

6-inch M1900 Seacoast Gun Elevation Counterweight Project
Design, Fabrication and Installation
Ft. Hancock, New Jersey
(October 2019 to April 2022)

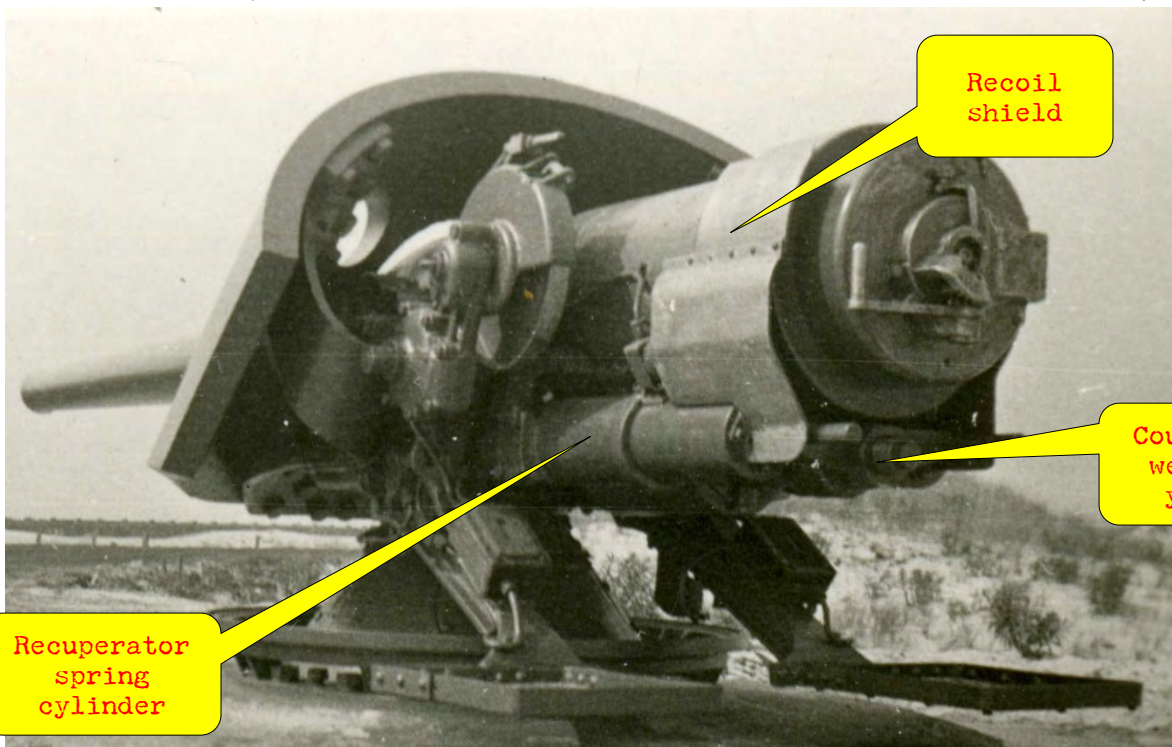
The two M1900 6-inch guns at Battery Gunnison/New Battery Peck are fully articulable. They traverse and the gun tubes elevate. The photo below shows Gun #1 with the gun tube fully elevated to 20 degrees.



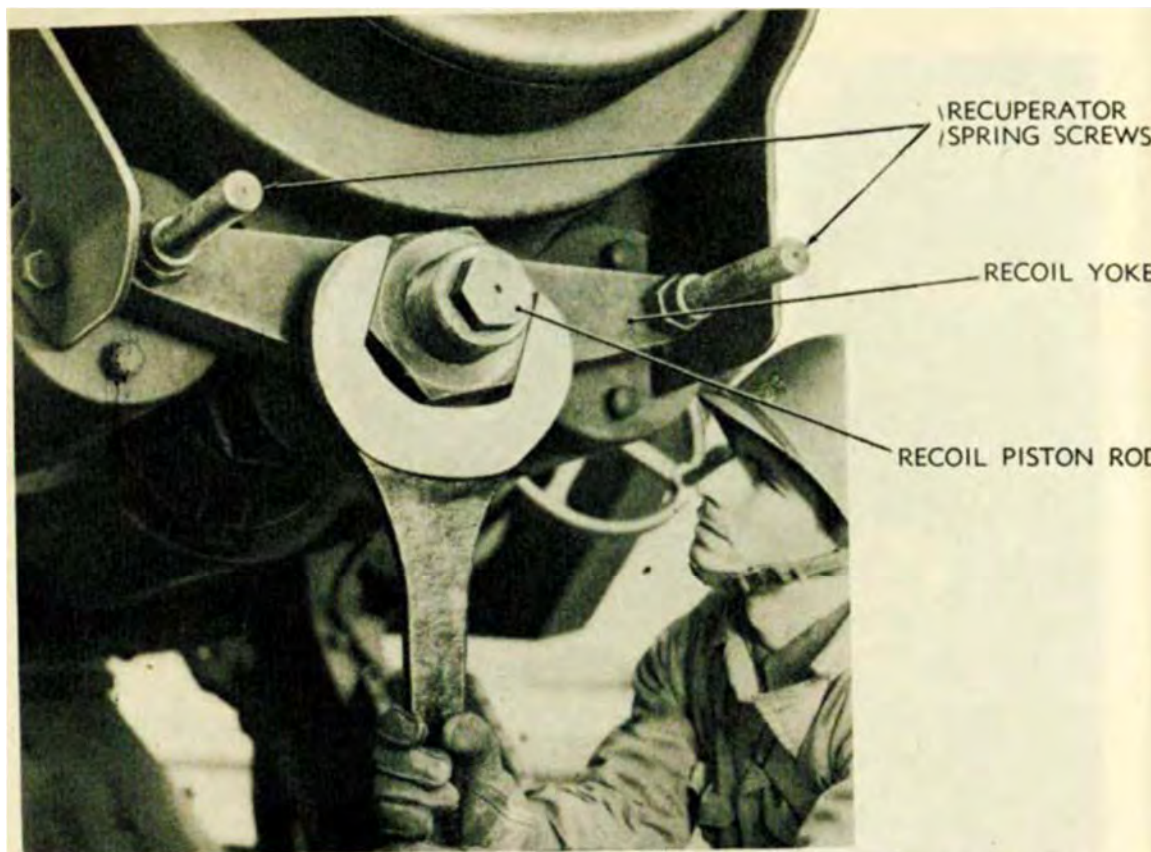
When AGFA began work at Battery Gunnison/New Battery Peck, the gun tubes were out of balance by about 1,200 pounds. In accordance with TM 9-428, the normal elevation effort required is 2 pounds of pressure. The missing weight is due to the removal of the recuperator springs, shafts and dampers. There are two of these cylinders, one on each side of the gun. In order to elevate the gun tubes (which are muzzle heavy), it typically required five or six grown men to sit on the breach area. The picture below shows four men preparing to replicate the missing weight. The left foot of the gentleman on the right is resting on the right recuperator spring cylinder.



The guns were missing the Recoil shield and the yoke at the back of the gun. These are shown in this 1937 photo of one of the guns of Battery Kessler at Fort Tilden in the 1930s (Gateway National Recreation Area collection number 4193).



The two photos below show recoil yoke, recoil piston rod and recuperator spring screws. This photo is from page 52 of TM 9-424 - 6-inch M1900 Seacoast Gun, Mar 1945.



The team that developed the counterweight solution consisted of T-4 King, T-4 Ciemniecki, T-5 Tunison, and LTC Welch. The solution evolved over eight months from being a lead to steel solution. Lead was ruled out in late September 2019 and the team moved forward on securing steel rod sections.

On 10 October 2019 the first order of steel slugs was placed. This was for 18 each steel slugs weighing about 41 pounds and measuring approximately 5-7/8 inches diameter 5 to 6 inches long. These slugs represented the first physical action replace the missing weight in the carriages. Cost for these slugs was about \$515 total. The 18 slugs would be fit 9 per cylinder on Gun #1. The slugs arrived at Fort Hancock on 10 October and they were coated with POR-15 as a rust preventative. The slugs were to be installed on Friday 12 October 2019. The approximate weight of these slugs was about 740 pounds - approximately 462 pounds short of the goal.

The design of the counterweight system was evolving and this initial weight installation of 9 slugs to each of the recuperator cylinders would serve as the starting point for analysis.

In the photo below, the 18 slugs have been coated in POR-15. After hardening, they are stuck to the table and PVT Morrison is using a sledge hammer to break them free as T-4 King looks on.



The breach end of each recuperator spring cylinder has a 1-1/8-inch diameter hole. In order to get the slugs out of the cylinders it was decided to drill a hole into the top of two of the slugs to enable the seating of a metal rod to either guide the slugs down into the cylinder or to enable the slugs to be removed from the cylinders. In the photo below, LTC Welch drills a 1-inch hole into the top of one of the two slugs.



In the photo below T-5 Tunison holds one of the slugs with the seating hole after hit has been coated with POR-15.



In the photo below PVT Budjos, PVT House and SSG Minton prepare to place the slugs in the recuperator spring cylinders on Gun #1. All 18 will be installed.



Below SSG Minton lifts the first of the slugs into the cylinder. Notice this slug has the half inch hole for the steel rod to seat for removal or as a guide during installation into the cylinder.



Below PVT House and SSG Minton install the slugs as PVT Budjos and TSG Weaver stand by to assist as needed.



Below the team continues to install the slugs.



As the slugs move down into the cylinder, sometimes they need an assist. Below TSG Weaver and SSG Minton use the 1 inch steel rod to push the slugs into the cylinders.



With all 18 slugs in the cylinders the additional weight is 740 pounds. Adding PVT Budjos and PVT House to the breach area adds an additional 400 pounds. With this additional weight, LTC Welch is able to easily elevate the gun tube.



T-4 King researched options and found 7-inch diameter six-inch-long slugs that weigh about 70 lbs. each. A shipment arrived in early November of eleven 7-inch slugs and two 9-inch "cap slugs" (right of wrapped stack) for the backs of each recuperator cylinder for Gun #1. This cost AGFA about \$1,000 total. Also sent with this shipment was four of the 1-1/8-inch diameter stainless steel threaded rod to simulate the recuperator rods. We later discovered the rods were in fact 1-1/4-inch.



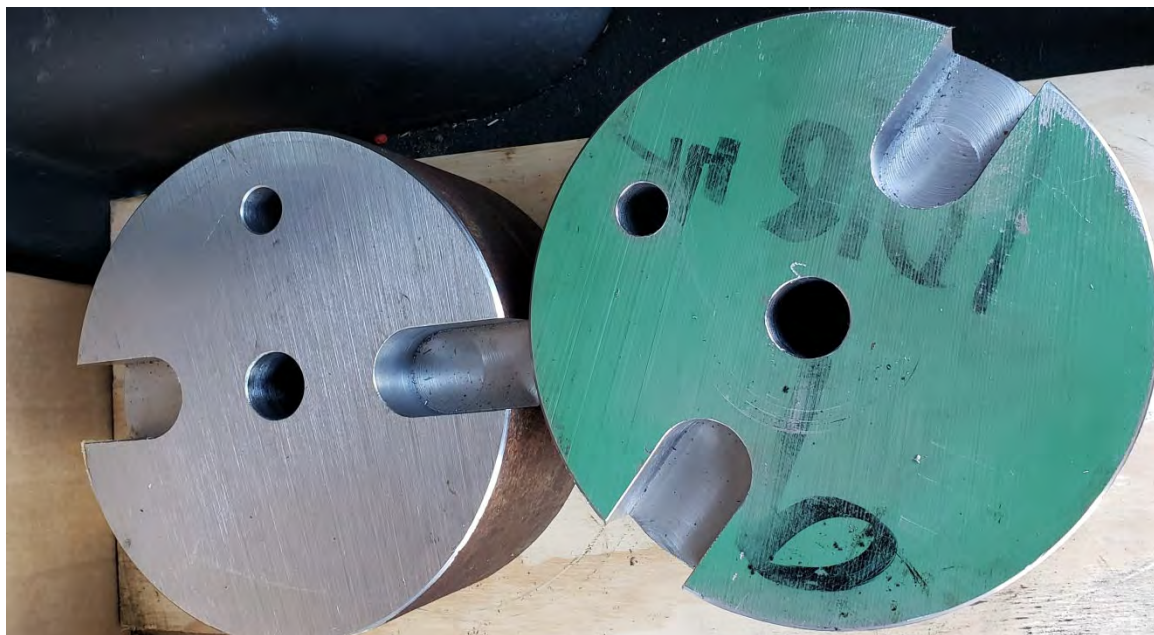
That weekend the slugs were treated and prepared for POR-15 application. Below TSG Weaver, T-4 Ciemniecki and T-4 King stand by after placing the slugs on the table for POR-15 application. The two slugs nearest the camera are the large 9-inch pair for external attachment to the recuperator cylinders.



The large 9-inch slugs required off-site machining. This work was done by James Wolf at Motion Systems Corp., Eatontown, NJ. Their lathes are much bigger than AGFA's lathes and much better suited to the difficult work required.



On 26 November 2019 the two end slugs for Gun #2 returned from Jim Wolf's shop ready for POR-15 treatment and installation on Gun #1. However, we would later discover the rear of the cylinders on the two guns are different which required the two slugs made for Gun #2 to be altered.



21 November 2019 T-5 Tunison and T-4 King have applied the POR-15 to the slugs and to platform light top plates.



The difference in size of the exterior cap slugs for the recuperator cylinders is apparent in the photo below.



Below T-4 Ciemniecki inserts a bolt to hold one of the end slugs onto the cylinder of Gun #1 to confirm they fit.



Below T-54 King and T-4 Ciemniecki continue testing the fit of the two new slugs.



The team also tested the new "yoke" pattern concept. This pattern will be sent to a foundry to make a copy of the "pattern" for a 100 to 150 pound cast iron yoke for the guns. The two stainless steel threaded rods simulate the spring rods.



Below T-4 Ciemniecki drills the half inch deep seating hole into the center of one of two 7-inch steel slugs.



By the end of the day, the eleven new 7-inch slugs and the new 9-inch slugs had been treated with POR-15 to prevent rusting.



Below is another view of the slugs after treatment with POR-15.



Below four of the 7-inch slugs have the half-inch seating holds drilled.



On 9 December the 9-inch end slugs were painted OD ready for installation upon Gun #1.



On the weekend of 3-5 January 2020, the team moved to swap out six of the 5-7/8-inch slugs with three 7-inch slugs. This increased the weight from 740 pounds to about 900 pounds.



Below LTC Welch is preparing to insert one of the 70 pound 7-inch slugs into the right side recuperator cylinder. The board will assist in lifting the slug into the cylinder.



Prior to installing the 7-inch slugs, all 18 of the 5-7/8-inch slugs had to be removed. Below one of those slugs is being readied for movement out of the cylinder.



Below CPT(CH) Uhler and LTC Welch continue to install the 7-inch slugs.



For the right side cylinder, T-4 Ciemniecki was the "slug installer". Below PVT Morrison and CPT(CH) Uhler help with the installation.



Below the installation of the six 7-inch slugs and twelve 5-7/8-inch slugs continues.



Below PVT Morrison, CPT(CH) Uhler and TSG Weaver assist moving the slugs forward in the cylinders with the 1-inch steel rod.



Below T-4 Ciemniecki installs the newly painted end slugs onto Gun #1. Total weight is now approximately 1000 pounds.



The photo below shows the left end slug installed.



Below PVT Morrison and CPT(CH) Uhler assist T-5 Ciemniecki in installing the right side end slug.



The photo below shows both slugs installed.



Below T-4 Ciemniecki and CPT(CH) Uhler make the final adjustments to the two end slugs.



On 9 January 2020, after some testing, T-4 King and T-4 Ciemniecki determine the treading of the end slugs is off center. This is a problem and the two slugs will require re-threading.



Below is a view of the 1-1/4-inch threaded stainless steel rod. This rod simulates the spring rods for the recuperator cylinders. For the design, this rod will thread and lock into the end slug and the yoke and the nut on the end will secure the assembly.



27 January the end slugs returned fully threaded and ready for POR-15 treatment and installation on Gun #1.



31 January 2020 CPT(CH) Uhler, T-4 Ciemniecki and PFC Budjos discuss the new yoke pattern.



A test fit of the pattern is conducted to ensure that it fits and that it clears the emplacement at maximum elevation.



Below the yoke is shown on the gun - however, another problem is discovered - the yoke is too small for the threaded rods to fit properly.



However, at maximum elevation it is determined that the yoke clears the emplacement to ensure no problems with 360-degree traverse of the gun carriage.



15 March T-5 Ciemniecki and T-5 King are hard at work making a new yoke pattern.



T-5 King continues working on the yoke pattern.



19 March 2020 five additional 7-inch slugs and two additional 9-inch end slugs are delivered. Below they are being "cleaned" and treated for POR-15 application.



Below are the slugs ready for application of POR-15.



26 March 2020 we placed five of the 7-inch slugs and six of the 5-7/8-inch slugs into Gun #2. Below PFC Budjos prepares the gun for work.



As he continues preparation, T-4 Ciemniecki assists him and tests components of the new breach block cover for the gun. The pan for the breach cover can be seen to the right of T-4 Ciemniecki.



Below we are using the 1-inch steel rod to help move the slugs down into the cylinder. The five 7-inch slugs are shown below.



Below LTC Welch hands PFC Budjos one of the 5-7/8-inch slugs as we finish the installation.



The photo below is of the inside of one of the recuperator cylinders.



Below PFC Budjos prepares to install a 7-inch slug.



On 7 May we finished the job with the last five 7-inch slugs. Below PFC Budjos inserts one of the slugs.



After the slugs were inserted, the wooden cylinder caps the Army installed were placed back into the cylinders and painted OD.



In March 2000 we discovered that the back of the recuperator cylinder for Gun #2 was different from those of Gun #1. Gun #2 is shown below. The center hole is for the recuperator rod. This difference in design of the cylinder also helped explain the difference in the yoke design between the guns. The differences in design may be attributed to different builders - one carriage was manufactured at Rock Island Arsenal (Illinois) and the other at Watertown Arsenal (Massachusetts) in 1903.



Gun #1 cylinders are shown below and the difference from Gun #2 is noticeable. Instead of a large "hex" pattern protrusion, there are two opposing smooth protrusions opposite each other with the recuperator rod hole in the center.



The two end slugs for Gun #2 are shown below just after they were coated with POR-15. However, for Gun #2 these slugs were useless.



The backs of the cylinders on the guns are different, and the second set of cylinder end slugs had to be modified from the Gun #1 design to fit Gun #2. This modification was done by Mike Brennan in his machine shop. He filled in both of the indents for the two protrusions on the backs of the recuperator cylinders of Gun #1 and then cut a circular hole into the back of the slugs to accept the "hex" protrusion at the back of each recuperator cylinder on Gun #2. The photo below shows both slugs upon return from Mike's shop in August 2020. The slugs were prepared for POR-15 on 27 August and were ready for treatment.



After treatment, the two slugs were then painted Olive Drab in November 2020.



On January 8 2021, CPL Cusano and LTC Welch installed the two slugs on Gun #2. The first step was to clear out the threaded holes in the back of the recuperator cylinders. This was done with a 3/4-inch course thread tap as shown in the photo below.



The photo below shows the threaded hole cleaned by the tap and ready for a bolt to hold the counterweight slug in place.



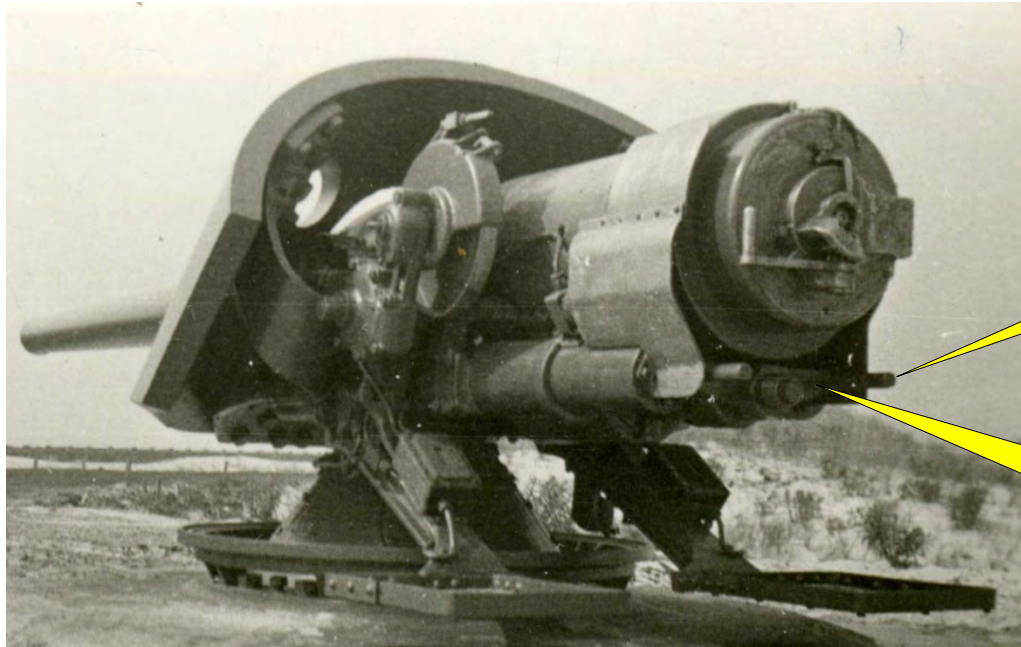
The photo below shows CPL Cusano after the right slug was affixed to the recuperator cylinder and the bolt tightened in place.



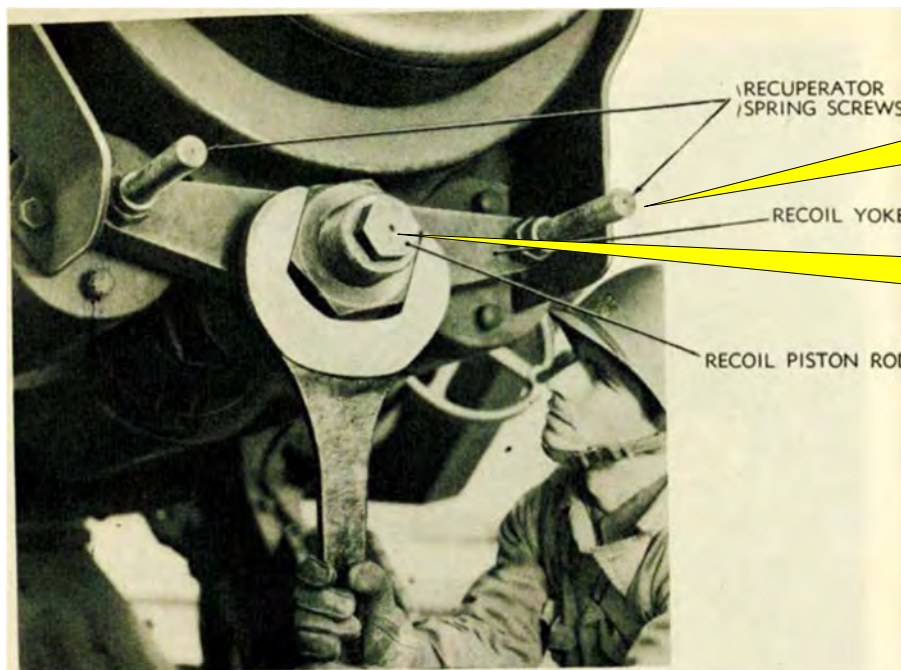
The photo below shows both 9-inch 76-pound counterweight slugs in place for Gun #2. All that remains for both guns are to cast the yokes, install them and the threaded recuperator rods into place.



During the fabrication of the external counterweight steel slugs, we discovered the two M1900 carriages are in fact different in design and dimensions in the counter-recoil and recuperator areas. These patterns enabled the creation of cast-iron counter-recoil yokes. As a refresher, the 1937 photo of one of the guns of Battery Kessler at Fort Tilden in the 1930s (Gateway National Recreation Area collection number 4193) shows the location of the yoke and the two recuperator spring screws.



The photo below shows the recoil yoke, recoil piston rod and recuperator spring screws. This photo is from page 52 of TM 9-424 - 6-inch M1900 Seacoast Gun, Mar 1945.



Gun #1 yoke pattern fits as designed. It requires no modification and is ready for casting. The only anomaly is the stainless steel (SS) bolt on the right of the photo is not perpendicular to the steel slug. It is on a diagonal to the left. In order to fit the yoke pattern, the right bolt must be installed after the yoke is placed on the left SS bolt and the center 3-inch diameter counter recoil bolt.



The photo below shows Gun #1 with the yoke from the side.



The yoke pattern for Gun #2 does fit but with significant problems. It is shown assembled below.



The Yoke Pattern #2 center hole for the large 3-inch counter recoil bolt is about $\frac{3}{8}$ of an inch below the level it should be in relationship to the two SS bolts. This can be seen in both pictures below. While the yoke can be installed, it requires the bolts to be attached after putting the yoke onto the large counter recoil bolt. The resulting "stress" on the two SS Bolts prevents tightening of the bolts adequately as designed.



The photo below shows the offset nature of the 3/4-inch counter-recoil bolt to the top of the yoke pattern.



The photo below shows the yoke pattern with rough pen marking of the area of pattern that needs to be removed. The ideal solution would be relocating the hole about 3/8 of an inch up towards the top of the yoke pattern.



As discussed on Friday 21 May 2021 it appeared that about 5 inches of the SS Bolts needed to be removed to ensure the bolt did not protrude past the face of the breach block housing. During the test installation, it was determined that by slightly loosening the retaining bolt on the threaded steel slug, it was possible to insert the SS Bolt into the hole in the center of the counter-recoil cylinder. The photo of Gun #1 below shows the far SS bolt well inserted into the counter-recoil cylinder. The shortness of the far (left) SS Bolt shows this depth of penetration into the counter-recoil cylinder.



The photo below shows the depth the bolt was inserted into the counterweight and the counter-recoil cylinder. Unfortunately, this is too far in and is pushing the steel slugs inside the cylinder and stressing the retaining nut on the counter-recoil steel slug. The best option appears to be inserting the SS Bolt no deeper than the end of the counterweight slug. This requires at least five inches of the SS Bolt to be removed and refaced.



Both wooden yoke patterns (as marked for adjustment) and all four SS bolts with their respective nuts are in the plotting room as shown below.



A significant issue was discovered - Gun #1's cylinders are made of brass or bronze. These threads are weaker than steel threads and are susceptible to being stripped if subjected to excessive stress. Gun #2's cylinders are made of steel and the threads for the 5/8-inch bolts are much less susceptible to stripping under a load.

Each recuperator cylinder has a 1-1/4-inch diameter hole in the center that can accommodate the SS Bolt. This was for the original screw that held the springs inside the cylinder. The spring shafts (screws) are simulated by these SS Bolts. The steel nuts were used to tighten the tension on the springs as they lost tension from firings. These nuts will be used to secure the yoke to the two counterweight slugs on the ends of the cylinders.

The two counter-recoil cast-iron yokes were delivered on 21 October and are shown in the photograph below.



On 11 December 2021, the two counter-recoil cast-iron yokes were tested on both guns. The focus was to ensure a fit and that any discrepancies could be addressed. CPL Cusano and 2LT Gonzalez are conducting the tests.



The cast-iron yoke for Gun #2 requires adjustment by removal of metal to ensure the SS bolt will fit without undue stress.



The photo above shows the misalignment of about 1/8 of an inch towards the left of the threaded hole in the external counterweight slug. This will require part of the yoke to be trimmed using an "end-mill" bit in the drill press. The yokes shrink in size during cooling after casting and do not fully match the size of the patterns. This was expected so the foundry compensated for that shrinkage. However, we knew there would still be a requirement for machining.

After test fitting, the yokes were primed and painted. Below, CPL Cusano primes one of the yokes.



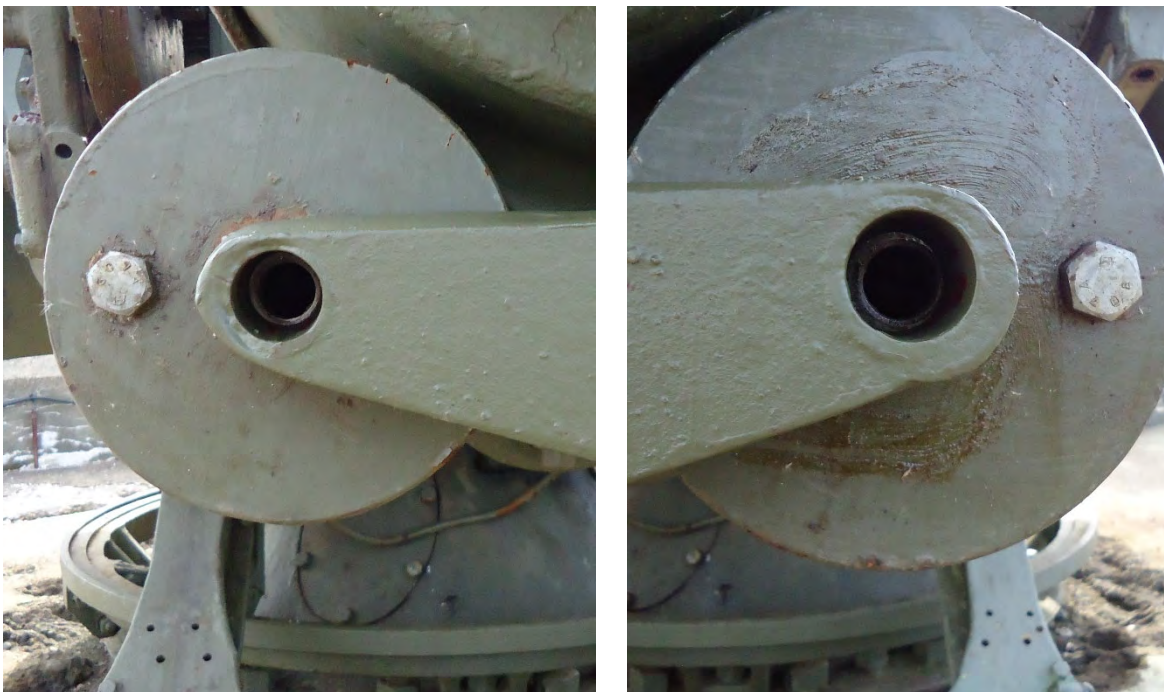
In late December 2021 we cut the threaded rods to the proper length. The black lines show the cut locations.



The photos below show the rods on 8 January after being cut by Jim Wolf.



The photo below from 14 January 2022 shows the alignment of the yoke on Gun #1 with the left photo showing acceptable alignment and the right photo showing the alignment off by about 1/8 of an inch. This requires trimming to ensure a fit.



On 14 and 28 January 2022, trimming of the inside of the threaded rod holes on the yokes. The large drill press with an end-mill bit was used to shave the metal away from the side of the hole.



The photo below shows a more detailed view of the end mill bit and drill press being used to "shave" the steel out of the threaded rod hole.



4 February 2022 we took both yokes and tested them on both guns. They were properly aligned. This enabled planning installation and final assembly of the counterweight system. Below is the test on Gun #2 lead by 2LT Gonzalez - in the cold rain!

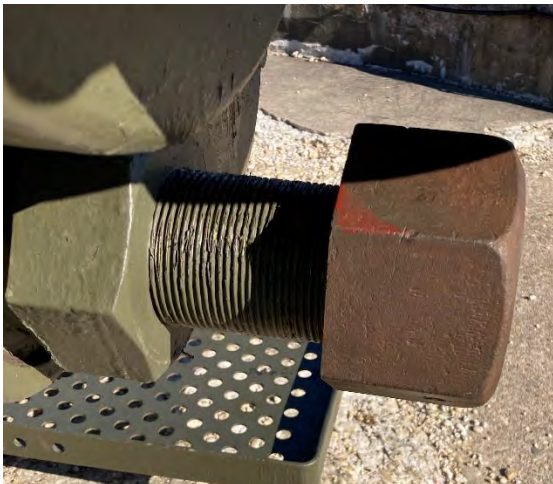


The photo below shows the successful test of Gun #1 system.

A significant issue was discovered as we mounted the external counterweights - Gun #1's cylinders are made of brass or bronze. These threads are weaker than steel threads and are susceptible to being stripped if subjected to excessive stress. Gun #2's cylinders are made of steel and the threads for the 5/8-inch bolts are much less susceptible to stripping under a load. This requires firm locking of the yoke to push the external counterweights firmly against the recuperator cylinders. The answer is a large 3-3/4-inch fine thread nut to lock the yoke onto place.



On 20 February 2022 we tested a 3-3/4-inch fine thread nut. The nut cost AGFA \$207 including shipping and weighed 19 pounds. The nut is large enough to be cut in half to make two nuts - one for each gun.



On 22 February 2022 Jim Wolf cut the nut. Jim is the Production Manager and expert machinist/toolmaker for Motion Systems Corp., Eatontown, NJ. Motion is the primary US producer of custom ball screw actuators. Jim has long experience with custom manufacturing for US Arsenals and defense contractors. Jim has been a huge help with major machining tasks. Below he uses a professional bandsaw to cut the nut. This took 20 minutes! He then faced the back half of the nut to look like the top of the original nut.



The bag below contains both halves of the original nut. They are faced, cleaned and ready to be primed and painted.



On 28 February 2022 we tested the nuts on the guns and then prepared them for priming and painting.



On 26 March 2022 we began final installation of the counterweight yokes on both guns. The photo below shows a new handwheel that looks very similar to the original handwheels supplied with the guns. Jim Wolf expertly fitted this handwheel to enable attachment to the existing shaft. This new handwheel has greatly improved elevation.



26 March 2022 as a very bright, sun shiny day. Below, CPL Cusano and PVT Hill clean out all the threaded components and prepare for parts installation.



The 3-3/4-inch threaded counter-recoil shaft required significant cleaning to accept the new bolt. Below CPL Cusano and PVT Hill clean out the threads.



In the photo below PVT Hill test fits the large nut.



Below, CPL Cusano prepares to test fit the two stainless steel nuts on the stainless steel threaded rods. The large nut is already in place.



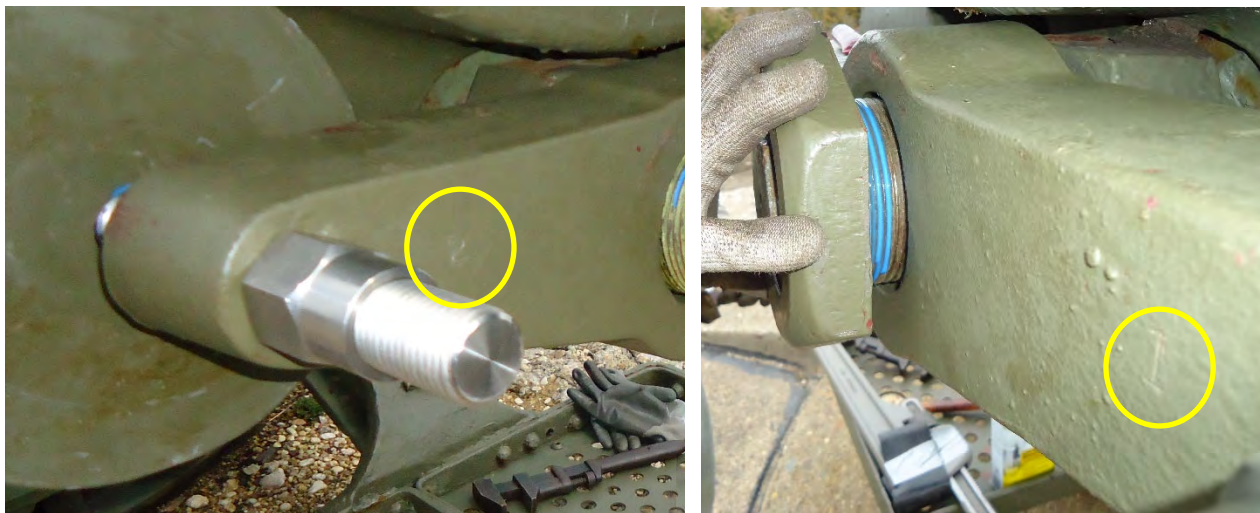
Once the yoke and stainless steel rods were in place, it became time to tighten the large nut. Lacking a 6-inch jaw wrench, we used a pipe wrench with thick rubber gasket material to protect the nut from the jaws of the wrench.



Below LTC Welch uses the wrench to tighten the large nut and lock the yoke and external counterweights against the back face of the recuperator cylinders. The wrench worked as intended and did not scar the nuts.



As each of the yokes are slightly different in measurement, they needed to be marked to their corresponding gun. On the left the yoke is marked "2" and right "1" corresponding to the gun they are mounted on.



Similar to Gun #2, Gun #1 also received a new cast iron handwheel for elevation. The two handwheels are slightly different. Gun #1's wheel is "flat" where as Gun #2's wheel is concave.



Below CPL Cusano begins the process of cleaning out the threads in the external counterweight slugs for the Stainless-Steel threaded rods.



Below CPL Cusano surveys the test installation for Gun #1 with all stainless-steel bolts and nuts locked and aligned.



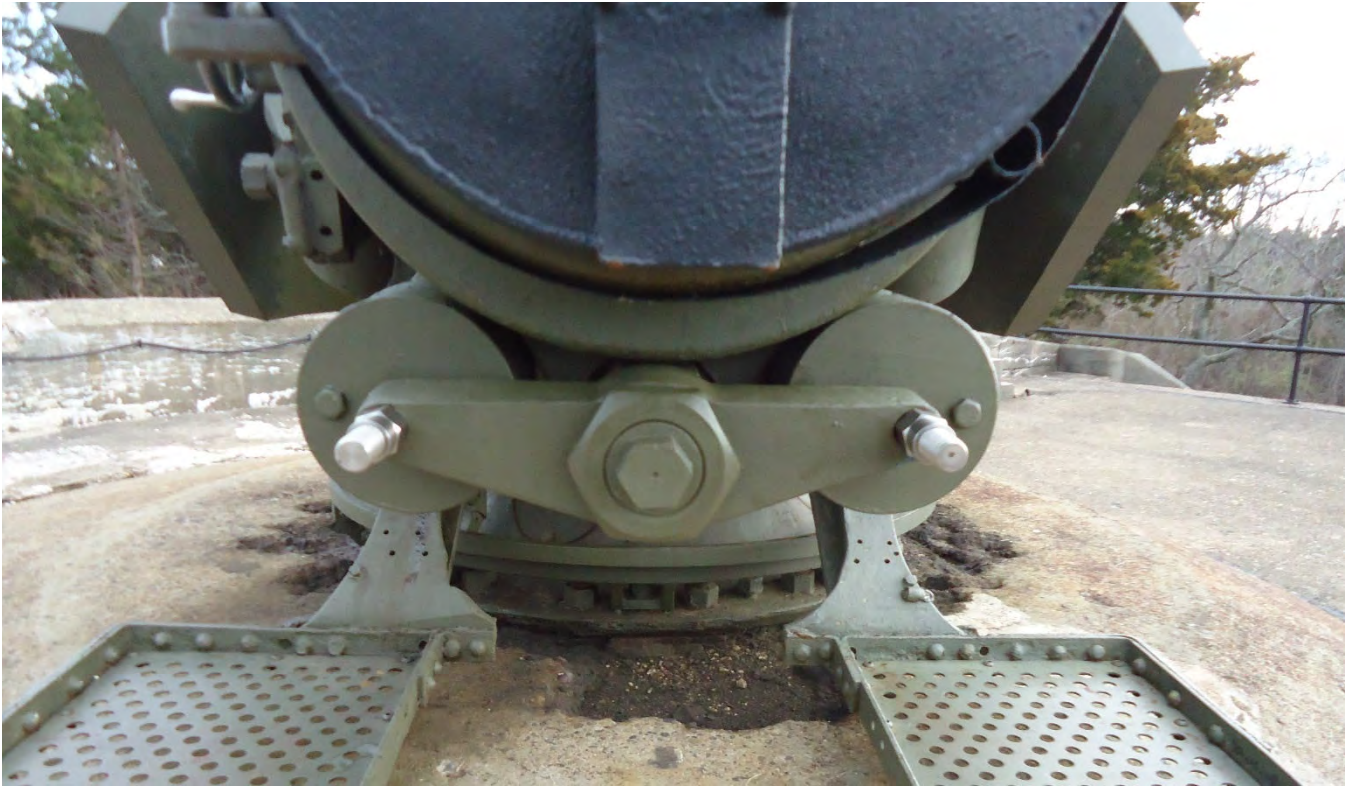
Once all the rods and nuts were confirmed in their locations, the large center 3-3/4 inch nut was secured using the pipe wrench. Below LTC Welch seats the nut.



Below LTC Welch applies the final tightening of the large nut, locking the yoke and the two external counterweight slugs to the back face of the recuperator cylinders.



The photo below shows Gun #1 system in place and painted.



The photo below shows Gun #2 system in place and painted.



The photo of Gun #2 below shows the approximate 1-inch clearance between the face of the counterweight and the small half inch thick stainless-steel nut. This small nut allows the yoke to seat and push the external counterweight against the recuperator cylinder.



The photo below shows Gun #1 and the lack of a full inch space on the threaded rod. In this case the half-inch thick nut locks the stainless-steel threaded rod into the counterweight slug. The yoke then pushes against the half-inch nut, securing the counterweight to the back face of the recuperator cylinder.



The next change is a locking mechanism for the elevation square where the handwheel connects. This ensures the gun cannot be elevated or depressed when otherwise not attended.



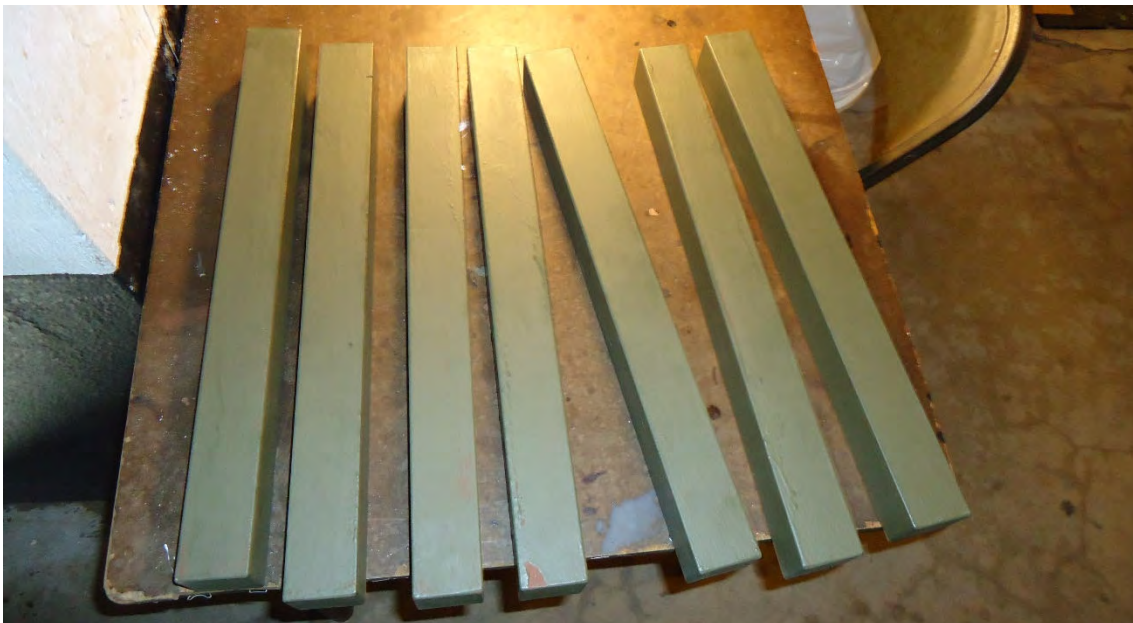
The photo below shows Gun #2 with elevation lock and yoke in place.



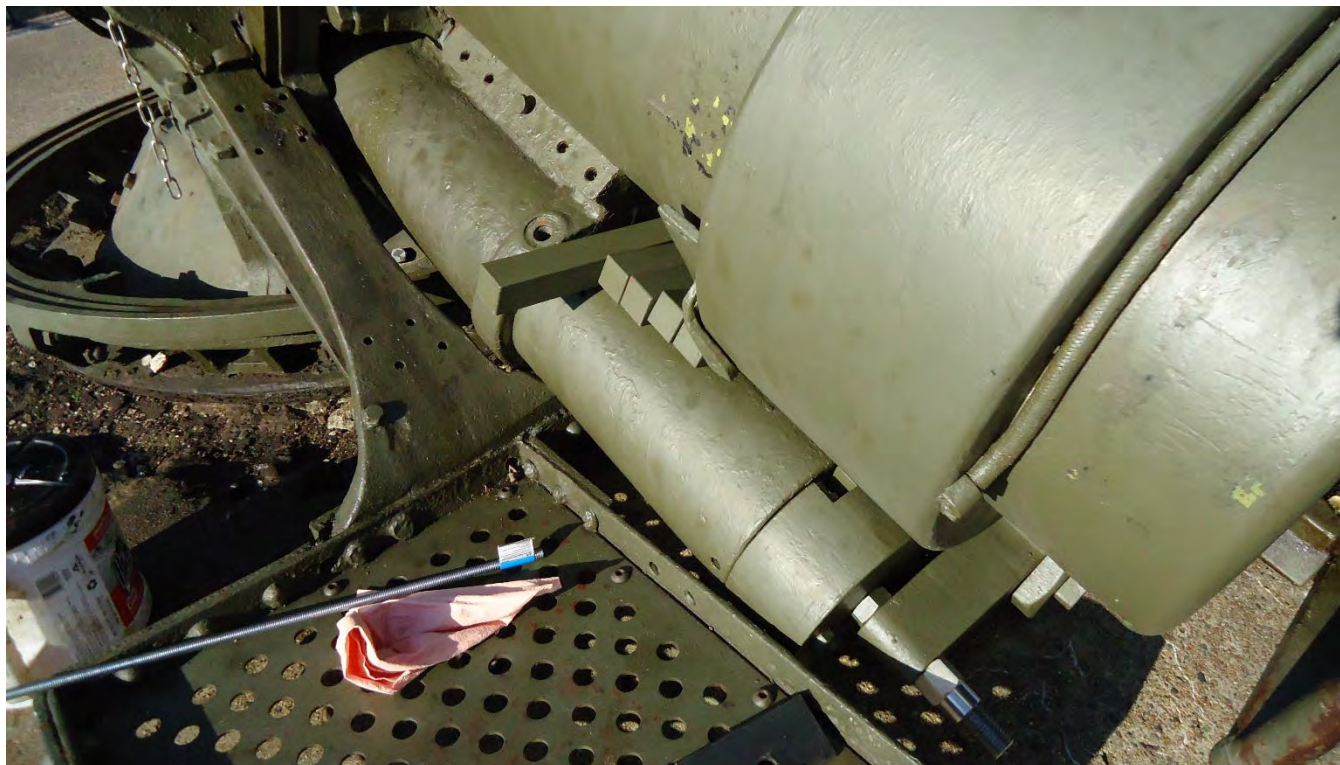
The chart below shows the various weights of the components of the counterweight system upon completion as of 25 March 2022.

| <u>Item</u> | <u>count</u> | <u>weight (LBS)</u> | <u>Total LBS</u> | <u>Sub-Total LBS</u> |
|------------------------|--------------|---------------------|------------------|------------------------|
| <u>Gun #1</u> | | | | |
| 5-7/8 inch steel slugs | 12 | 41 | 492 | <u>Sub-Total slugs</u> |
| 7-inch steel slugs | 6 | 70 | 417 | 909 |
| 9-inch backing slugs | 2 | 76 | 152 | |
| Threaded rods and nut | 2 | 7 | 14 | <u>Sub-Total</u> |
| yoke | 1 | 60 | 60 | 1,135 |
| | | | | |
| Cover Pan | 1 | 40 | 40 | |
| Cover Frame | 1 | 50 | 50 | 1,225 |
| | | | | |
| <u>Gun #2</u> | | | | |
| 5-7/8 inch steel slugs | 6 | 41 | 246 | <u>Sub-Total slugs</u> |
| 7-inch steel slugs | 10 | 70 | 695 | 941 |
| 9-inch backing slugs | 2 | 76 | 152 | |
| Threaded rods and nut | 2 | 7 | 14 | <u>Sub-Total</u> |
| yoke | 1 | 60 | 60 | 1,167 |
| | | | | |
| Cover Pan | 1 | 40 | 40 | |
| Cover Frame | 1 | 50 | 50 | 1,257 |

The balancing weight for each gun appears to be about 1,250 to 1,300 pounds. Each breach cover weighs about 90 pounds. When removed, the gun tube is out of balance between 90 to 150 pounds. Removal of the breach covers requires external weights to be applied to the gun tubes. This is done using 1-3/4-inch square steel rods cut into 18-inch sections and placed between the gun tube and recuperator cylinders. These steel bars weigh approximately 15.5 pounds each. Seven bars equal approximately 108 pounds.



An initial test on 15 April 2022 demonstrated a very close balancing of Gun #1 with the breach cover removed. While four of the bars fit well on the left side (elevation setter's station), one extended from the placement area. That bar can be cut in half and the other half placed on the other side of the gun.



On the right (gun pointer's) side of the gun, two bars fit, but one should be cut and the two pieces will fit better. Notice the new yoke and recuperator "spring rods".



The photo below shows Gun #1 on the late afternoon of 15 April 2022. The counterweight system is essentially complete and the gun elevates and depresses as designed.



The counterweight project took approximately three years from start to finish. Total cost of materials was approximately \$5,000 and lots of donated skills and machine work. None of the modifications to the gun are permanent and can be easily reversed by simply removing the weights and fixtures. While we doubt the recuperator and other materials will ever be returned to the guns, we have ensured that all of this work is easily reversible without the requirement to modify the guns.