**SECTION TWO-**

**Accucraft Cab Forward (AC-12) Upgrade: Combination levers, Cylinders and valves**

Thanks to the work of Gordon Watson, Ryan Bednarik and Jeff Redeker; this DYI sheet can help owners of the Accucraft AC-12 upgrade their fine steam locomotives in areas that can improve performance and/or prevent premature failures.

There are several mechanical and structural areas on the Accucraft Cab Forward that could be improved. These improvements would be necessary for the betterment of running characteristics, overall functioning and preventative of premature wear and tear. Based on this premise we offer a series of key areas that will enhance your AC-12 for the long term: crosshead and guide, rear engine flex joint, cylinders/passageways, combination levers and suspension.

If you have any questions feel free to post them here or contact us at:

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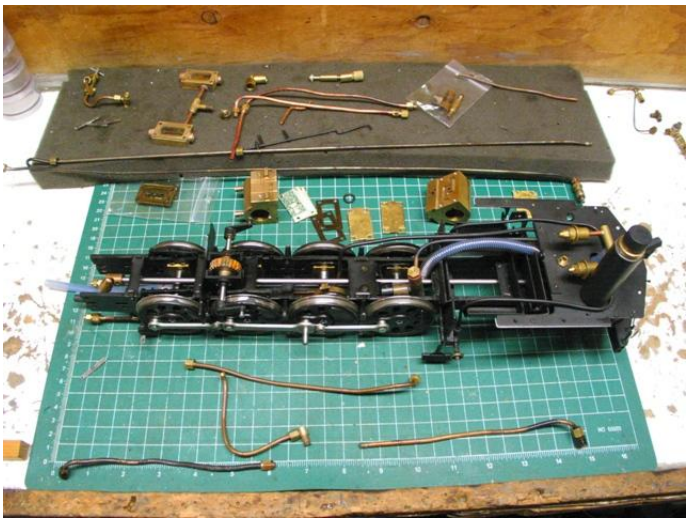
There are three basic aspects to an efficient locomotive: making steam, steam delivery and steam utilization. The heart of the locomotive is the cylinders and valves. The baseline performance of a stock Accucraft locomotive, as advertised, should be able to pull about thirty cars at a reasonable speed (40 SMPH). Our experience indicates that a stock AC-12 will pull 4 pounds (as indicated by pull test at Diamondhead International Steamup) and have the capacity to run at least 30 minutes before running low on oil.

So, why and how can one improve on these perimeters?

Design- the completion of the combination levers, valves and cylinder changes allow for proper function of the valve gear, with the; radius rod, expansion link, and combination lever working in unison to admit steam relative to the motion of the engine.

Function- having the ability to run with cutoff (notched up or back in layman's terms), better steam passages (Oval ports instead of holes), and proper structural setup makes for an improved performance along with prevention of premature wear of critical parts. The following photographs give a general overview of the power units (engines) during various stages of the rebuild:

Front engine-



Rear engine-

**Combination levers:**

The operational setup of a gauge one engine should match those of the 1:1 counterpart. To have dummy combination levers will result in a less efficient running locomotive as the valve gear will be running full admission regardless of the radius rod position. There will also be no direct correlation between the valve and the piston, (when cutoff is used, the piston action assists the valve to complete its throw independent of the radius rod position), creating a heavy consumption of water and fuel. The 1:1 prototype had the capacity to utilize cut off to reduce the valve throw through the raising of the radius rod in the expansion link, relying on the expansion of the steam in the cylinder rather than the

volume of that steam, thus requiring less steam to achieve the same net force (similar to an overdrive on your car). In particular terms this would allow for longer runs with less strain on the moving parts.

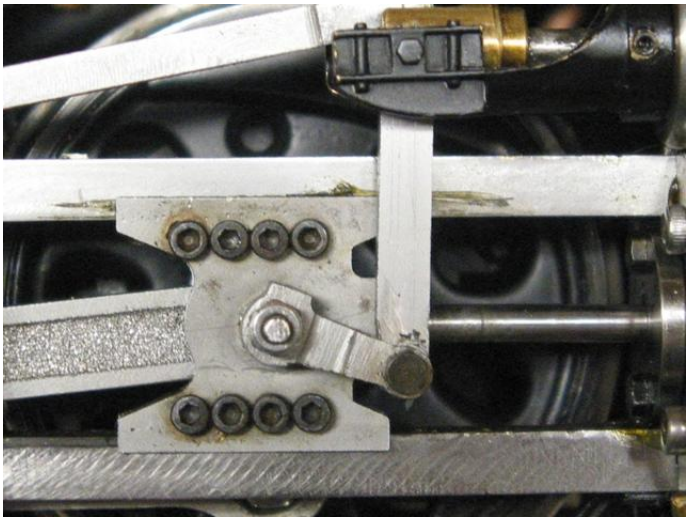
The installation of the combination lever would be straight forward if the stock valves were able to account for the necessary lap and lead. The GS-4's were fitted with valves having 1mm of lap, unfortunately, the AC-11/12's were not.

The dimensions of the combination lever are:

Stock- 1.5 mm 304 stainless
Length 30.2mm
Holes 2mm except for uppermost hole at the top, which is 1/16 to accommodate the connection to the radius rod
-Distance between holes
Top to middle: 3mm on center
Top to bottom: 26.5mm on center

The photo below shows the difference between the OEM on the left and new lever (prototype for dimensional and functional purposes) on the right:

The new working combination lever fitted in place:



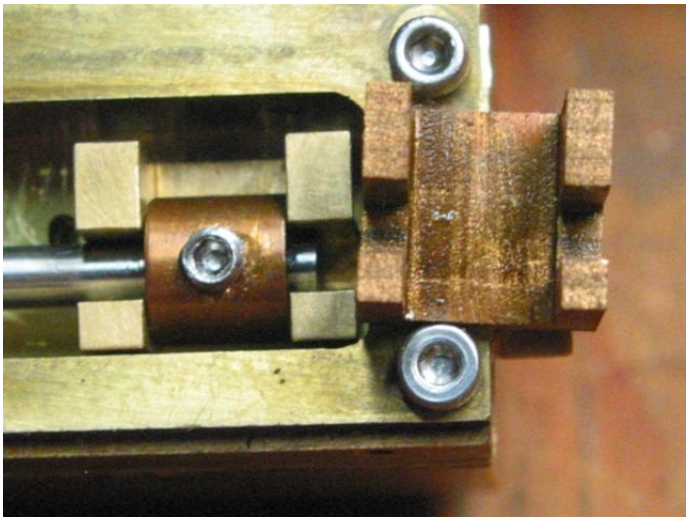
**Valves:**

The valve and its movements are arranged so that the steam ports, which are how steam is admitted or exhausted to the cylinders, are open only during a portion of the piston stroke. At full admission, the valves allow the largest volume of steam into the cylinders as possible, limited only by the port size and steam pressure. When the steam supply is "cut off" however, less steam is admitted per stroke, utilizing expansion over volume to move the piston.

If a slide valve is designed with lap, the amount of forward and rear lap should be equal when the valve is in its center position. Inside lap (often called lead) should be less than outside lap. Most high speed locomotives did not have inside lap as it delays the exhausting of steam.

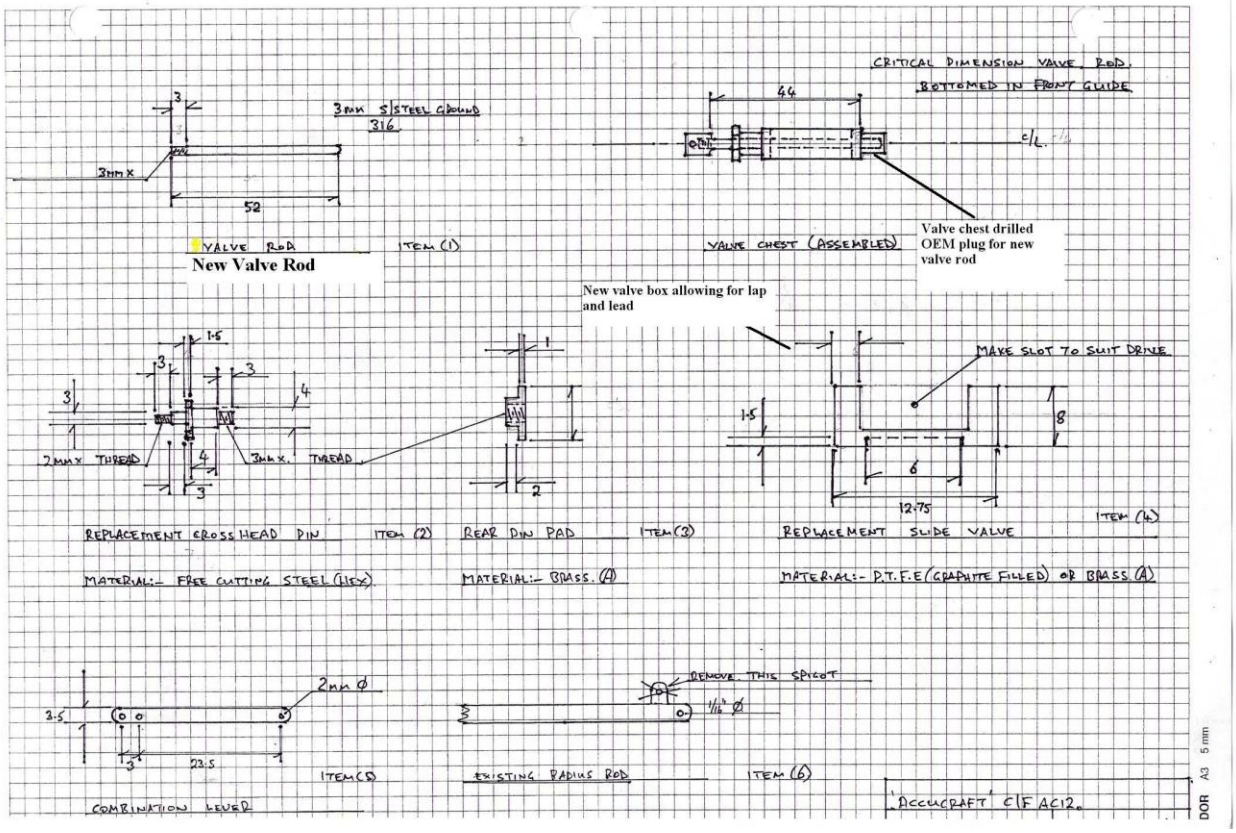
Unfortunately, the AC-11/12's were not fitted with lap/lead in the valves. The benefit of producing a zero lap valve is that the valve gear can remain single eccentric and the events will always be square, albeit possibly overdriven (the valve opening past the port face).

In this case the valves were remade to a larger size to allow for the proper range of motion to reduce the valve throw:



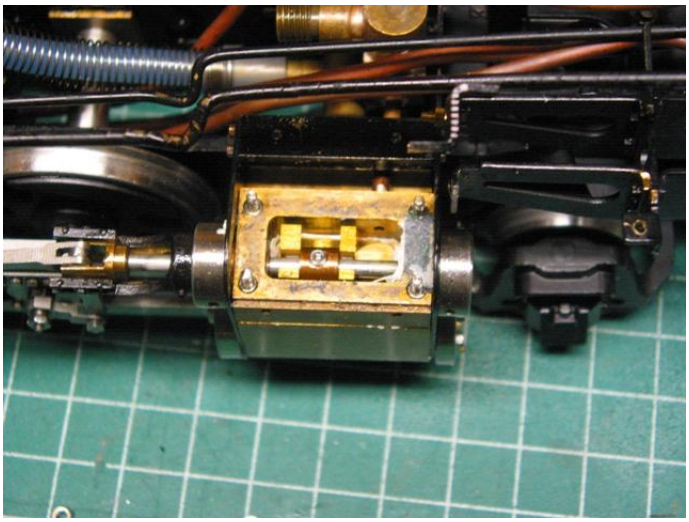
Valve block dimensions and the longer valve rod and front supporting guide were the necessary upgrades. We also changed the studs that are prone to slipping, stripping and breaking to stronger stainless allen cap screws.

Drawings (G. Watson) of the critical changes to the valve block and rod:




The valve chest needs to be setup for a new rod and guide that allow for proper support during the movement front to back, preventing wear of the rear stuffing gland and damage to the rod. The OEM

rod is too short and is not supported at the front end requiring the front plug to be drilled out for the longer valve rod.



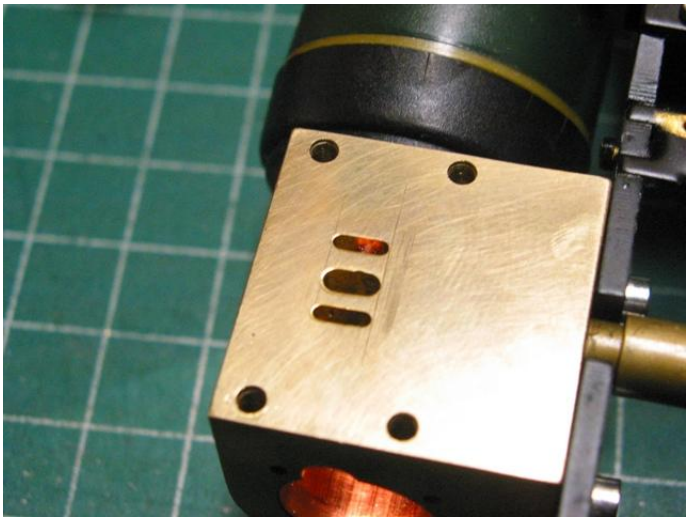
So, we have upgraded the combination lever, valve block components now to the core unit: cylinders.

Cylinders:

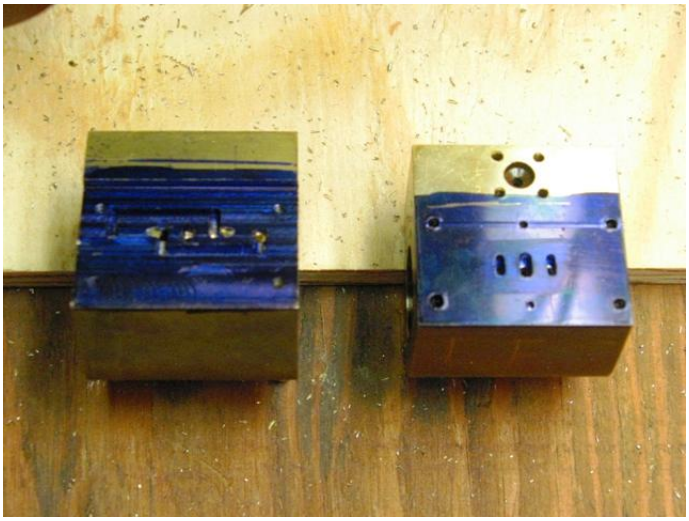
There are three changes done to the Cab Forward cylinders:

- Increase passage sizes to: 2mm intake (delivery) 2.5mm exhaust
- Port sizes are 1.5mm and 2mm for intake and exhaust, respectively.
- Plug and redrill the existing ports to comply with the cross porting design
- Produce a port plate used to cover the cross port passages (keeping the original valve face layout)

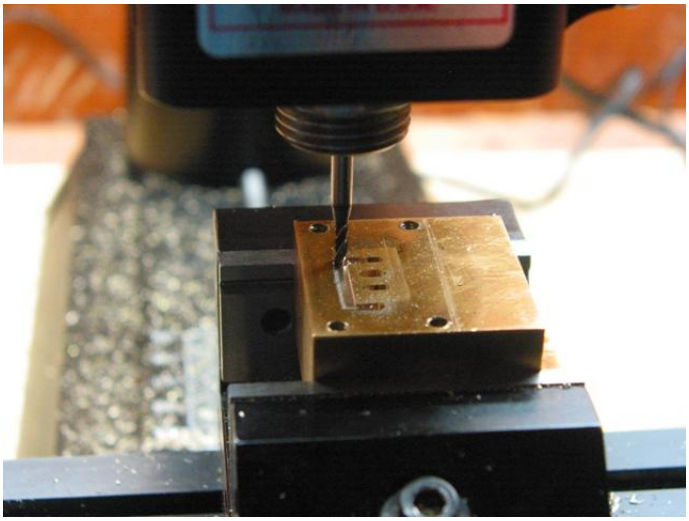
The photo below is the original cylinder block modified with increase steam passages.



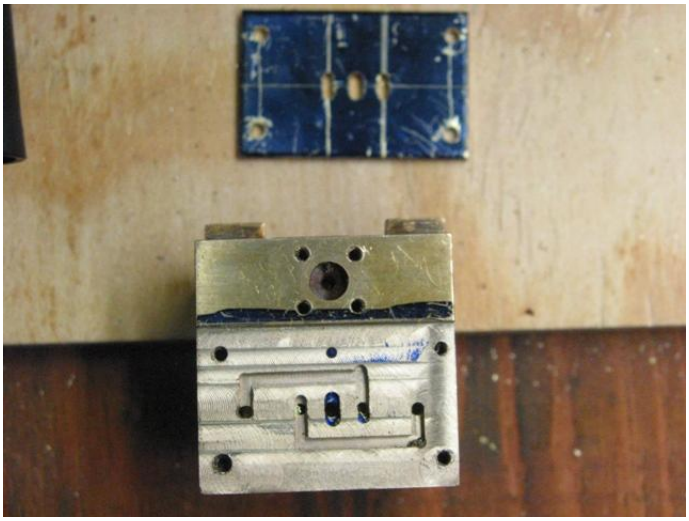
The starting point of making the changes to the cylinders as shown with this set; on the left is an outline for the cross porting and on the right the original layout:



Milling of the cross port passages is the first step.  The ports are milled to a depth of 3.5mm

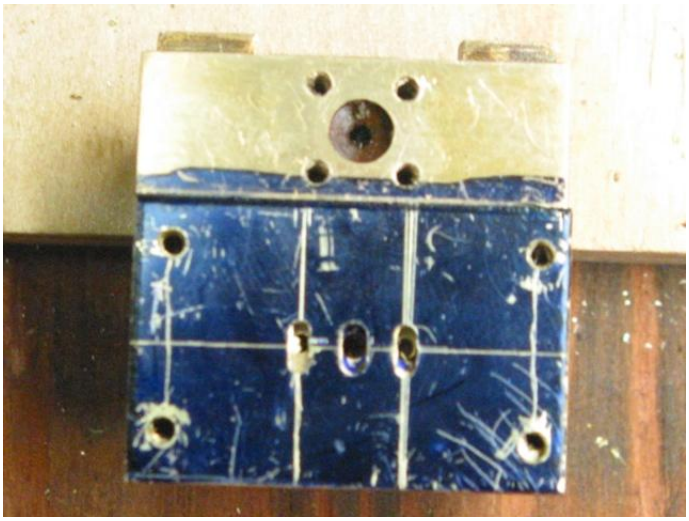


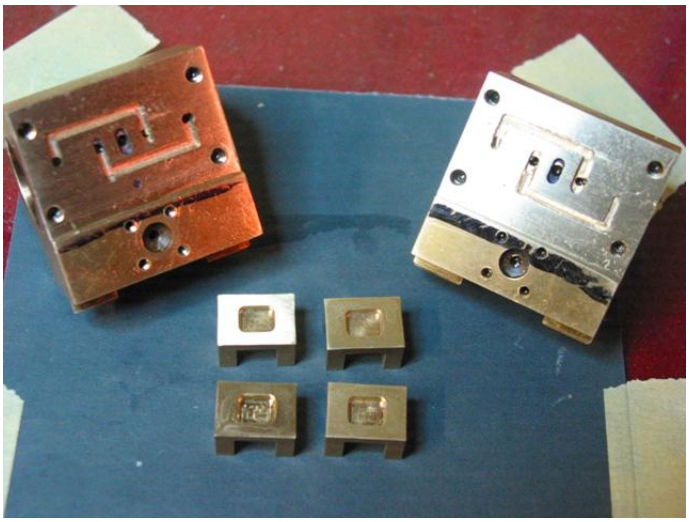
The next milling job is to take off the material necessary to fit the plate (1.5mm taken off):



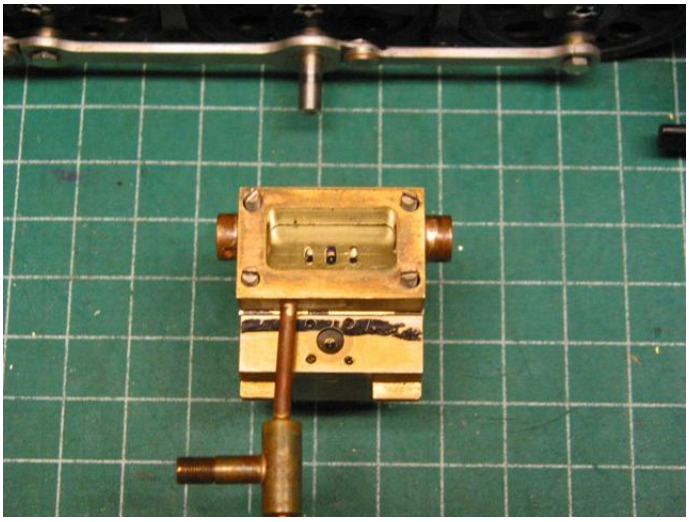
The cross passages are milled to the following dimensions [13.37mm long x 4.06mm from centre x 2mm wide x 2mm deep]

Here is a check of alignment for cylinder, plate which will have to be matched to the valve chest bolt pattern later:



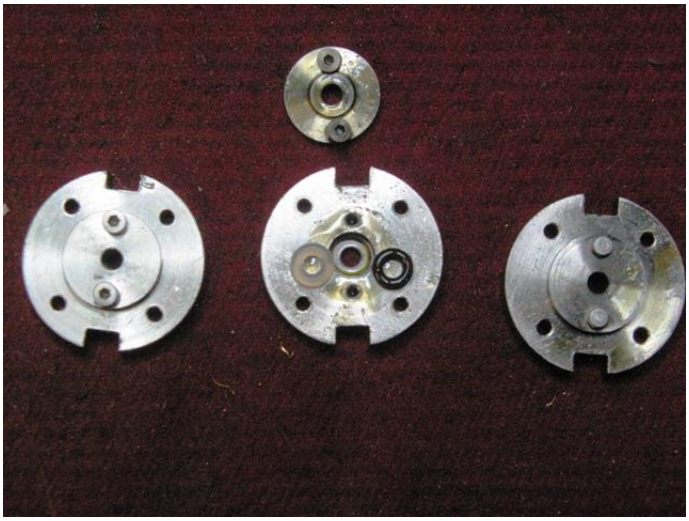


The next phase is the lapping of surfaces to ensure a flat and level assembly with no leakage.

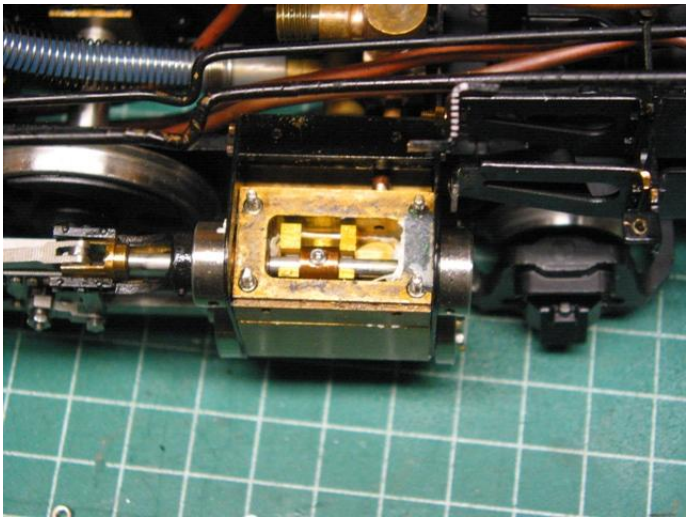


The upgrade for the pistons has new graphite impregnated PTFE rings in a compression or cord style; much like those found on the full size loco, or on an IC engine (original o-ring is on the bottom):

The cylinder plates and valve cover need new “O” rings (new one on the left):



The photo below is a complete unit (by G. Watson).



The completed rear engine: awaiting the oil line to be installed onto the dog bone.