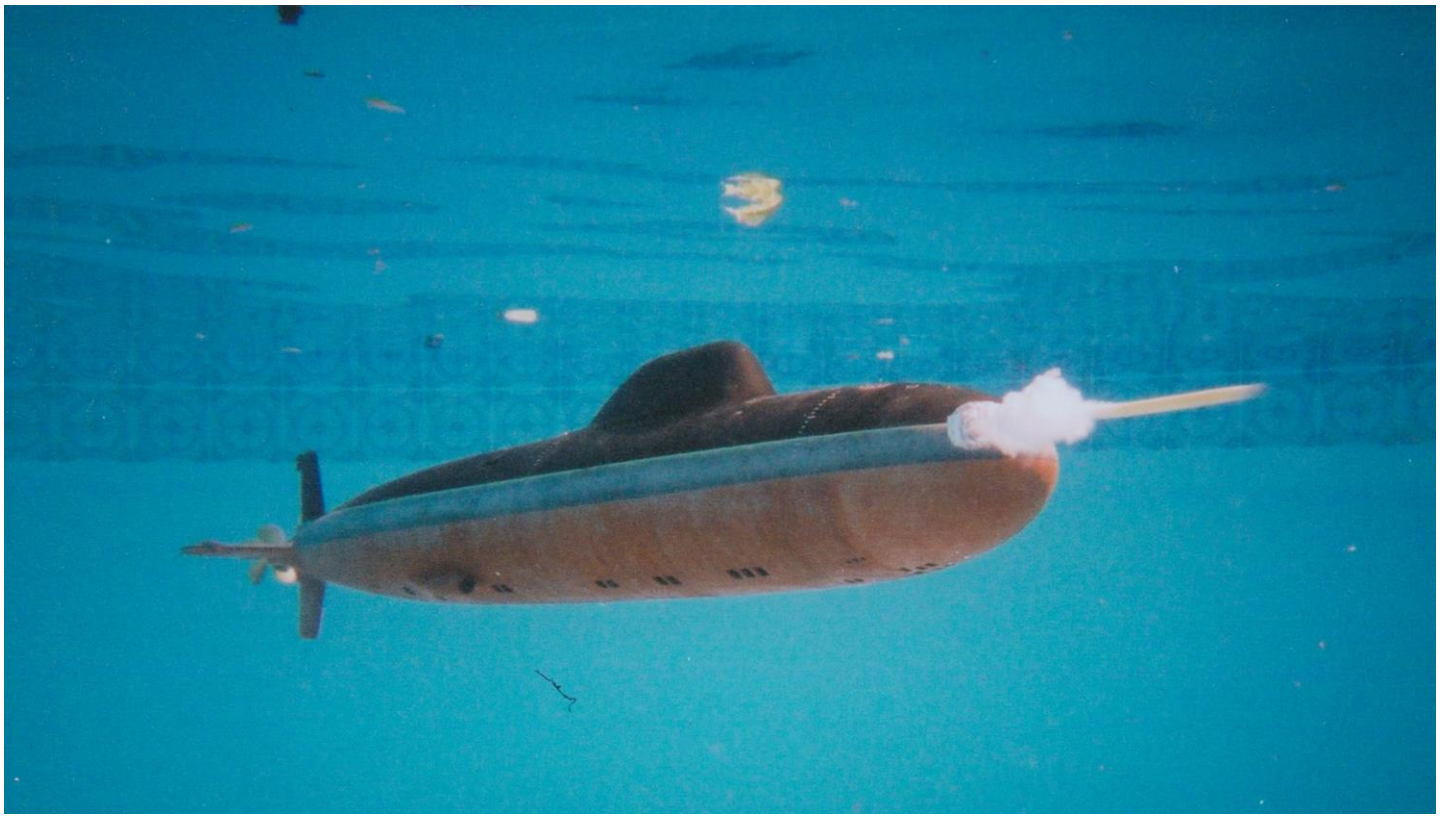
1/72 WEAPON SYSTEM
(MECHANICAL LAUNCHER)



WARNING: Do not attempt, for any reason, to charge a weapon off-launcher. The torpedo tube serves as a containment to protect personal and property from shrapnel should a weapon cook-off (explode) for whatever reason. Only charge the weapon while it is safely contained within its launcher.

INTRODUCTION

A torpedo is a self propelled underwater missile, be it guided or unguided. A missile requires a ***launcher*** to support and contain it on or within the launching platform, in this case a model submarine. The launcher projects the ***weapon*** in the proper direction, clear of the launching platform. The launcher is half of a ***weapon system***. The torpedo, referred here as the weapon, is the other half of the weapon system.

For over twenty years I've worked on the problem of designing and building a practical launcher-weapon system suitable for use aboard my model submarines: Launchers that failed to retain the weapon reliably; weapons that leaked their supply of liquified gas; over-weight launcher sub-systems that could not be compensated for when installed within the model submarine, just a few of the many problems that had to be

identified and addressed before a successful system was realized. Interestingly, the only design element of the system that has not seen radical change is the form of weapon propulsion. From the start I settled on the rocket principle. The weapon thrust forward as a consequence of the reaction principle. An amount of commercially available liquified gas, known collectively as ***Propellant,*** expanding into a gas at the moment of launch. That gas exiting the weapons nozzle at a relatively high velocity, producing the reactive 'kick' that thrusts the torpedo forward through the water.

Now, there are any number of propulsion options that can be employed to drive the model torpedo through the water: Electrical or elastic band cranked propeller(s), elastic bladder water-jet, solid propellant gas jet, kinetic (think: bullet), and the chemically reactive 'cold' gas jet. Complexity, weight, and cost has driven me to settle on the use of the propellant gas jet type of propulsion aboard my weapons.

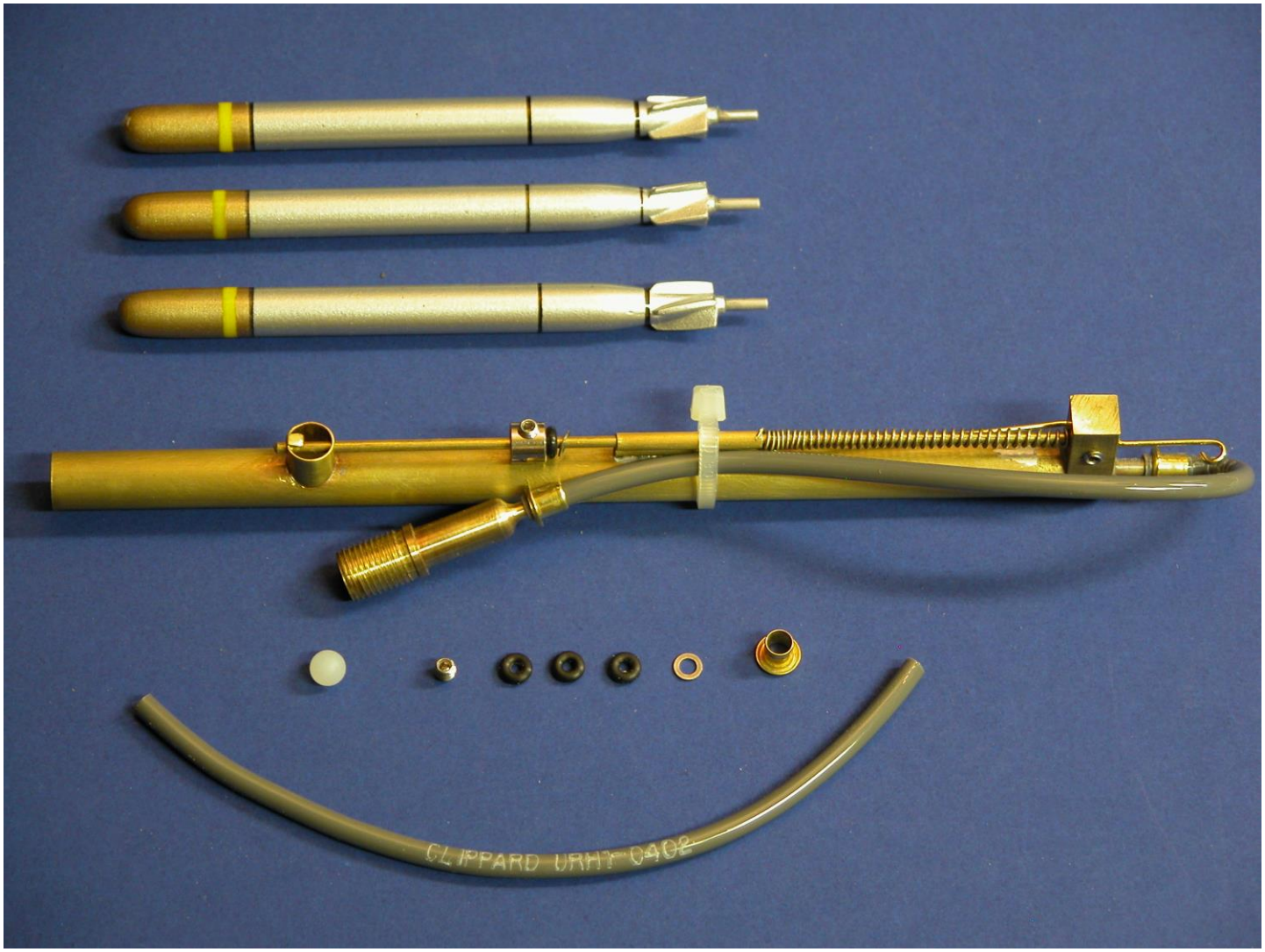
Commercially available air-brush propellant is what I use. Propellant is typically a Methane-Butane mixture that is transferred between the can and weapon via plumbing incorporated within the launcher and weapon.

I must acknowledge the innovative and important work Mike Dorey, Ron Perrott, and Gene Berger have done in this field: These men stand out as the early pioneers of gas jet propelled model submarine weapons. Mr. Dorey identified a source of readily available air-brush propellant as the motive power for the weapon. Mr. Perrott came up with some very sound weapon-launcher interface ideas – enhancements by me of Ron's concepts resulting today in a launcher that almost never suffers miss-fires (unintentional launch) and very few hang-fires (failure to launch) and, to date, not one single cook-off (catastrophic explosion of the weapon) incident. And Mr. Berger must be credited with the development mass-production techniques that have significantly reduced the coast of weapon manufacture.

So, for the record: The system presented here is not entirely the invention of one David Douglass Merriman lll. No. What I've come up with is a refinement of several good ideas, authored by others. My systems functionality and reliability represents my efforts and very much the efforts of the above Craftsmen, the guys who came before me.

THE WEAPON SYSTEM

Congratulations on your purchase of this weapon system. Included in your package are three weapons a ***loading ram***, and launcher. Spare parts are also included in your package: ***breech-block*** o-rings, ***flexible hose***, ***stop-bolt ball***, setscrew, hose retainer, and washer.



Weapon Sub-System Functional And Physical Description The torpedo is propelled by the discharge of propellant gas through a nozzle at the weapons stern. A small amount of propellant liquid is injected, under pressure, into the weapon. An operation that can only be done with the weapon secured within its launcher. As long as the propellant is pressurized within the weapon (that pressure proportional to the temperature of the system) it will remain in the liquid state. At the moment of launch, when the breech-block is pulled away from the weapons nozzle, the sudden drop in pressure within the weapon causes the liquid to boil off as a gas. That gas ejected through the weapons nozzle, producing the thrust needed to propel the weapon through the water.

The four stabilizing fins at the stern of the torpedo are canted to induce a left-hand roll to the weapon as it travels through the water. This helps to keep the weapon on track during the majority of its run. At the end of the run the weapon will typically circle to the left in a tight pattern, making weapon location and eventual recovery an easy matter.

The weight of the weapon with its charge of propellant is very close to the weight of the water displaced by the weapon – this accounts for the nearly negligible change in the model submarines immersed weight regardless of there being a weapon in the launcher or not. In other words: the weight of water within the empty launcher

is about equal to the weight of the charged weapon in the launcher. Run the submarine with or without the weapon(s) aboard and the boat will posses the same trim – no torpedo compensation measures required when using the Caswell-Merriman weapon system.

The weapon is fabricated from polyurethane resin. At the after end of the ***nozzle tube*** a .008-inch orifice forms the nozzle throat where the ejected gas begins its expansion through the divergent nozzle. The orifice is sized to produce just enough thrust to move the weapon along at a good pace without compromising range adversely. Typical range is between 10 and 20 feet with a single ‘shot’ of propellant, but longer ranges are possible by chilling the weapon, an operation explained in detail later.

Now, as to any specific type of weapon you may wish to represent: The three weapons in your package arrive painted to represent a world war two era 'steam' powered torpedo. Old school. However, a fair representation of other type weapons can be achieved simply by painting the appropriate colors and applying specific marking, unique to the type weapon you wish to represent. If you do elect to re-paint your weapons, insure that the paints, markings, and clear-coat chemistries you employ are compatible to a hydrocarbon environment. You don't want any blow-back propellant stripping off you nice, new paint job!

Launcher Sub-System Physical and Functional Description The launcher/torpedo tube is a brass mechanism that houses, holds fast and provides for the charging of the weapon. The launcher releases the weapon on command, and as it does it provides a shot of quickly expanding gas -- contained within the flexible hose and breech-block -- to the stern of the weapon to eject it out, at a considerable velocity.

You purchased the 'mechanical' launcher. Unlike our other product, the 'pneumatic' launcher, the mechanical launchers launch trigger requires tripping my a mechanism you supply. Our pneumatic launcher has built into it an actuator that trips the launcher trigger through a solenoid firing valve.

The launcher sub-system is normally in one of two conditions: Ready to launch, referred to here as the BATTERY condition. Or, the launcher is in the LAUNCHED condition. The launcher can be in any of these two conditions with or without a weapon in the tube. With the launcher in the battery condition with a weapon in the tube, the weapon can not be removed. With the launcher in the battery condition and empty, a weapon can not be loaded until the launcher is cycled to the launched condition. A weapon in the launcher can not be charged with propellant unless the launcher is in the battery condition.

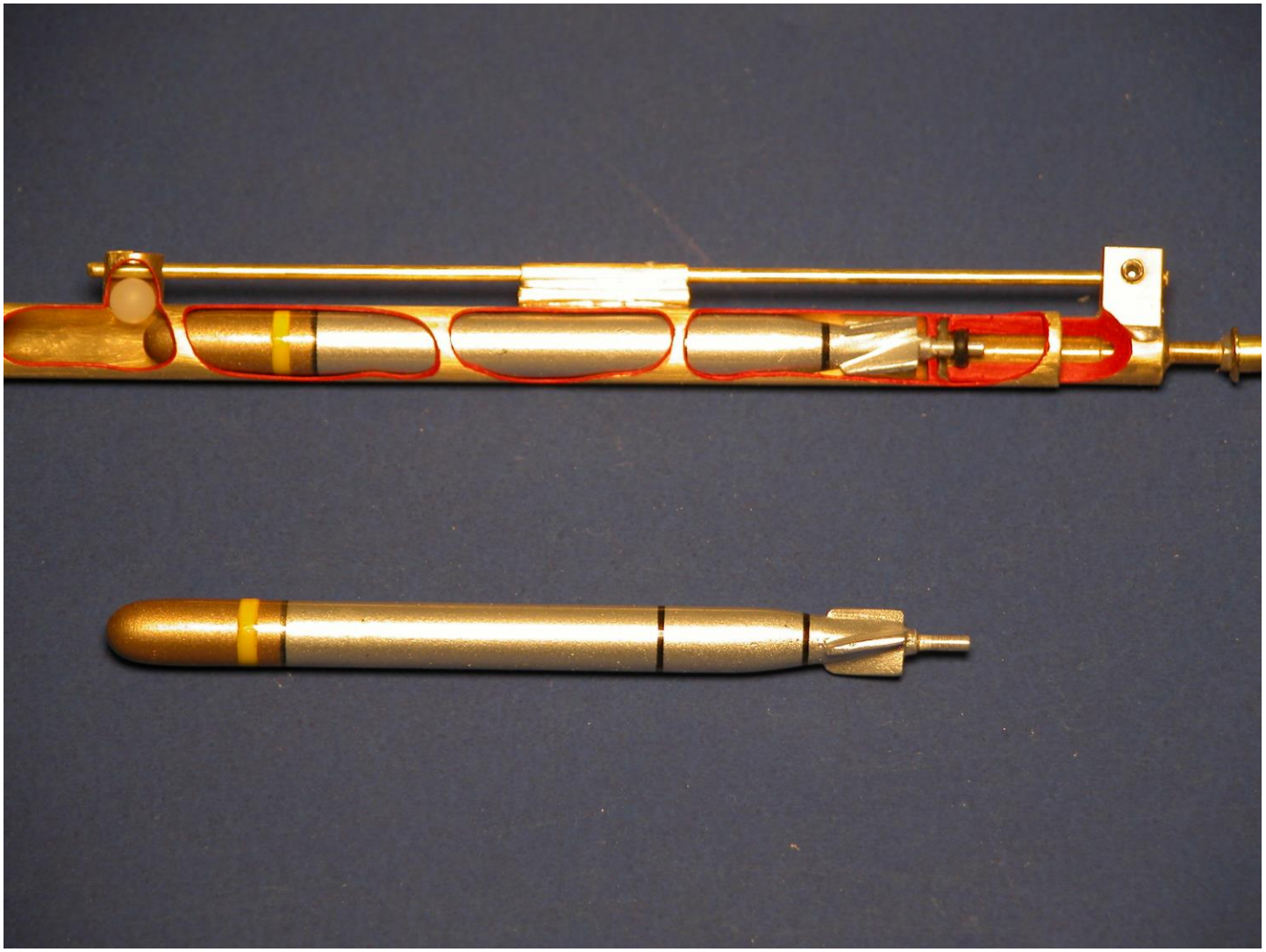
It is the position of the ***breech-block*** and ***stop-bolt ball*** – the two working in unison through the ***interlink rod*** – that dictates which of the two conditions the launcher is in. The launcher is in battery when the breech-block is forward and the interlink rod pushes the stop-bolt ball down blocking forward motion of the weapon within the launcher. The launcher is in the launched condition when the breech-block is fully aft and the stop-bolt ball is free to rise up into its housing, freeing the weapon for forward travel.

With the empty launcher in the launched condition a weapon is introduced through the muzzle (forward) end of the launcher. The weapon is pressed home with the aid of the loading ram, the stabilizing fins of the weapon making contact with and kept from further rearward movement within the launcher by the ***weapon stop disc***. As the weapon is held fast with the loading ram (very little force required here), the launchers breech-block is moved forward by applying adequate thumb pressure hard enough to overcome the force presented by the ***breech-block spring***. When the breech-block is at the battery position, the ***launching trigger*** springs into place, engaging and holding the breech-block fast.

As the breech-block moved forward, during the weapon loading process, the nozzle of the weapon made up to an O-ring within the forward end of the breech-block, making a gas-tight fit between breech-block and the weapons nozzle tube. That union established, it is then possible to make a transfer of propellant through the ***charge fitting*** at the after end of the flexible hose. The flexible hose makes up to a brass nipple located at the after end of the breech-block.

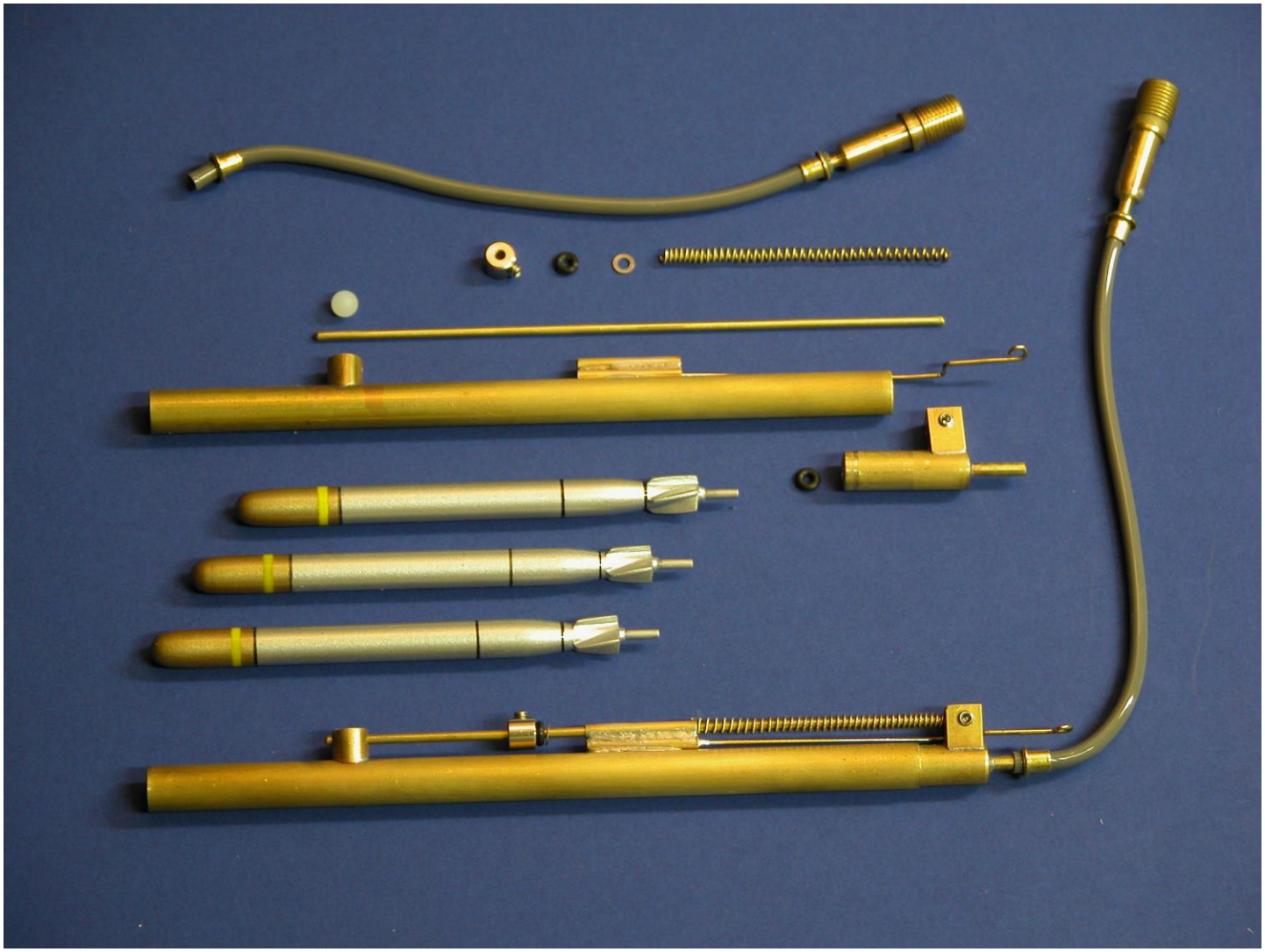
A standard Caswell propellant charging adapter, made up to a can of airbrush propellant, is required to make propellant transfer through the launcher charge fitting.

With the launcher at battery, there is no way for the weapon to leave the tube because of the stop-bolt ball preventing forward movement of the weapon, and the weapon retaining disc (soldered within the tube, just forward of the breech-block) preventing rearward motion of the weapon. Below is a cut-away launcher showing the weapon retained forward by the stop-bolt ball. Note that the weapons nozzle tube makes a gas-tight union to the bore of the breech-block by the Breech-block O-ring.



Only at the moment of launching, when the trigger is released (permitting the breech-block spring to shove the breech-block aft, and through the interlink rod releasing the stop-bolt ball) is the weapon free to leave the tube through its muzzle end. The below photo shows our cut-away torpedo tube with the launcher in the 'launched' condition: The breech-block has been shoved back by the breech-block spring (the spring has been omitted in this shot), That action, through the interlink rod, freeing the stop-bolt ball to move up into its housing, out of the way of the weapon. The instant the weapon nozzle clears the breech-block O-ring, residual propellant within the flexible hose and breech-block bore flashes to a gas, ejecting the weapon from the launcher.

The launcher is designed for easy disassembly should the need arise for adjustment or repair. We have provided spare O-rings, stop-bolt ball, and an extra wheel-collar set-screw. Note in the picture below an assembled launcher in the battery condition. A disassembled launcher is presented above the assembled launcher. This shot should pretty much tell you all you need to know about launcher design and operation.



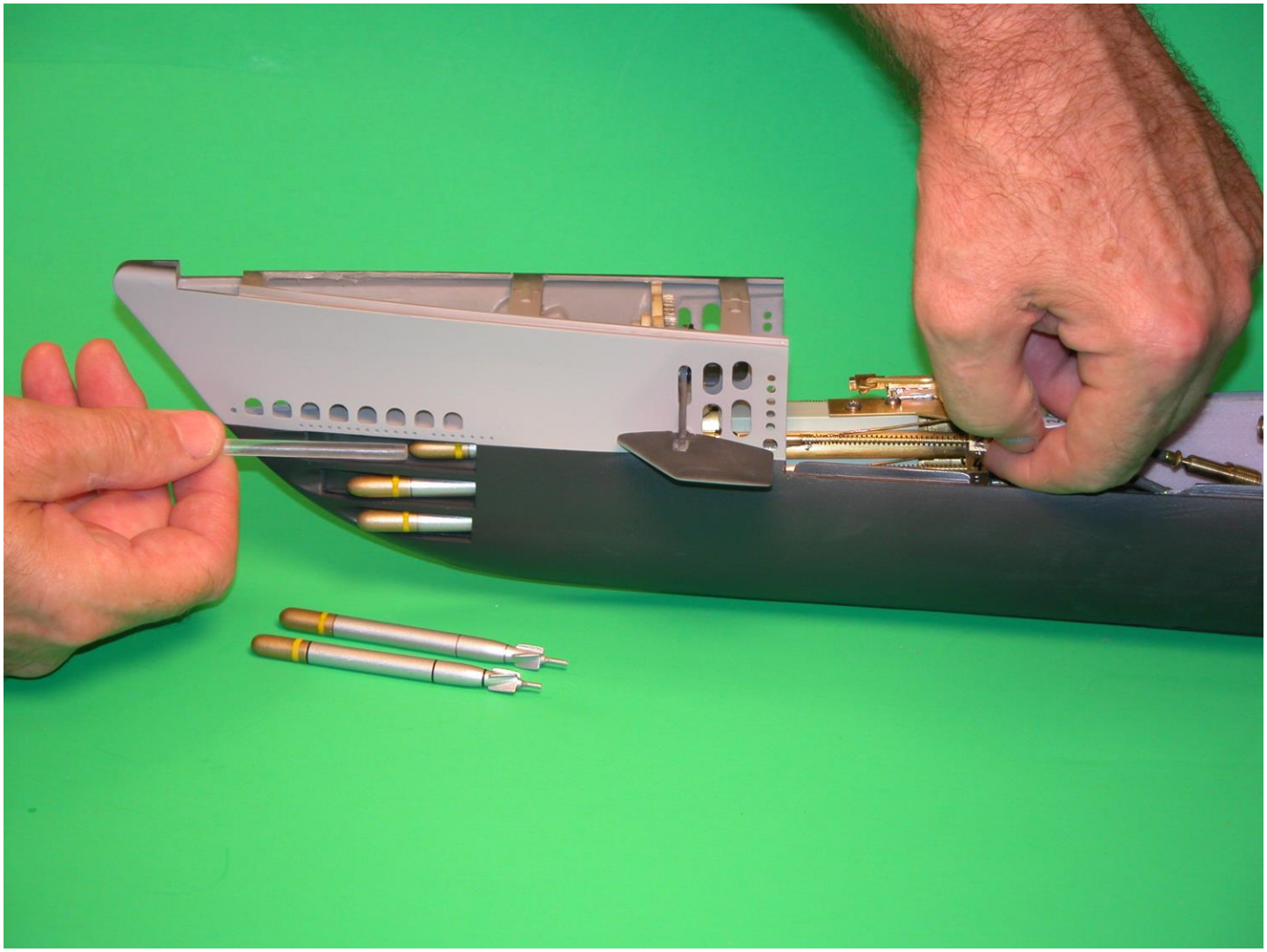
WEAPON LOADING INTO THE LAUNCHER AND SYSTEM CHARGING

The cycle of operation of the weapons system goes like this: load the torpedo into the launcher; set the launcher to the battery condition; charge the weapon with propellant; get the model out into the water, submerged and on the hunt for targets; and at a depth of three hull diameters or more launch a weapon; recover the weapons and the model submarine and repeat the cycle.

I find it best to make the entire launcher nest into one big, removable assembly – this permits you to do all the maintenance and loading chores without having to work you fat fingers within the tight confines of the models hull. Later I'll show you how I did just that for the bow nest that fits within my 1/72 Revell GATO model submarine. This is the preferred method for model submarines depicting hulls of narrow beam. You'll find that the modern hull designs of today, that the hulls are wide enough to permit all operations on the launcher to be performed, without too much difficulty, with the launchers fixed in place. I'll carry on this discussion assuming that you will be working the launchers as they sit in the hull.

Loading the Weapon Apply a small amount of silicon grease to the outside of the weapons nozzle tube – take care not to get any grease into the nozzle itself or there is the likelihood of the grease being driven into the .008-inch throat of the nozzle during the propellant charging operation.

With the launcher in the launch condition – breech-block fully aft and the stop-bolt ball clear of the tube bore – into the muzzle of the launcher place a torpedo, ass end first. Finish pushing the weapon into the tube with the supplied 3/16" diameter loading ram until the backside of the torpedo makes contact with and is stopped from further rearward travel by the weapon stop disc located just ahead of the breech-block. From the inside of the model (the upper hull has to be removed for the loading and charging operations), with a finger or thumb, push the launchers breech-block forward until the launch trigger seats behind the breech-block. The launcher is now at battery. Remove the ram.



Charging the Weapon The system is so designed that you can not charge the weapon off-launcher. If the launcher is wet from recent immersion, insure that you blow out the little bit of water trapped within the face of the launcher charge fitting – failure to do so will result in water being driven into the system plumbing during the charging operation. If any water gets within the weapon it may flash to ice crystals as the propellant

undergoes its state change at time of launch. Such ice may find its way into the nozzle tube, plugging the throat of the nozzle during the run, severely reducing the weapons range.

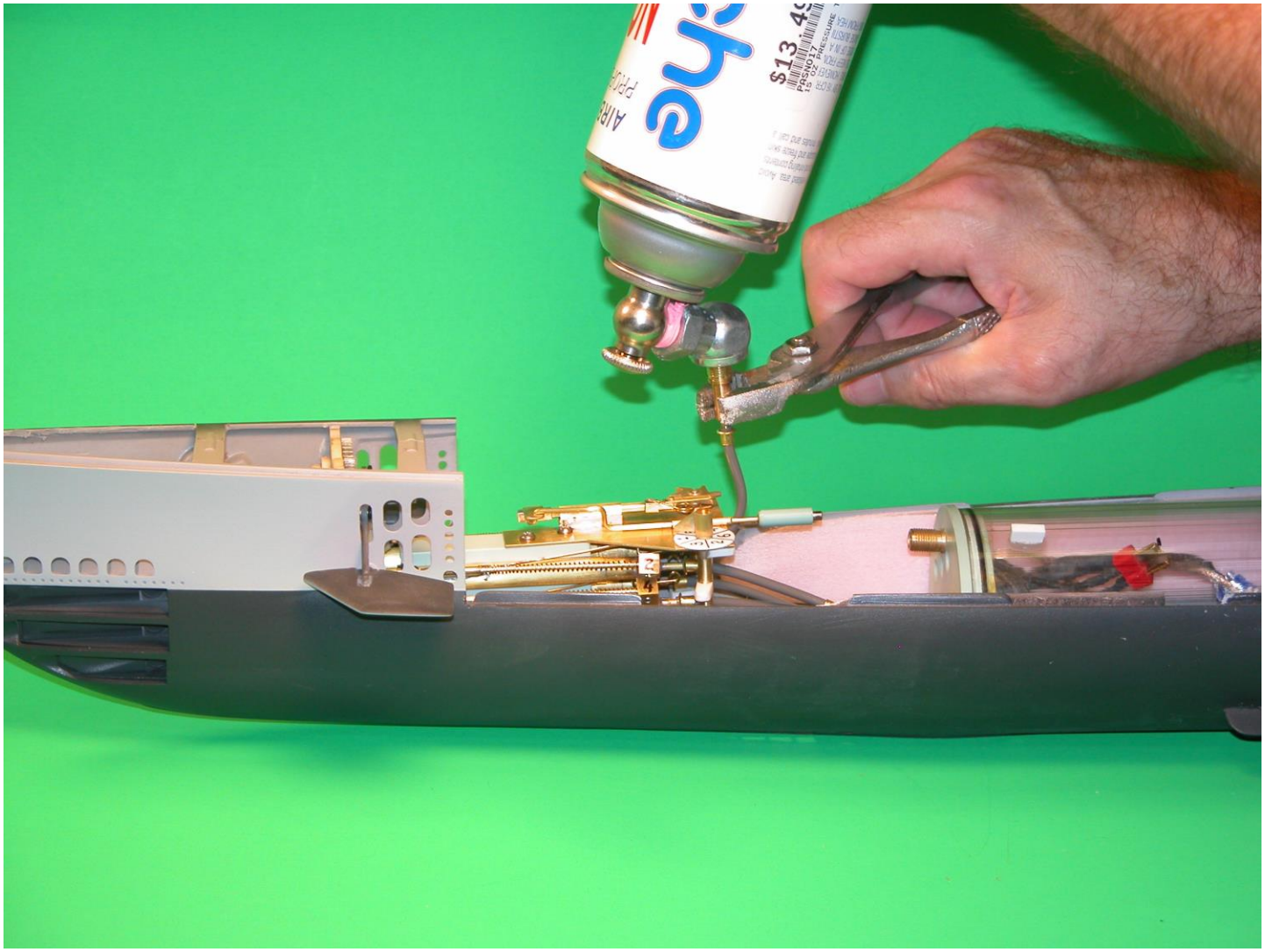
WARNING: Do not attempt, for any reason, to charge a weapon off-launcher. The torpedo tube serves as a containment to protect personal and property from shrapnel should a weapon cook-off (explode) for whatever reason. Only charge the weapon while it is safely contained within its launcher.

With a weapon secured in its launcher you then introduce a charge of propellant into the weapon and launcher through the charge fitting located at the after end of the launchers flexible hose.

CAUTION: The propellant can is outfitted with a propellant charging adapter, that item terminating in a tire-valve air chuck. When the air chuck and launcher charge fitting are firmly pushed together the transfer of propellant occurs. You'll want to take care to perform this operation quickly or you'll waste propellant through the leaky union. Excessive leaking of the quickly boiling propellant can give you a cold burn if too much propellant gets on your hand.

As the internal Schrader valve of the charge fitting unseats, so does the check-valve within the air chuck of the propellant can charging adapter. Unseating those two check-valves permits the free passage of pressurized propellant liquid (the propellant can is inverted during the charging operation) from the can to the weapons cavity and bore of the breech-block where the pressurized propellant remains in the liquid state until the moment of launch.

A single shot charge into a room temperature system introduces enough propellant to produce a 15-foot or so range after launching. Now, if you wish to increase the range to about 30-feet, you need to chill the weapon and propellant charging path, this in order to degrease their thermal energy. The higher thermal energy disparity between the weapon system and propellant can, the greater the amount of liquid transfer achieved before the energy between the two equalizes, stopping the exchange of propellant. The trick is to chill the weapon system. You do so by first charging the system, then quickly unseating the Schrader valve of the charge fitting, dumping the small quantify of gas initially placed within the weapon system – the rapidly expanding gas absorbs energy from the weapon and launcher structures, chilling the system. You then quickly charge the system again. This time you more than double the amount of propellant injected into the weapon and launcher as compared to the first charge of propellant done with the system was at room temperature.



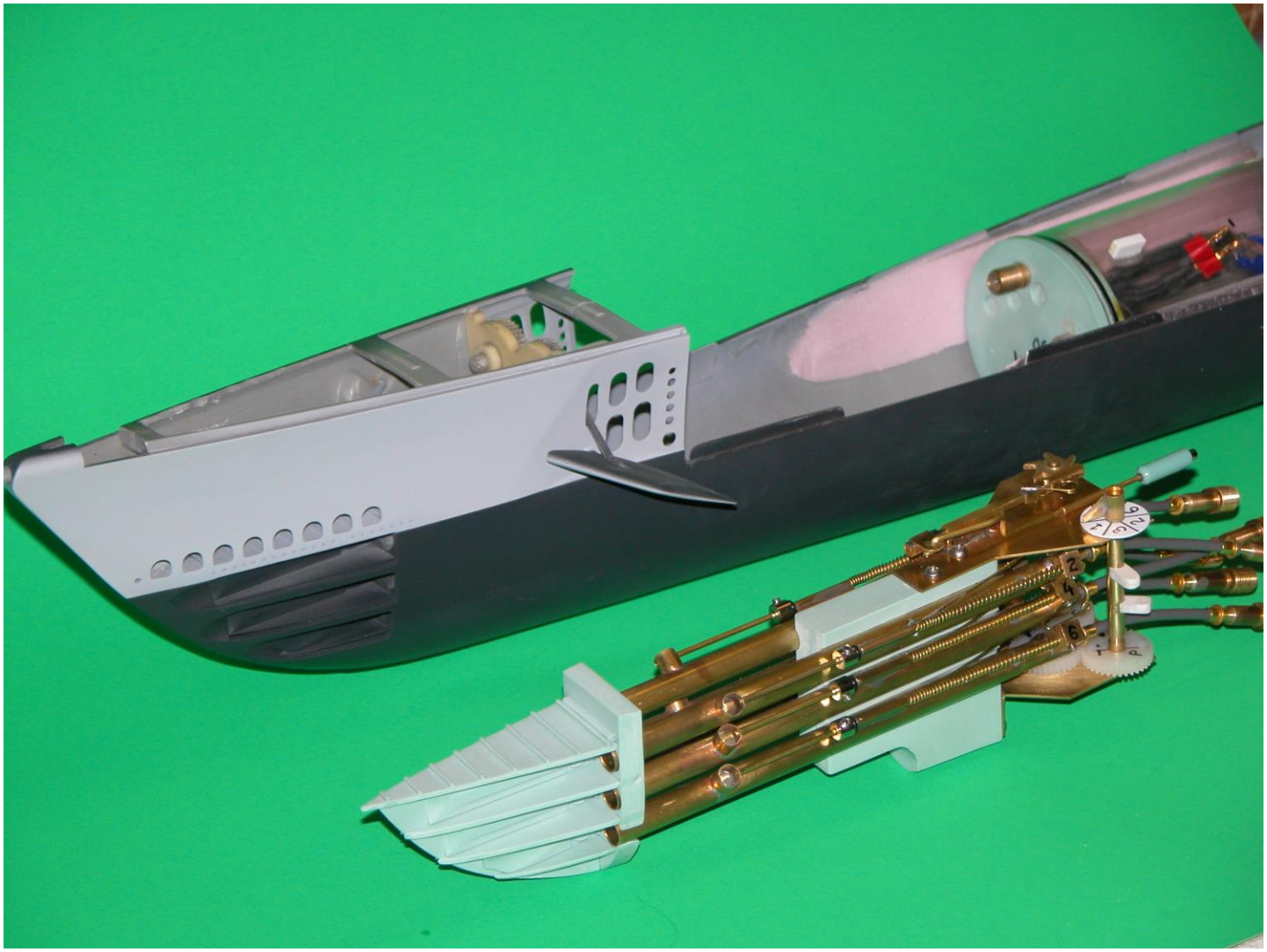
LAUNCHER INSTALLATION INTO A MODEL SUBMARINE HULL

There are a reasonably large number of 1/72 model kits representing submarines that are suitable for conversion to r/c operation. These kits fabricated from either hand laid-up fiberglass (GRP) or the more traditional styrene injection formed plastic model kits.

The 1/72 submarine kits available to us today that can be outfitted with our weapon system include: ALFA, TYPHOON, ROMEO, KILO, GATO, STURGEON, THRESHER/PERMIT, SKIPJACK, COLLINS, I-53, M-1, Type-23, Type-7, and TYPE-2. There may be other 1/72 scale model submarine kits I'm unaware of out there.

How the tube muzzle ends project into the water, and specifically how the bow (or stern, if we're talking the stern nest) of a specific class of submarine is configured is of vital concern to the careful kit-assembler and scratch-builder. The objective is to incorporate the same elements into your model display as are observed on the prototype. We're talking SCALE FIDELITY here, boys and girls!

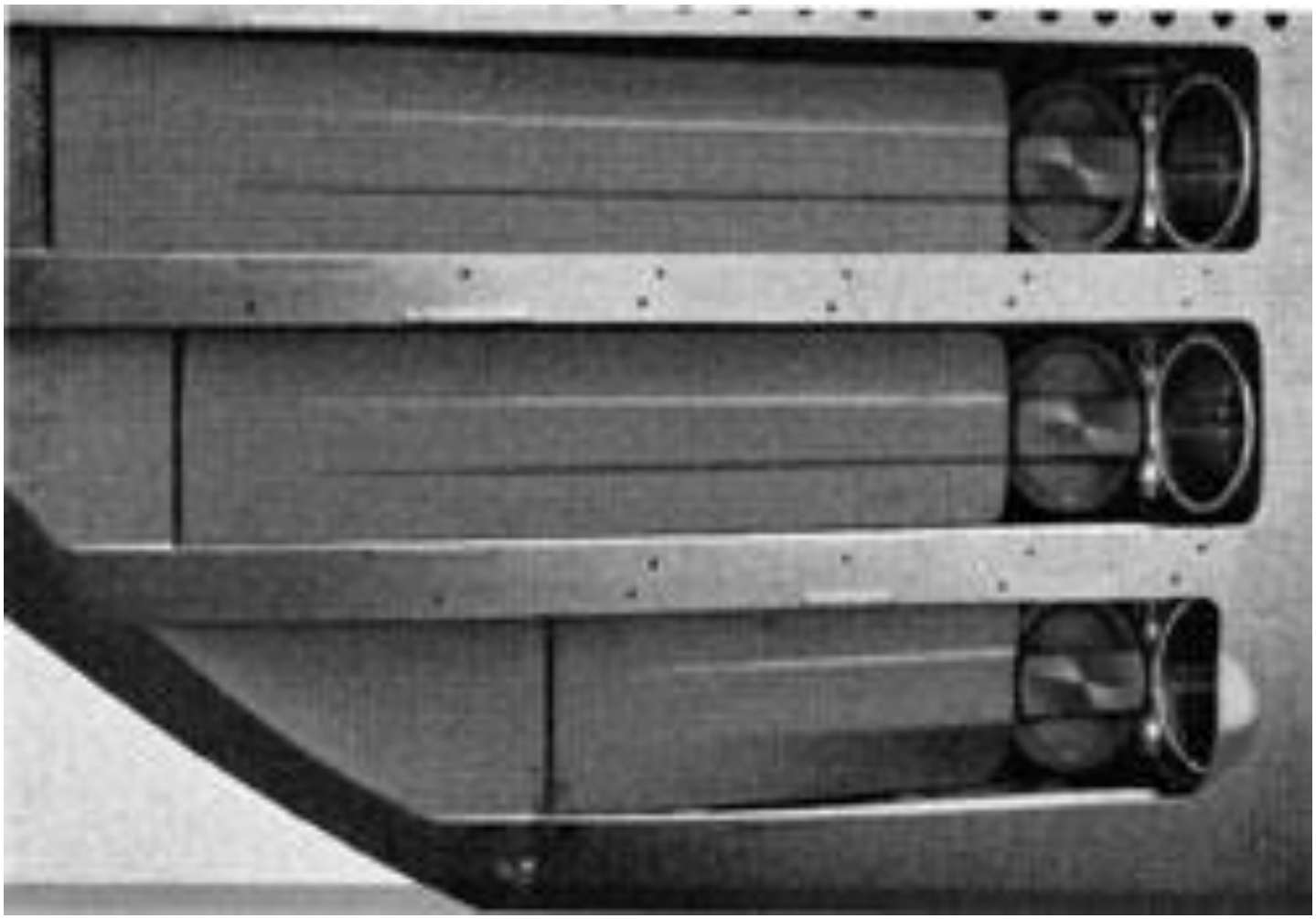
More likely than not you're model kit will not have the parts to represent the torpedo tube muzzle doors and associated shutter doors in the open position. It will fall on your shoulders to make your own scale looking doors and to integrate them into the models bow and/or stern. The below shot shows the work I went through to create a resin shutter and muzzle door assembly that represents all six of the GATO's muzzle and shutter doors in the open position. A painted unit has already been installed into the GATO model. In foreground we see a unpainted GATO shutter door assembly fit to the muzzle end of the GATO bow launcher nest. Break out the research material and tools, you're in for a hell of a time working this sort of thing out for your specific model. Have fun!



The following discussion deals with the conversion of the Revell 1/72 GATO bow for acceptance of a Caswell-Merriman weapon system. First thing is to remove the kits closed shutter doors(s) at the positions you plan to install a launcher. Cutting GRP or styrene, the work will go pretty much the same. Just keep in mind that GRP, glass re-enforced plastic, is indeed glass and will dull your tools quickly – be prepared to go through several sets of rotary and hand tools as the work progresses. Punching out holes in styrene is like sliding a hot knife through butter by comparison.

(Below is an illustration of a GATO/BALAO/TENCH class American diesel-boats bow torpedo tube shutter doors. How well I remember this, it was one of many illustrations in the operational pamphlet we Torpedoman studied through several decades, as we operated and maintained the launchers assigned to us aboard diesel-electric American submarines. Mine was the USS TRUTTA (SS 421), a TENCH class boat).

This artists retouched photo-illustration clearly shows how the slide-and-tuck shutters doors, carried by the opened muzzle door, conform with the inboard diameter of the tube bore, insuring clearance of the weapon as it leaves its tube. Note the 'rub land' on the inside face of the muzzle doors and built into the outboard faces of the shutter doors. These lands form a slide bearing that mitigated weapon damage should the torpedo come into contact with the boat as it sped out the tube. The reason for the rub lands is, in no small part, owed to the Bernoulli effect – the launched weapon, close to the side of the bow, sees the water on its bow side as a lower pressure fluid than the water on the outboard side of the weapon. This pressure differential producing a lateral force pushing the weapon into the bow of the submarine. A torpedo traveling through an open trough arrangement, like on our old diesel boats, is more susceptible to Bernoulli effects than weapons launched from boats featuring a bulbous bow or from the flank of a boat – both characteristics of today's submarine designs.



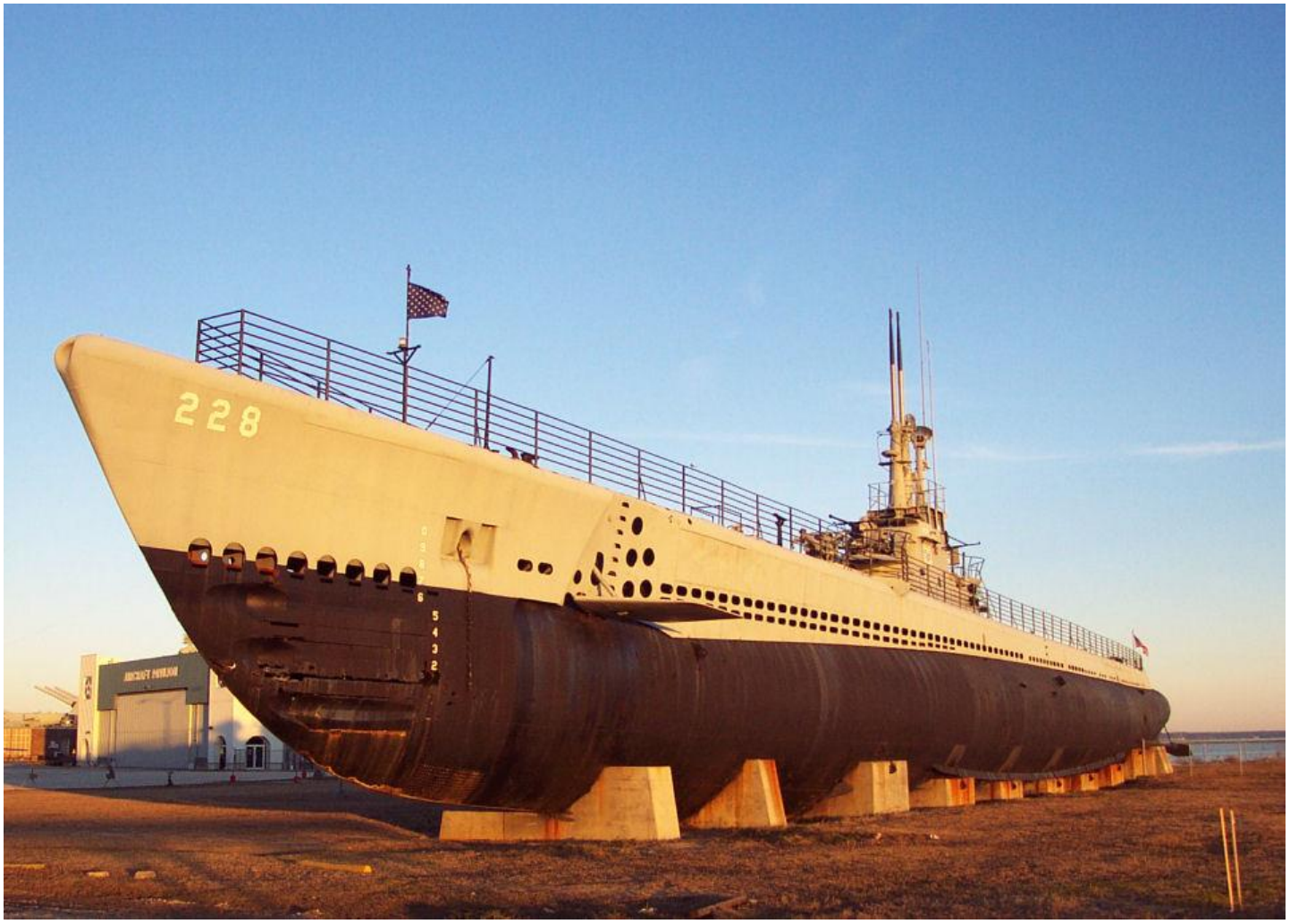
No, the shutter door geometry seen in the above illustration does not reflect that of the Revell GATO kit. Not all world war two era American diesel submarines were the same. So, if you are a stickler for detail, you may

wish to make alterations to your Revell GATO kit to show the arrangement specific to the boat you are representing.

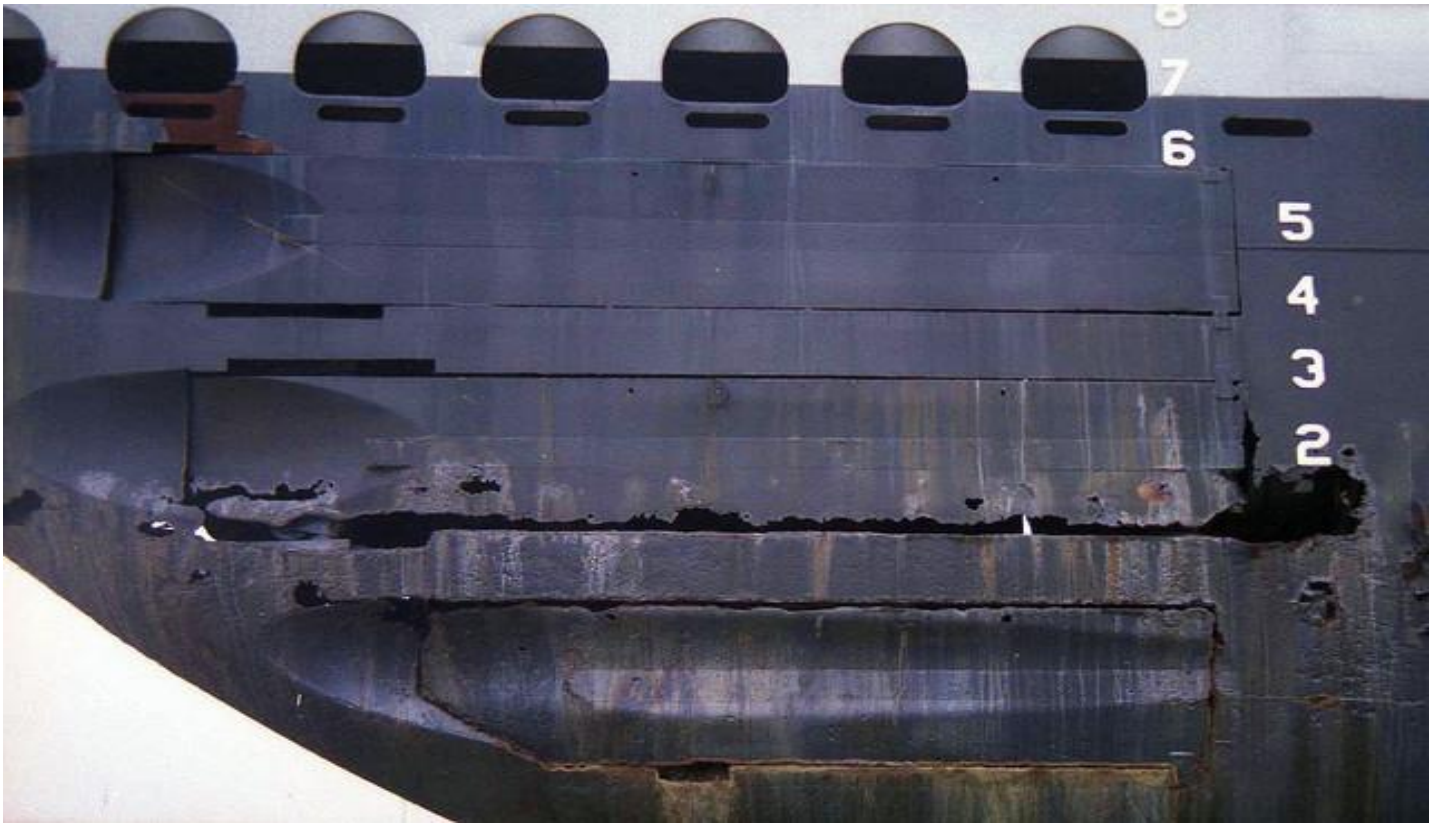
Boats within the GATO, BALAO, and TENCH classes differed from one another owing to the fact that a specific boat would have been built to the standard of one of two general designs. A boat was built to either the government/Portsmouth (a Naval Shipyard) or the Electric Boat (a private shipyard) design – both designs matching in overall hull, machinery, and compartmentation, but differed in many details, such as shutter doors. Adding to the confusion are the field changes, refit alterations, and evaluation equipments installed over the life of any particular boat. Further variances of detail from one boat to the next occurred because of different yard construction methods employed during the hectic war years

(Yes, yes, I know that this is all a bit too much rivet-counting, bull-shit for a weapon system manual. However, I include it here to illustrate just how stupid things can get when you go about the task of building a scale model component).

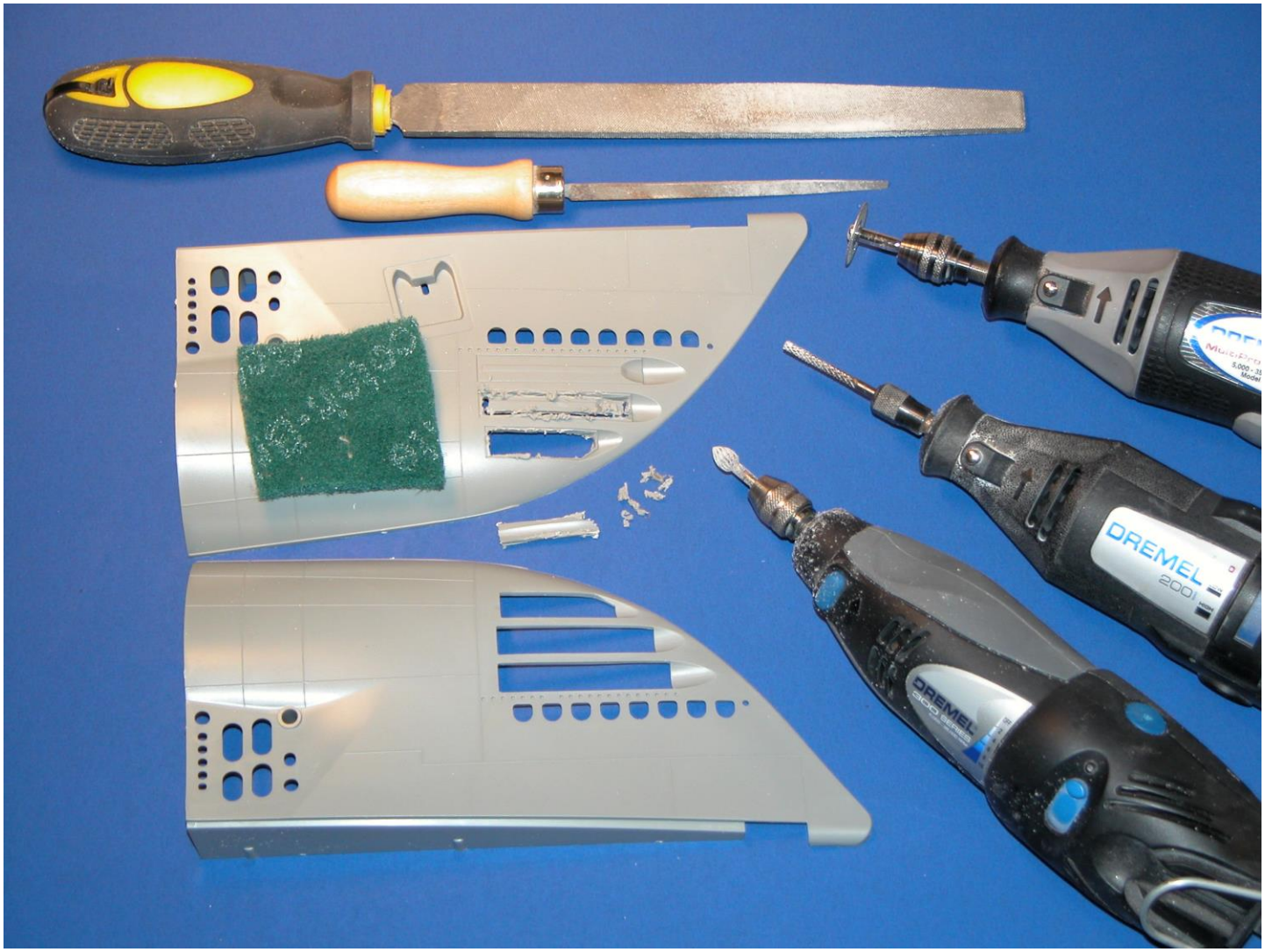
A web search netted me these two fine shots of the shutter doors of this rather poorly preserved GATO/BALAO museum boat. Important to my research in that it shares the same type shutter doors as those of the Revell 1/72 GATO model submarine kit.



I used these shots almost exclusively as I built the masters and rubber tools from which I eventually produced model parts representing the GATO shutter doors in the open position.



Let's say you are going to install all six launchers into the bow of the GATO kit. As the kit is engineered with the hull divided into three main sections (a left-right part comprising each section), you would be will served to fit the foundation for the launchers into the bow section before joining its two halves permanently. Remove the 'closed' shutter doors. Just follow the engraved outline of each shutter door and the work is done in no time – cut away the shutter doors to the port and starboard bow pieces. An easy process with drill, grinder bits, and small circular saw, all swung by the Dremel Moto-Tool. Finish off the rough edges around the shutter-door openings with files and sanding sticks.

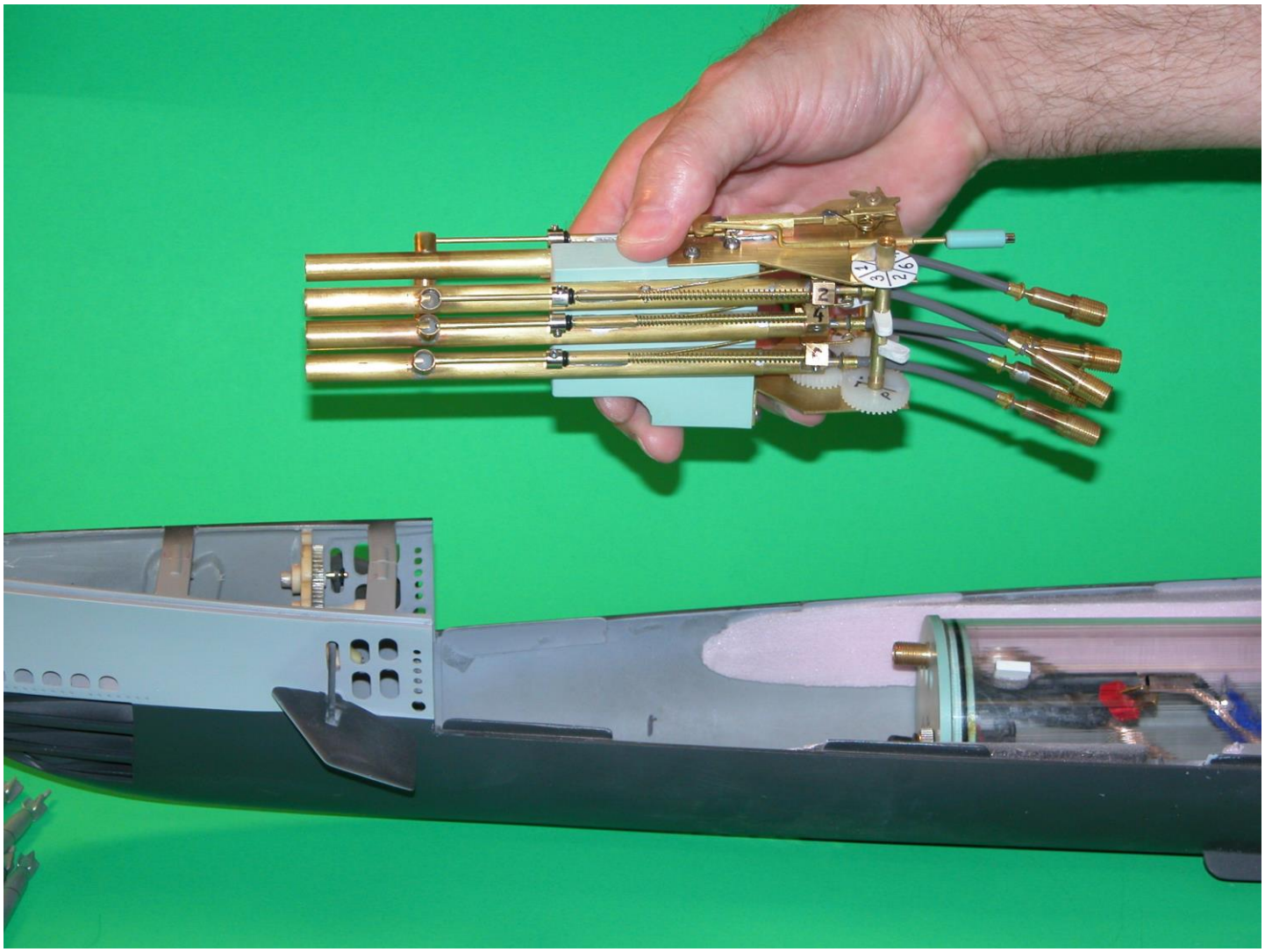


When installing two or more launchers you first establish the distance between the center line of each tubes bore and the adjacent tube(s) in height and width. You form a block, that when positioned between the adjacent tubes, acts to hold the launchers to the correct distance apart in width and height. The block is indexed with shims or is machined with grooves to maintain the launchers in the correct nest pattern. I call it a launcher nest foundation.

You then form a muzzle bulkhead piece. This conforms to the frame-station within the bow where the torpedo tubes end. Into this muzzle bulkhead are punched holes that will fit the muzzle ends of the launchers. The muzzle bulkhead and launcher nest foundation are the elements that secure the tubes and hold them in correct alignment within the bow of the model submarine. Additional parts, later added to the forward face of the muzzle bulkhead, include the bottom of the bow-buoyancy tank (which can be seen through the bow buoyancy tank limber holes), the central muzzle-door and shutter-door piece, and the six platform pieces that define the troughs that clear the bow structure from the weapons as they are launched.

The photo below clearly shows the bow launcher nest foundation and muzzle bulkhead assembly – these position the six launchers within the bow of the 1/72 Revell GATO kit. RTV silicon adhesive is used to hold

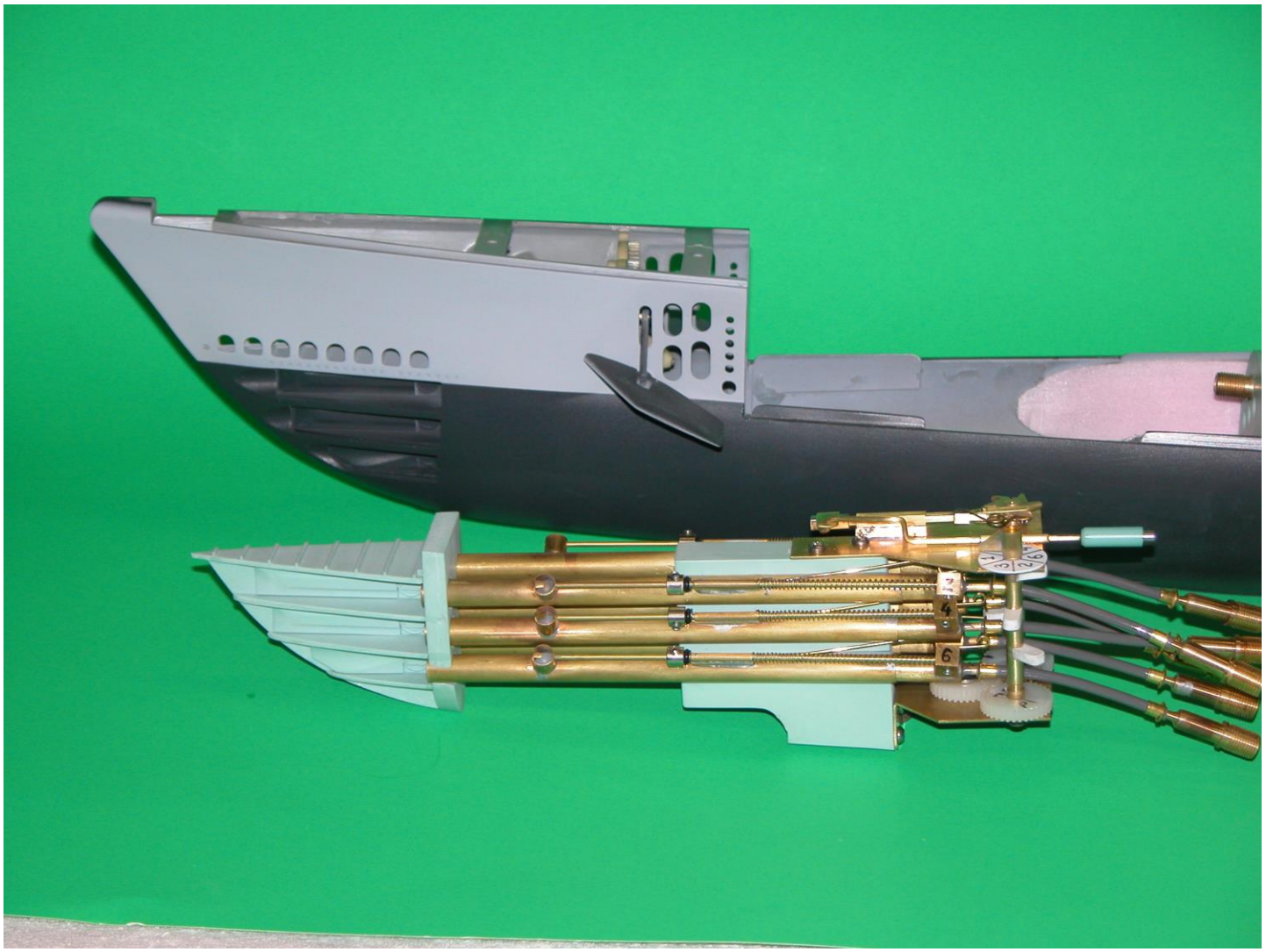
the launchers against the launcher nest foundation piece. The muzzle bulkhead assembly will eventually be glued into the bow of the GATO model. The entire nest of six tubes is removable. Installing the nest is an easy matter: the nest is positioned into the bow, the forward edge of each launcher tube sets within a hole in the muzzle bulkhead, the nest foundation block is then sat down till it makes contact with the hull – the bottom of the launcher nest foundation piece is shaped to give the correct angle of the launchers in relation to the hulls center line. The nest is secured within the bow of the model submarine with a single small machine screw that makes up to a bracket at the after, bottom edge of the launcher nest foundation.



Mounting of the four tube nest at the stern of the GATO is done in a like manner. Of course there are variations of installation, the type and utility of the tube/nest installation you come up with is limited only by your imagination and craftsmanship.

I've made no attempt on this model to make the shutter doors operational. It was enough for me to install a set of false shutter doors represented in the 'open' position. However, depending on your wants and ability, there is nothing stopping you from making the shutter doors work – likely a staggered trip working off the same

mechanism that engages the launcher triggers, which would allow a spring-loaded shutter door to open an instant before the launcher transitions from the battery to the launched condition.



As you can see, things are a bit tight in the bow of the GATO with a complete set of launchers and the attached launcher trigger tripping mechanism.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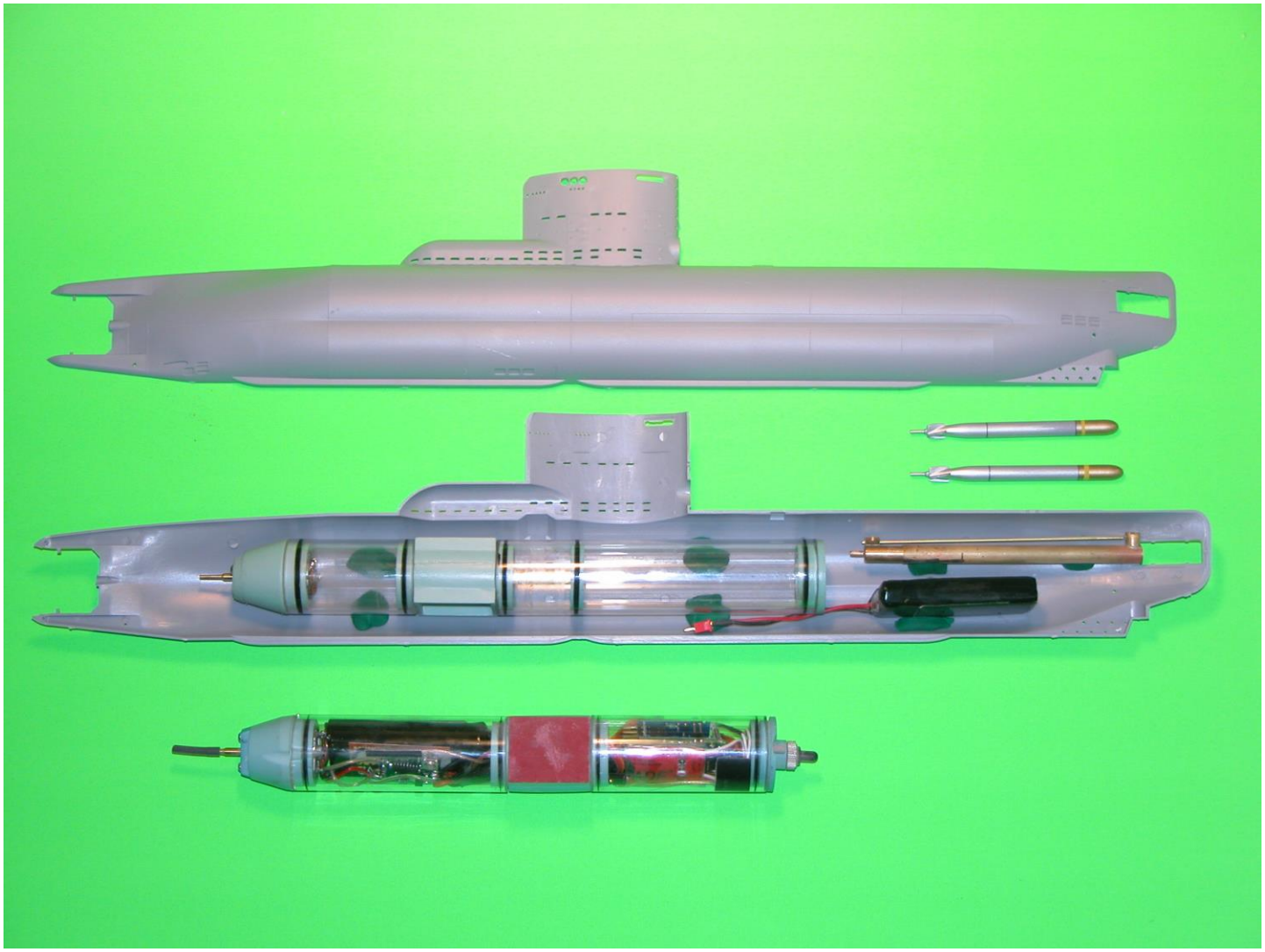
You must allow unobstructed after travel of the launcher flexible hose and attached charge fittings so that the launcher can transition from the battery to the launch condition. Any obstruction of the charge fitting and associated hose could result in a jam when attempting to launch a weapon. To gain the clear space between the launchers and the forward bulkhead of my GATO's SubDriver I removed 2.5-inches of cylinder from the after dray space – there was enough unused room in that space to permit this modification of the SubDriver cylinder.

Smaller 1/72 model submarine kits can be converted into weapons platforms as well: This styrene plastic model kit of the Type-23 is one example. Note that through careful design of the 1.25-inch diameter SubDriver, room can be made for inclusion of the two launchers this type submarine featured. Preliminary study of where to locate things within the hull is being conducted in this photo; I'm finding where to place the SubDriver, battery, and launcher (only one fit here) by temporarily holding these items in place with clay. Later, once the internal layout of gear has been finalized, foundations for these items will be built into the hull; the two halves of the hull glued together, and the hull split into an upper and lower half in order to get access to the model submarines interior.

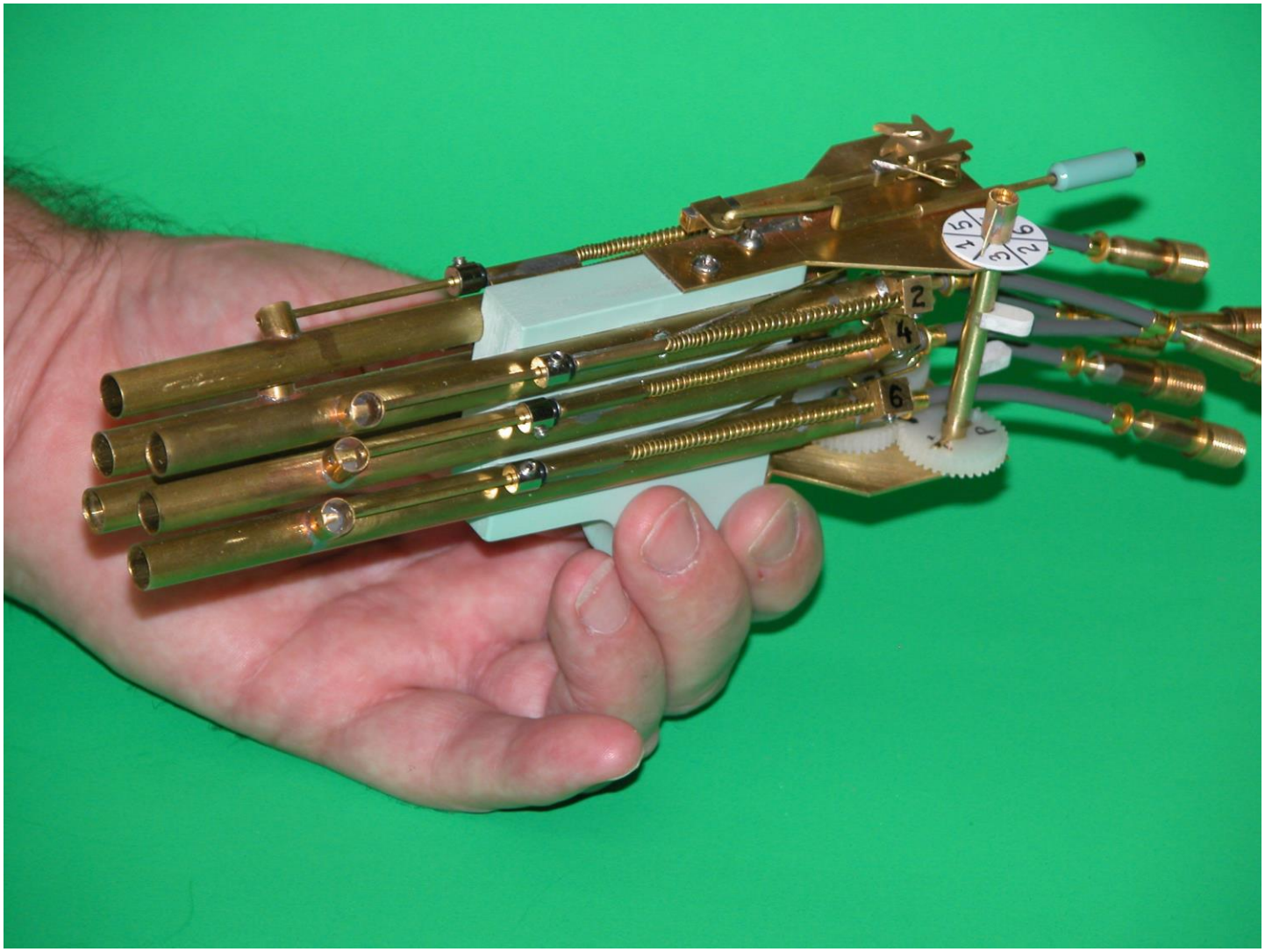


LAUNCHER TRIGGER TRIPPING MECHANISM

Scale model r/c submarines vary as to the number of launchers they employ. Some as many as ten launchers, some as few as two. Whatever mechanism you come up with to get your launcher from battery to the launched condition, the objective is the same: your launcher trigger tripping mechanism must reliably unseat each launcher trigger from its breech-block, and do so only at your command. How many launchers you put aboard your model submarine, and how tight the space available is: those are the two main considerations that dictate the specifics of your launcher trigger tripping mechanism design.

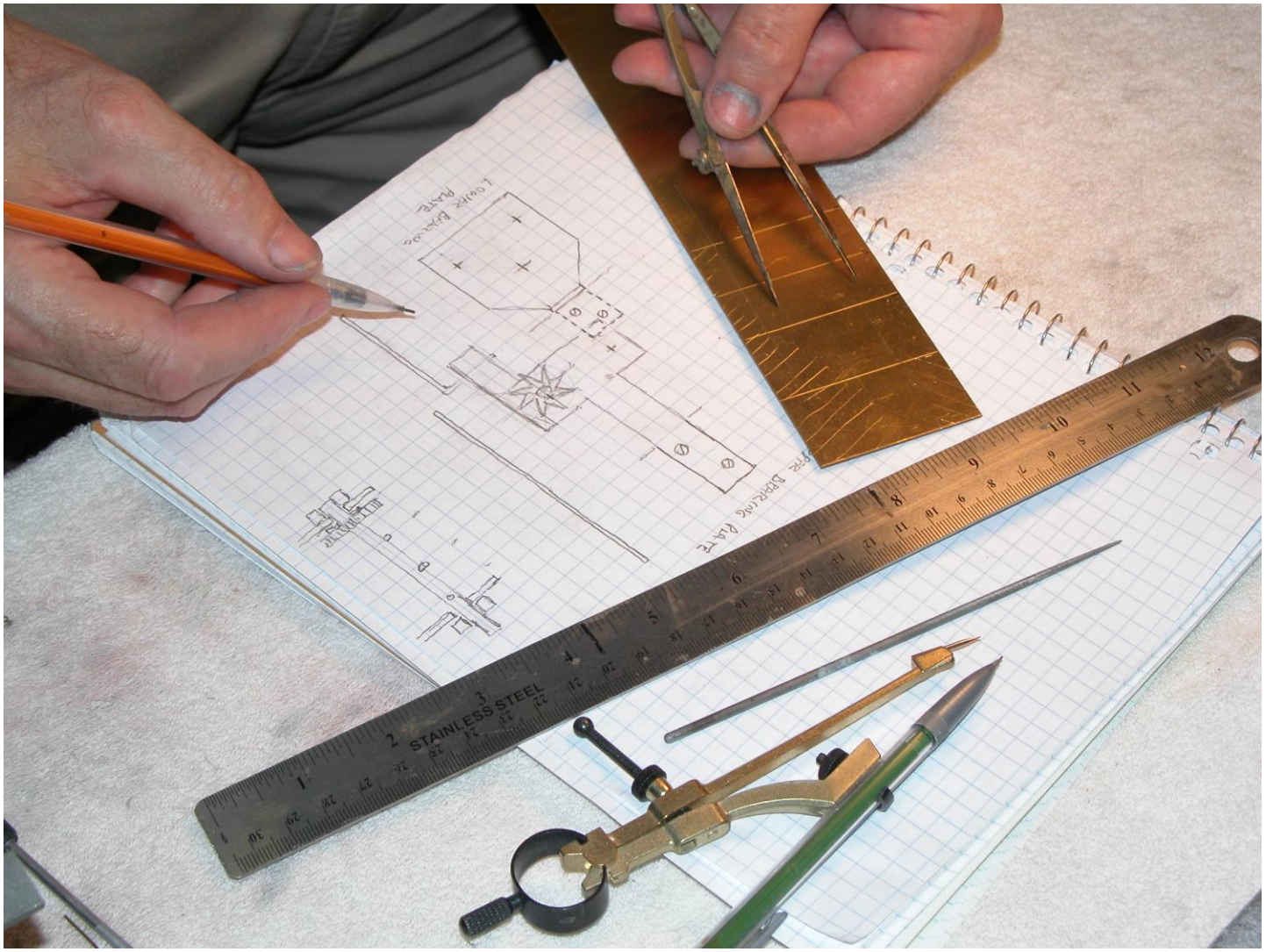
The simplest means of tripping the launcher trigger is to employ a servo to swing a bell-crank arm into making contact with and unseating a launchers trigger. A single servo in this arrangement can be used to actuate two launchers, one at a time. Full throw of the servo from neutral in one direction pushes one end of the bell-crank into one launcher trigger. And full throw from neutral in the other direction pushes the other end of the bell-crank into contact with the second launcher trigger.

You can configure your launcher trigger tripping mechanism any way you see fit – you can rig it so that your tripping mechanism shoots one weapon with each cycle of the transmitter switch. Or, ripple fire the entire or a portion of the nest with one switch throw. Or, you can arrange the tripping mechanism to salvo fire the entire nest with one switch throw.

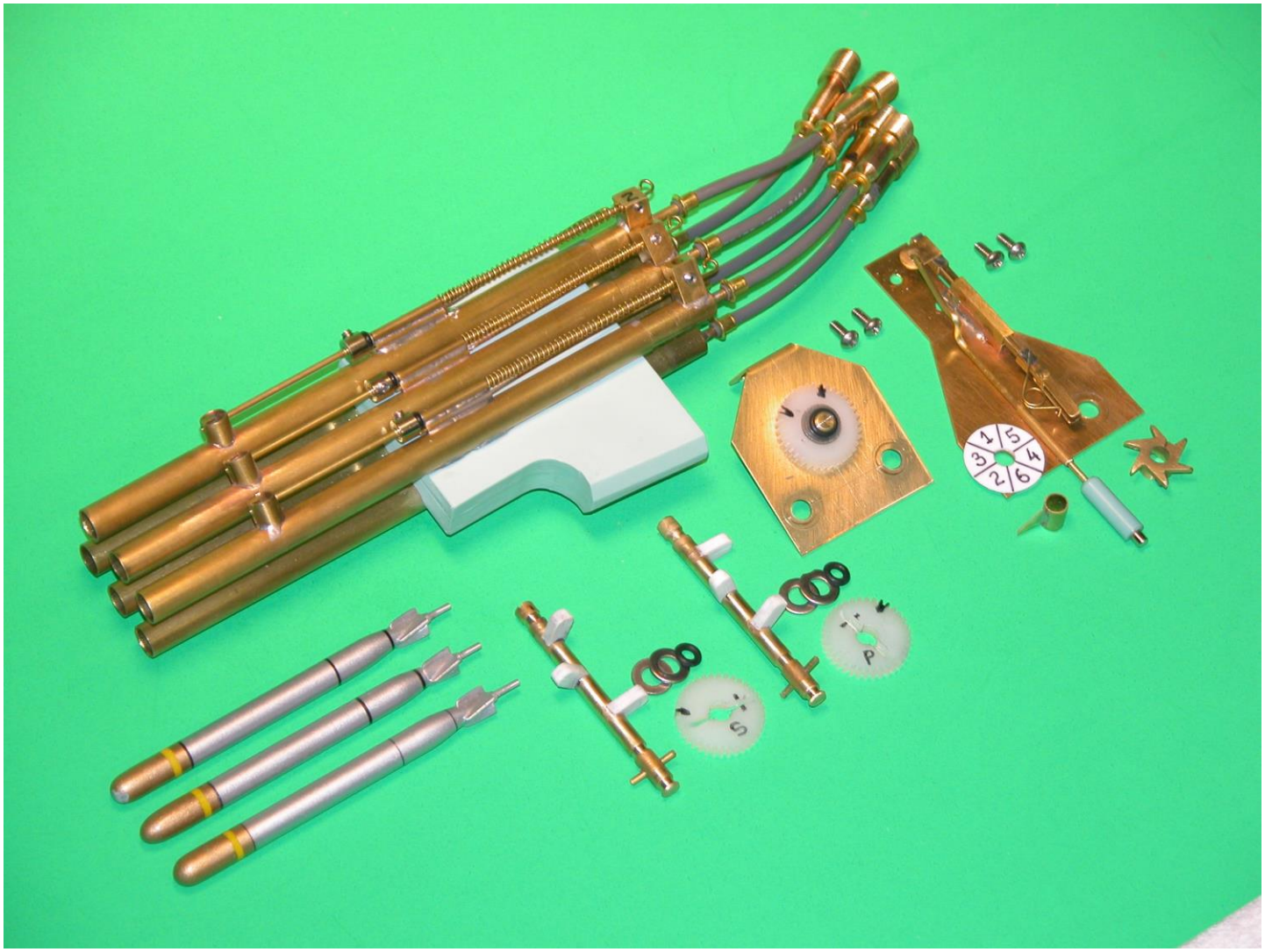


But, what if you wish to employ the Caswell-Merriman mechanical launchers in, say, a six-tube nest like what I've done for my GATO? In that case: you get creative! To help you out, I'll give you a little insight on how I designed, built, and installed a launcher trigger tripping mechanism onto the bow launcher nest of my 1/72 Revell GATO model submarine.

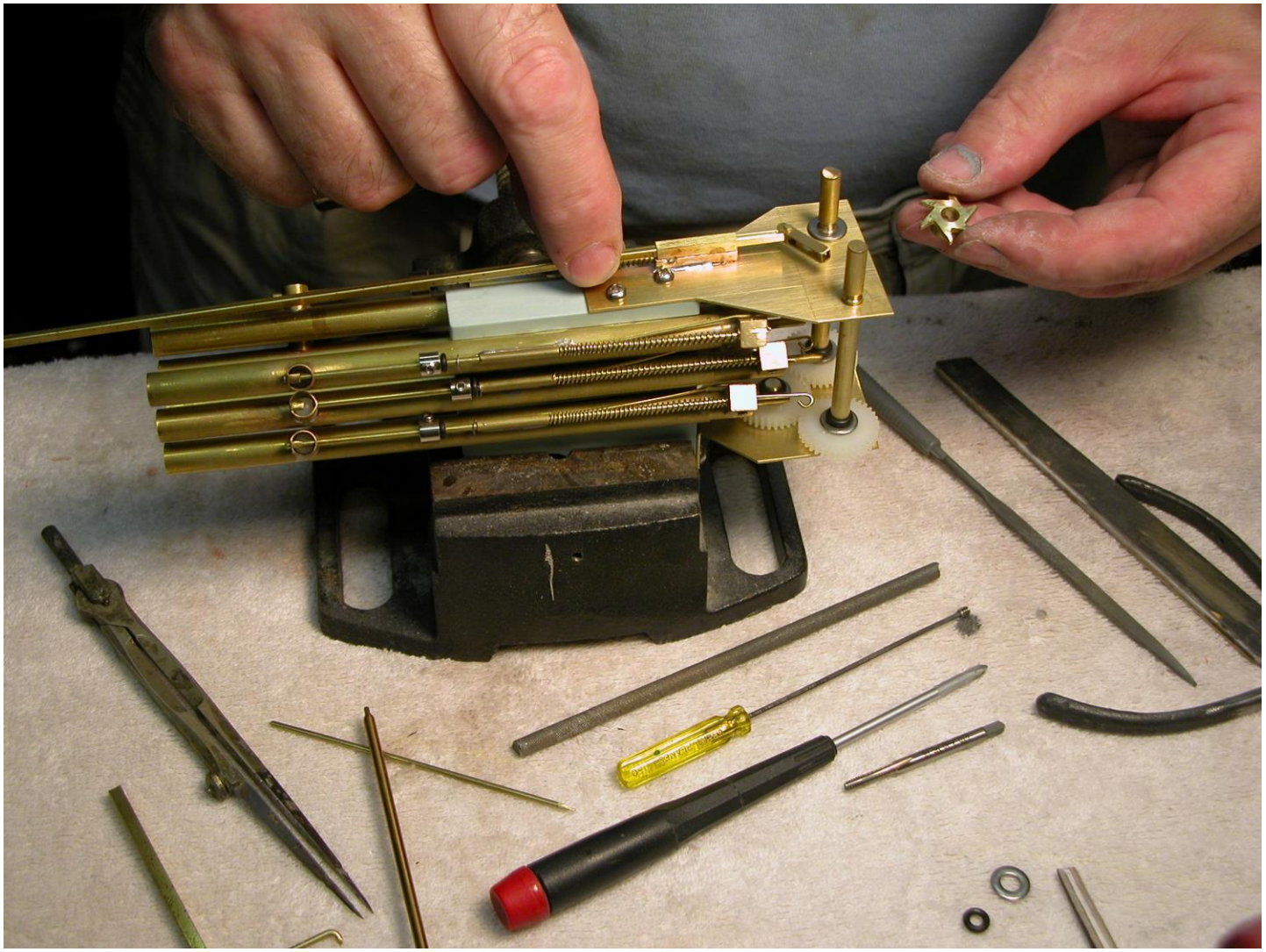
This is where we separate the men from the boys. How to take a single servo and get it to launch one weapon each time the servo is cycled from one end-point to the other end-point? I did it by translating the linear servo travel, via pushrod, to a sixty-degree rotation of two cam shafts – the sixty-degrees achieved through the use of a six-point ratchet wheel driven by a pushrod linked ratchet pawl. From a basic working drawing I laid out the form of the parts – essentially two bearing plates and two cam shafts with associated gearing, ratchet mechanism, and mechanical fasteners – onto some brass sheet and rod and worked the metal with saws, milling machine, lath, and hand-tools.



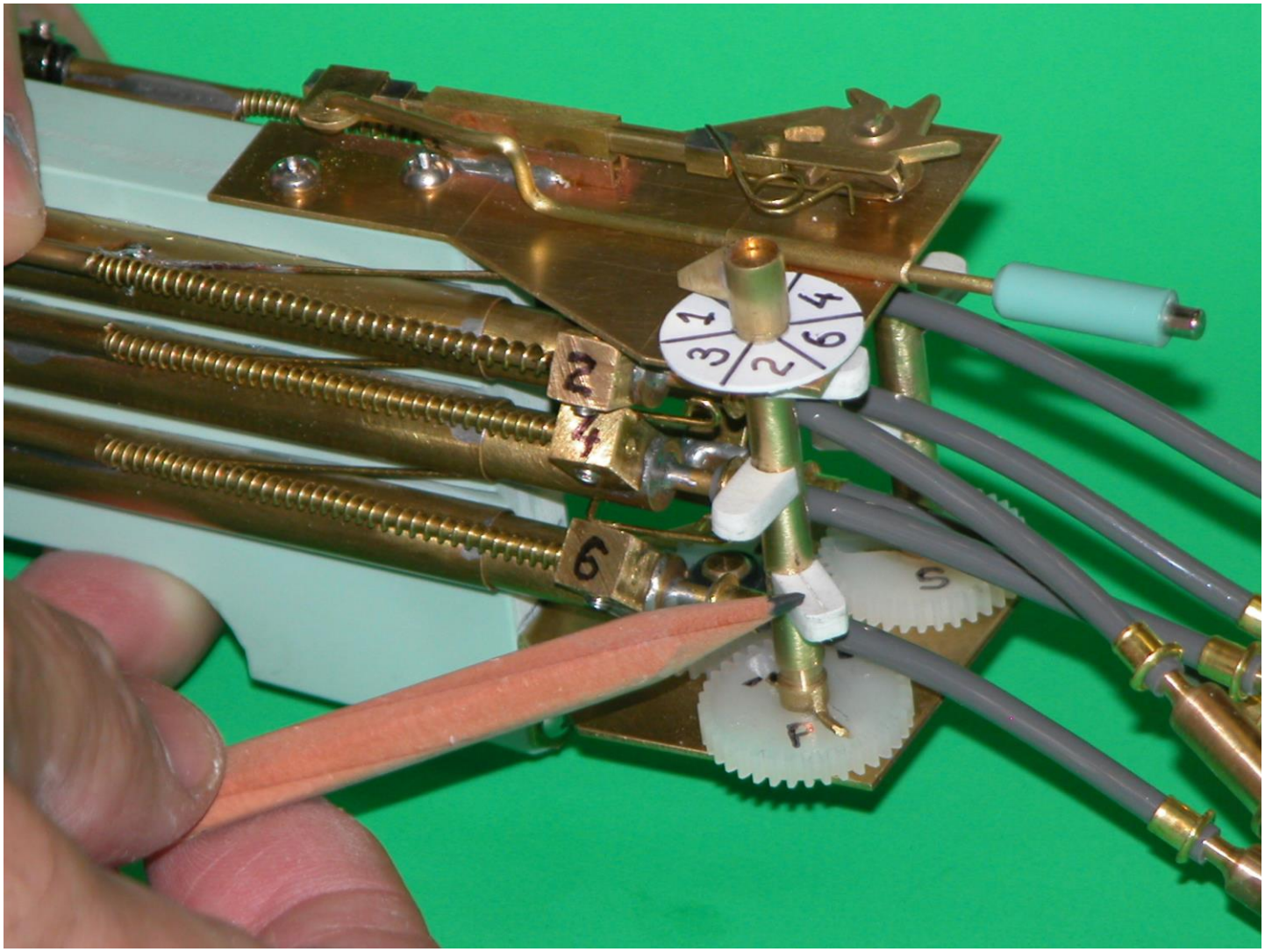
The geometry of the parts driven by function by the need to make clearance for the per-existing linkages, hull structure, and fittings within the bow of the GATO model. As it turned out the rearward face of the launcher nest foundation was the perfect mounting point for the launcher trigger tripping mechanism – the entire launcher trigger tripping mechanism could be removed quickly by pulling only four little machine screws that secured the two bearing plates to the launcher nest foundation.



As you can see, if you are working on the GATO nest, and using the nest foundation piece supplied by Caswell (an element of that GATO launcher fittings kit), the base of the launcher nest foundation is a perfect grab-point for the jaws of a small machine vice – making the vice a great holding fixture to support the work as you go about the task of installing a launcher trigger tripping mechanism. Here you can see that I've installed the two cam-shaft bearing plates to the nest foundation and am working on the ratchet mechanism.



The heart of this particular trigger tripping mechanism are the cams that come into contact and unseat the individual launcher triggers. There are three cams on each cam-shaft and each cam is distanced sixty-degree from its mate. As the servo cycles through, a singl cam unseats a single launcher trigger – after three-hundred-and-sixty degrees of rotation, all launchers have been fired. By staggering the cams radially (providing that the radial displacement between the cams is 60-degrees or multiples of 60-degrees), I can vary the tube order of fire. So, by simply replacing the cam-shafts with a set of cam shafts of different cam off-sets, I can change the order of launching. Note the white circular dial with brass pointer, affixed atop one of the two cam-shafts, upon the upper bearing plate: It indicates which is the next tube to be fired when the servo is cycled.



Anyway … that's how I came up with a single-servo launcher trigger tripping mechanism. Hope it gave you some good ideas. Have a bottle of heavy-duty aspirin nearby when you start in on this gadget!

LAUNCHING AND RECOVERING THE WEAPON

Launching The Weapon Normally, you will launch a weapon as the model submarine is underway and submerged. The recommending launching depth is three hull diameters, that typically is the maximum periscope depth on most submarine types. If you launch too shallow there is the possibility of the weapon broaching (breaking the surface) and flying through the air for some considerable distance, making loss of the weapon a distinct possibility.

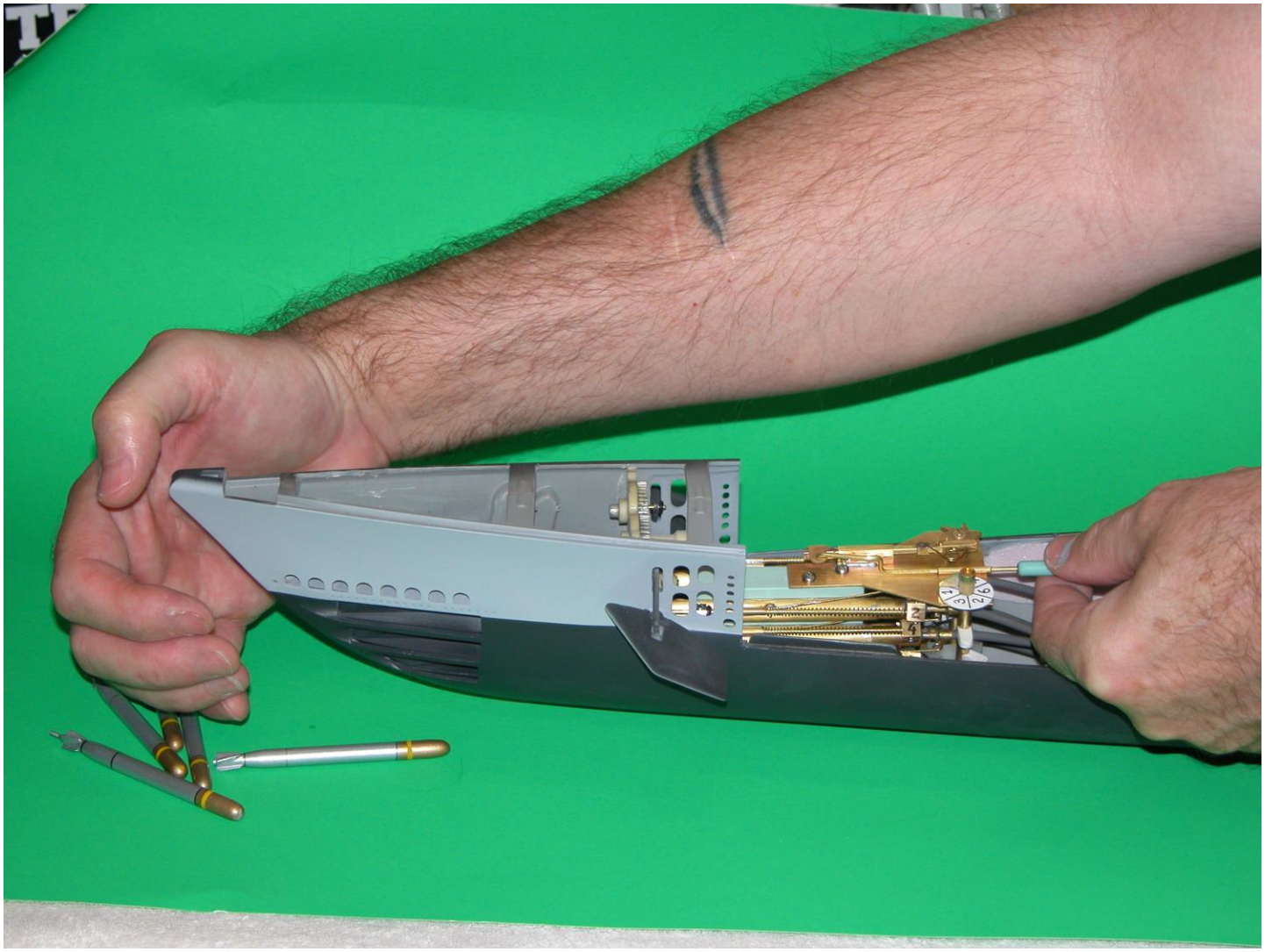
CAUTION: Do not keep a charge of propellant on board the weapon any longer than six-hours. Also, do not permit the charged weapon system to become heated above one-hundred degrees, Fahrenheit. The nominal pressure within the system at seventy degrees Fahrenheit is about seventy PSIG – that pressure increases radically with temperature. A submarine sitting in the July sun with a charged weapon system will soon heat to the point where the four-hundred PSIG burst pressure of the flexible hose is exceeded, resulting in a

catastrophic failure of the hose or cook-off (explosion) of the weapon itself. However, the launcher sub-system is designed to totally contain the debris resulting from a weapon cook-off. Never charge a weapon off-launcher.

Recovering The Weapon(s) To aid you in the recovery of your weapons make it a practice to maneuver your r/c model submarine in such a way as to place the target between where you stand on the shore and your model submarine – the track of the weapon will be towards shore, where you can pick it up at the end of its run. Another means of quick and easy weapon recovery is to outfit a small tug type model boat outfitted with a bow mounted rigid net – you use the tug to scoop up your torpedoes that can't be reached from the shore. Or, you can go swimming. Think before you shoot!

In the event you need to unload a weapon from its launcher, simply place your palm over the muzzle end of the launcher, transition the launcher to the 'launched' condition, catching the charged and thrusting weapon in your hand.

WARNING: A charged weapon, set free in the air, for all practical purposes, is an unguided missile which will attain a significant velocity before the on-board gas is used up. A loosed weapon in the air is very much a missile hazard. Do not launch weapons underway from a depth that is less than three submarine hull diameters deep.



WEAPON AND LAUNCHER MAINTENANCE

Any mechanical system is subject to wear, damage, and the need for occasional preservation and adjustment. So is the case with the elements that comprise the Caswell-Merriman 1/72 weapons system. I've laid out specific checks and operations needed to maintain your system, and when to do them. The list is not exclusive, there might be other things you will need to do to get your system working and to keep it working reliably. Basic shop hand tools, silicon grease (automotive distributor grease), and silicon oil should must be at hand when performing shop or field repairs/adjustments.

Pre-Mission Checks and Operations Before you begin a days use of the r/c model submarine, with the intent of firing torpedoes, you'll perform these checks and operations in the shop:

1. To the weapons, you'll use a piece of .008-inch wire and will run it up through the throats of each weapon. This to insure that the nozzle tube is clear of any potentially clogging matter.

2. Apply a very light coating of silicon grease (distributor grease, available from most automotive parts stores) to the outside of the nozzle tube – insure that no grease gets into the nozzle area where it might be driven into the throat during the charging operation.
3. If so designed, remove the launcher nest(s) from the model submarine. Examine each launcher looking for obvious damage and loose fittings. Examine the flexible hoses, looking for 'ballooning' or rupture. Check for free operation of the breech-block by cycling it between battery and the launch condition – observe that the breech-block, forced rearward by the breech-block spring, travels fully. If not, remove the breech-block from the tube and apply a coating of silicon grease, and pull on the breech-block spring to increase its tension. Re-assemble the launcher and check for proper operation.
4. Load all tubes, get them to battery, charge them all, and launch each weapon into your hand to check for proper launch operation. As each weapon is caught, put it's nozzle near your ear and listen for the sound of escaping gas. A single shot of propellant should be heard hissing out of the weapons nozzel for at least fifteen-seconds.
5. Load all tubes again, get them to battery, but do not charge. Re-install nest into the model submarine.

You've completed your pre-mission checks. Once the boat has been checked out, you're ready to load things into the car and go to the lake. Perform submarine pre-mission checks.

Mission Checks and Operations These are the operations done at the lake to get the weapon system ready for use as well as re-use.

1. Charge all weapons. Cover muzzle ends of launchers with a towel as you energize the r/c model submarine – a small chance exists of a 'transient' occurring during power-up that might cycle the launcher firing servo which, if a full throw occurs, will inadvertently launch one or more weapons accidentally.
2. Recover weapons, reload, blow down launcher charge fitting and recharge weapons as required.

When you put things away and get ready for your trip back home, inventory your weapons – leave with the same number of weapons you arrived with! And cycle the nest to insure that no charged weapons remain aboard.

Post-Mission Checks These are mostly preservation operations, intended to minimize corrosion and to re-condition the mechanisms of the launcher, should the need arise. Post-mission checks and operations are performed in the shop. Ideally the launcher sub-system is designed so that the entire nest can be removed from the model submarine.

1. Rinse all launchers and weapons in clean fresh water to dislodge any sand or dirt that might have gotten in there at the lake. Blow dry the launchers and take care to remove any water trapped within the charge fitting.
2. Load, charge and launch a weapon from each launcher to insure correct operation.
3. Apply silicon oil to the cylinder of the breech-block, and to the interlink rod bearing.
4. Check that all launcher breech-blocks and interlink rods move freely from the battery to the launch condition. Leave the launcher in the launched condition in order to save the breech-block return spring.
5. Put all launchers and weapons in safe storage.

After this work is done, place the launcher nest and weapons in a secure, dry space.

TROUBLE-SHOOTING THE WEAPONS SYSTEM

This is not a perfect world and things do break and require adjustment. Basic shop hand tools, silicon grease (automotive distributor grease), and silicon oil should be at hand when performing shop or field repairs/adjustments.

WEAPON FAILS TO CHARGE In the event you go through the propellant charging operation and the weapon either fails to accept or will not hold the charge of propellant:

1. The breech-block O-ring unseated from its machined groove. Remove the breech-block from the launcher by loosening the breech-block-to-interlink rod set-screw and sliding the breech-block off the rod. Inspect the forward end of the breech-block. If the O-ring is missing you'll find it tucked up within the breech end of the torpedo tube, likely against the weapon stop disc. Re-install or replace the O-ring into its machined groove within the breech-block.
2. There is a rupture in the flexible hose.
3. The charge fitting Schrader valve has loosened. Re-tighten the Schrader valve.
4. Propellant gas is leaking from the weapon. This rare situation can be identified by charging the system then dunking it into water. Leaking gas from the muzzle end of the tube or through the opening atop the ***stop-bolt ball housing*** indicates a breech somewhere within the weapon body. Replace the weapon.
5. Failure to press the propellant can charging adapter and system charge fitting tight enough to effect a gas-tight fit between the two.

UNABLE TO GET LAUNCHER FROM LAUNCHED TO BATTERY CONDTION When the attempt is made to push the breech-block fully forward to latch it to the launch trigger but will not engage:

1. the weapon is not fully seated against the weapon stop disc so that the stop-bolt ball makes contact with the cylindrical portion of the weapon. The still elevated stop-bolt ball prevents the forward end of the interlink rod from traveling further forward – as a consequence the attached breech-block will not make its full travel forward. Use the provided weapon loading ram to seat the weapon against the weapon stop disc while, at the same time, you push the breech-block fully to the battery position.
2. The weapon is properly seated against the weapon stop disc, but the stop-bolt ball has not dropped in front of the weapon. This can occure if the system is inverted or if water in the stop-bolt ball housing exerts enough surface tension force to overcome gravities pull on the stop-bolt ball to drop it down past the point where the forward tip of the interlink rod can act to push the stop-bolt ball down. Gental tapping on the launcher as you push the breech-block block to battery will unseat the sticking stop-bolt ball.
3. The last launch cycle unseated the breech-block O-ring and it is blocking full forward travel of the breech-block as you attempt to position it to the battery position. Remove the breech-block, re-install the O-ring, and re-install the breech-block to the launcher.

WEAPON FAILS TO LEAVE LAUNCHER AT MOMENT OF LAUNCH When an attempt is made to launch a weapon and the weapon fails to leave the tube, the cause is one of three things:

1. Failure of your linkage to fully engage the launch trigger, moving it enough to clear the backside of the breech-block. Either increase the throw of the linkage or find what is blocking full throw of the linkage.
2. Excessive binding between breech-block and the bore it rides at the breech end of the tube. Or, excessive binding between the interlink rod and its interlink rod tube bearing. Or, binding of the forward end of the interlink rod as it travels through the two holes within the stop-bolt ball housing. Remove launcher from the nest, remove wheel-collar stop, slip breech-block and interlink rod assembly from launcher, set breech-block spring aside, re-install breech-block and interlink rod assembly to the launcher, and check for source of binding by moving the breech-block and interlink rod assembly from battery to launch condition. Corrective action will include, but is not limited to, slight bending of the interlink rod and re-application of silicon grease to the breech-block and interlink rod tube bearing. Once binding has been eliminated, re-assemble the launcher, test for correct operation with a weapon, and return the launcher to the nest.
3. You either failed to charge the system or there is a leak somewhere in the system. Identify and correct the leak.

WEAPON BROACHES (JUMPS OUT OF THE WATER) AT MOMENT OF LAUNCH The velocity of the weapon at the moment of launch is high. This is a consequence of the combined thrust of the weapon and the impulse provided by the rapidly expanding gas within the breech-block cavity the moment water gets to it. It is during this critical moment of weapon travel, as it makes the sometimes disturbing transition from travel through a gas to travel through a liquid, where the weapon may go astray from its intended course. As the weapon emerges from the muzzle end of the launcher it may zig up/down/left/right. A contributing factor of weapon skewing at the moment of launch is the geometry of the submarine structure. Interacting with water flow and setting it into chaotic motion, the shape of the submarines bow also contributes to the forces working to upset the weapon.

WEAPON EVIDENCES VERY SHORT RANGE Range of the properly running weapon is a function of how stable it ran, and the amount of Propellant you got into the weapon during the charging operation. Five things that effect the range of your weapon that you have control over include:

1. Insuring that the bore of the weapons nozzle throat is not blocked – your pre-mission work-up of the weapons you'll be using includes a step where you run a piece of .008-inch wire into the bore of the weapons nozzle, insuring that the throat is clear of obstructions.
2. During the charging operation you may not be holding the propellant can charging adapter up tight enough against the launcher charge fitting to fully unset the two fittings check-valves – only enough liquid gets into the system to achieve a low velocity launch, but not enough propellant gets into the weapon to achieve a reasonably long run.
3. You may not be holding the two charge fittings together long enough to transfer enough propellant to get a reasonably long range from the weapon. Five seconds is long enough for the propellant energy in the can to match the propellant energy within the weapon system.
4. There may be a small leak somewhere in the system, venting off the charge of propellant. Identify the leak and correct it.
5. Water has gotten into the weapons hollow interior. As the weapon is launched, that water will crystallize and some of it may enter the weapon nozzle tube and find its way to the nozzle throat, partially or completely blocking the flow of gas. Insure that no water is introduced into the system during the charging operation.

That's it. Now you know all about the care and feeding of your weapon system. Good luck, and …

… GOOD HUNTING!