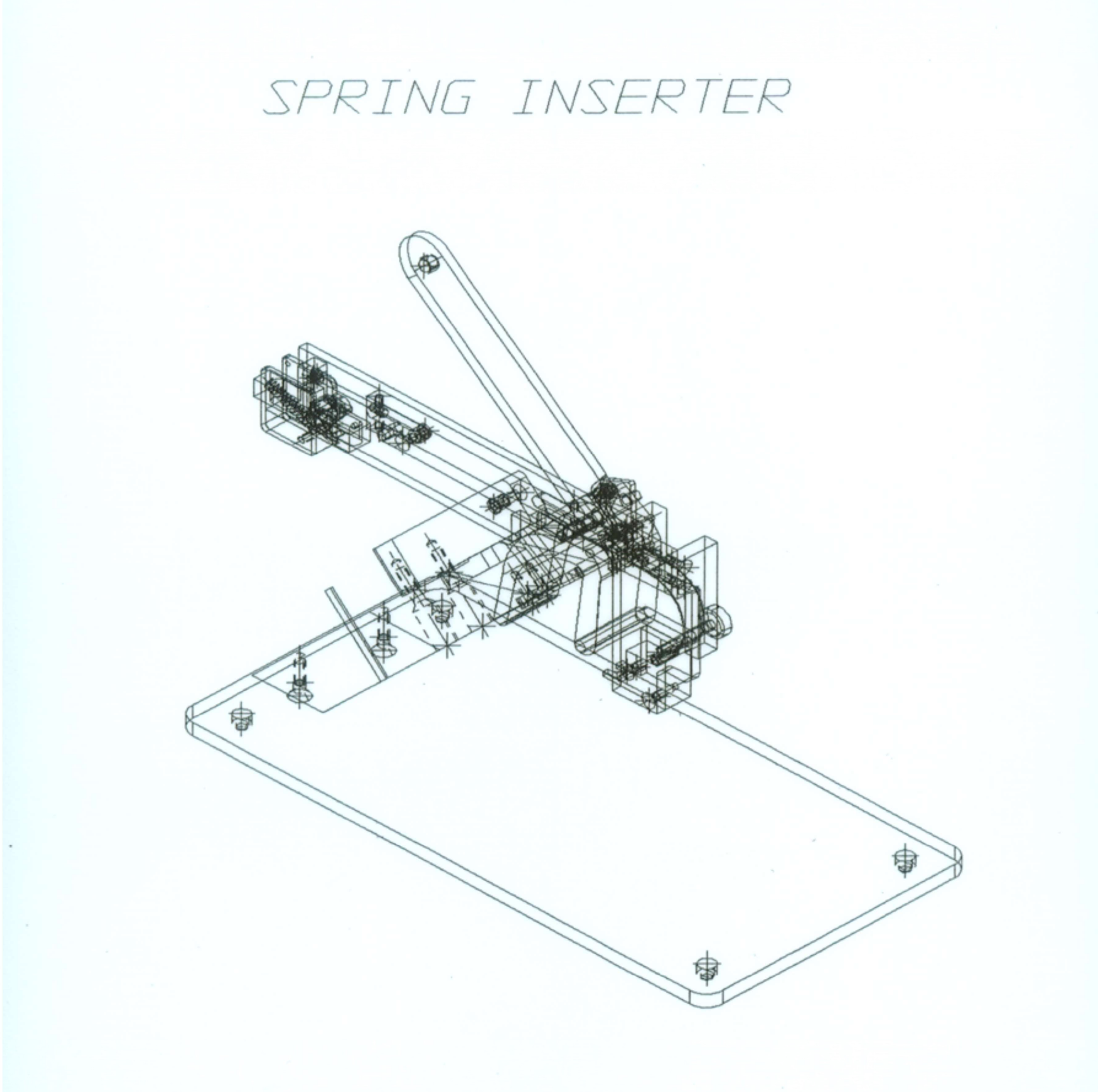
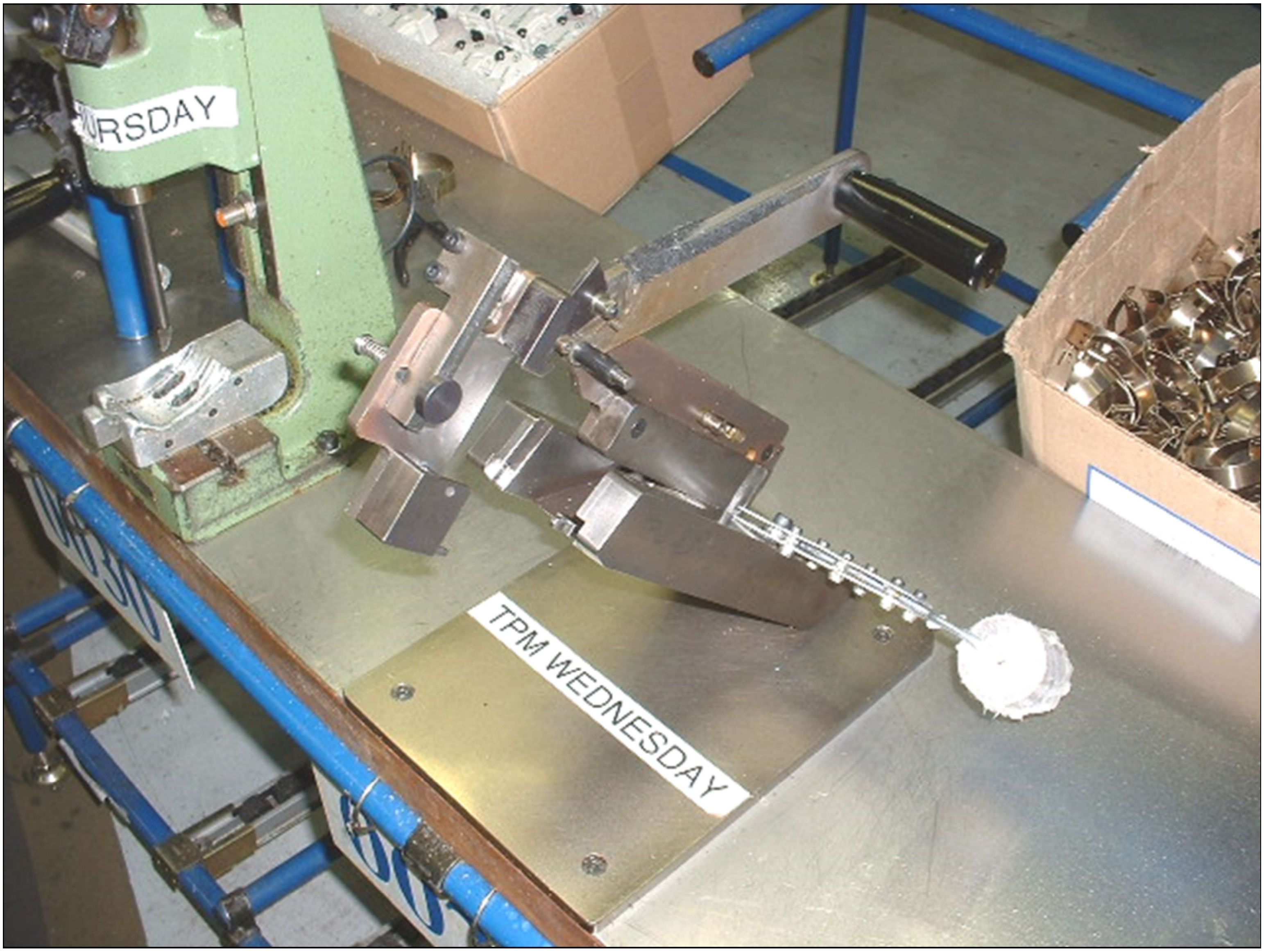


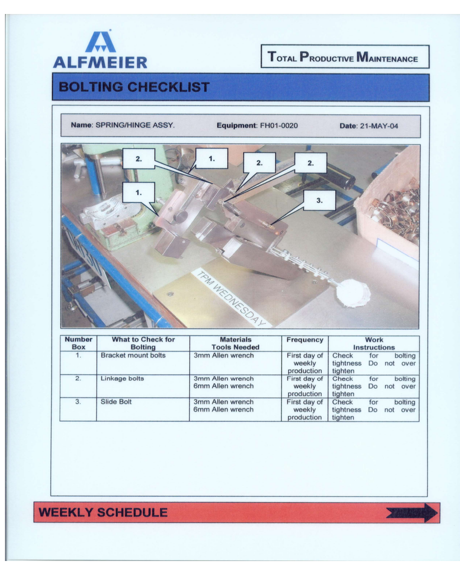
Repeat failure in disassemble of a simple machine used to install a leaf spring to a car gas filler neck recess cover flap - see inset picture.



Using the methods of P-M Analysis I determined that the machine was of good design mechanically but simply was made of the wrong choice in grade of material - metal fatigue.

I had all the parts made from D-2 grade steel and hardened to Rockwell C70. I re-assembled it and as part of the TPM Autonomous Maintenance for Operators, I developed a TPM Lubrication and Bolting standard checklist - see inset. This completely eliminated the problem from mean time between failure of 5 days to infinity - to the day we stopped making the product.

Amazing that a small machine like this can shut down a process that stops the revenue making of thousands of dollars by the hour.



ALFMEIER

TOTAL PRODUCTIVE MAINTENANCE

BOLTING CHECKLIST

Name: SPRING/HINGE ASSY. **Equipment**: FH01-0020 **Date**: 21-MAY-04

Number Box	What to Check for Bolting	Materials Tools Needed	Frequency	Work Instructions
1.	Bracket mount bolts	3mm Allen wrench	First day of weekly production	Check for bolting tightness Do not over tighten
2.	Linkage bolts	3mm Allen wrench 6mm Allen wrench	First day of weekly production	Check for bolting tightness Do not over tighten
3.	Slide Bolt	3mm Allen wrench 6mm Allen wrench	First day of weekly production	Check for bolting tightness Do not over tighten

WEEKLY SCHEDULE

ALFMEIER

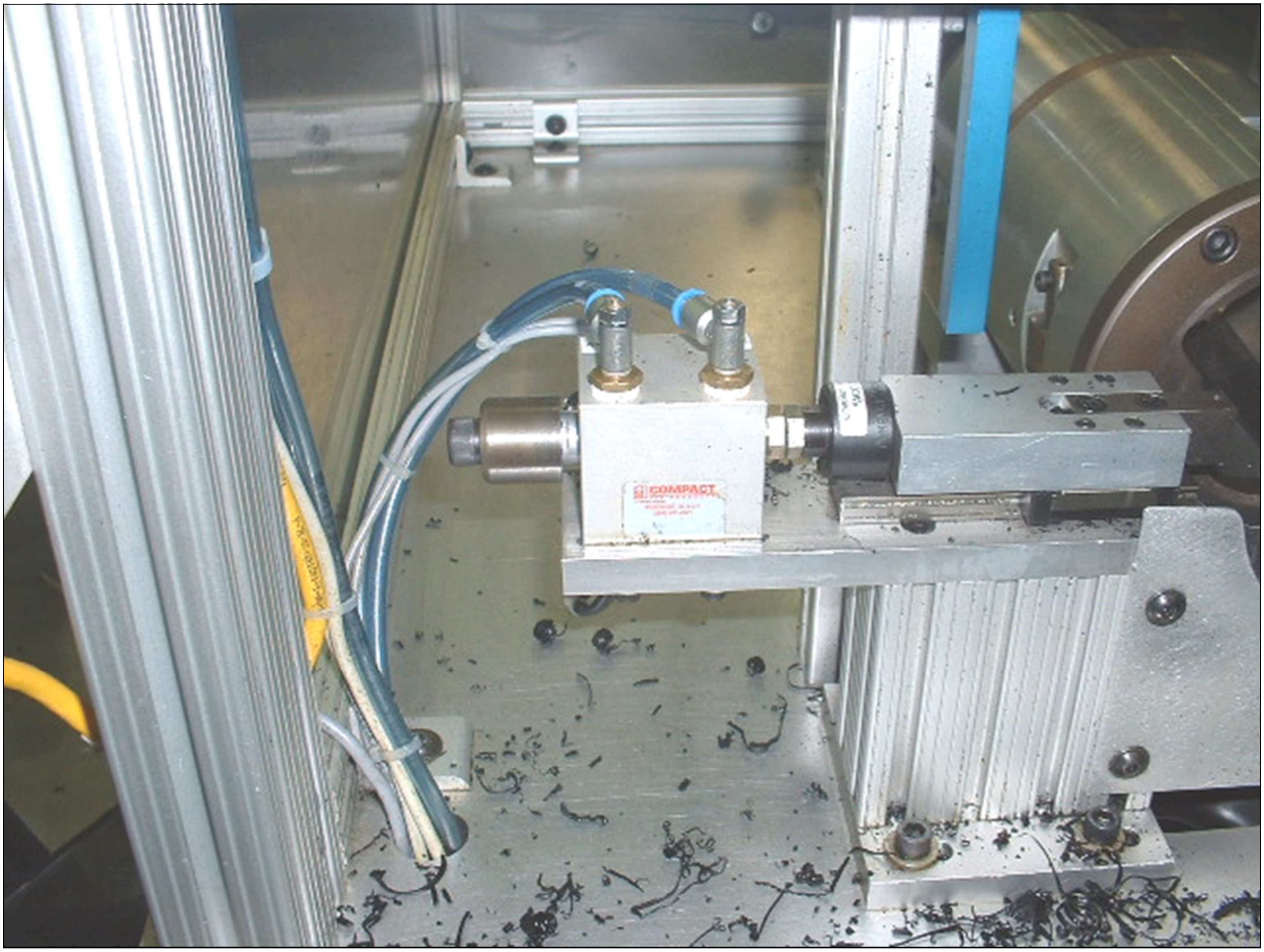
TOTAL PRODUCTIVE MAINTENANCE

LUBRICATION CHECKLIST

Name: SPRING/HINGE ASSY. **Equipment**: FH01-0020 **Date**: 21-MAY-04

Number Box	What to Lubricate	Materials Tools Needed	Frequency	Work Instructions
1.	Cam slot	Grease Applicator brush	First day of weekly production	Clean away old grease and apply a coating of grease to cam slot
2.	Pin guild slot	Grease Applicator brush	First day of weekly production	Clean away old grease and apply a coating of grease to pin guild slot

WEEKLY SCHEDULE

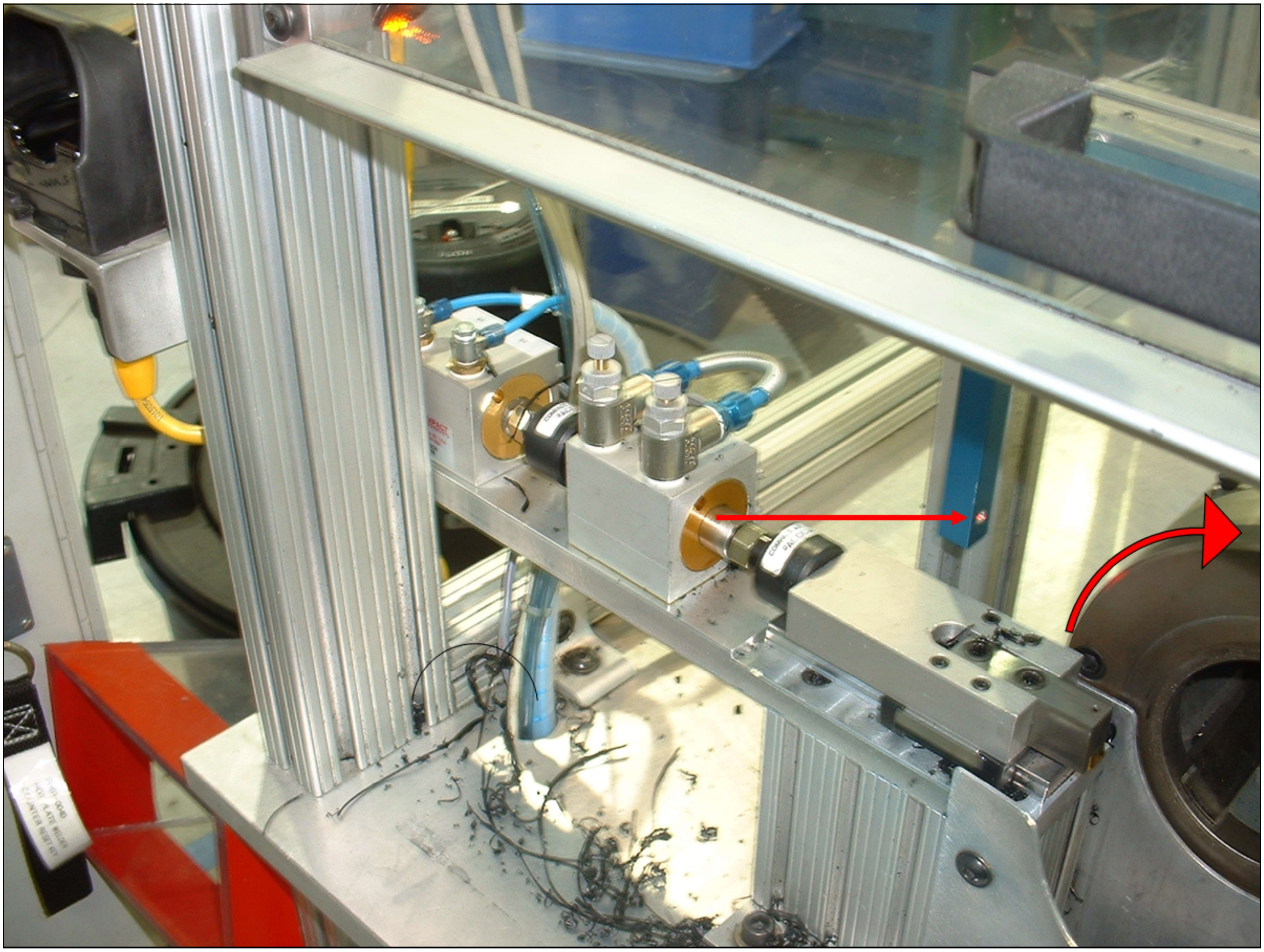


Problem here was a machine that was used to trim excess plastic from a flange of a gas filler nozzle neck for a well known luxury car manufacturer after a vulcanizing process.

The trim tool feed rate was very difficult to control the air cylinder extension speed resulting in jams and tool and product damage. I solved this problem by adopting an air-over-oil configuration using an another identical air cylinder mounted and connected to the through piston rod of the air feed cylinder.

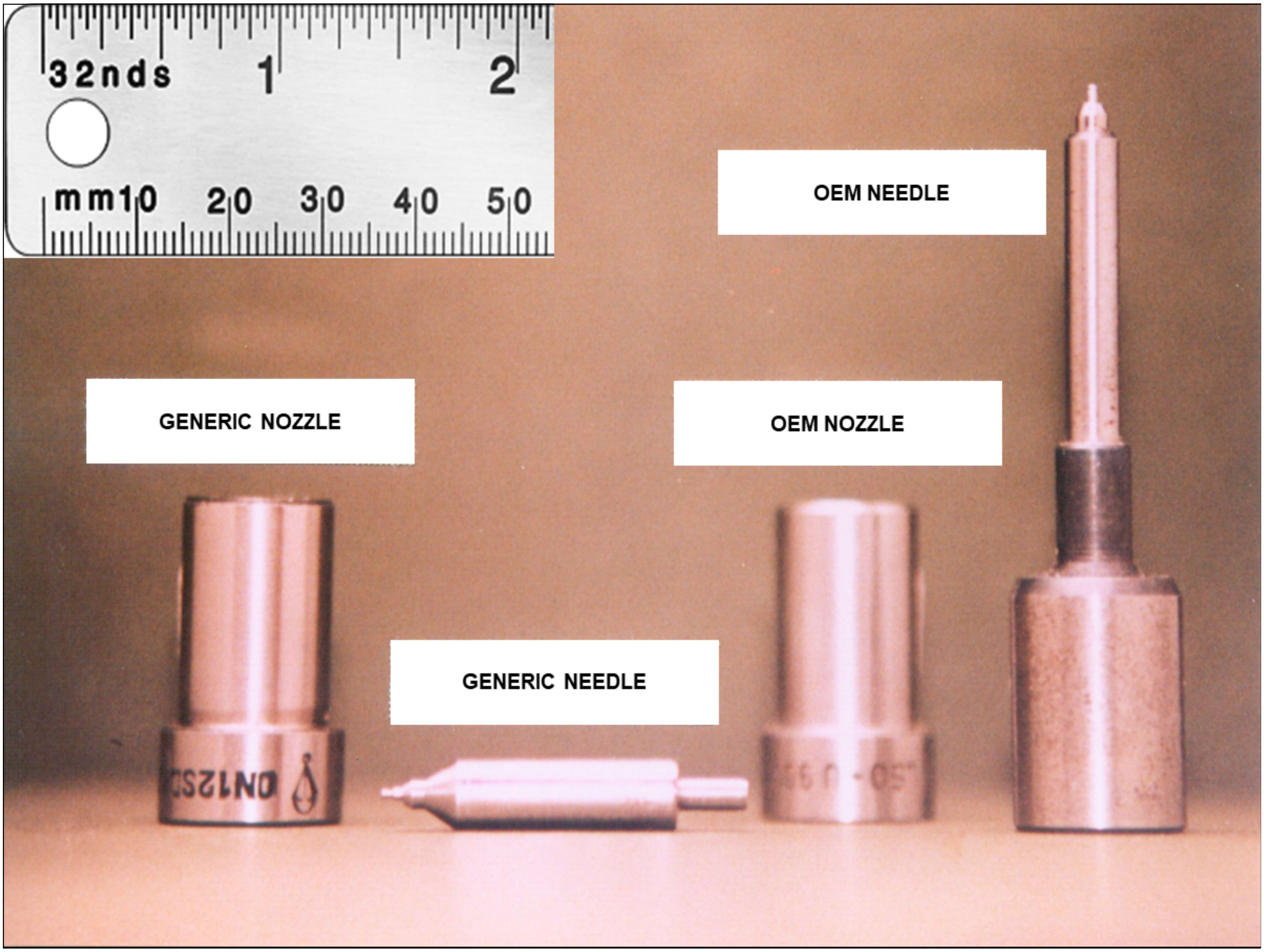
The additional cylinder I filled with hydraulic oil and looped the extension and retraction ports with air hose using compression fillings to prevent leaks. I had to make a new longer mounting bracket too.

This modification allowed the speed of the extending tool to cut and trim into the product surface with a much improved uniform feed rate and far greater rigidity, no ‘bouncing’ of the cutting tool.



Final configuration showing the full assembly of the tandem arrangement of air-over-oil. Another modification I had to make was the installation of a fixed alignment through-beam sensor mounted over the part clamping chuck - see arrowed.

This very fine through beam was used as a mistake proofing over check to make sure the part to be trimmed was fully inserted into the part clamping chuck. The sensor was programmed into the PLC in a manner that would not allow the machine to start if the part was not inserted all the way into the clamp chuck and would stop the machine during operation if the part became dislodged.



Another illustration of my intellectual capacity to apprehend, conceive, and implement cost saving contrivances and my engineering prowess. What you are looking at are metering needles and nozzles for a reaction impingement foam molding machine for a polyurethane and isocyanate mixing head.

Very basically, RIM is a technological method used in the thermo-set foaming industries of mixing two chemicals together under very high pressure. The mixing is achieved by impingement of the two chemicals controlled using these metering needles and nozzles through which the chemicals pass through and spray into each other in a self cleaning mixing chamber, thus the term - impingement mixing.

Because of the high pressure - 3000 thousand psi or more - the immense energy generated by the two chemicals passing through an orifice that could be .7 mm Ø these two components had a definite useful life cycle of about a week before they were worn out and had to be replaced.

The cost of the original equipment manufacturer's needle and nozzle was $280 dollars a set - see right side in picture - so the annual maintenance of replacement needles and nozzles alone for this RIM machine was $27,000.00 dollars a year based on 49 weeks production calendar.

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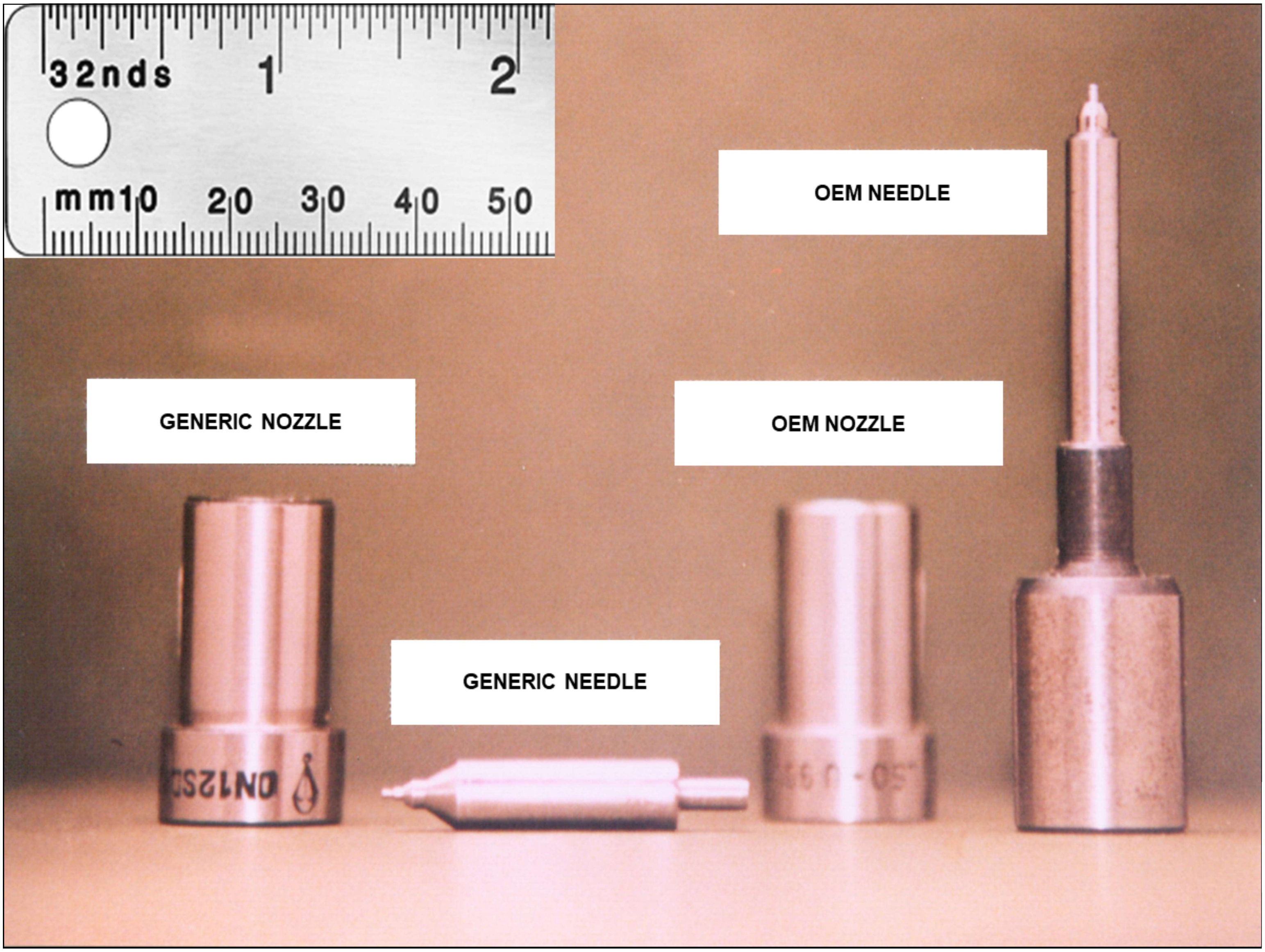
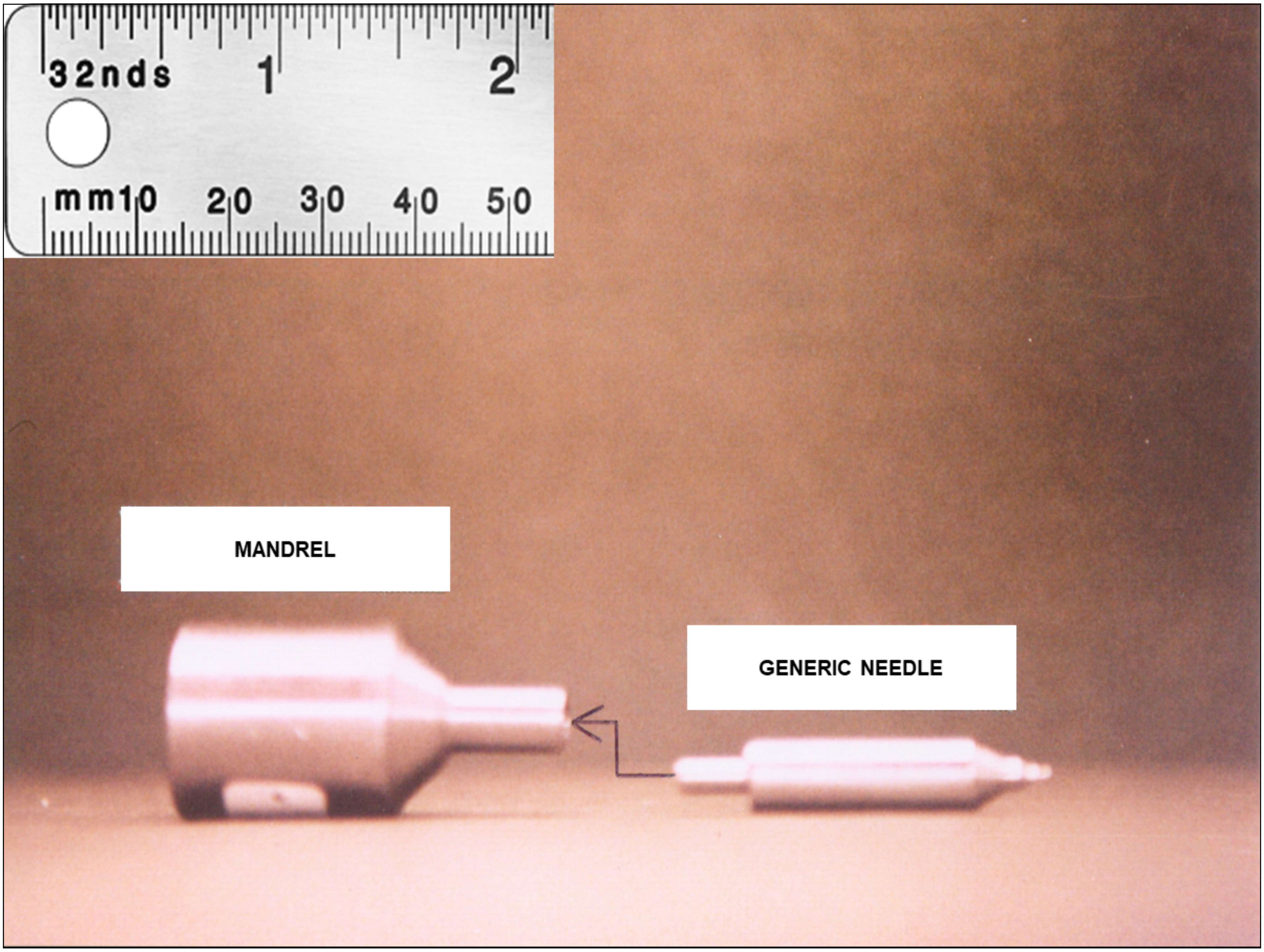


Upon my return to work I went to a local Ford truck dealer - as that was the manufacturer of the truck engine that I was viewing at the car show – and purchased the needle and nozzle you see on the left in the picture for $18.00 dollars a set a cost savings of nearly 90% percent. The only thing was I had to manufacture a mandrel to hold the generic needle - see next picture - this was the only part that was truly an OEM feature…



Picture showing the mandrel that I had to manufacture. The mandrel was installed to the generic needle by means of heating up and shrinking its recess bore on to the shank of the generic needle So, the cost savings amounted to $24,650.00 dollars per year and that includes $1,000.00 dollars to have 98 mandrels made by a local machine shop per year. Life of the program was 8 years, so almost $200,000.00 dollars in cost savings…

I remained with the company where I did this for 3 years afterwards and paid back my employer my salary in my first year there…

This pictures shows the high impingement mixing head from the previous slide. Quite possibly the one thing you did not want happen by any act of human omission, slip, lapse or violation with this process is crossing feed and return lines of the polyurethane and isocyanate with one another. The consequences of that failure mode are very, very expensive. We're talking hundred of thousands of dollars $$$$ replacing lines, hoses, pumps, storage vessels etc.…

To err is human, but we need a poke-yoke or better still a baka-yoke approach to mistake proof this potential disaster. For our non-lean visitors poke-yoke and baka-yoke are Japanese methods of defect, mistake and error detection and prevention methods.

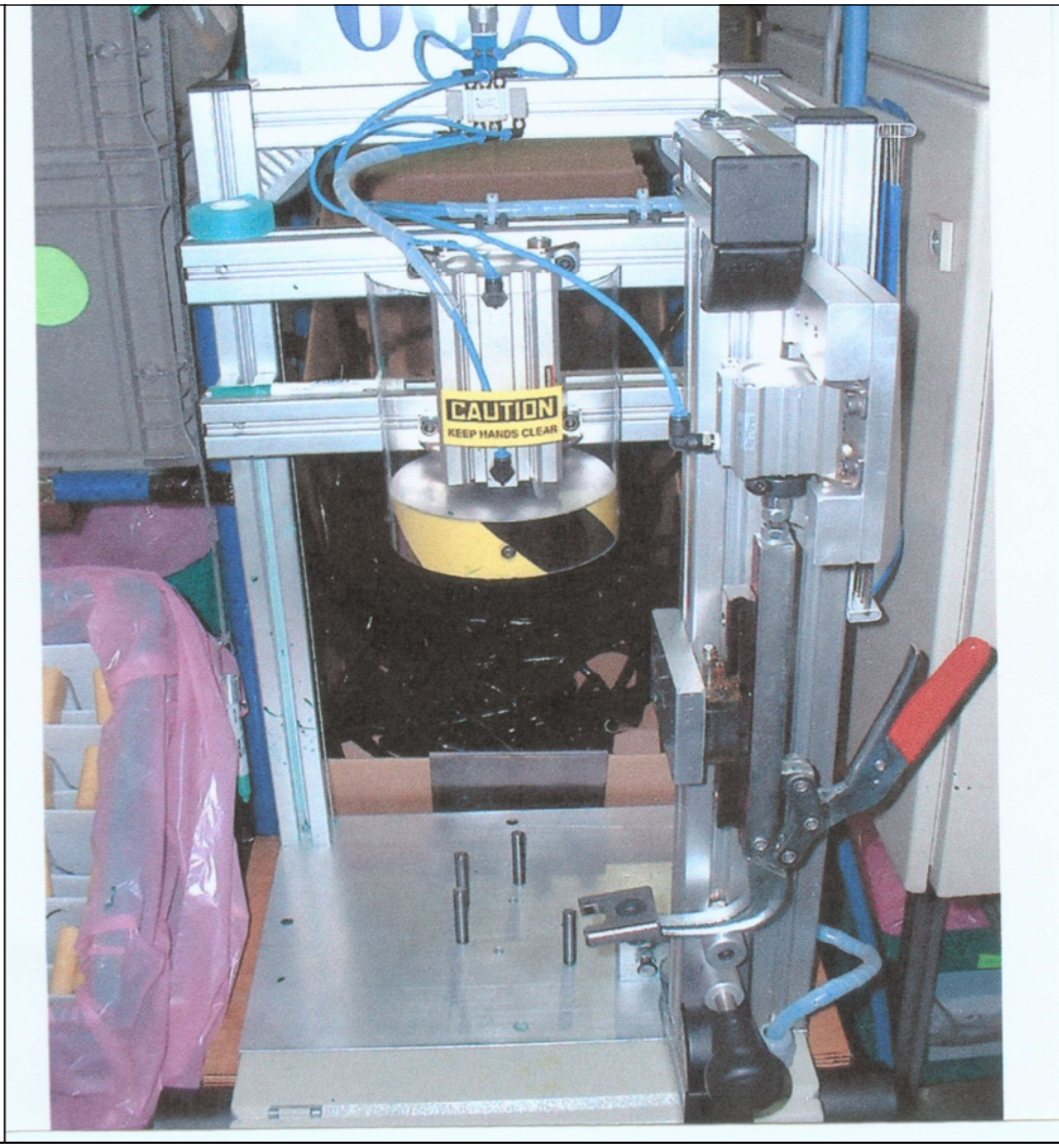
The baka-yoke approach here to make it physically impossible to make a mistake of screwing the isocyanate feed line hose onto the polyurethane line hose or any other combination you can think of except the right way was too expensive. It would have meant replacing all the lines on all the machines on all the mixing heads with left and right hand threaded hydraulic fittings.

So, the next best thing is poke-yoke, I color coded the fittings and hose lines and the isocyanate and polyurethane sides of the mixing head to serve as a warning that a mistake could be made - I did this spray painting all 25 machines mixing heads and lines. Continued on next page.

I would like to think that in 10 years time the reason why we didn’t have to deal with that mistake and resulting effect and consequences was by designing it out of capability of happening…

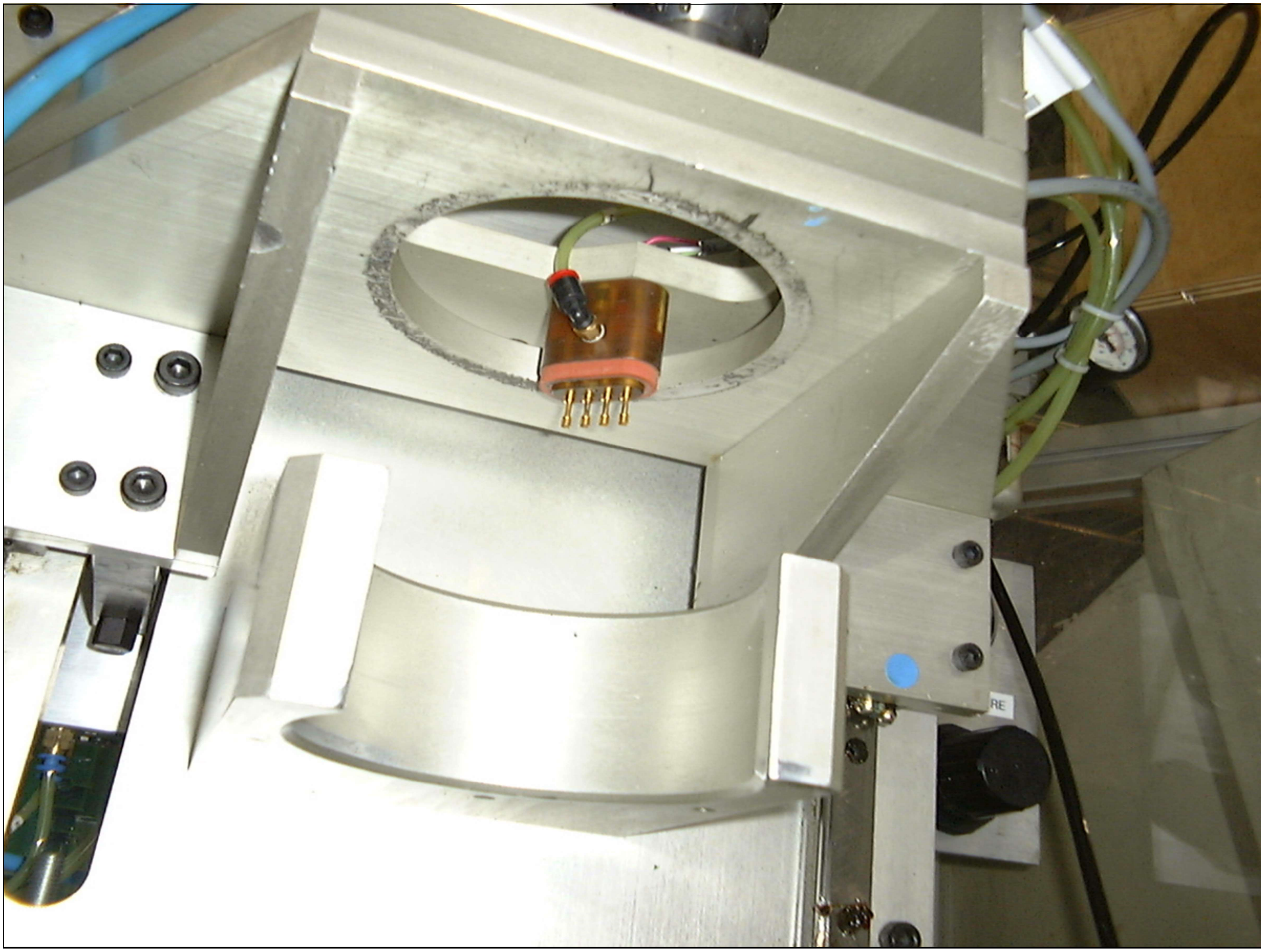
This picture shows a simple machine that was used to install an electrical circuit harness plug into the receptacle of gas tank level sender unit flange at a former employer.

This was of a very inferior design, poorly constructed and simply didn't work. The operators typically installed the harness plug into the receptacle by their hands and that was very hard on their hands and fingers. I later learned that $5,000.00 was paid to a local engineering company to design, build and install this unreliable machine.



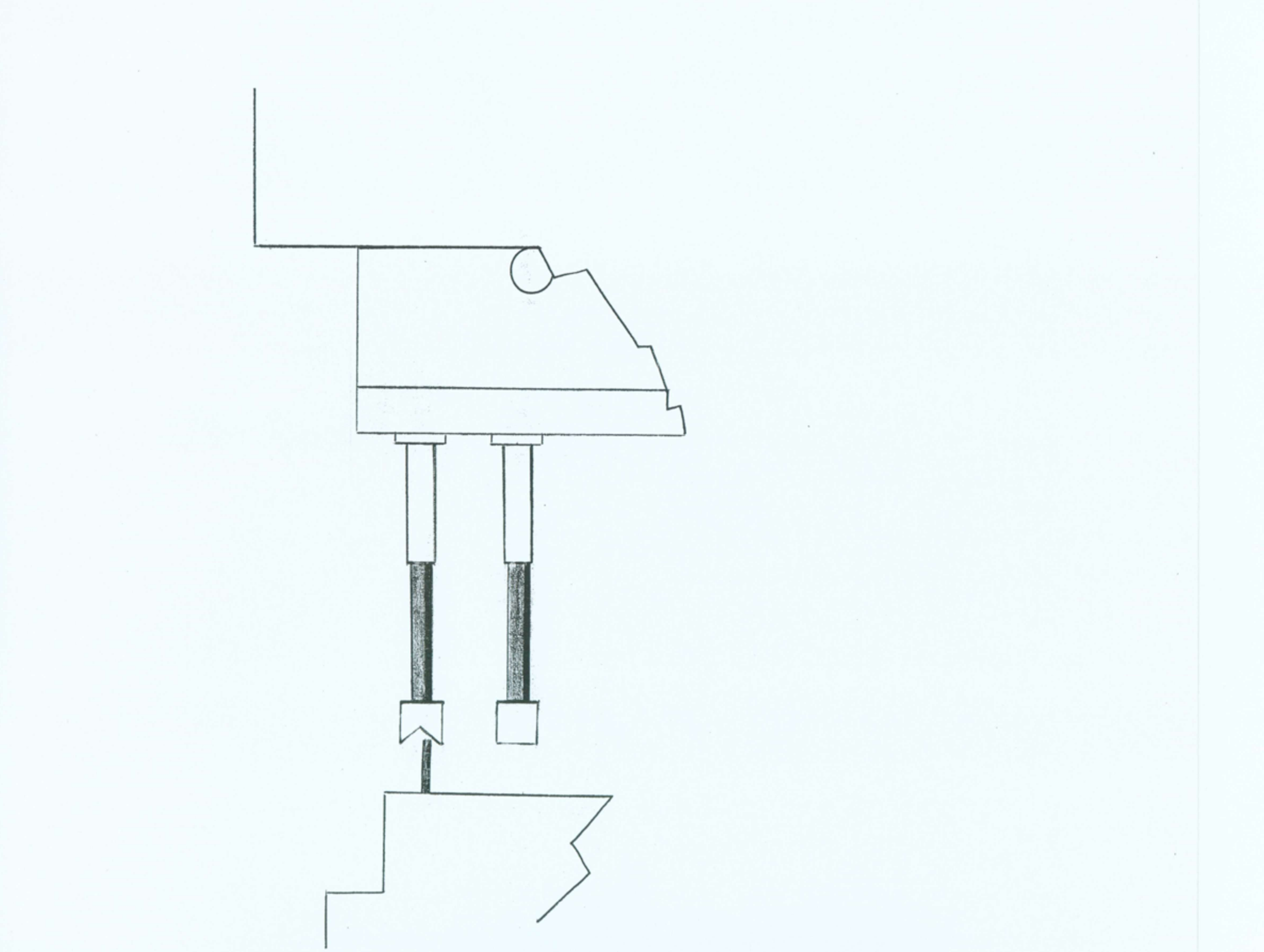
Fed up with having to constantly repair the original machine and not happy with the operators having to install the receptacle by their hands, I took matters into my own hands and designed, built and installed my own machine to do the job.

This was a major improvement in weakness in design, it was reliable, easier to operate and lasted with virtually no maintenance required to the end of the program of the manufactured part. Materials cost was under $1,000.00.



Picture showing an electrical spring loaded contact test probes assembly. The service life of these test probes should have been in the high 10 million cycle range, but were lasting only a fraction of that life time cycle.

Because the test probes were gold plated they were expensive $20.00 each X 4 $80.00 and had to be changed out on average 4 times a month. Do the math…



Changing out the test probes was easy and only took seconds to replace, but the cost was prohibitive considering that they should last much longer.

Using the P-M Analysis approach I set about to investigate this chronic problem. The original test probes were of a concaved head - see left sectioned test probe in illustration. During testing the part to be tested would be inserted into the test machine tool nest and the test probes would come into contact with the part's recessed socket contact terminals by way of pneumatic actuation of a mechanical fixture.

During my survey I observed that the recessed socket contact terminals did not always align itself exactly centered to the concaved test probes causing lateral stress on the inside surfaces of the spring loaded test probes. This mechanical misalignment was what was causing the accelerated deterioration and shortened life cycle of the test probes - eventually the failure mode was either breakage of the test probe or high internal contact surface electrical resistance resulting in false high resistance testing results - I tried to improve the repeat and reproducibility of the alignment of the test probe to recessed socket contact terminals, but this only resulted in an improvement of 50%.

I asked the manufacturing engineers who had overseen years previously the inception of this process why they used concaved test probes. To my surprise they didn't know why citing possibly that the concaved test probe would help correct any minor misalignment during operation.

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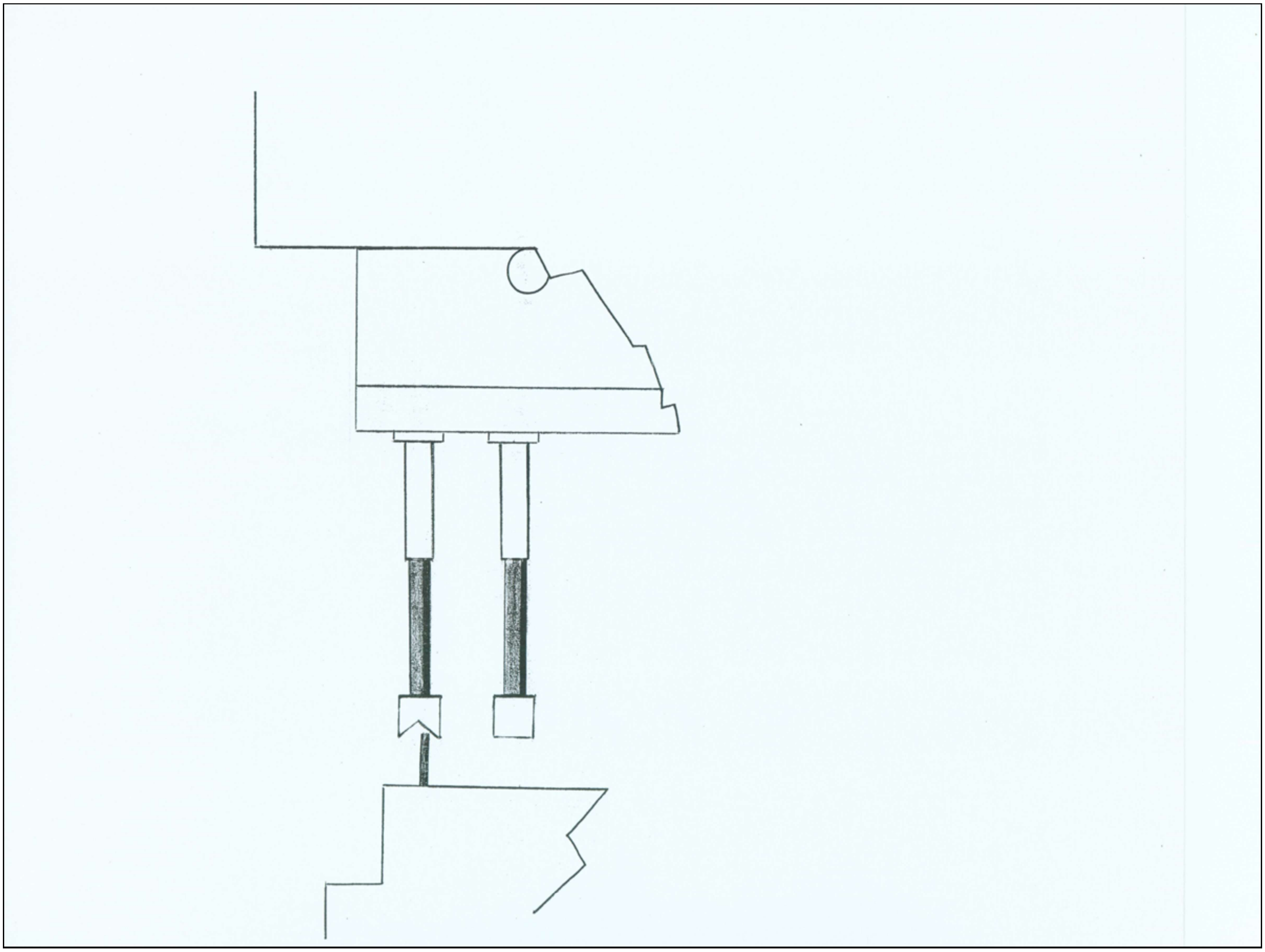
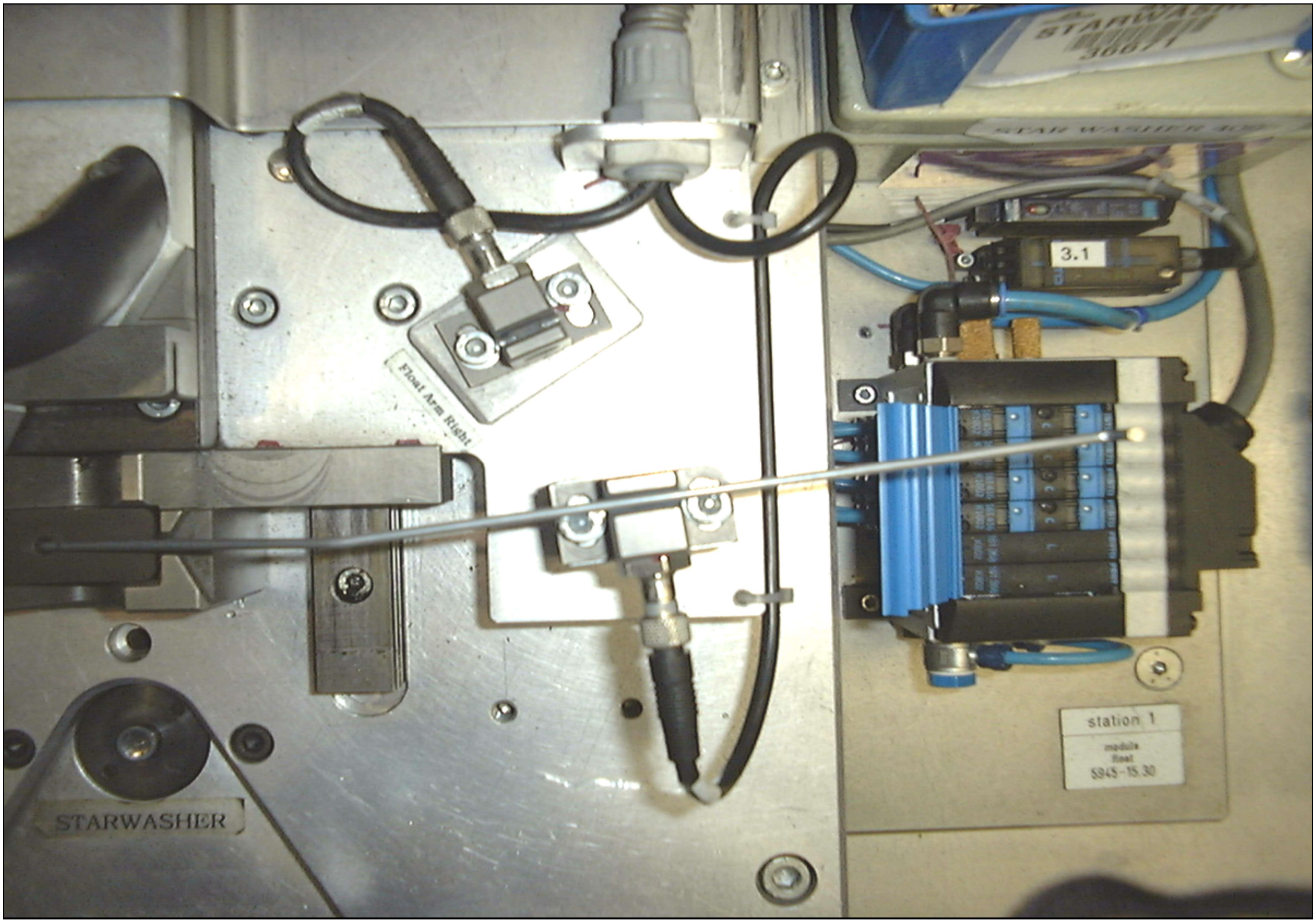


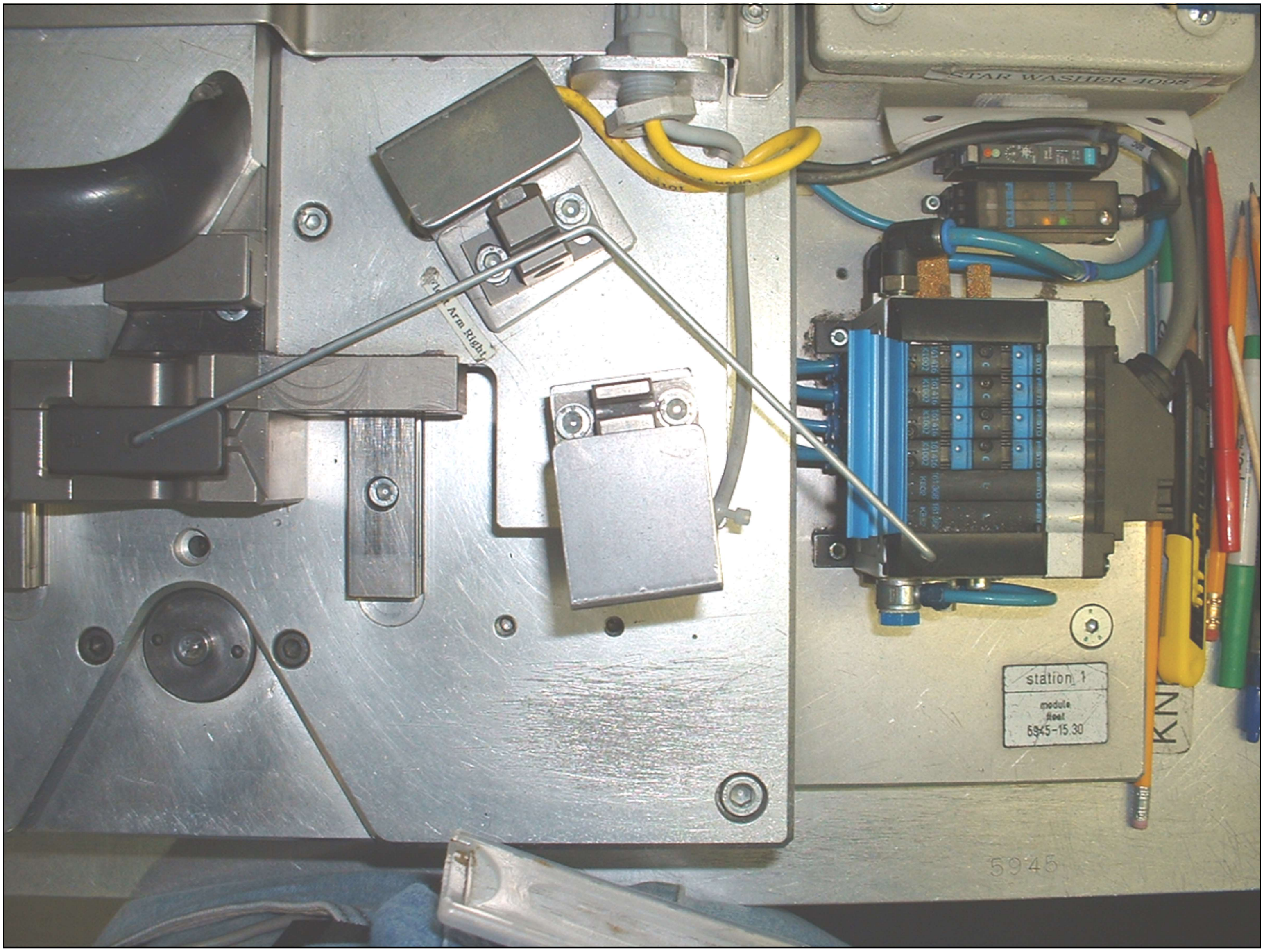
To rectify the problem completely I simply replaced the test probe head from the concave design to a flush surfaced head design which was also a little larger in diameter. This change in design did not adversely affect test quality. Now sight mechanical misalignment could be tolerated as there was no lateral force acting on the internal contact surfaces of the new flush surface head test probes (see replacement flush surface head test probe head design on right) This resulted in $11,000.00 in cost savings for the remaining three years of the product program.



Minor stoppages and idling account for much downtime which go unrecorded. Pictured is an assembly machine that is used to assemble a star waster retainer on to a gas tank level sender unit float arm. Part of the mistake proofing the process (Poke-Yoke) was present/absent component detectors and in this case proximately sensors were used to detect that the correct float arm was being used for the part type being made.

The operator of the machine occasionally would snag the cables to these proximately sensors breaking them from their electrical couplers. When this happened the entire cable had to be changed out. Asking the operator to be more careful does not fix a faulty process, so I installed mechanical protection shields to protect the cables from the operator accidentally snagging the float arms on them.

This problem never happened again. Another example of hitting singles…



Picture showing the mechanical protection shields installed.