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Air cooled 2-cycle motorcycle racing cylinder

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Thread: Air cooled 2-cycle motorcycle racing cylinder

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12-14-2015, 08:07 AM

#1

jhenise 

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

Air cooled 2-cycle motorcycle racing cylinder

Making a pattern for a new cylinder for my race bike.
story about the bike here:

<http://www.highwaymanbikes.com/the-h...ge-road-racer/>
<http://www.highwaymanbikes.com/desig...acing-chassis/>

The current cylinders break off on the bottom, not to mention take way to many hours to make, from rare Kawasaki F3 cylinders..

The F3 cylinder comes with the wrong iron liner, port windows in the wrong place, and the way too weak flange that breaks.

I literally bore out the stock cast-in iron liner, weld up the aluminum to relocate to port windows, make a custom iron liner, re-machine/grind all the ports back in, and fabricate a base plate to fix the wrong deck height.

I have ideas on how to reinforce the modified F3 cylinders, but making one is so labor intensive, I might as well be spending the time to make a casting pattern for a superior cylinder, with bosses for through-clamping studs that wont break, the correct deck height that wont require a base plate spacer, streamlined transfer port passages (only possible by casting, not machinable) , and no iron-liner but rather a "Nikasil" plated cast aluminum bore.

And SO IT BEGINS....

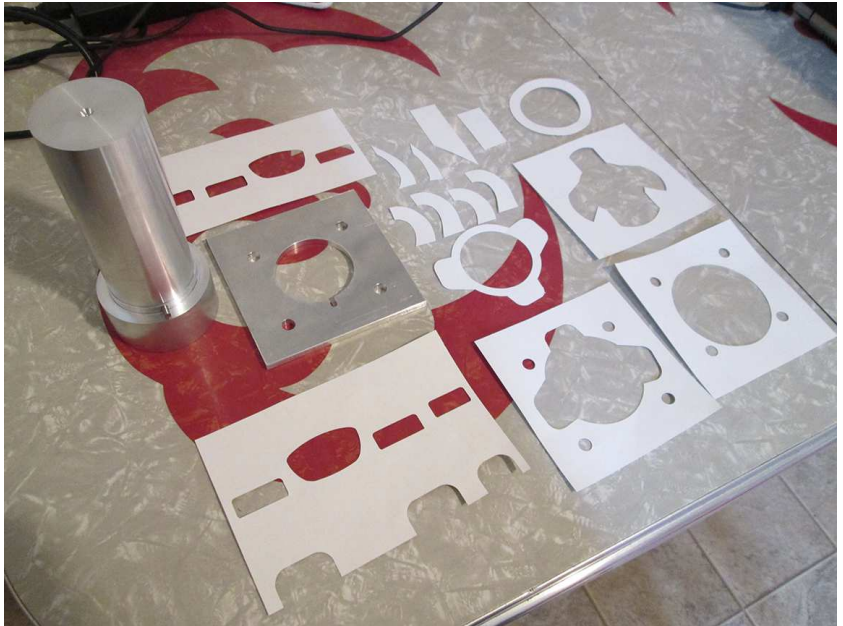
The old cylinder showing where they break off...



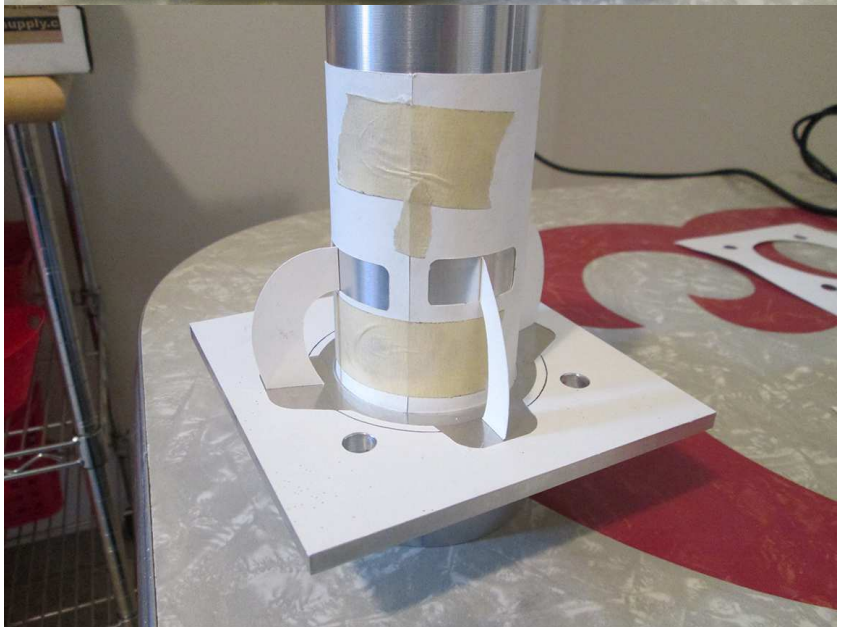
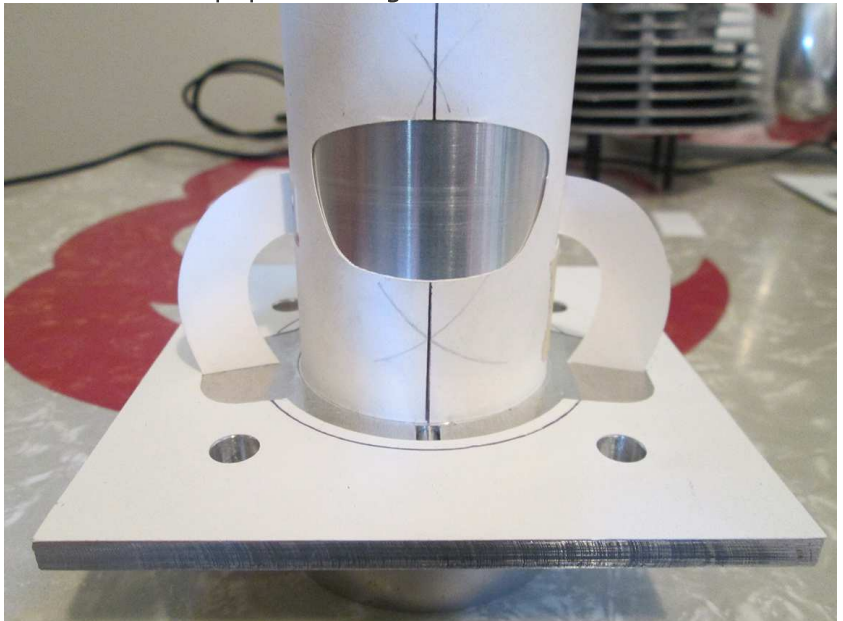
Making Vinyl castings of the old ports for reference of the shape...



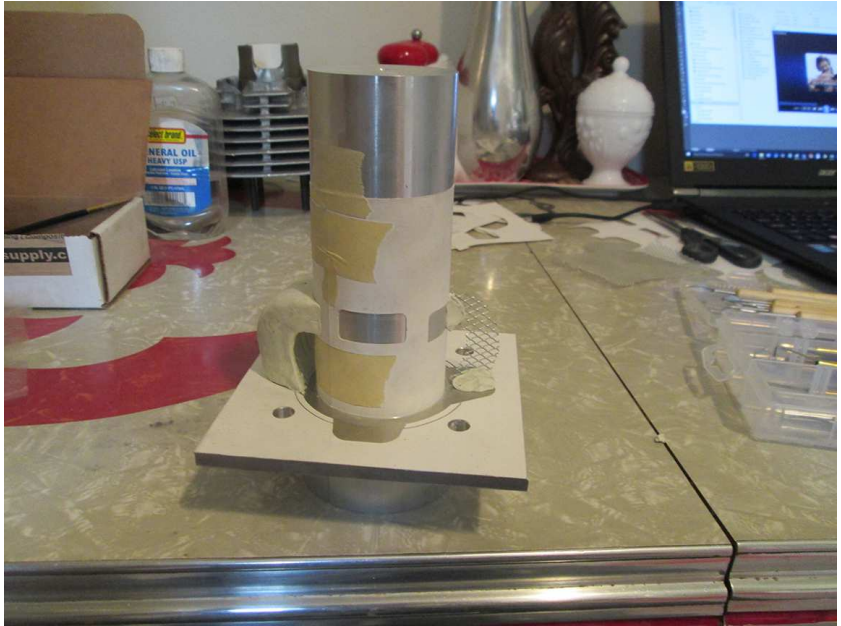
My favorite thing: CNC cut "Paper Tooling" and an aluminum fixture to aid in forming the new transfer port patterns...



How I use the paper tooling...



Roughing out the port shape in clay, just like grade school art class, only the big boy version :-)



Showing what the new streamline ports will look like compared to the old "turbulent-bend" ports...



smoothing op on the inner wall...

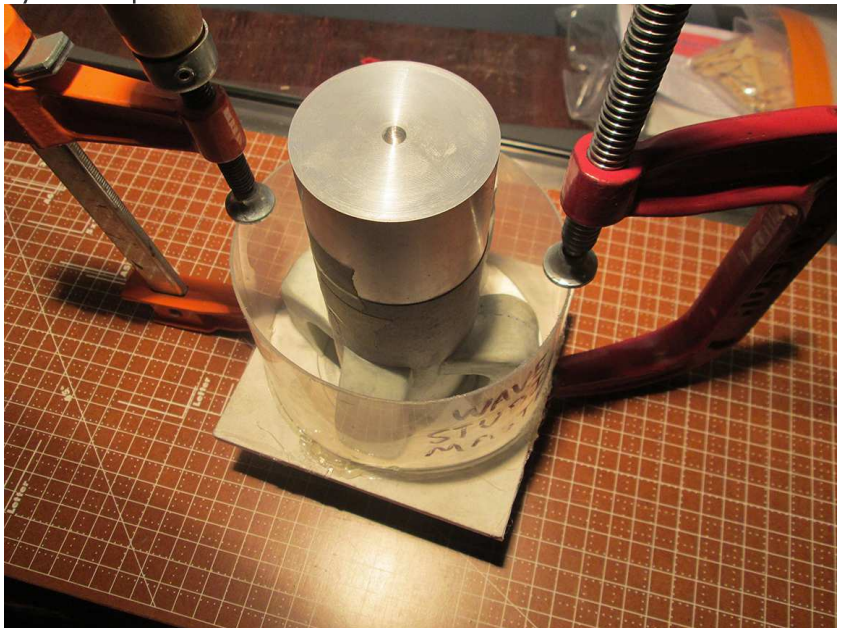


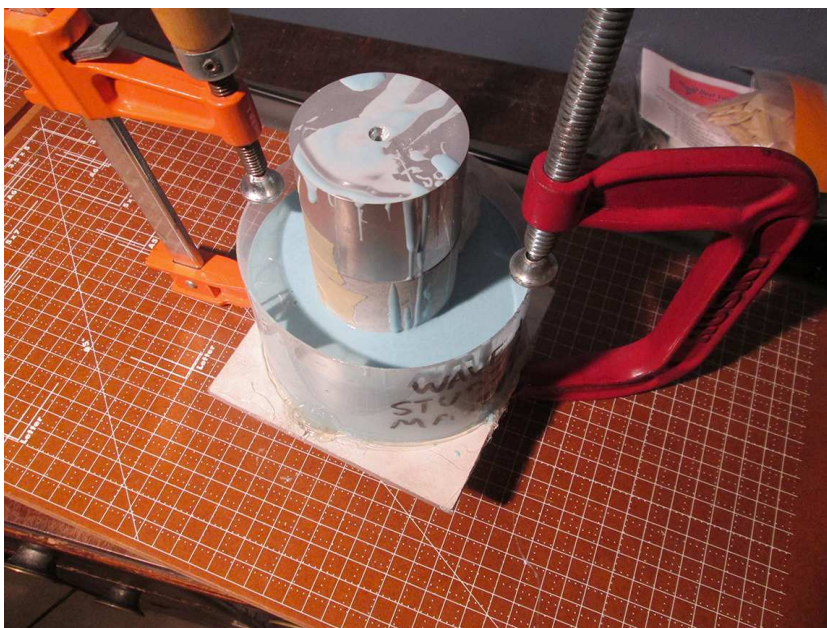
Finished transfer port models...





And molding of the ports in silicone. The silicone mold will be used to generate urethane hard copies that will be used for core-box patterns, and reference shapes in the cylinder-pattern...





More to come!

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12-14-2015, 09:16 AM

#2

4cylndrfury

Senior Member

Join Date: Jul 2009

Location: Cincinnati, Ohio, USA

Posts: 3,406

Blog Entries: 1

wow!Subscribed!!!!

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12-14-2015, 09:55 AM

#3

sicivcdude

Senior Member

Join Date: Nov 2013

Location: Butner, NC

Posts: 583

WHOOOOOOAAAAAAAAAA! I love it!

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12-14-2015, 04:19 PM

#4

bluerider

Member

Join Date: Mar 2012

Location: central coast,
California

Posts: 82

looks great!

How are you calculating shrink? It's a tricky shape for shrinkage. If it were a plate with a hole in it, the shrinkage would be across the diameter. And if it were a paper thin simple cylinder the shrinkage would be along the circumference. A thick walled cylinder has a bit of radial shrinkage i.e. the thickness of the wall plus

shrinkage along the circumference. With your casting the edges will cool first and with the larger width on the corners I think you may get an out of round casting, not by much and it will likely be different at the top and the bottom because of the transfer ports.

Just give yourself enough stock to true things up and you may want to add some stock to the transfer ports to allow for uneven shrinkage and for port matching to the case.

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12-14-2015, 06:33 PM

#5

Wolfcreek-Steve ◉

Senior Member

Join Date: Apr 2014

Location: Central Wisconsin

Posts: 712

Threads like this are the reason I signed on here, I'm staying tuned in.

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12-15-2015, 08:21 AM

#6

jhenise ◉

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

I plan to compensate for shrinkage by popping a Viagra before I pour the metal...

HaHa, well for real, when I did my cylinder head pattern I inflated every cross section by 2% in size (maybe over kill? I haven't measured the result yet.)

For this pattern, I am only as far as the transfer passages in the photos, to make them though there has been significant thought into the as-cast cylinder bore diameter and upper and lower deck height. I am trying to avoid as much port work on the cast-cylinders as possible, so the port windows will be cast ~0.7 mm undersized in the vertical dimension, to allow some "finish match" porting on the final cylinder, the excess stock has been directed to the easiest-to-port face of the passage. The actual transfer flow passages will be used as-cast, and are non-compensated in the clay model shown in the photos, if they shrink/warp up to 1-2% it really won't be a big deal at all, however some compensation will occur by coating the port patterns with a decent layer of high build primer prior to using them to make the core boxes. The Cylinder-bore diameter will be cast 4mm undersized to allow an ample amount of stock to be bored off, and the upper and lower decks will be given +2mm of extra stock as-cast. So no much calculated shrinkage compensation at all so far, but more of a cast over/undersized where appropriate and rely and machining for the critical features. Machining the decks is used to adjust overall port timings, and ports can be matched to each other.

I do agree though I would expect a complicated mixed-mode shrinkage in this type of casting, rather than it happening perfectly along a given axis, there is not much symmetry or constant cross sectional thickness in these things at all!

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12-15-2015, 06:18 PM

#7

bluerider

Member

Join Date: Mar 2012

Location: central coast,
California

Posts: 82

2% is a bit over what you should be getting. I have always just used my shrink rules but if I did the math right 5/32"/ foot would be 1.3%.

I wouldn't be too worried about too much build with the primer on the transfer port cores because it will allow you to use core wash on them to get a better cast surface. I use an alcohol based wash and "sand" the dried wash with my fingers to create a smooth surface. with a bit of practice you can almost eliminate the sand cast texture.

I think you will be just fine with your plan.

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12-16-2015, 10:56 AM

#8

jhenise

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

To make the core boxes for the transfer ports, and the cylinder / exhaust port cores, I was planning on taking a couple solid wood squares, pinning them together for a parting line, then hogging out a cavity a little larger than the port patterns. Suspending the pattern in one half of the cavity (one wood square), filling with urethane, dressing the parting line, adding wax release, assembling the box and pouring the other half with urethane. With the idea being to have about 1/4"-1/2" thick urethane as the mold, with the wood backing. I have seen this done by filling the cavity with bondo and pressing the core pattern into that instead of urethane, but bondo has more shrinkage. I may need three parting lines for the transfer port core boxes.

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12-16-2015, 10:20 PM

#9

nudge

Senior Member

Join Date: Sep 2005

Location: NorthShore,Auckland
New Zealand

Posts: 5,030

sounds like a bit of fun.... Thanks for posting!

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12-17-2015, 12:26 AM

#10

Hopefuldave

Member

Join Date: Mar 2013

Location: Surrey, England

Posts: 61

I'm watching this one too...

IANaTST (I am not a two-stroke tuner), but won't the increase in volume of the transfer ports reduce the crankcase compression? Also, the turbulence may be deliberate to improve scavenging the waste gases and cylinder filling, two-strokes are complicated like that, four-strokes I can get my head around valve timing / overlap / port shapes, but two-strokes? Black art 🤖

Early two-strokes had deflector pistons to direct the transferred mixture towards the cylinder head to help with scavenging, modern flat-top pistons I assume need the transfer ports' flow characteristics to do the same job, how they do it? Pass!

Dave H. (the other one)

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12-17-2015, 07:23 AM

#11

jhenise

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

"IANaTST (I am not a two-stroke tuner), but won't the increase in volume of the transfer ports reduce the crankcase compression? Also, the turbulence may be deliberate to improve scavenging the waste gases and cylinder filling, two-strokes are complicated like that, four-strokes I can get my head around valve timing / overlap / port shapes, but two-strokes? Black art"

High crank case compression and poor streamlining in the transfer passages = old school, high rpm power, narrow power band, low BMEP engines.
You want turbulence in the combustion chamber but not the transfer flow passages, that later just restricts flow of the fuel/air charge entering the engine...

Lower crank case compression, streamlined transfer flow with ports aimed properly for good loop scavenging = modern, wide power band, high BMEP engines, these motors rely more on pressure waves in the pipe to drive scavenging then crank case pressure... the smooth flow in the transfers is one of the major improvements comparing engines of the 1960's/70's to modern engines...

"Early two-strokes had deflector pistons to direct the transferred mixture towards the cylinder head to help with scavenging, modern flat-top pistons I assume need the transfer ports' flow characteristics to do the same job, how they do it? Pass!"

Those are reffered to as "cross flow scavenged" engines, and still see wide spread use in out boards... here we are dealing with a "loop scavenged" engine. the loop scavenged design is generally makes more powerful engines, and you are exactly right transfer flow aiming is key....

if anyone is seriously interested in two stroke engine theory I strongly suggest reading:
Design and Simulation of Two-Stroke Engines -Gordon P. Blair

comparing racing engines of the 60's-70's to modern times you seen this general trend: crankcase compression has gone down, transfer and exhaust port flow area has gone way up, transfer flow aiming and streaming has improved significantly, and expansion chambers have become better. Crankshaft, piston, and head design is nearly identical.

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12-17-2015, 09:04 AM

#12

bluerider 

Member

Join Date: Mar 2012

Location: central coast, California

Posts: 82

Your plan for how to make the core box is spot on. Establish the parting line on your cores and then make what is sometimes referred to as a follow board, basically just a scrap board that you cut as close to the profile and then smear bondo on it and smoosh it against the part (using mold release of course). depending on the shape and size sometimes I will drill a hole a 1/2" or even a couple of holes and pour the urethane from the back side.

Don't forget to plan the core prints for your cores before you make the core boxes. This is also the point where you will want to decide how you're going to pour the cylinder, horizontal or vertical. If your using chem bond for the mold I would go with vertical but if you're using green sand I would probably go with horizontal unless you are using cores to get the fins in which case I would pour it vertical. Once you get the orientation sorted out you need to decide how you want to place and secure your cores. Is everything going to just sit in the drag or are the transfer port cores also going to have a print that sits in the cylinder core? will the transfer port cores be glued to the cylinder core using a jig and then set as a one piece core or will they be dropped in one at a time? If the later you need to do a full scale cross sectional layout of a transfer core and the cylinder core to make sure the draft on the prints will allow you to set the core in place, don't forget to draw the fins.

Back to the cores and the prints. As you can probably tell I would lean towards a print on each end of the transfer port core, but either way I would pour the urethane

without the print attached and make that part of the box as a removable piece which will essentially look like a frame. Depending on how you part the core you could potentially have problems with the prints being at 90° to each other so for that reason one or both prints may need to be smaller than the part where they meet up, hence the separate removable piece for the print portion of the core box which would eliminate any shoulders that would lock the core in the box due to the 90° orientation of the prints.

I would also leave the tops of both prints open, in other words the core box will have two openings. you can always clamp a board over one opening but on small curved cores like that you might need to pack it from each end.

I know the deck height can be machined to change the port timing but my understanding is that you want the transfer ports to all have the same top and bottom heights relative to each other. For this reason I would be inclined to have at least a shallow print in the cylinder core and if you want to glue them up and drop them in as a single core then you need a bit larger print. The box for the cylinder core will be the more complicated of the boxes. It will be split on the center line with one print in one half and the other two prints in the other half. the half with two will be a box with two large loose pieces with split being on the center line, i.e. the entire mold surface on that half of the box is formed by the two loose pieces vs. having only the prints being loose pieces. If I haven't explained this part very well I can make a couple of sketches.

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12-17-2015, 02:04 PM

#13

Hopefuldave

Member

Join Date: Mar 2013

Location: Surrey, England

Posts: 61

Thanks J, for the explanation and for the book recommendation - I'm half-heartedly thinking about getting a small 2-stroke bike (350LC perhaps, or a 250 Gamma?) for Sunday morning Hooligan rides, and I like to know the Inner Workings of my machines 😊 Do you have the ISBN off the cover of the book I can use to look it up, see how extraordinarily pricey it is?

Dave H. (the other one)

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12-17-2015, 03:55 PM

#14

jhenise

Junior Member

Join Date: Dec 2014

Thanks again for the advice Bluerider. I have been enjoying our discussion about wood and reading the related wood thread you started...

Location: San Francisco, USA
Posts: 28

I have seen cylinders done where the transfer port cores have prints on both ends.

My approach was going to cast the cylinder vertical in a chem bond mold, the transfer ports will have prints on the bottom that serve three purposes: 1) aligning the port with the cylinders axis, 2) setting the port window and deck height (yes all three need to be the same), 3) molding the lower portion of the port into the cylinder "liner skirt" (the portion below the deck).

I was planning to use a simple rod shaped core for the cylinder core with no prints for where the transfers attach. But with a step used against the core prints to set the port heights. The cores would be glued together and dropped into the sand mold as one piece. Or the sand mold would be the actual fixture used to glue the cores together.

When I go to make the pattern I will first make the entire core structure with prints (probably from urethane castings made from the actual core boxes) and build the pattern around that, this way I can insure that the prints will be in workable positions in the sand mold...

Will be posting some progress soon!

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12-17-2015, 06:45 PM

#15

Michael Moore 

Senior Member

Join Date: May 2008

Location: in the fog of San Francisco

Posts: 166

Dave, you might also look at

<http://iheartstella.com/resources/ma...nce-Tuning.pdf>

and

<http://www.amrca.com/tech/tuners.pdf>

for the 2T books by A. G. Bell and Gordon Jennings. The price is right.

cheers,
Michael

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12-17-2015, 09:04 PM

#16

jhenise 

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

I pulled these of amazon form Blair's book:

ISBN-13: 978-1560916857

ISBN-10: 1560916850

I think A.G. Bell's book that Michael posted above is

probably the most fun to read of the three, and explains two stroke tech/tuning very well, but leaves a lot to be desired in terms of "what exactly to do", if you want to apply the knowledge.

Jennings is getting a bit dated but there is still a lot of great information in there, and some of it is timeless, either of those books is a better read for the basic understanding, then Blair.

Jennings offers quantitate solutions to tuning, I actually drew the engine geometry and calculated port time areas on graph paper for the first motor I ported and designed a tuned pipe for it after reading Jennings.

If you really want to design an engine study Blair's work, but it is very dry and technical and will put you to sleep if you aren't interested in the hard core math to predict how an engine works.

This one can take years to understand :-)

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12-18-2015, 07:46 AM

#17

jhenise ▾

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

Holiday business has been slowing my progress this week so minimal progress to report but there has been some. I need to have this casting done by the first week of February to have time to have the bore plated, and be able to do some test and tune on the bike before its first race in New Orleans in March, so plan to see me get busy!

Here are some photo updates of the project...

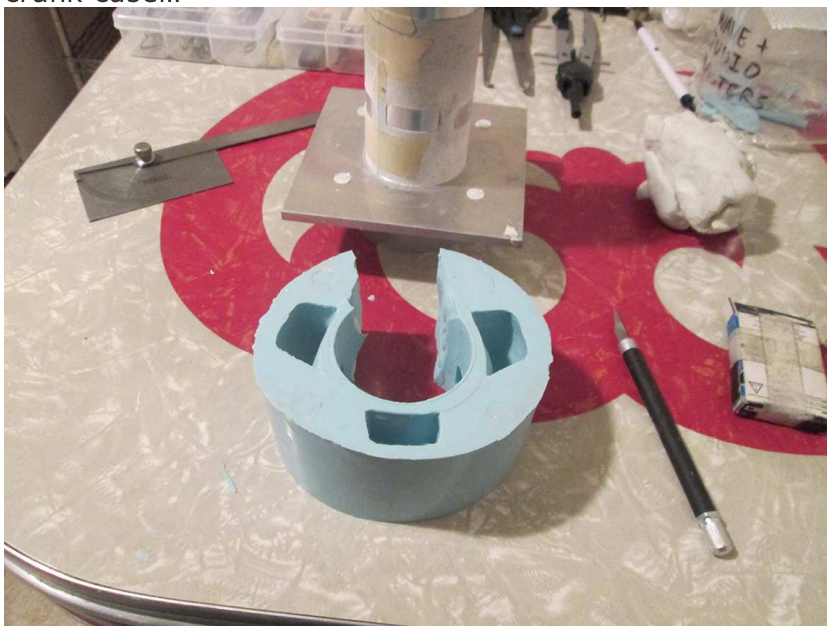
Demolding the silicone transfer port mold...



Tools of the trade, I like how this clay work can be a "kitchen table" job...



Silicone transfer port mold showing the lower cylinder-deck face where the transfer port windows will meet the crank case...



Here are some urethane copies of the transfer ports that were cast from the silicone mold. These are just for reference and will not be used to make core boxes. Urethane copies cast with integral core prints and the missing "cylinder liner-skirt" face will be cast next, and those will be tuned up a bit with bondo and sanding, then used to make the core boxes...



A load of rough sawn, dry, poplar stock for the pattern shop, following Bluerider's wood advice:
<http://www.alloyavenue.com/vb/showthread...-patternmaking>

Now he has me wanting an 18" disk sander, but I priced the good ones and they seem to weigh in at about \$2-3k new and \$1k used! Crap, seems like such a simple tool, but expensive! Although I LOVE my basic 6" belt sander it is worth its weight in gold and I am sure the big disk would be too....



More fun with silicone and urethane: these are the "Henise mold alignment button Model 1"





You can see the machined aluminum version of them in this pattern and sand mold... Making these urethane castings sure beats running the lathe! That story published here:

<http://www.alloyavenue.com/vb/showthread.php?p=ns-to-castings>



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12-18-2015, 08:06 AM

#18

4cylndrfury

Senior Member

Join Date: Jul 2009

Location: Cincinnati, Ohio, USA

Posts: 3,406

Blog Entries: 1

I love seeing your images - its clear you are skilled when it comes to pattern making and fabrication. Thanks for posting. I hope the holidays dont slow you down too much, I am enjoying the ride thus far!

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01-08-2016, 10:17 AM

#19

jhenise

Junior Member

Join Date: Dec 2014

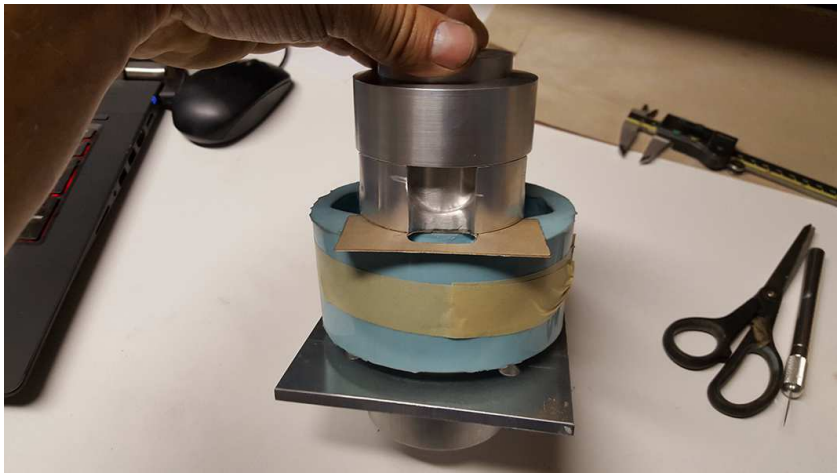
Location: San Francisco, USA

Posts: 28

Progress to report!!



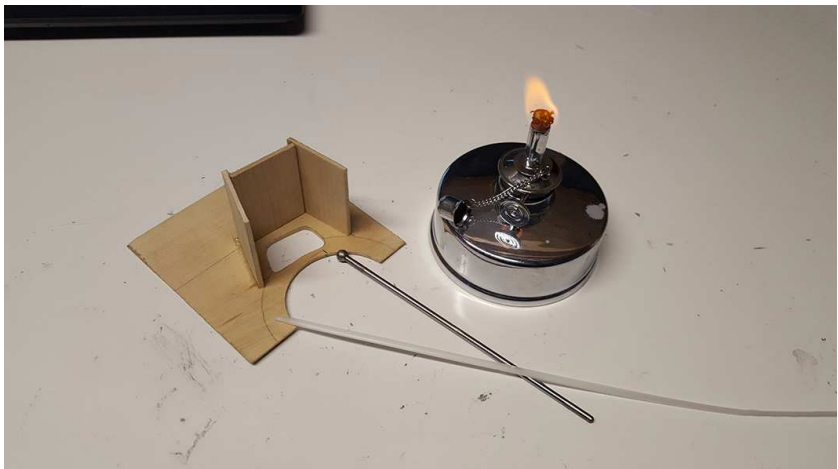
here is a pattern made from aluminum to model the cylinder liner-skirts portion of the transfer ports...



here is how the liner skirt pattern will be used with the silicone mold of the port passages...



this shows the five-piece mold that will be used to make a urethane casting of the transfer port passage with the liner-skirt portion and integral "core print"...



wax fillets were used to get rounded corners on the core print...



A urethane pour...



transfer port castings with core prints after a little sanding to smooth...



Here are the transfer port core patterns after a little polyester tune up, also shown is the exhaust port pattern with core made from foam...



and finally all of the port-core patterns after all sanding smoothing and given a coat of primer for final smoothness...

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01-08-2016, 11:17 AM

#20

jhenise

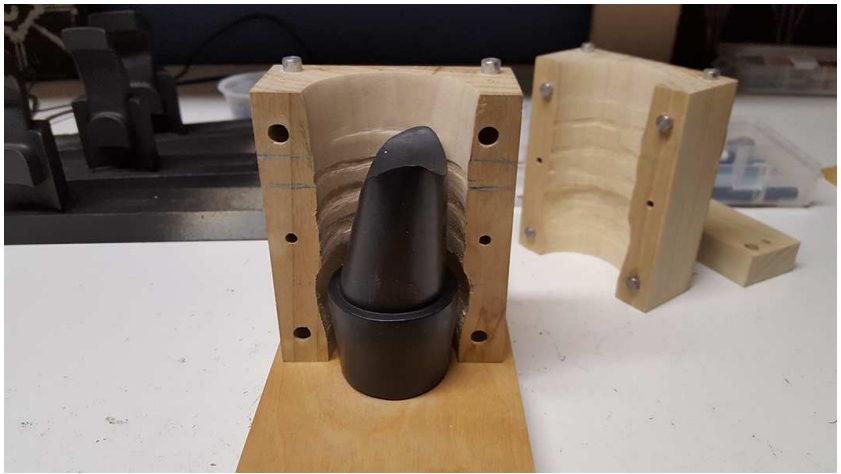
Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

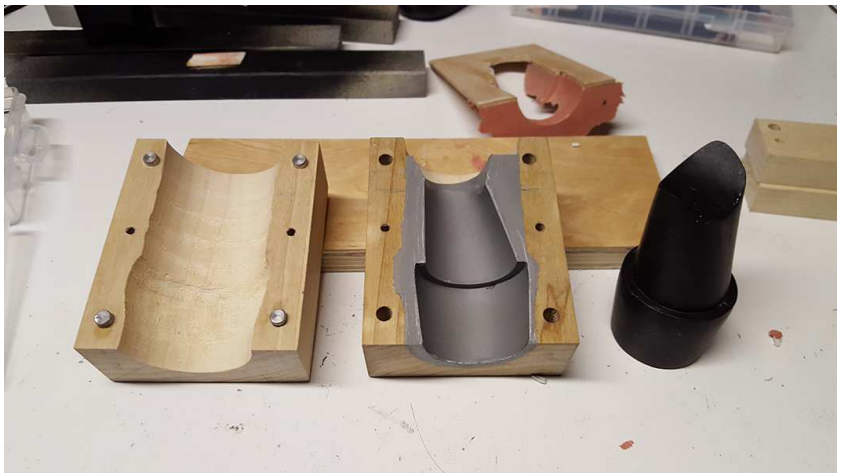
After the core pattern exist, core boxes must exist...



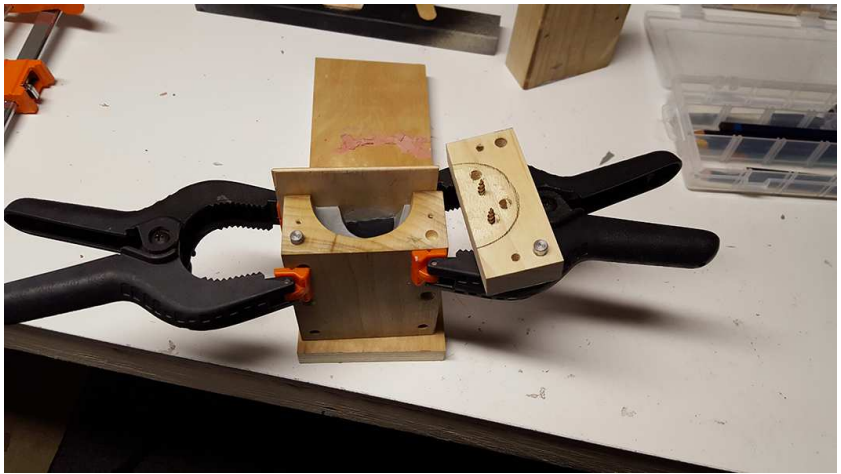
Poplar halves that will for the exhaust port core box...



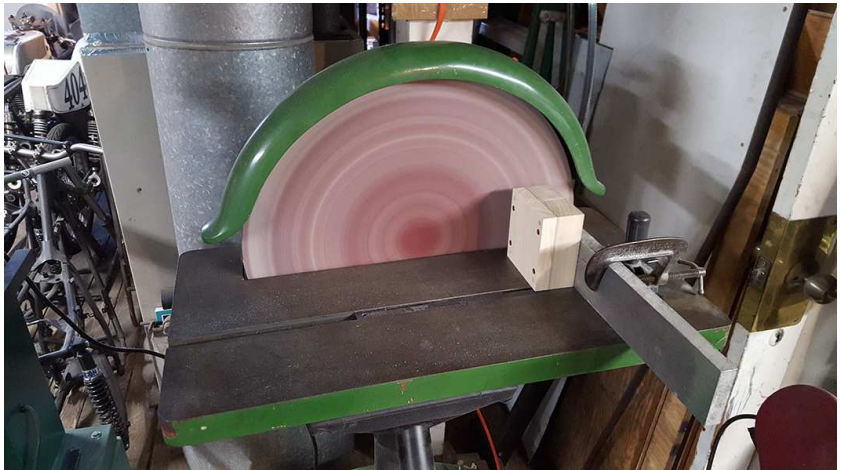
Wood, bondo, and clay are used to make a follower board and establish the parting line...



After pouring urethane and demolding a core box section exists...



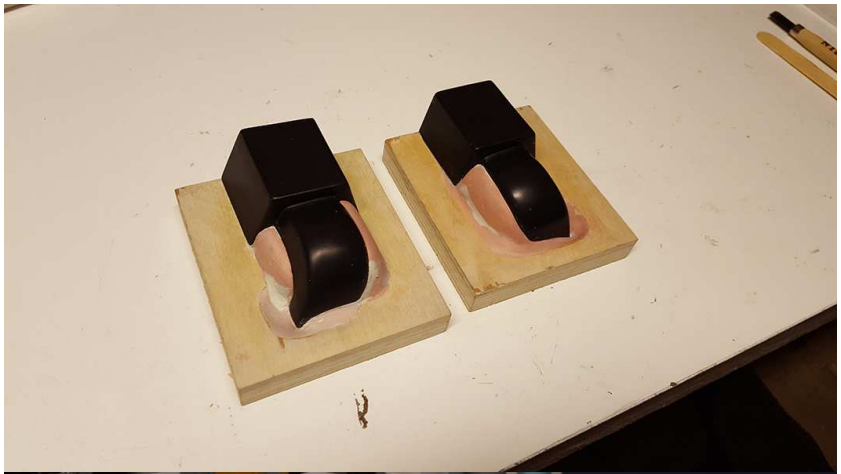
Setting up to pour the top insert, this one used a sprue and riser though the board...



the super-awesome 20" "pattern makers" sander in action...



Setting up follower boards for the main transfer port core-patterns...



Bondo and clay are used to build the irregular parting line...



here you can see the wooden core box, urethane facing (grey), core pattern (black) and sacrificial bondo (pink polyester) follower to make the parting line...



More core box parts, patterns, and followers...



And some more urethane pours...

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01-08-2016, 11:40 AM

#21

bluerider

Member

Join Date: Mar 2012

Location: central coast,
California

Posts: 82

looks good, nice 3d puzzle your making there. Looks like a four piece mold with two loose pieces, one for the very bottom of where the transfer port joins the cylinder for the piston skirt, and one for the other end of the port. Its always preferable to have cores like this open from each end but in this instance I think that would result in some thin and fragile core box pieces. I would make a box with

steeply tapered sides to hold all the individual parts. Done right you wouldn't need to use any screws or dowels to hold the parts together. turn the box over and rap it and all the parts come out then you can pull each part off the core.

Are those registration button molds you have sitting near by for the extra plastic?

- - - Updated - - -

I spoke too soon, It didn't look like you had the draft for a three piece mold. Your getting good with the bondo.

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01-08-2016, 01:04 PM

#22

jhenise 

Junior Member

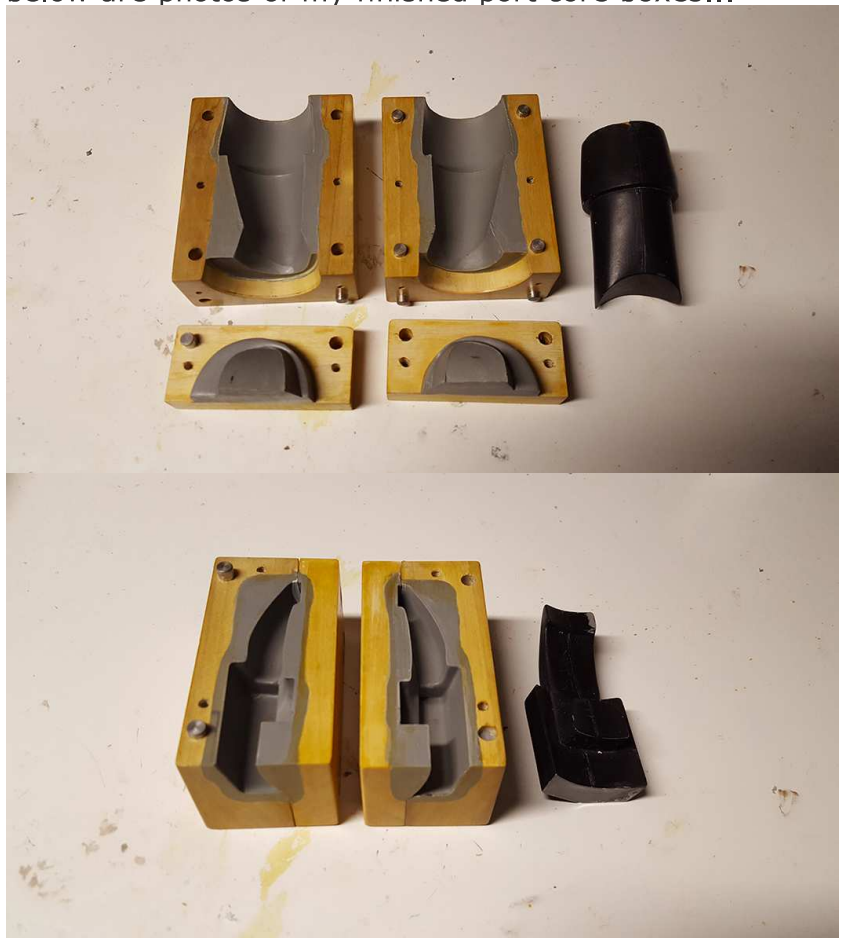
Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

thanks! yep those are registration button molds that i use for the excess plastic. I am accumulating a lot of the buttons, they are designed to for the buttons in sand. I like the idea of the tapered core-box with drop out look parts.

below are photos of my finished port core boxes...





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Yesterday, 02:06 PM

#23

jhenise

Junior Member

Join Date: Dec 2014

Location: San Francisco, USA

Posts: 28

More progress, beyond core boxes an onto the pattern...



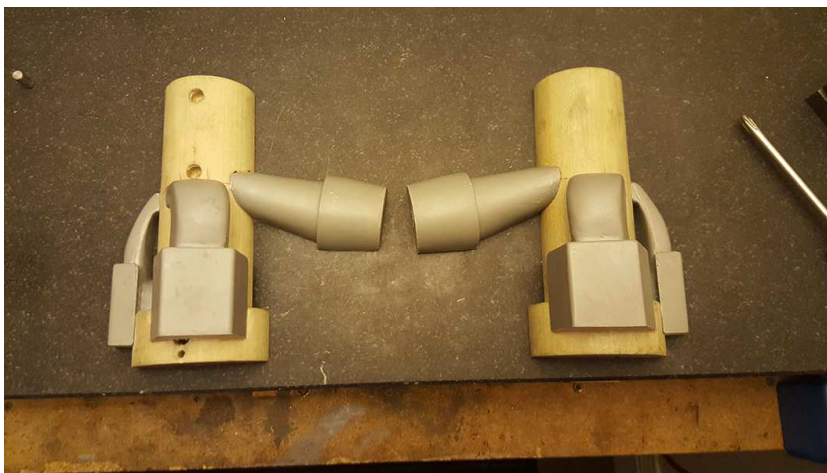
One last core box for the cylinder core, and shellac coating...

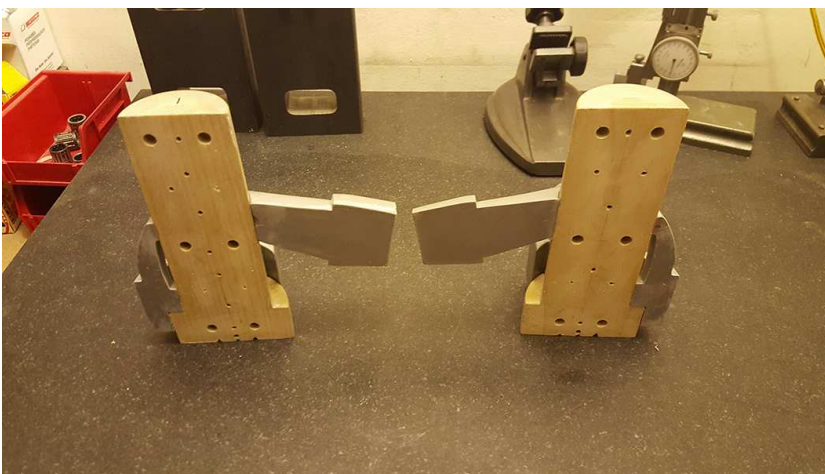


The actual core boxes were used to make urethane castings of the core structures that will be used as parts of the pattern, note two of the ports are split at what will be the parting line and were cast as two pieces.



These are all the parts that will make the core structure, however two port-cores here were produced as two pieces to use in the pattern as they will be split at the parting line.





And here is a full model of the core structure with core-prints, as a split pattern. The rest of the pattern will be built on top of these models.

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Yesterday, 05:13 PM

#24

nudge

Senior Member

Join Date: Sep 2005

Location: NorthShore,Auckland
New Zealand

Posts: 5,030

Very cool! I will have to keep a good eye on this thread..... I may just require it later.

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Yesterday, 08:28 PM

#25

Quadra

Junior Member

Join Date: Jun 2015

Posts: 13

Awesome work, That sander is sweet! is it a Wilton?

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Today, 06:32 AM

#26

rotarysmp

Senior Member

Join Date: Dec 2010

Location: Vienna, Austria

Posts: 374

Blog Entries: 4

Very impressive core work. I just read your Website postings on your bike deveopment. Wow. Impressive work with a welder, with the grinder, with the lathe. Great skills.

Regards.
Mark

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Today, 07:07 AM

#27

DavidF

Moderator

Join Date: Jan 2012

Location: Wilmington DE

Posts: 1,758

A very informative thread and great work. Well deserving of a sticky 😊

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Today, 01:32 PM

#28

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