that's when I discovered another problem. Although the recoil starter was correct for the counter-clockwise rotation, the cup it engaged to was for clockwise rotation and the pawls in the recoil wouldn't grab the cup! Back to the computer to see if I could order one from one of the parts suppliers. I sent out a couple inquires but came up empty! So now I really have a dilemma, I started thinking Ok maybe I can just start it by flipping the prop, but visions of bloody chopped fingers popped into mind and I immediately abandoned that idea! The next idea was to cut the cup in half and flip it upside down and weld it back together, the only problem with that

idea is the top of the cup has a flange on it and it would put the flange half way down the cup on the outside. I didn't know if it would work but until I thought of better way it was the easiest fix!

After I made a couple measurements I chucked the flange side of the cup in my lathe, found a tool I had ground down to cut it in half. It went pretty well till the tool caught, broke and pulled the piece out of the lathe chuck. So rather than trying to finish the cut on the lathe I decided to do the rest of it with a hacksaw. With the two pieces cut in half I filed the edges smooth and fit them together with the flange in the middle. This reversed the direction the pressed in edges the pawls of the recoil starter engaged against. In order to weld them together and hold the two pieces centered I cut a hexagon wood block the size of the i.d. of the cup and pressed it into the two halves with the flange in the middle. I welded 6 spots around the flange then took it down to my lathe again to see how concentric it was, it checked out Ok!

Now to fit it on the engine and see if it actually worked. As they say in the prototype world "Even a blind squirrel finds a nut once in awhile!" With the cup installed I mounted the recoil starter on the engine with just a couple bolts and tightened everything down, then pulled the cord. Bummer! It was locked up tight! No big deal as one of the bolts I used in the recoil starter was too long and hit against the flywheel. With the correct length bolts installed it pulled over nicely!

The next step was to put the two pieces of the propeller hub together. I machined the piece that will go on the engine drive shaft a couple thousandths bigger than the hole in the plate that will attach to the propeller, I now needed to shrink it so I can press it into the hub plate. Knowing aluminum expanded when heated, and shrunk when exposed to cold temperatures I put the piece for the shaft in the freezer. Once it was cold enough I heated the plate for the hub with my propane torch, retrieved the piece from the freezer and it dropped right in no pressing necessary! I had chamfered both the hub plate and the shaft piece so I could weld them on the face side. Once the face was welded I

turned it over and welded the back side of the shaft at the hub plate. It was now ready to go to the machine shop to be bored for the 3/4" shaft and have a keyway broached in it.

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Moving on to other parts of the project I could see I was going to need some kind of a mount to attach to the transom of a boat and just happened to spot a set of light blue transom clamps under my work bench. I believe they are from a 5 1/2 or 7 1/2 Evinrude of the 50's they looked like they were just the ticket. (5 1/2 clamps) I pulled them out from under the bench only to grab a handful of greasy black goo attached to the swivel bracket. One of the first things I usually do is to clean any parts I plan on using before disassembling anything, but in this case I had to take it apart in order to get to the real dirty part, cleaning always takes more time than expected! The clamp set had the swivel bracket with it so I was part way there for the steering system for the air drive motor. It came apart easily but the swivel tube was packed with the blackest grease you could imagine, and once you get it on your hands it's next to almost impossible to wash off! So here I am, hands full of this black gooey grease and off course the phone rings. Somehow I managed to wipe most of it off but no way was I picking up the phone!

Now apart and mostly clean I had to modify the bottom end of the swivel tube as I didn't need the two pieces that the rubber cushion mounts bolt to. I cut the bottom of the swivel tube flush with the bottom of the housing it slid into and machined a piece of aluminum to press into the bottom of the tube leaving just enough to weld it to the tube. On the top end I cut out a piece of 1/4" thick aluminum to match the flange with the four threaded holes in it. Making a template I copied the hole pattern and drilled it to match. The swivel tube is hollow so I machined another piece of aluminum to match the i.d. of the swivel tube and left a register of 3/4" diameter X 1/4" high on the end of it. This I drilled for 3/8" NC bolt thread, then pressed the piece into the 1/4" aluminum plate with the four holes in it and welded the two together. I then needed a 11" long 3/8" bolt to hold the bottom cap to the swivel tube and the piece I had made for the top. The top piece serves to give clearance for turning the swivel tube back and forth.

If you've ever seen one of these air drive outboards you would see that the propeller is positioned above the transom so it is clear of any obstructions. The propeller I got from Jerry is 24" in diameter so I knew I needed to raise the engine so it will clear everything and provide good thrust from the back of the boat. While looking at some of the factory designed air motors they all had a section of tubing or casting that elevated the engine high enough to provide good clearance for the propeller.

The top of the swivel tube from the Evinrude transom clamp assembly has four threaded holes where the powerhead mounted that I could use to attach something to give me the height I needed. So now a trip out to my good friend Jim's was in order to search through his endless shelves of parts. I knew I needed something not too big but strong enough to take the thrust from the engine and propeller. With a couple of measurements I determined it would have to be about 8 - 9" long. looking through several shelves I spotted another swivel tube from one of the larger OMC engines, perhaps from a 30 - 35 hp. It was just the right size and plenty stout to handle the job.

With permission from Jim I was on my way! The bigger swivel tube had a similar bolt arrangement on the top of it that would provide a good solid mount for the WestBend engine base. Now I needed a way to attach it to the tube on the Evinrude Clamp & Swivel bracket. In my supply of aluminum salvage I had saved a piece of 2" X 2" X 1/4" thick channel that would work to connect the two pieces together. I cut a piece off about

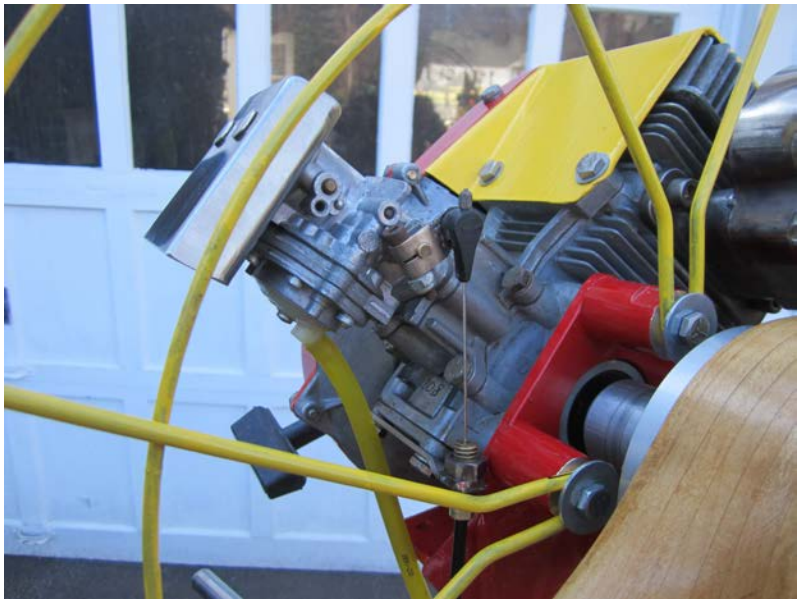
2 1/2” long that I could weld to the bigger swivel tube. The bigger tube would have to be shortened to the proper height, so I had to cut about 3” off the bottom of it and then welded the piece of channel to it. I had made a template of the hole pattern from the swivel tube in the transom clamp and marked and drilled the piece I welded to the bigger tube. Now I could bolt the two together.

As I wasn’t sure how much force the engine and prop combination would exert on the tower I had welded to the piece of channel, I decided to make an insert for the inside of it that is threaded for a 3/8 NC bolt. I used a piece of solid aluminum about 1 1/2” long and about 1 1/4” in dia. and tapered to match the inside of the tower tube. Once this piece was made I used JB weld and lock it in place down at the bottom of the tower tube. Even though the tower tube was welded to the piece of channel I wanted the extra strength of a bolt thru it locking it to the piece of channel.

Now that most of the pieces were made It was time to start painting. One of the engines I saw on a go cart was painted a bright red and looked great, so that was one of the colors I chose yellow was the other.

Now it was time for the details and as that famous saying goes, “The Devil is in the details.” Trying to figure out how and where to place a fuel tank was a real problem, there just didn’t seem to be a good place for one and everything I tried, was either too big or didn’t compliment the whole design. So I decided to just forget it for now and move on to other parts of the project. I needed to add a tiller handle somehow and a throttle mechanism. I didn’t want anything to big or to gaudy, and didn’t think it needed to be very long to handle steering it, after all how much torque could a little 2 ft propeller exert? What did I have to work with?

A couple years ago I happened on a great deal, down at our local marina there was an old derelict wooden boat that was being stripped apart and sold for parts by the owner. It happened to have a beautiful stainless steal railing with all SS fittings on it. I need to replace some of the old pitted fittings on my SeaRay so I bought the whole railing for a song and still have several lengths of very nice 7/8th SS tubing to work with, and it even has a couple bends in it that will work for my tiller handle. So with a little imagination I fabricated a tiller handle. Now I needed a throttle. In salvaging a couple bicycles from being scraped I had several brake levers, cables and fittings to attach to my new tiller handle. It was almost too easy, but remember the devil part? That's where I ran into problems. When I removed the engine from the pump assembly I had originally mounted it to, I had made a throttle mechanism for it so it seemed it would be a simple thing to adapt it to the tiller handle and the carburetor. Everything was working out nicely till I tried stretching the cable between the lever bracket and the carburetor, just an couple inch's too short! Seemed like an easy fix, just find a longer cable! That took a couple hours as I had to make new ends for the inner cable and solder them on, seemed simple right, only one end had a barrel that needed to be just the right size, both in length and diameter, and the other end had a ball on it. As the boys down south would say "Got'er done!"



While making some of the pieces to hold the cable, that's when I came to a blinding flash that I didn't need a fuel tank as this carburetor has a fuel pump in it and could suck fuel just like the big boys! So all I needed was to bring fuel to the carburetor with fuel line, and a quick disconnect to connect to a remote gas tank. More pieces to make for the QD and add the fuel line to it and it's done.

Years ago I had attempted to build an air drive outboard to put on an ice boat, I got as far as to mount a propeller on an engine (this one was a clockwise rotation) but for some unknown reason I never finished it and it has been sitting down in my basement all these years. But the one thing it did have was a very nice propeller guard (wire cage) in great condition, and it just happened to fit perfectly on the new engine with one small modification. The bolts I had used on the first attempt were 5/16th NC with spacers to put it in the correct position for the prop. For the new engine I had to make four standoffs to position it correctly with the propeller. The bolts to hold the engine to the mount were 5/16th NC, so I made the standoffs out of 1" aluminum and drilled and tapped them for 5/16th NC on one end, the other end I tapped for 1/4"NC to hold the fan cage. I made four 5/16th" NC studs and loctited them in the standoffs. I cut two flats on the standoffs to fit a 7/8th wrench in order to tighten them down on the mount. Four 1/4 NC bolts now hold the fan cage on. One of the things I forgot to mention was how I attached the tiller handle to the frame of the tower. I welded the tubing to a piece of flat stainless steel that was a part from a steering bracket, had to do a little modifying to the bracket but once I cut it into the shape I needed I drilled a 3/8th" hole in the center and welded a 3/8th" nut to it, then placed the tube handle over the nut so it was hidden and welded it on to the bracket. This allowed me to bolt it to the piece of channel welded on the tower. One edge of the bracket had a bend on it that locked on the channel of the tower so it couldn't turn. With the handle all fit and the throttle attached I was ready to try starting it.

I took it out to the garage and mounted it on my mobile vice stand, I need it to be on something pretty heavy and secure as I wasn't sure how much force or power it would produce. The vice stand is pretty heavy, weighing in about 240 lbs so I thought it would hold it nice and solid. With my gas tank connected and primed up to the carburetor I started pulling, nothing not even a pop. So I thought it hasn't had gas in it since I checked the carburetor so maybe a shot of starting fluid would do the job. A couple

squirts and finally I got a pop, but that was all it would do, it wouldn't continue to run and sounded weird like it was out of time, back to the drawing board. My first thoughts were it was just out of time as the mount for the points, coil and condenser were adjustable and all it would take was to remove the flywheel and readjust the timing a bit. They are supposed to be timed at 26 degrees BTDC and although I thought I had it set correctly, maybe I missed something? It had good spark with the points set at .015 so why wouldn't it run? That's when I decided to go look up some of the specs. I found a site that had all the information on the Chrysler Westbend 820 engine and after reading through most of it I came to the one more thing I needed to make it run CCW looking at the flywheel, a different crankshaft! Bummer !

So back to the parts supply, knowing they made several different types and styles of crankshafts and I knew I had a couple to choose from but thought I'd check on the internet to see if a new one might be available, they were but were currently out of stock, but would be back in, in a couple months for the meager price of $ 218.00, bummer! One of the things I always prided myself on was being able to build these little projects under budget and this would definitely put it way above if I had to go that route!

The extra crankshafts I have actually turned out to be for a CCW rotation "Yeah!" But with a minor setback "Boo", they have the stepped shaft on the output end and what I need is the 3/4" driveshaft to match the hub that I already made. The stepped end is 5/8" X 11/16" stepping down to 9/16" X 1&1/16" with a 1/2" long 7/16" LH thread on the end. I have had to deal with problems like this before, but with all things there's more than one way to skin a cat!

A couple ideas started to form in my mind, the first was I could make a couple sleeves to fit over the stepped shaft. That would work but they would have to be an exact fit so there wouldn't be any slop for the propeller hub to flex on. Then there is the problem of the key way, the stepped shaft has a half round key slot cut into the 5/8" section so the sleeve would have to have a slot cut into it so the key would stick thru and be able to drive the propeller hub. Not an impossible thing to do but not exactly easy as the sleeve only has a wall thickness of 1/16" and if I made it a press fit it would be tricky to press on the shaft and hold alignment for the keyway.

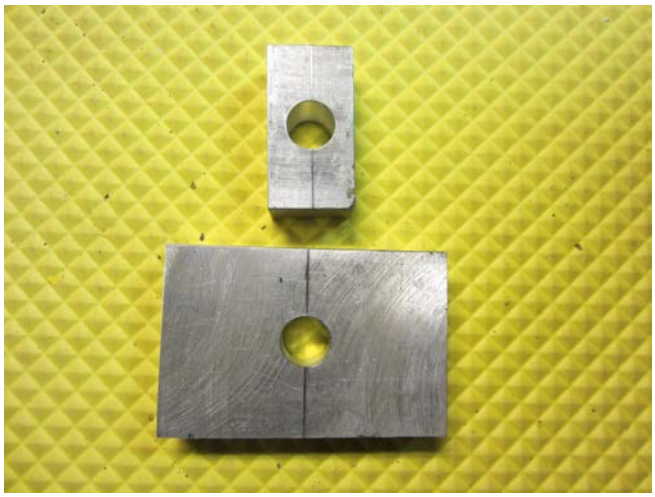
My next idea was to figure out exactly where the CCW keyway for the flywheel is and cut a second keyway in that position into the CW shaft with the 3/4" drive end. So I took the shaft over to my friends at the machine shop to see if they had a way to lay out the correct position from the CCW shaft. Danny took one look at it and told me it would be cost prohibitive as they would have to somehow lay out the position for the keyway then build a fixture to hold it at the exact angle to cut the keyway, another Bummer! But being a positive thinker I wasn't about to give up!

My next visit was to one of my good friends at Wiseco Piston, Dave Sulecki Jr. After explaining my problem to him, he made a couple suggestion on how to establish the keyway position and said he thought his dad could cut the keyway. Dave's Dad, Dave Sr. is one of the founders of the machine shop I refer to and is one of the best machinists I have ever known. A quick call to him and I was on my way over to explain the situation. Knowing Dave always likes a challenge he didn't disappoint me when he said sure I'll give it a try just let me know where you want the keyway cut. Dave has a milling machine and a couple other pieces of equipment in his shop at home and said he could cut the keyway there. Hmm, so now I'm back to figuring out how to establish exactly how to lay out where the keyway needs to be cut.

Many times with problems like this I lay in bed at night thinking about how to work out the solution, knowing I already had a crankshaft with a keyway in the correct position to work for a CCW rotation I thought why not just copy it ? Between Dave and I we established the keyway was cut straight into the taper of the crankshaft for the flywheel and not on the angle of the taper. So this meant I could hold the crankshaft level in a fixture to make the cut.

All I needed were a couple aluminum blocks to mount the crankshaft on and lock it in the correct position with the keyway at top dead center. Then somehow make a stop that the throw of the crank journal would rest against. This would give me a reference point when I removed the CCW stepped shaft and installed the CW shaft with the 3/4 output end that needed to have the keyway cut in it. Doesn't sound that hard to make so now that I had a plan I was on my way, I just needed to find all the material to make the fixture. Fortunately I had a bunch of aluminum in a garbage can just for situations like this! I found just what I needed, a piece of 1" thick aluminum about a foot square, I cut a piece off about 2 1/2 " wide by about 5" long and took it down to my lathe. I measured the diameter of the crankshaft where the bearings fit and then drilled a hole thru the center of the block. Once the hole was bored to the correct dimension of the crankshaft

I cut the block in half down thru the middle of the hole. I did the same procedure to a smaller block to make two top caps for the bigger blocks. I mounted the two big blocks on a piece of 5” X 5” 3/8” thick aluminum plate at the correct spacing for the crankshaft to fit between them and then mounted the top caps which I had drilled and tapped for 5/16” bolts.



With the CCW crankshaft mounted in the fixture I centered the keyway at top dead center by measuring from each side of the bearing area on the crankshaft to the edge of the keyway. I had made an adjustable stop to go under the connecting rod journal so once the keyway was centered I could adjust the stop to meet the crankshaft journal which would establish the reference point for the CW crankshaft. Now all I needed to do was take it over to Dave and see if he approved of the way I had made the fixture and see if it would work to mount on his milling machine. Dave said the fixture would work just fine, and after centering it on the milling machine and locking it down, he cut the keyway!

One of the things that puzzled me when I was looking up the specs on the Chrysler WestBend 820 engine and what I saw on my own CCW crankshaft is that it had left hand threads on both ends of the crankshaft? I could understand using a left hand thread on the drive side as it would tend to tighten due to the CW rotation from that end of the crankshaft, but on the flywheel side it would tend to loosen? The CW crankshaft I will be using has 7/16 NF righthand thread on the flywheel side and a 5/16 NF right hand thread tapped into the end of the 3/4" drive end of the shaft. I don't expect I will have any problem with this as I will locktite the nuts and bolt on both ends of the CW crankshaft, just thought I would mention it to see if anyone had a logically explanation why they did it this way?

With the keyway cut, reassembly was just the reverse of taking it apart! But first I wanted to fill the old keyway with J&B weld and then smooth it down with a file and lap the flywheel on the crankshaft with some lapping compound to make sure I had a good fit. With everything fit and finished, I was ready to give it the final test. While still down in the basement I shot a squirt of starting fluid into the carb, a couple quick pulls on the starter cord and it fired off, just enough to convince me it was going to run and the new keyway had done it's job. I took the air motor out to the garage and mounted it on my mobile vice stand, connected the fuel line from the tank and pulled it over. It was a little reluctant to fire but another squirt of starting fluid and it fired up! I didn't want to run it too long as I had mixed up a rich batch of gas & oil and it filled up the garage with fumes pretty quickly. So now that I was sure it was going to run I started wondering what I could put it on to test out it's power, Hmmmm!!

Stay tuned for the next project?

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