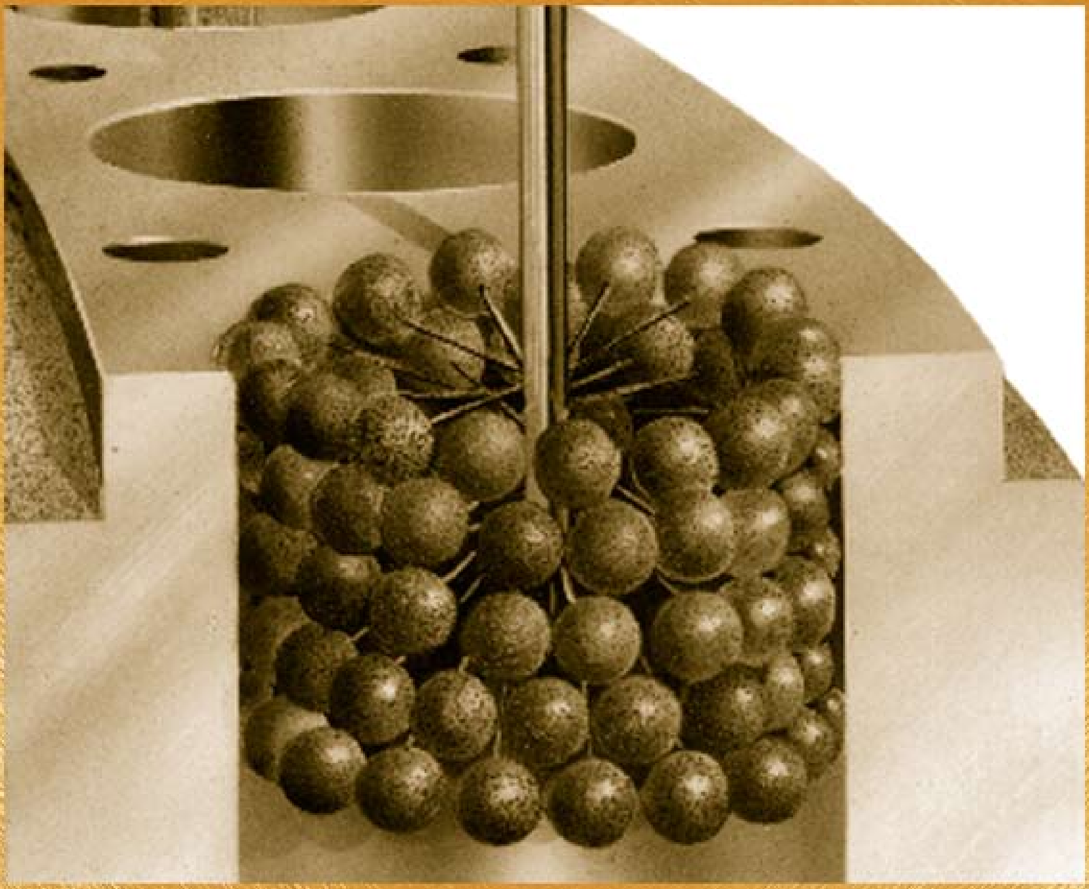






QUALITY AS IT AFFECTS PERFORMANCE

BRM

BRUSH RESEARCH MANUFACTURING CO., INC.

Editorial: QUALITY AS SPECIFIC KIND- FUNCTIONAL QUALITY

There is a quality of people in the manufacturing world, that is reflected in the reputation of their companies, the products they make and their integrity overall. Very high on our list is a piston ring manufacturing company who is well-known in the after-market. Their retiring vice president of engineering and I have been friends for many, many years. Our discussions always seem to turn to "Quality of Product." They continually practice it by performance testing. In one of our recent talks he asked a loaded question. "What is quality?", and further, he followed it up with the question, "What has the best quality, a Ford, a Cadillac, or a Mercedes? I know you own all three." My answer to the latter question would be in reverse to what might be the average opinion. The more we pay for something, the higher the quality we expect, and usually the only way we can judge is the incidence of repair, and the seeming ability and desire of the agency to correct the faults. Does quality refer to excellence of product in relation to cost, or to what standard? Is quality only reliability is its intended function? I am sure we never intend for every integral part to be absolutely flawless. But it must perform without failure for an adequate time and to produce the best results possible within the best knowledge and procedures available.

A letter to the editor of U.S. News & World Report in response to an article (Can Detroit Ever Come Back) says it would be good for America if Detroit survives, however, if it doesn't survive, at least we consumers won't be stuck with any more lemons (3/22/82 issue). It is the consumer who will be the judge and his buying habits will change to reflect his opinions. And respect once lost is not easily regained. The public is fed up with goods, once very durable and long lasting, which are now made of plastic with a life of a few months to a year or so at best. Too often you get the impression that the major manufacturers feel they are too clever and that John Q. Public is stupid and will buy anything that is properly hyped. Maybe he will, the first time. The second time he will take out his revenge if he has the chance.

So what is quality? At least sufficient to be honest with the User, to give him the best performance and durability that is possible. We owe it. That is the buying publics' expectation and his right and his due. And what he pays for.

My friend introduced me to a book written by Philip B. Crosby, "Quality is Free." I highly recommend the reading. Do it right the first time. Eliminate returns, rejects, reworks, increase sales and profits. All plus, and the cost of this quality control will return profit beyond the expense of the program. This is basically in-house quality control, to make the product to specifications. And there is a certain reverence attached to specifications. They are handed down from above and are never to be questioned. You can stake your job on them.

What we are talking about is SPECIFICATION QUALITY. What does quality mean if the designed part had an obsolescence factor built into it? What if design engineering has been instructed to save costs? Find a less expensive material, and put it together with fewer operations and labor providing it performs adequately. And what is adequately? Just enough to endure the test track and get it sold, and to perhaps outlast the warranty?

This is not all the fault of the major manufacturer; it is a situation he has been forced into. With union leaders and blind membership annually demanding higher and higher wages, and with the labor cost two, three, or more times than foreign competitors, the design function must eliminate labor costs to the absolute minimum if the end product can ever hope to be competitive. Better methods, including as many robots as possible, simpler assemblies, combined assemblies, less expensive materials, plus having to conform to countless government regulations, and having to show mandated miles per gallon ratings, all create a situation that sometimes seems an impossible task.

But the consumer is going to be the final judge in spite of all the problems which he inherits in the product he buys with his hard-earned after-tax money. And if he has to finance, paying the lender bank an equal amount for interest.

If "quality is free" as Mr.. Crosby states and surely endorsed by all readers, then quality must also be free in the design and specifications that go into a print which manufacturing must follow.

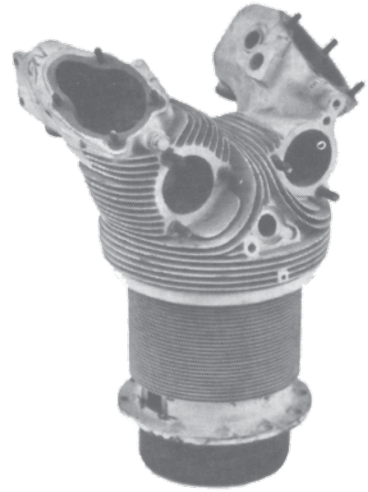
We have outlined in this booklet only a few areas, and in this case the effect and benefits possible in the field of surface finish. We have exposed areas that for many, many years have been taken for granted as the norm. The way it has always done. Methods that have never given any problems or at least problems that never became issues. As you know, problems never get taken care of until they become issues. But in presenting our case on surface finishing in the four booklets we have written on the subject, the question will invariably be, "Will it save us any money?" And we say, "But it will give you better quality." And we will probably get the answer, "But we haven't had any problems."

Fortunately the above tirade, our views on the situation, and our belief and zeal in what we are trying to do, only refers to the major transgressors who are tragically caught in the cost-reduction squeeze that is going to lead to their downfall.

We also experience the many, many companies who are receptive to any information of methods that will make their product better, who constantly strive to improve and who have the pride in themselves and in their companies and their products to excel. Of highest encouragement are the large replies to our advertisements of people wanting to know more, to experiment, to upgrade their products. To them, this booklet is dedicated.

Sincerely,
Steve A. Rands, C.B.

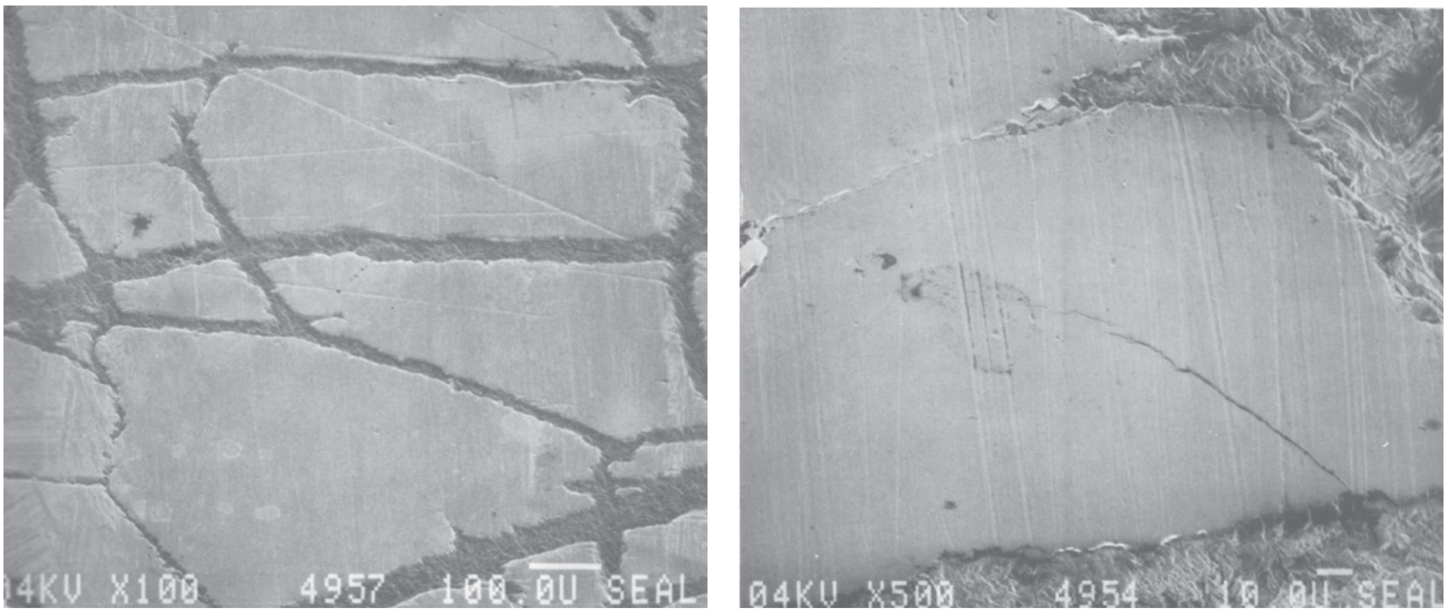
A PRELIMINARY STUDY ON CHROMED CYLINDER WALLS



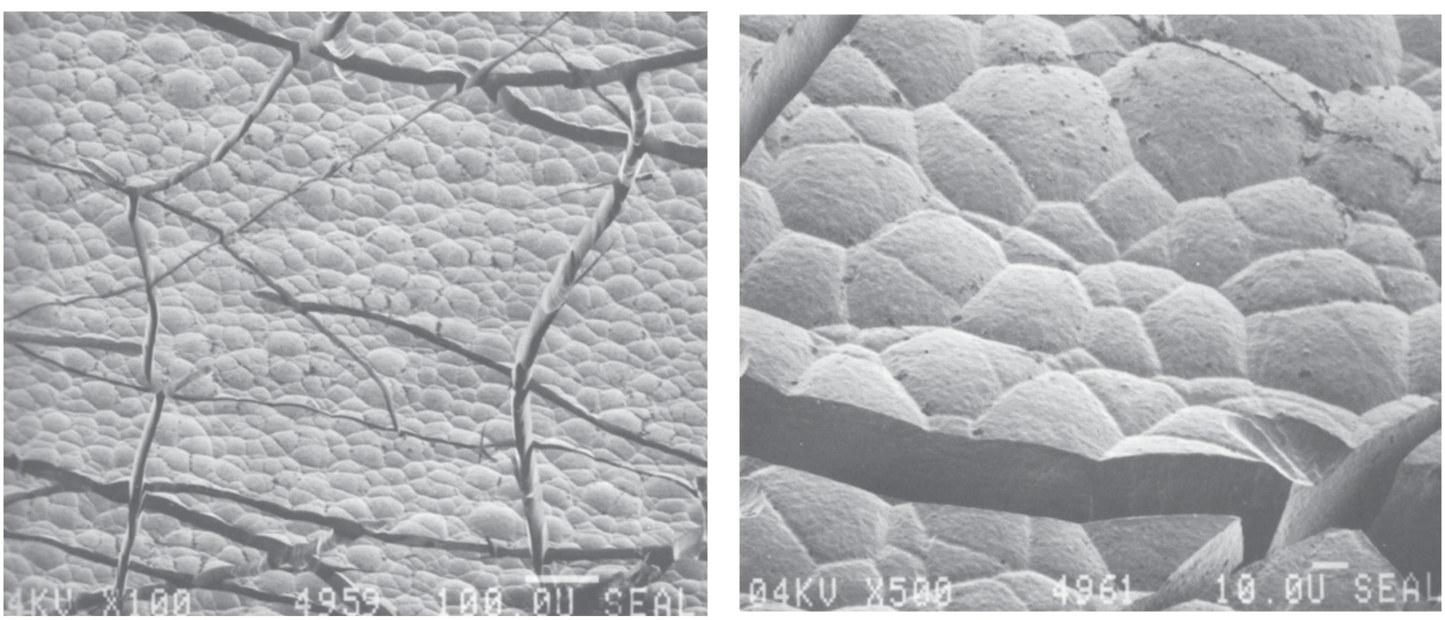
We know that there has always been a problem of ring-seating, or sealing on chromed cylinders walls or shafts. The general feeling is that chrome must be honed to create an oil holding surface and produce a cross hatch. Another problem is the flaking off without any real solution except the plater knows the original surface must be clean. Flaking or bubbling chrome is dynamite. It damages rings and gets into the system.

In order to overcome this, Van der Horst developed a system that over-chromes, then reverses the process removing some of the plating which creates a “wormed-surface” appearance which aids in providing oil reservoirs.

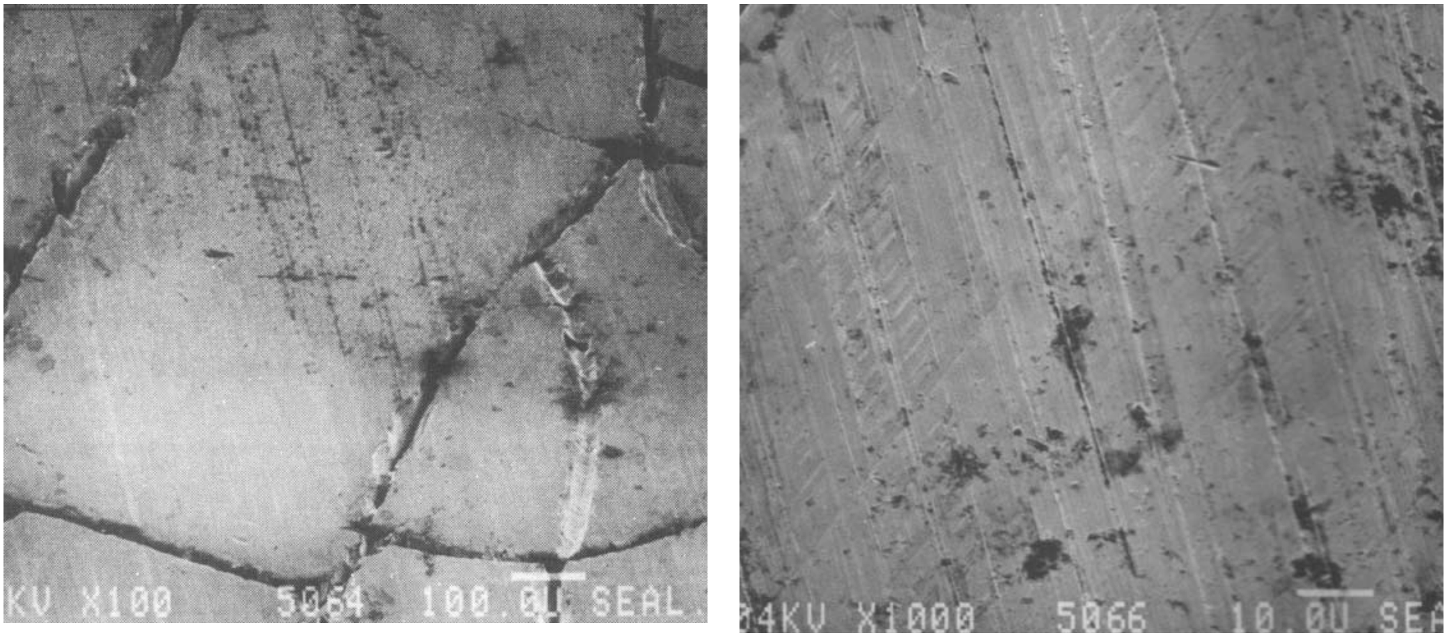
From a local rebuilder of air-cooled aircraft engines we got four cylinders-SEM photos follow:



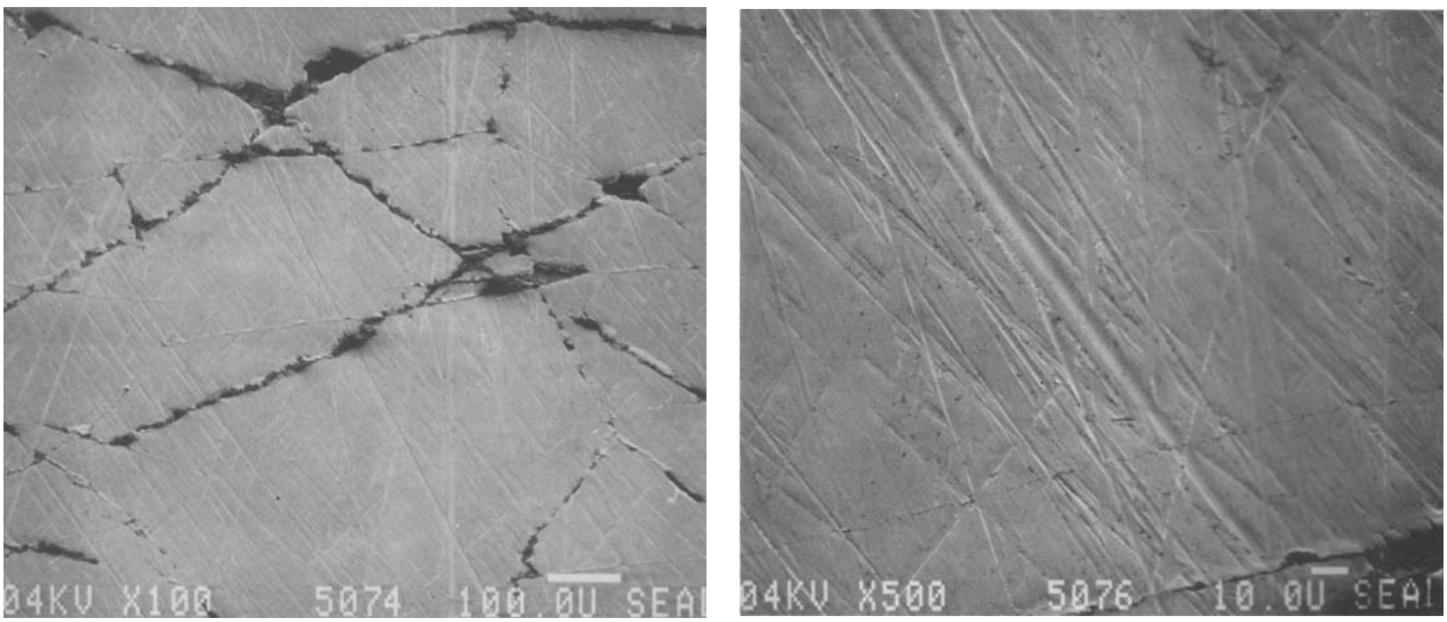
(1) Used, as sent in for rebuilding. Originally Van der Horst plated.



(2) As received back from the Plater. Van der Horst process of over chroming and reverse chroming to etch the surface creating the “worm” effect or channels in the surface to assist in oil retention.



(3) After the No. 2 process above has been rigid honed for 2 minutes



(4) After the No. 3 process has been further honed with the Flex-Hone with 180 grit boron for 2 minutes to aid in ring seating. This rebuilder said that prior to Flex-Honing that it might take from 12-20 hours to seat the rings in and then perhaps 1 out of 4 might not seat at all and had to be reworked. The Flex-Hone Process seated the rings in from 6-8 hours with 100% of cylinders seating. We have no comments to make, but only want to present photos. From testing we feel aluminum oxide to provide better finish, but the boron lasting longer was more economical.

#1 RA 37.4 m.in tp% 6 at 100	#2 RA 41.2 m.in tp% 24 at 100	#3 RA 26.2 m.in tp% 8 at 100	#4 RA 6.5 m.in tp% 98 at 50

STANDARD COMMERCIAL – TYPE CHROME PLATING:

Or we could have said, “Why does Chrome Plate Blister?”

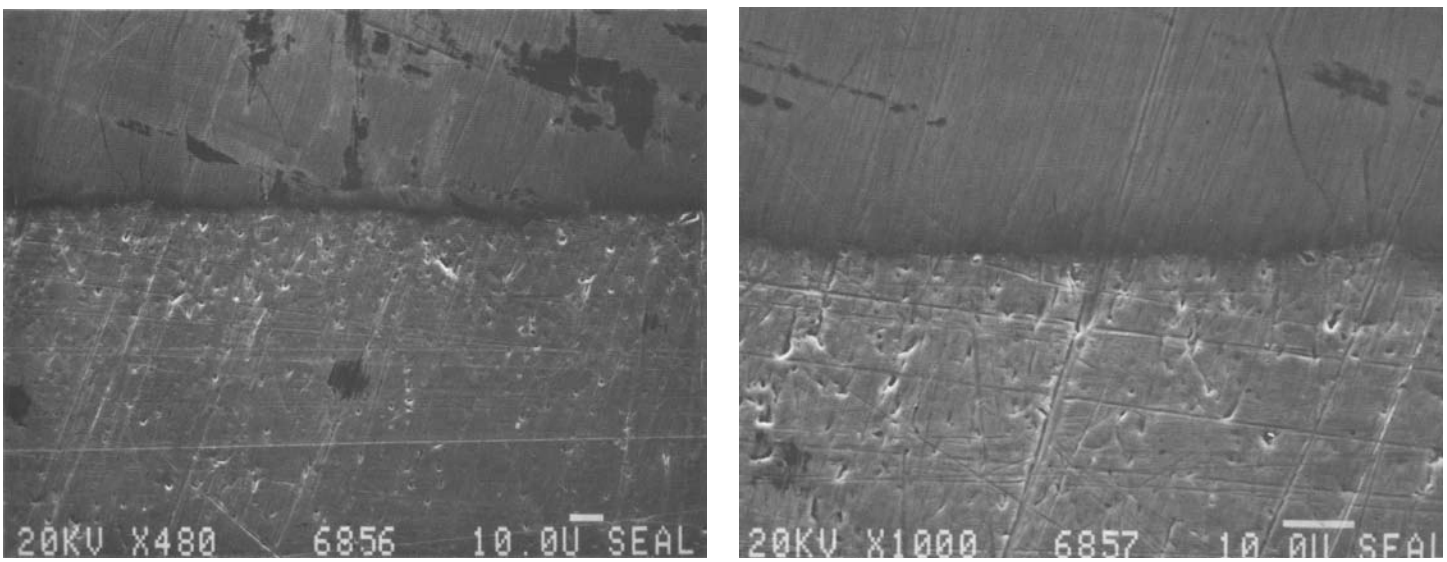
Some say:

- Aluminum Oxide blast the surface to get it really clean.
- Rigid Honing high temperature causes metal separation.
- .002 should be honed out to remove carbon particles in surface.
- Your finished chromed profile looks like the original with original high peaks accentuated and original valleys now voids.

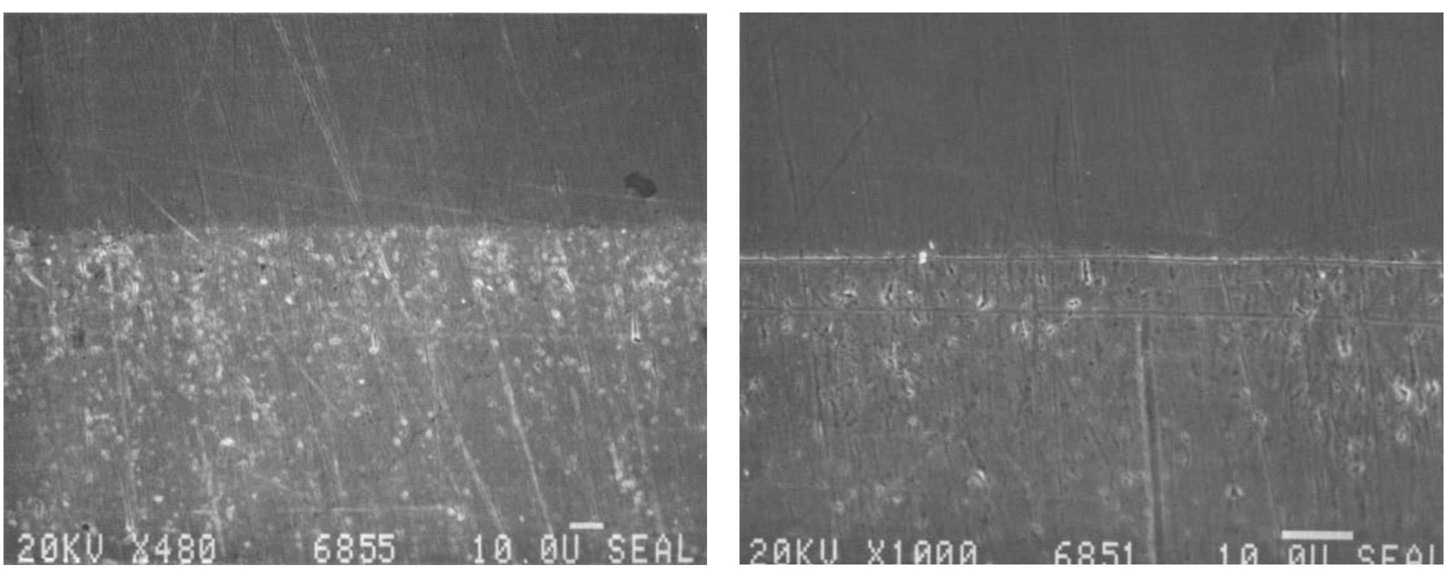
We have always recommended Flex-Honing before plating, to remove the cut, torn, or folded metal and to refine the finish, then Flex-Honing after chrome plating to develop your oil-holding cross hatch. A piece of DOM 1 ½ ID tubing sawn in half and one half sent out to a company who does commercial honing and requested to remove .002 to a fine finish. The other half of the tubing was Flex-Honed. Both pieces were sent out to be chromed .002. They were then cut at an angle to widen the cross-section, were lapped and photographed.

End View:

The darker side section is the base metal, - the lighter section is chrome. The dark line separating the chrome from the steel is cut, torn, and folded metal which will prevent proper plating and will cause the chrome to probably flake, blister, or chip off. In the 1000 power photo some flaking off is evident from the lapping process.



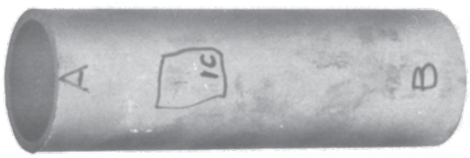
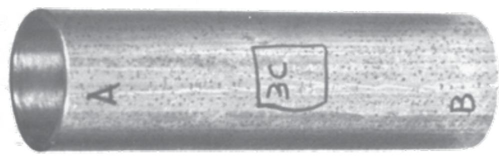
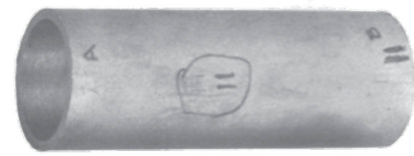
Chrome Plated after Rigid - Honed

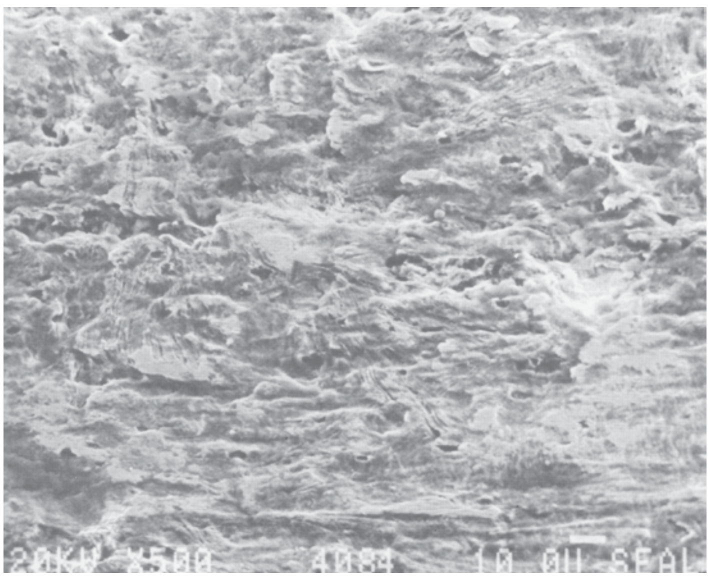
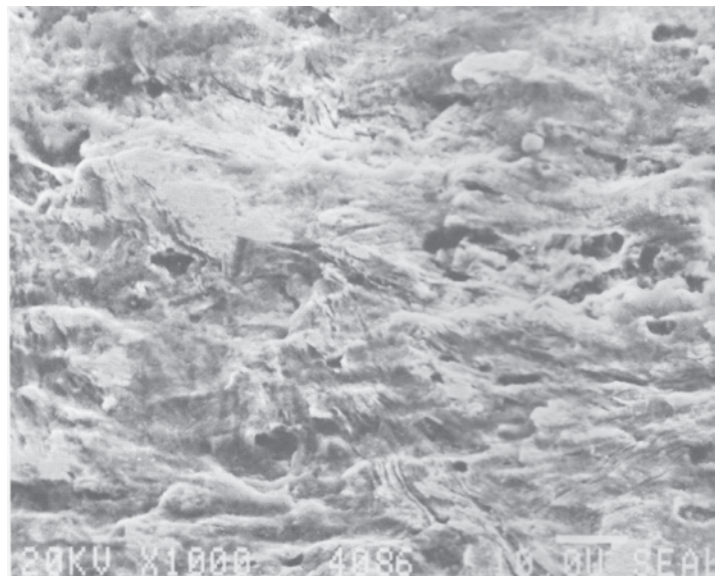


Chrome Plated after Flex - Honing

THE EFFECT (IN SURFACE FINISH AND PLATEAU) OF VARIOUS ABRASIVES AND HONING TIMES ON STANDARD DOM STEEL TUBING BOTH AS RECEIVED AND CHROMED

This report, in detail, is available on request but has been summarized. With a nominal 1.4970 ID and .001 inch out of round, this mill-stock tubing was cut into 15 pieces 6 inches long and numbered. DOM tubing is somewhat similar to roller-burnished as the finis is derived from pressure which folds down the peaks into the valleys and gives a false reading of smoothness. The surface is also work-hardened. Photo #4086 is typical at 1000 power, 4084 at 500 power (photo of #3 below.) Steel cylinders #1 through #5 were profiled and #3 was chosen as typical.

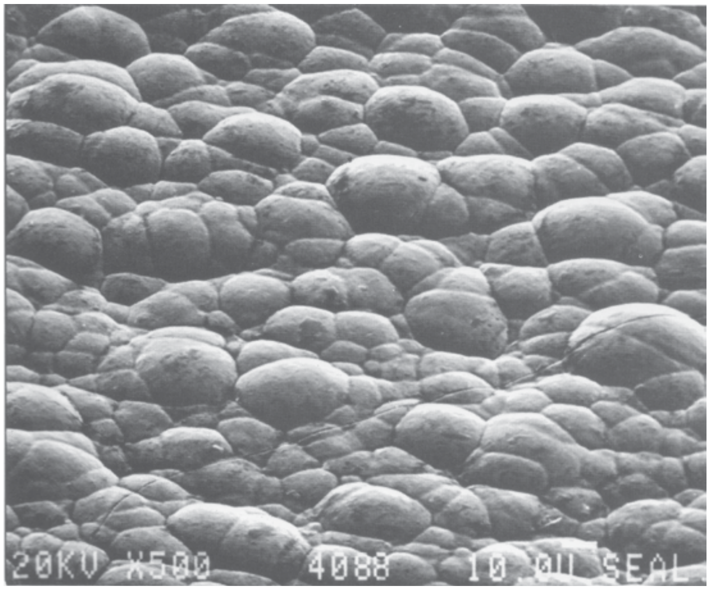




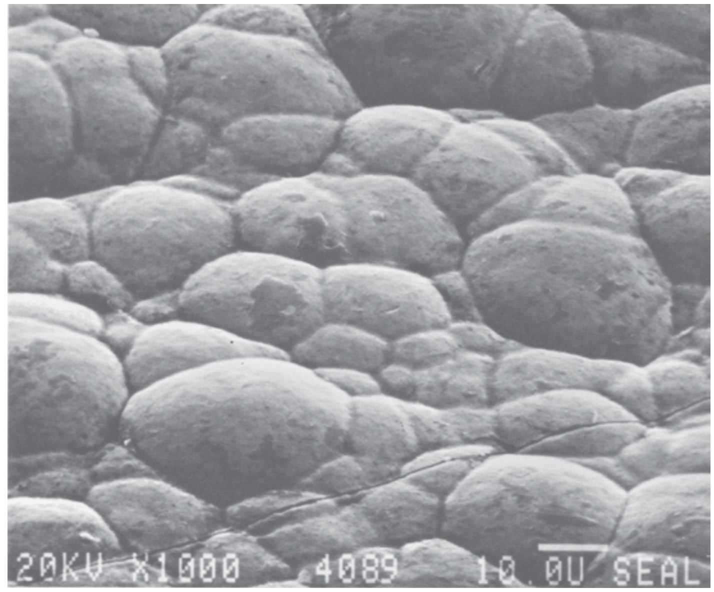



Test No.1 No.3 shown not honed. Balance of cylinders Flex-Honed 30 seconds. Balance No.11 thru 15 were Flex-Honed with 120 grit in Silicon Carbide, Aluminum Oxide, Boron Carbide, Tungsten Carbide, and Diamond 120/140. "A" indicates the top end of the cylinder. "B" indicates the bottom end of the cylinder.

(PLAIN) – FLEX-HONED 30 SECONDS (EXCEPT NO.3)

	0 TIME AS/REC		120 S/C		120 A/O		120 B/C		120 W/C		120/140 DIA.	
CYLINDER	#3 NO HONE		#12		#13		#14		#15		#11	
I.D.	1.4973"		1.4970"		1.4970"		1.4972"		1.4971"		1.4970"	
O.O.R. MAX.	.0012"		.0011"		.0012"		.0011"		.0012"		.001"	
A = TOP B = BOT	A	B	A	B	A	B	A	B	A	B	A	B
Ra (m.in.)	26.65	24.40	18.10	17.77	20.55	22.40	22.02	16.08	24.37	22.30	29.18	31.77
tp% .300 DEPTH m"		100							99	99	100	
tp% .250 DEPTH m"	100	99				100			99	91	99	98
tp% .200 DEPTH m"	95	91	100	100	100	99	100		96	34	98	89
tp% .150 DEPTH m"	70	42	99	98	97	94	97	100	59	2	88	48
tp% .100 DEPTH m"	14	4	84	68	59	47	74	96	5	1	45	7





Test No. 2. Cylinder as in Table 1, Page 6, commercially hard chromed .002 thick. No.1C (Photo 4088/4089). As received and chromed .002, not honed. Balance Flex-Honed with grits as in Test #1.

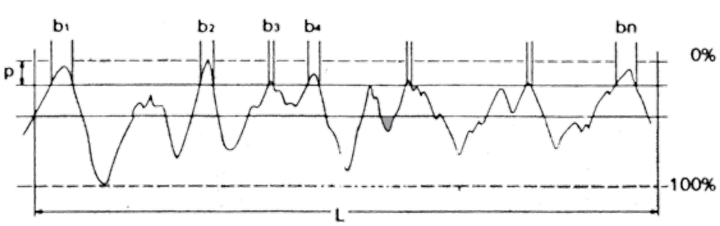
TEST NO.2 CHROME - 30 SECONDS

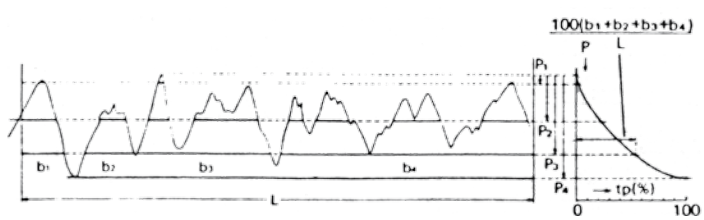
	0 TIME AS/REC		120 S/C		120 A/O		120 B/C		120 W/C		120/140 DIA.	
CYLINDER	IC		#12		#13		#14		#15		#11	
I.D.	1.4923″		1.4938″		1.4942″		1.4938″		1.4942″		1.4943″	
O.O.R. MAX.	.0010″		.0005″		.0010″		.0010″		.0005″		.0011″	
A = TOP B = BOT	A	B	A	B	A	B	A	B	A	B	A	B
Ra (m.in.)	32.14	43.51	31.36	27.08	22.80	20.00	36.63	25.64	39.14	27.28	32.68	29.47
tp% .300 DEPTH m″	100	83								100		
tp% .250 DEPTH m″	98	49	99				100		100	99	97	
tp% .200 DEPTH m″	89	18	93	100	100	100	94	99	95	97	84	95
tp% .150 DEPTH m″	58	6	61	94	97	98	76	94	71	74	45	72
tp% .100 DEPTH m″	19	1	17	55	55	82	38	58	33	17	6	23

The bearing ratio tp is the length of bearing surface (expressed as a percentage of L) at a depth p below the highest peak.

tp (level) is the depth p at which a selected bearing ratio is obtained. The bearing ratio curve shows how the ratio varies with level.

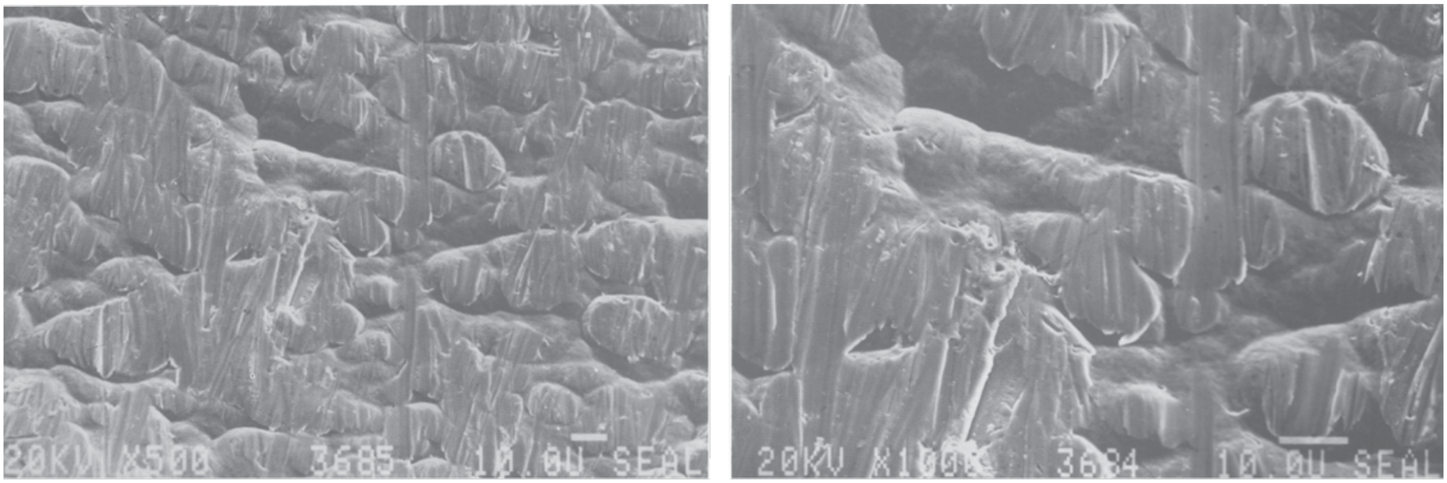
tp BEARING RATIO CURVE



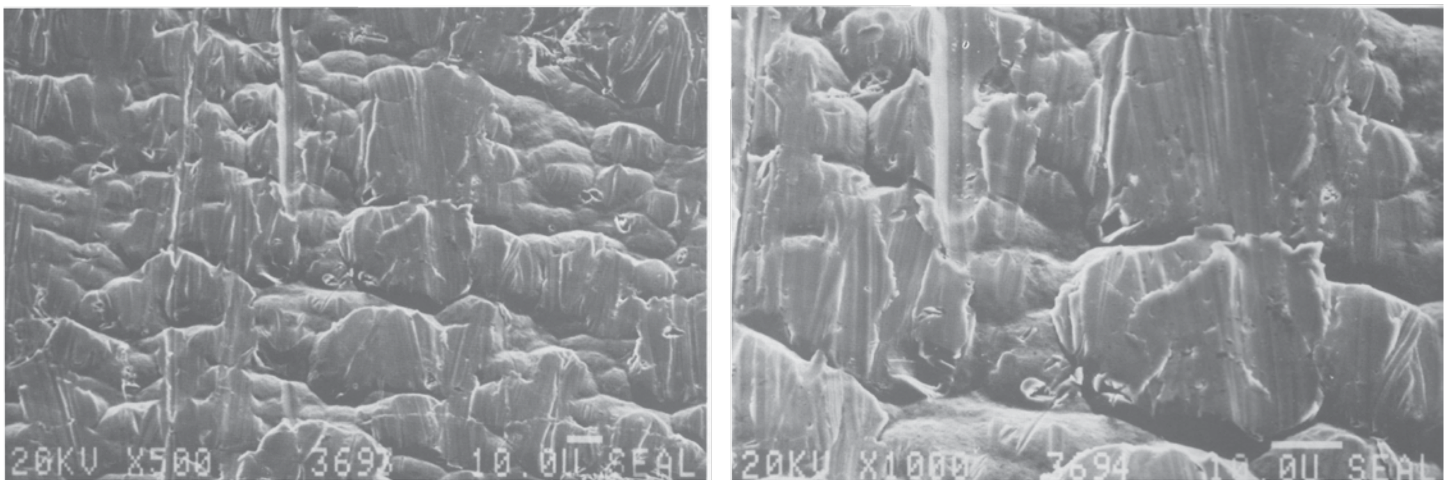


t_p (%) is the ratio at a selected depth p.

$$tp = \frac{b_1 + b_2 + b_3 + b_4 \ldots . bn}{L} \times 100 = \frac{100}{L}\sum_{i=1}^{i=n} b_i$$



CYLINDER # 15



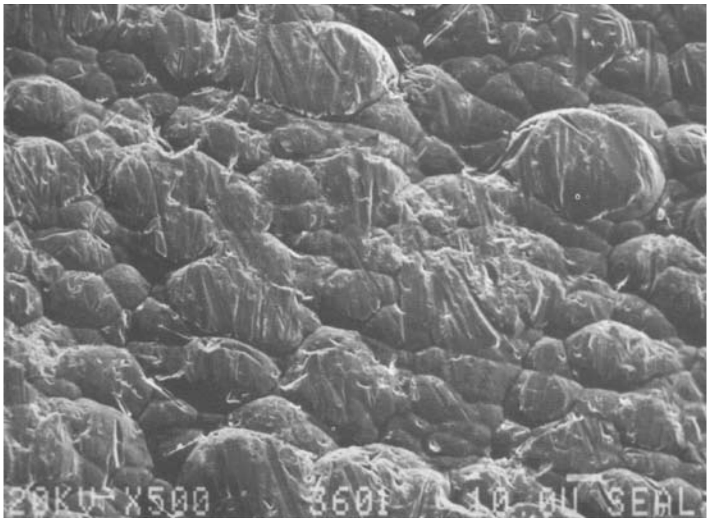
CYLINDER # 11

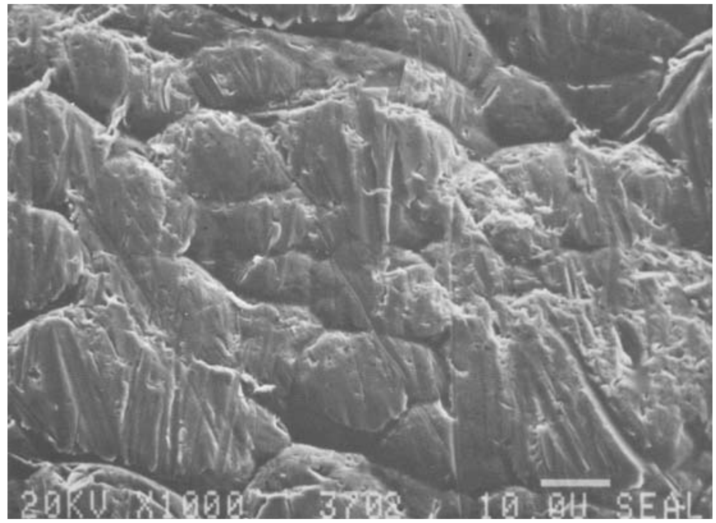
As you can see the Flex-Hone has established a proper surface finish, a proper plateau and a clearly defined cross-hatch. In the reverse-chroming process the channels developed in the dethroning appeared filled up at the end of the honing process. Could they have been filled with honing debris, and to what extent would they serve as reservoirs of oil?

TEST NO.3 CHROME FLEX-HONED 30 SEC. PLUS 30 SEC. ADDITIONAL

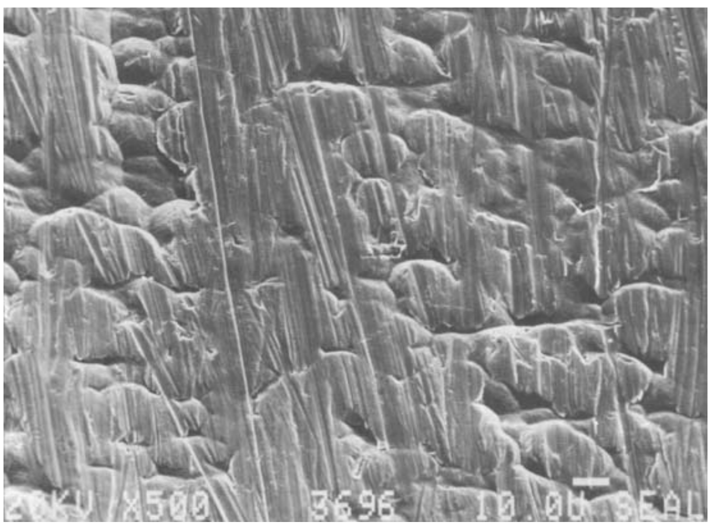
	AS/REC		120 S/C		120 A/O		120 B/C		120 W/C		120/140 DIA.	
CYLINDER			#12		#13		#14		#15		#11	
I.D.			1.4943″		1.4953″		1.4953″		1.4953″		1.4953″	
O.O.R. MAX.			.001″		.001″		.001″		.0005″		.001″	
A = TOP B = BOT	A	B	A	B	A	B	A	B	A	B	A	B
Ra (m.in.)			23.56	23.57	19.74	20.09	22.59	23.87	32.24	25.41	21.81	19.27
tp% .300 DEPTH m″												
tp% .250 DEPTH m″									100	100		
tp% .200 DEPTH m″				100		99	100	100	93	97	100	
tp% .150 DEPTH m″			98	97	98	97	99	96	68	84	98	
tp% .100 DEPTH m″			76	67	80	51	78	63	20	20	85	92

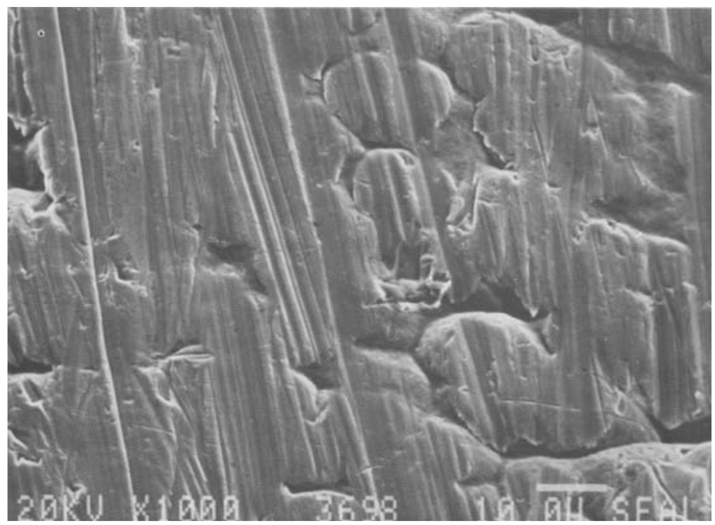
Test # 3 - As for Table 2 on page 2 except Flex-Honed an additional 30 seconds. Note the following S.E.M 's:



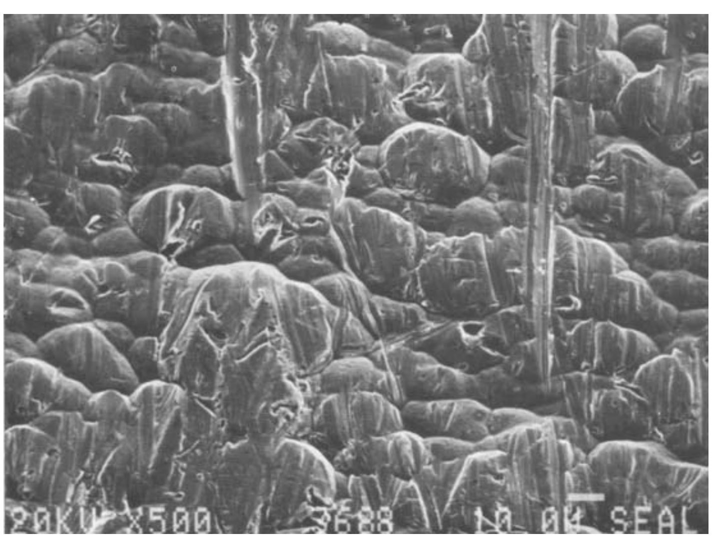


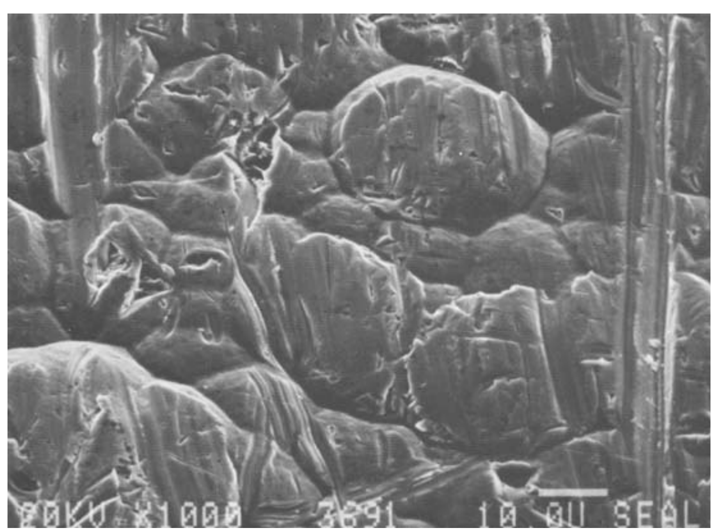
CYLINDER # 12





CYLINDER # 13





CYLINDER # 14

It used to be, and unfortunately still is in most cases, a situation where we had an intolerable finish (fast and cheap, however) in engine cylinder walls, and an almost equally rough finish on the faces of piston rings, and then it was left to natural attrition through friction for one to rub against the other until the Rings "Seated In." Probably 2000 miles or so until they abraided one another down to a finish that could have been there to start with. The buyer, or user, would have been happy if the latter had been the case, as he never really knew if the rings would ever really seat, or how much wear and damage had been done during this process or just how much potential life had been taken out of his engine.

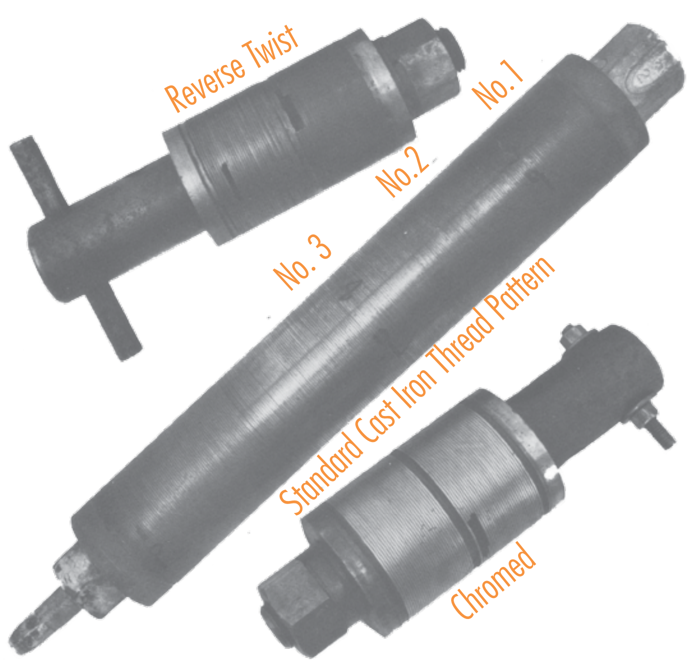
A couple of years ago we produced a booklet called, "The Necessity of a Plateaued Finish" which, as far as we were concerned, included a "State of the Art" on cylinder wall finish and included some detailed tests on engine performance under different conditions. Four tests done on one particular engine, reconstructed to normal before each test, and independently run, pointed out the values of quality finish. Oil consumption saving up to 67% during the 24 hour continuous running, 62% less ring gap increase, 50% less fuel dilution from the norm, 34% less blow-by, 7% higher compression, with profiles showing cylinder wear at the top of the ring travel.

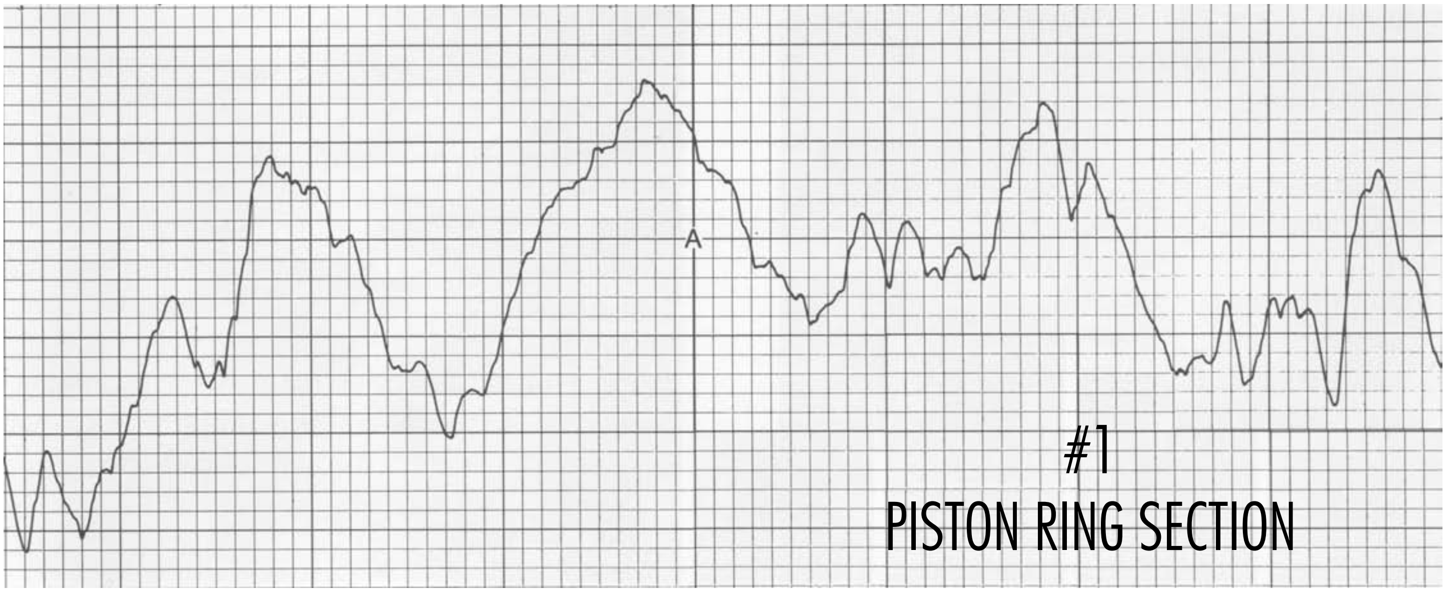
Did the manufacturer of this particular engine pay nay attention? Consumer Reports (Mar 82) reports on four economy cars, and we cannot repeat verbatim their copyrighted opinions, but they reported that on one car whose engine we tested and reported above, that in previous models there have been mechanical problems, particularly excessive oil consumption. And this is generally known. And will these manufacturers ever learn, or do they really care? To spend an extra buck on each engine might have saved hundreds of thousands in lost sales, customers costs, and dissatisfaction. Their sales are reportedly way down this year.

In our "Plateaued Finish" Book, see the ring face profiles on page 22, before and after running.

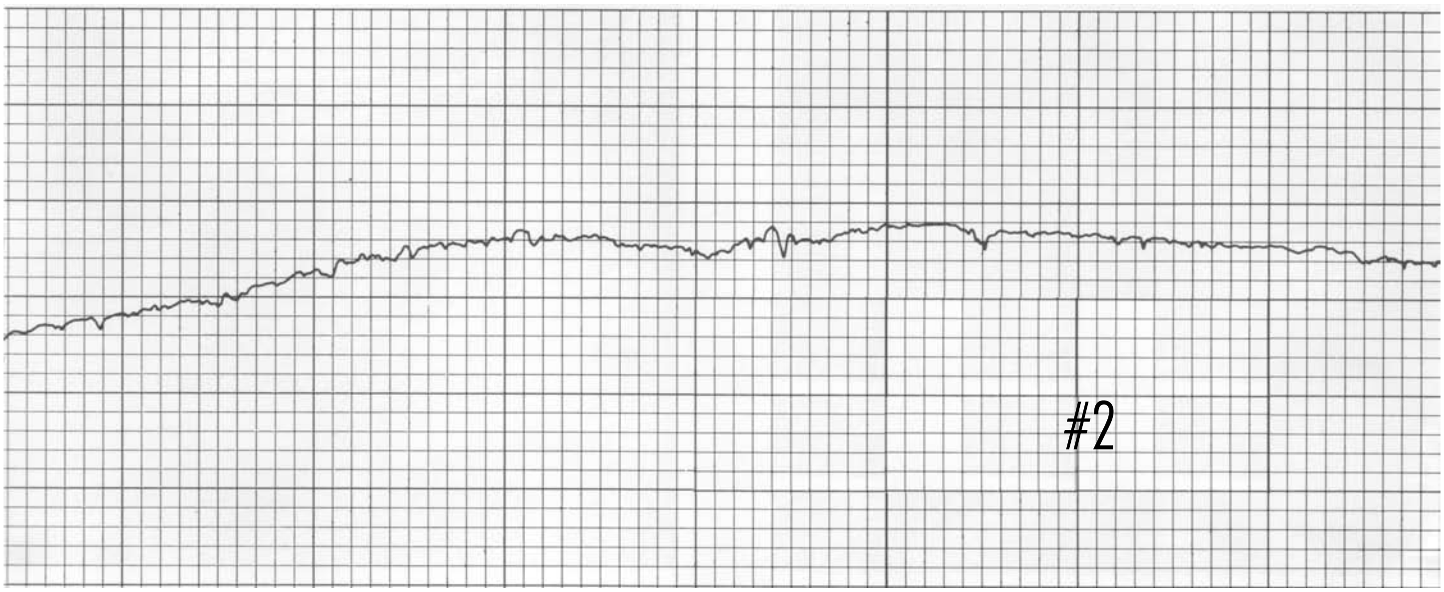
We feel so strongly in this area of compatibility of co-acting metals that after building 5 different prototypes we have an OD Flex-Honing Machine ready for further testing on Ring faces, or Shafting that must run in sliding bearings or Shafting that must seal (as on a hydraulic piston rod with a high psi for an extended time.)

Refer to the profiles and photos on page 10, 11, and 12. They are all keyed with reference numbers 1, 2, and 3.

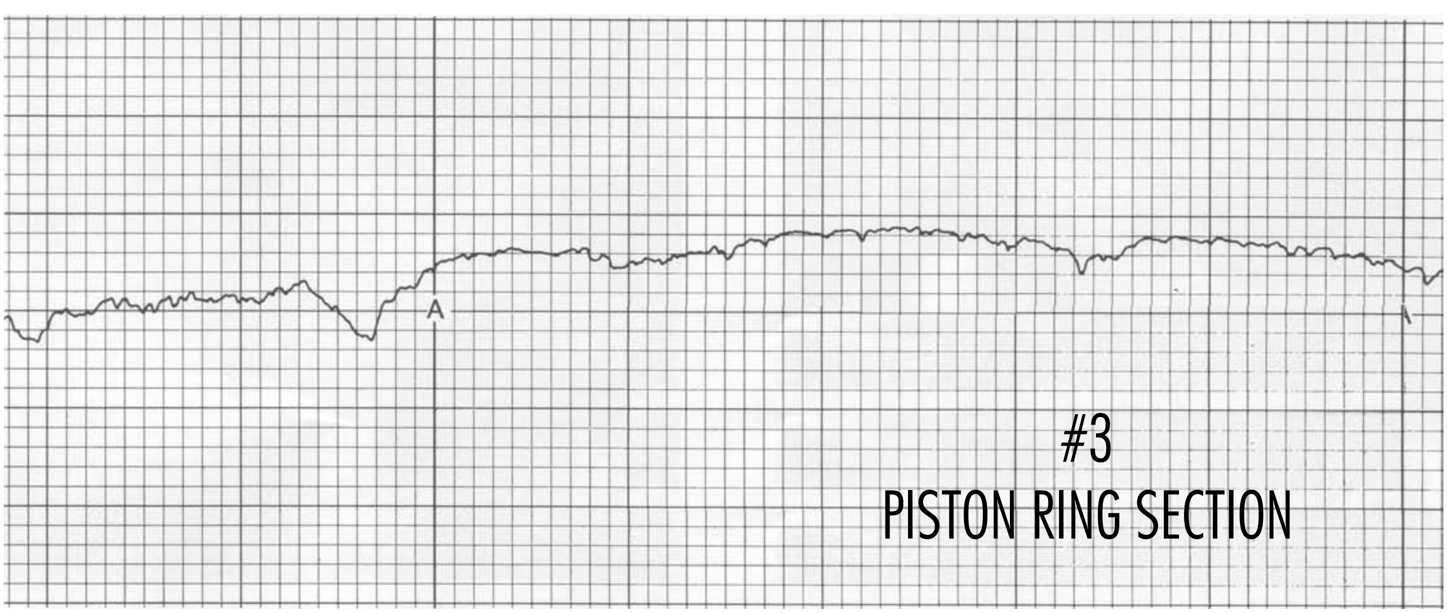




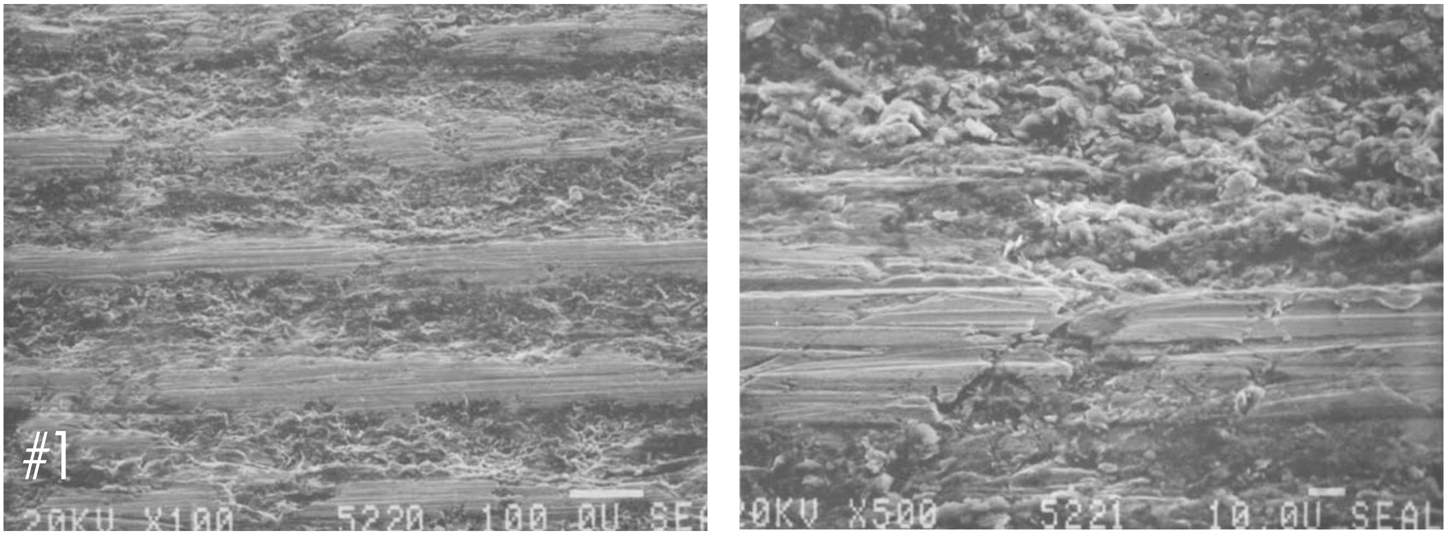
1. Profile of standard cast iron threaded pattern piston ring



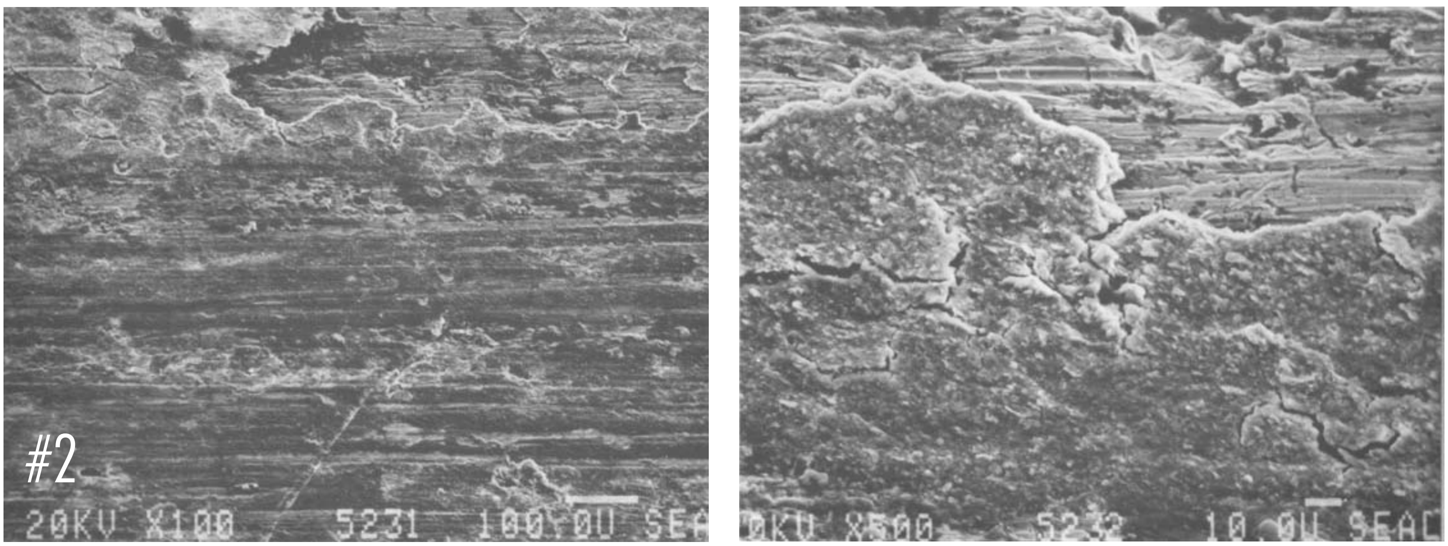
2. Similar ring externally Flex-Honed for approximately one minute (light pressure).



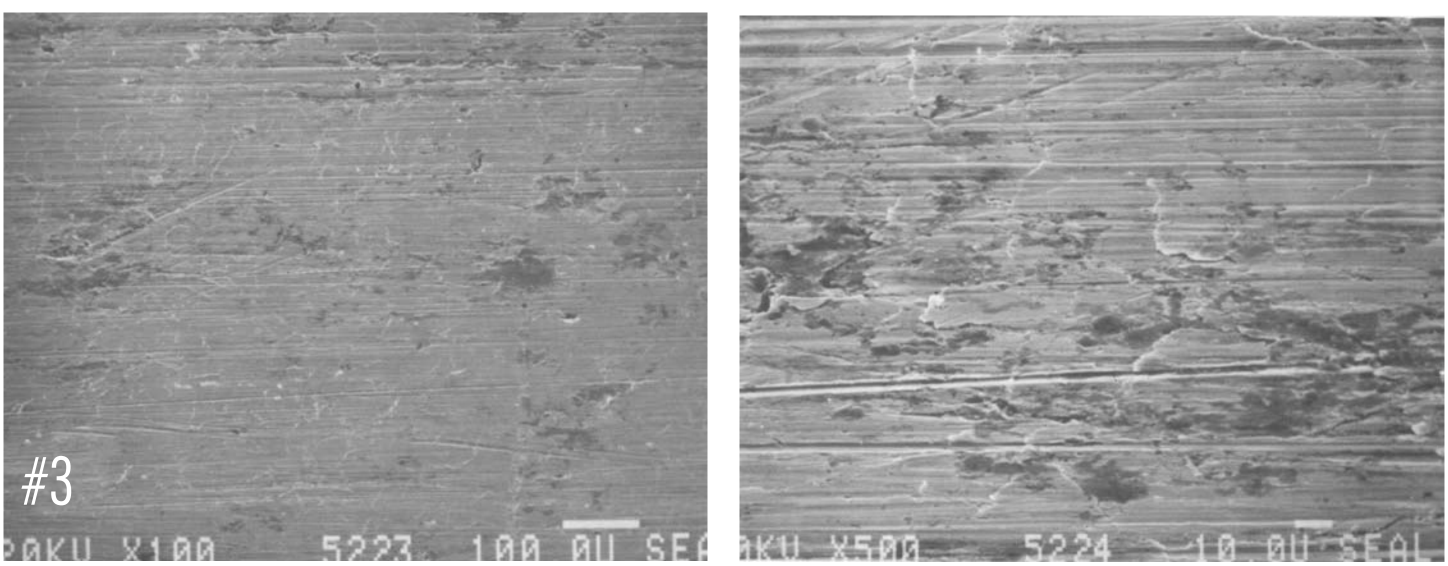
3. Similar ring externally Flex-Honed for approximately three minute (light pressure).



1. Standard cast iron threaded pattern piston ring.



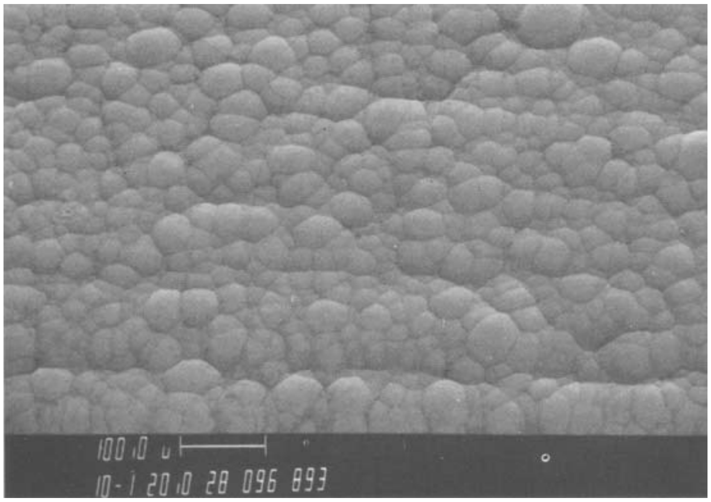
2. Similar ring externally Flex-Honed for approximately one minute (light pressure).



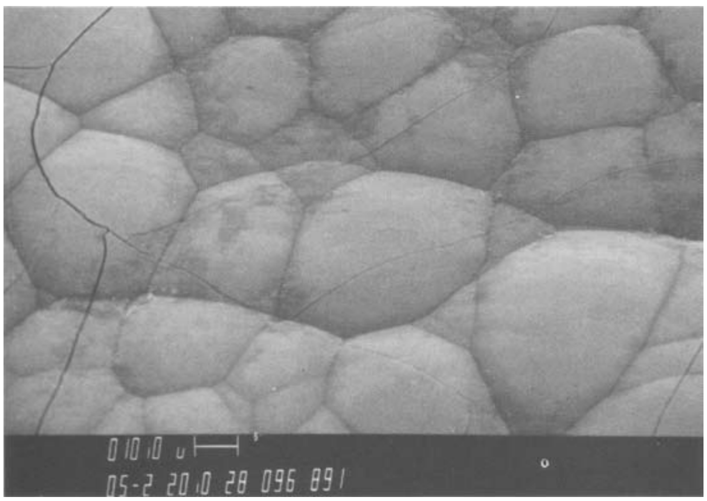
3. Similar ring externally Flex-Honed for approximately three minute (light pressure).
Ask yourself which ring you would prefer in your new car.

CHROME PLATED PISTON RINGS

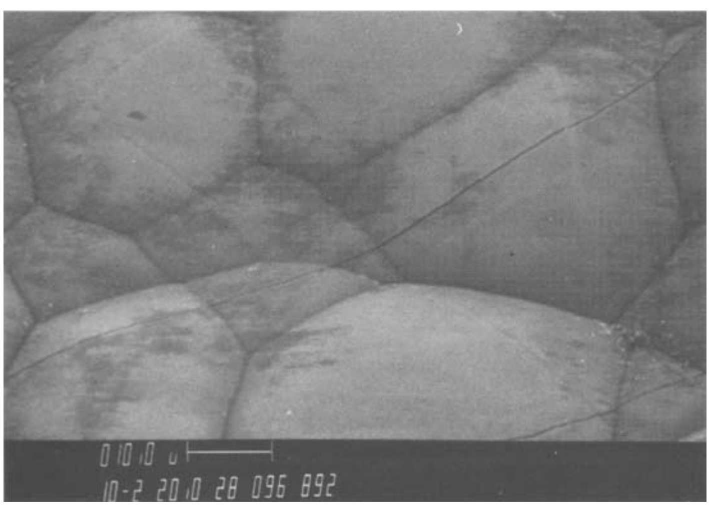
As Received



100X

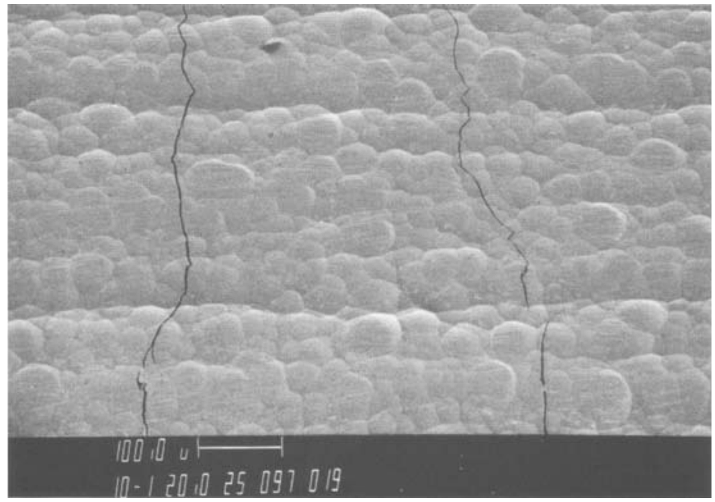


500X



1000X

After Flex-Honing



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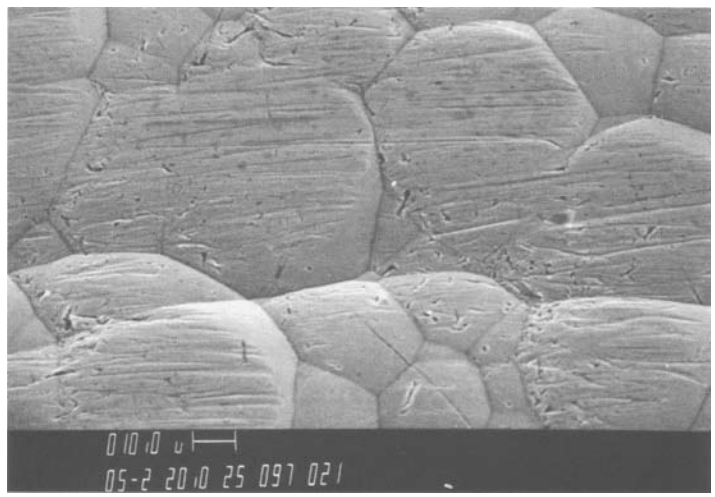

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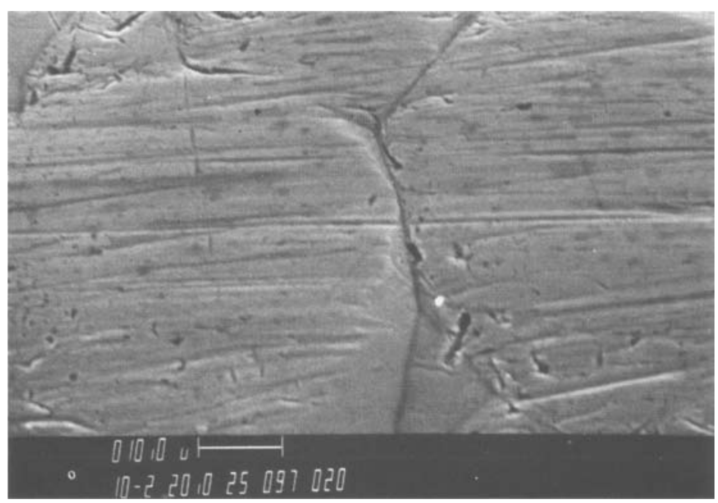
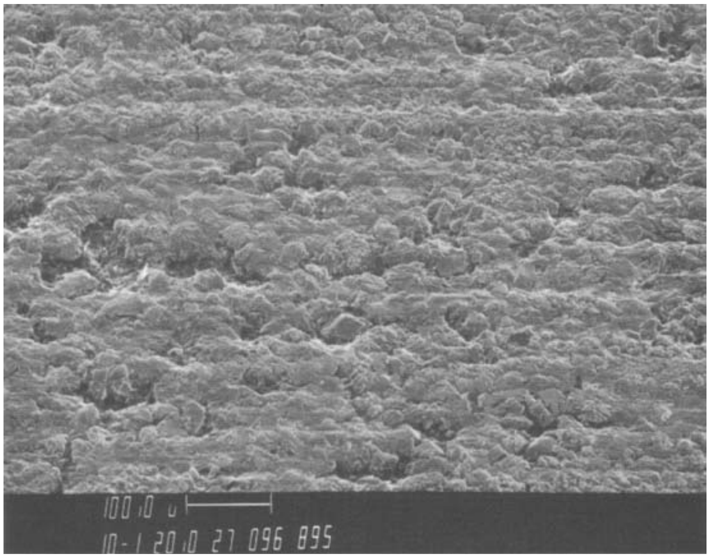


1000X

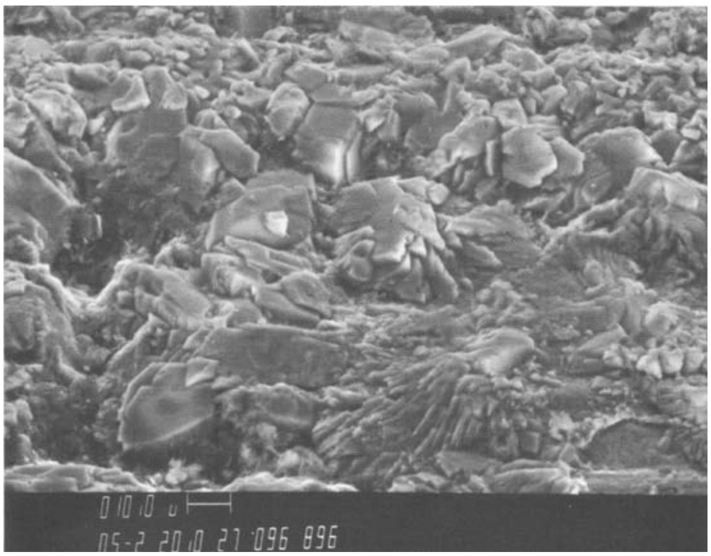
Our contention is that a cylinder-wall should have a plateau in excess of 60% free of cut, torn and folded metal. In other words, a Flex-Hone Process Finish. ALSO that the mating surface (in this case a piston ring) should be similar. The upper left column looks like a chromed finish. Wanting to plateau it if possible, we mounted the short rack of chrome rings in the External Flex-Hone machine and having no previous experience we arbitrarily ran to: honing head a medium speed of 170 RPM and using a 400 grit boron carbide honed the exterior for exactly one minute. We did not experiment with higher or slower speeds, different types of grits, or different honing times. But at the right hand column you can see what developed. We did plateau the surface, and perhaps sufficiently or maybe more honing time should have been applied. We only had the one short rack, and the results should be performance tested. If nothing else, we feel sure that faster seating will result with much less blow-by. On the next page see the same treatment on a Reverse-Twist Ring.

REVERSE-TWIST RINGS

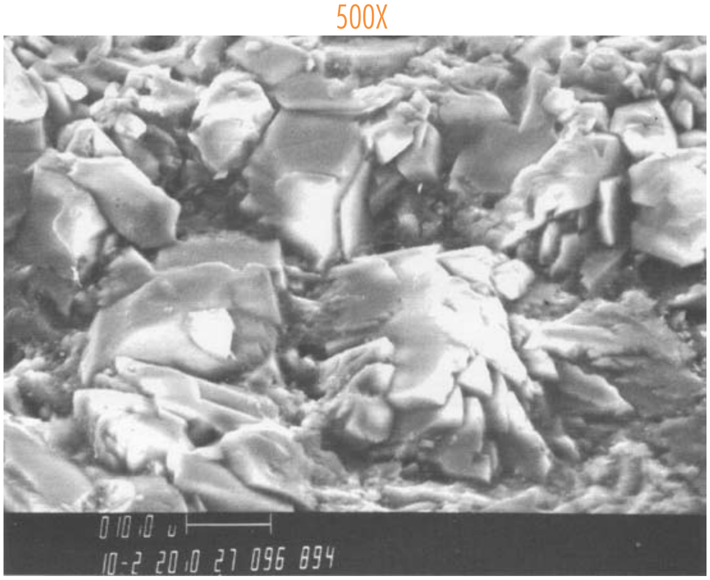
As Received



100X

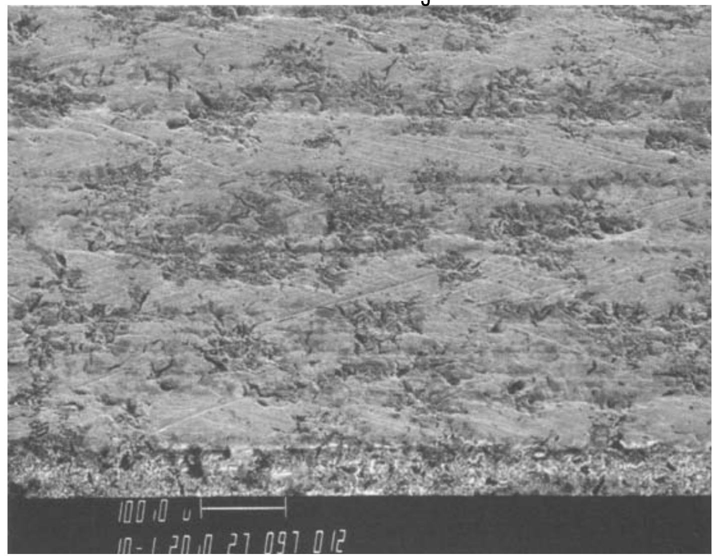


500X

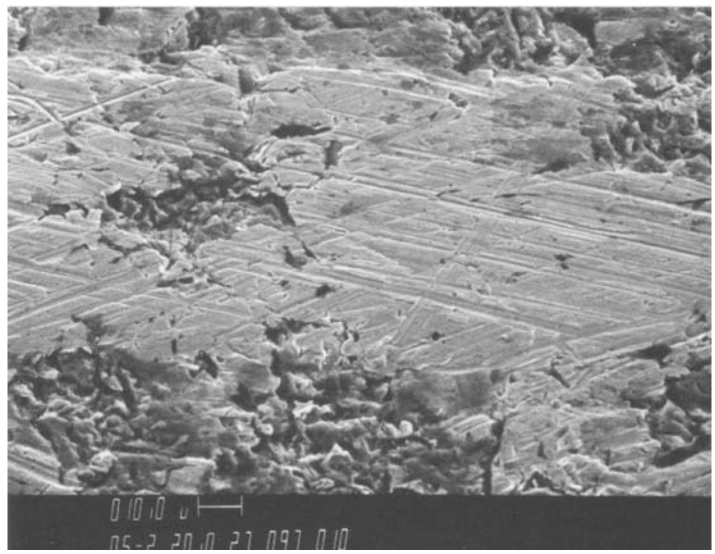


1000X

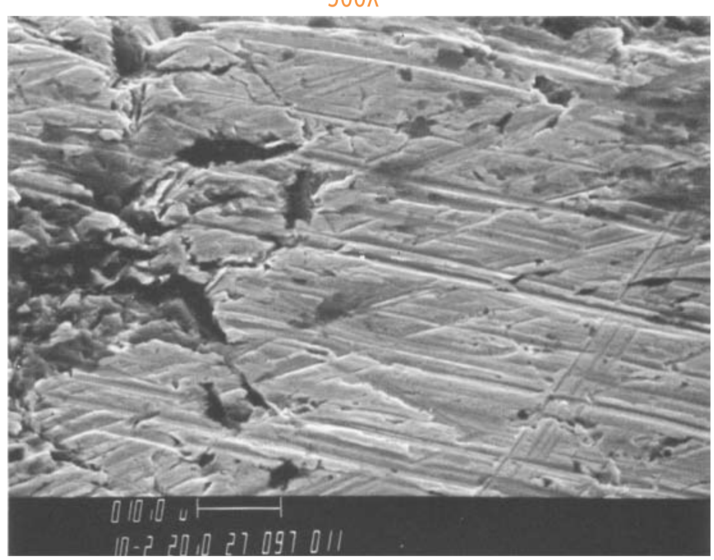
After Flex-Honing



100X



500X

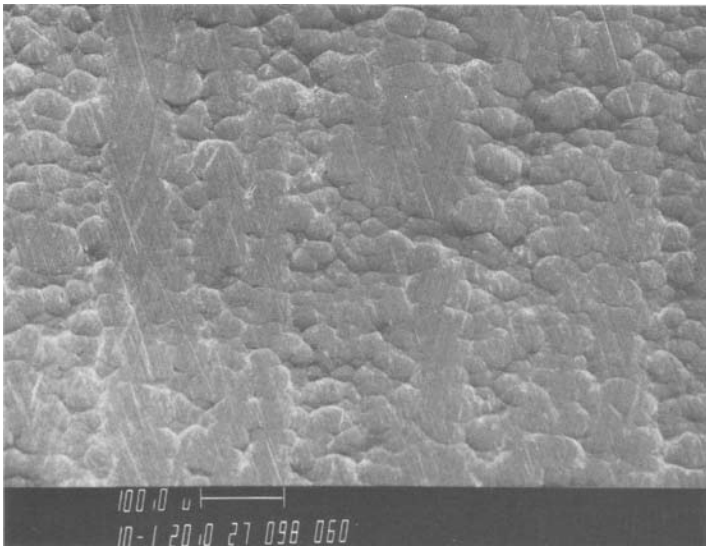


1000X

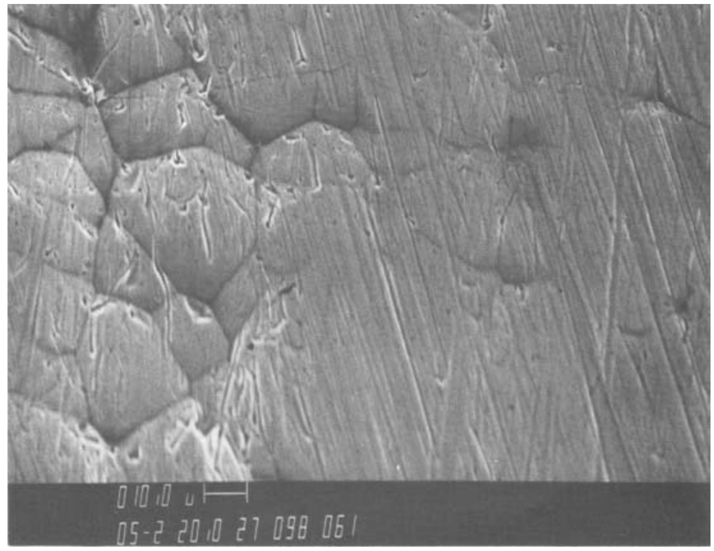
We do not know much about piston rings, and from the great variety of shapes and designs it would appear that we are not alone. The above Reverse Twist, we believe, is used as a second compression ring and the configuration is supposed to perform some magic. Our treatment to these was identical to the Chromed on the preceding page. Our comments are also the same, AND at this point we would like to refer you to the booklet necessity of a Plateaued Cylinder Wall Finish” and check pages 6 to 11 and particularly page 22. You should easily be able to draw your own conclusions.

PLATEAUING PISTON RINGS

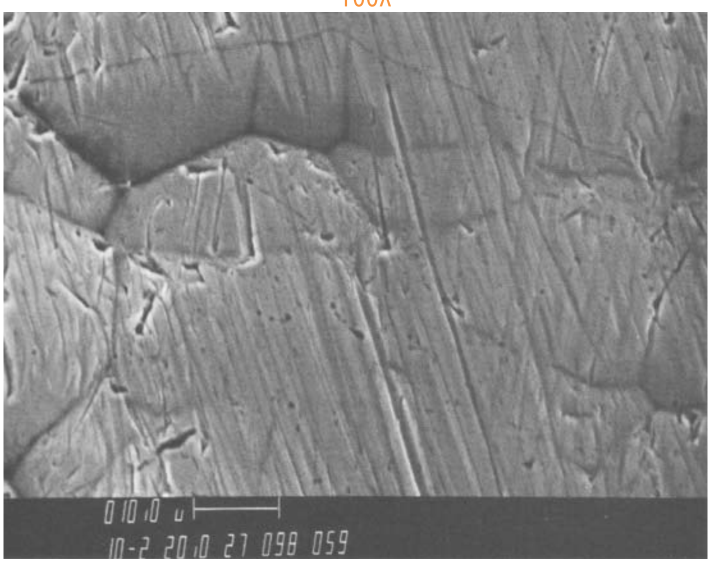
Not being satisfied with the appearance of the Chromed Rings and the Reverse Twist Rings we decided to give them some additional honing time on our External Honing Machine. Using, arbitrarily, a 400 boron carbide grit with the machine having a combined 135 RPM, (the workpiece and the hone body counter-rotate to ensure correct out-of-roundness) we added one (1) additional minute (total 2 minutes of honing) tithe Chromed Rings shown below at 100x, 500x and 1000x. You can see the development of a plateau. We have no explanation for the apparent high point chrome deterioration scratches.



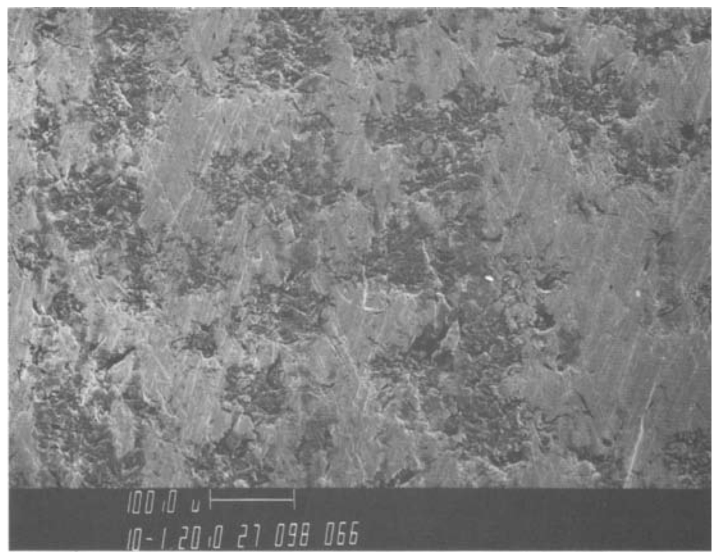
100X



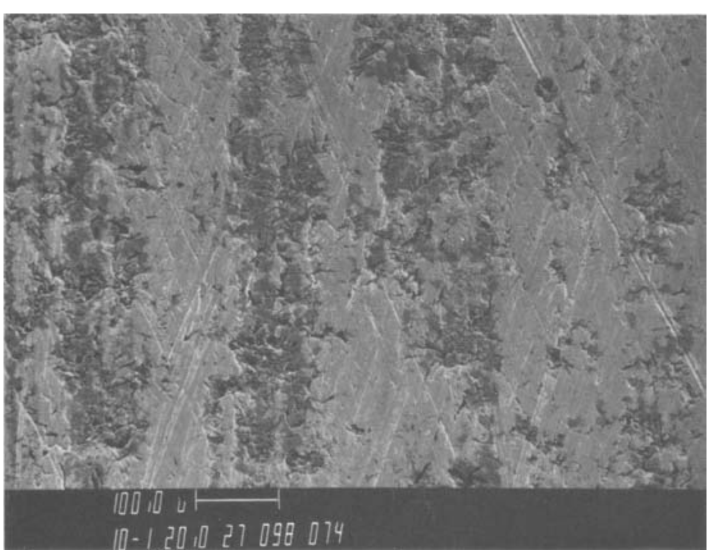
500X



1000X



Reverse Twist with additional 30 seconds of honing (100x) (total 1 ½ mins) Note good plateau developing



Reverse Twist with additional 1 ½ minutes of honing (total 2 ½).

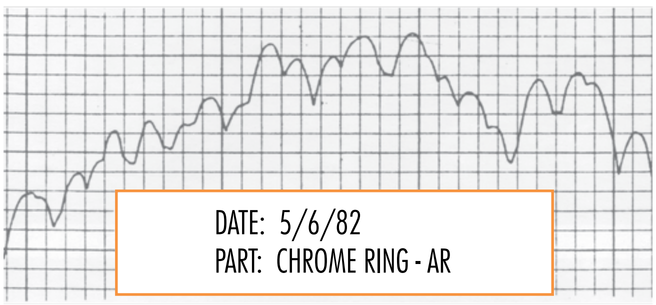
100X

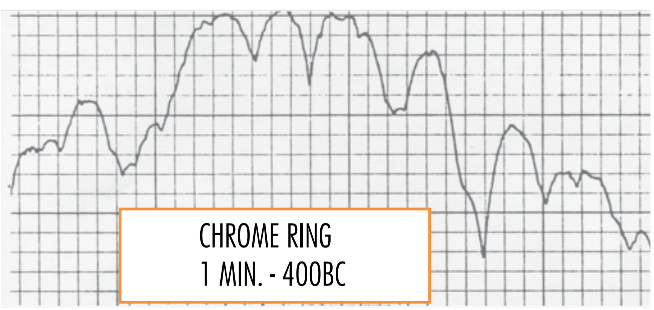
Reverse Twist 1000x. Extra honing time 1 ½ mins (total 2 ½). Good plateau compared to the original as is. This should give good fast ring seating without the friction, wear, heat, and cylinder damage.

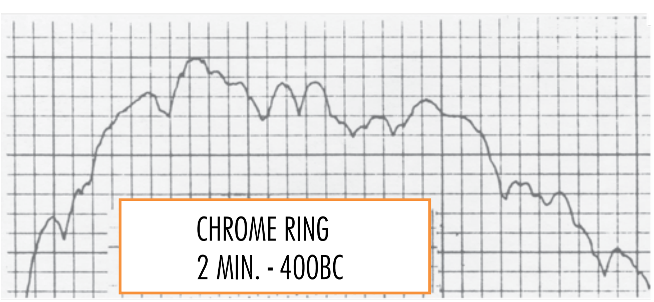
PROFILES OF CHROMED & REVERSE TWIST RINGS

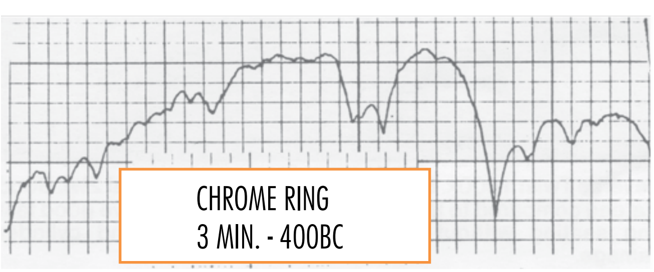
Chromed ring left hand column, as received and Flex-Honed as noted. Reverse twist right hand similarly marked. This ring is iron, with face angle about 1 ½ degrees and believe used as a second compression ring. From the photos on the preceding page you can see the surface finish being plateaued with the Flex-Hone Process. You can also note this refinement on the profiles.

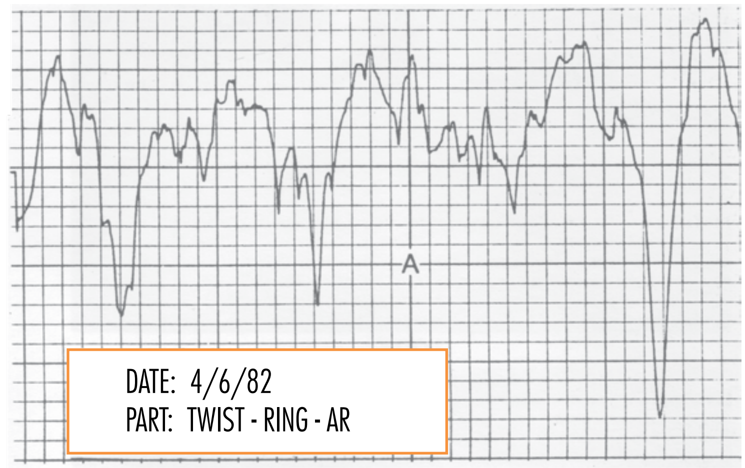
With a Flex-Honed finish on the cylinder wall and a similarly developed finish on the ring face, we should expect to see MORE instant ring seating than just the Flex-Honed Cylinder Walls, with even MORE compression, oil control, less friction, better performance, all-around better quality performance with longer engine life and customer satisfaction. And that is what we want, or the buyer wants, right?

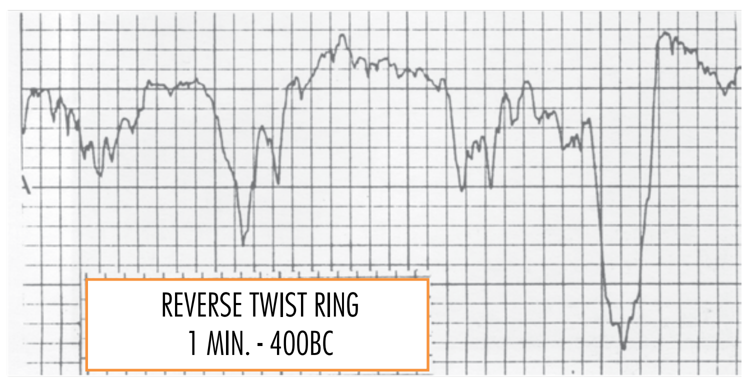


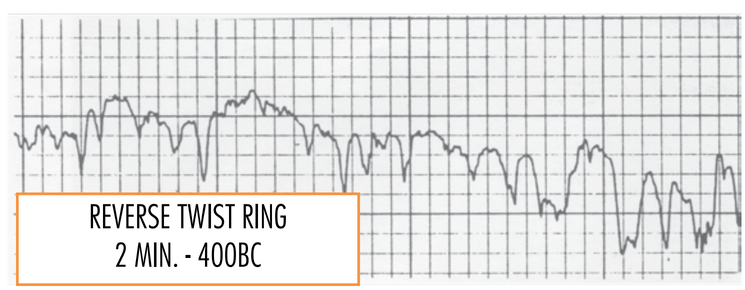


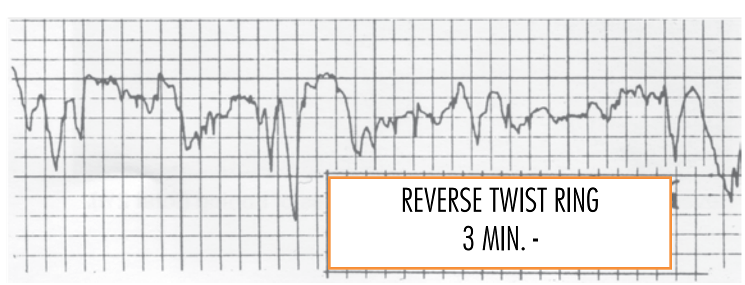












Roller Burnishing has always been a very fast and inexpensive method of smoothing a bored, reamed or turned surface to a previously acceptable work- able finish. The rough peaky finish left from the machining of the bore or the shafting is rolled down under great pressure from the expandable or otherwise roller to a specific size or diameter.

The problem is a false finish, as the peaks get broken off in the process, or get folded down which later on, under use, may break off from the surface. This cast- off debris gets onto the hydraulic system and leaves a finish that greatly shortens the life of the seal in a hydraulic or a bearing with a similarly finished shafting.

DOM (drawn-over-mandrel) tubing, commonly used in many hydraulics and shock absorbers, have a similar surface finish.

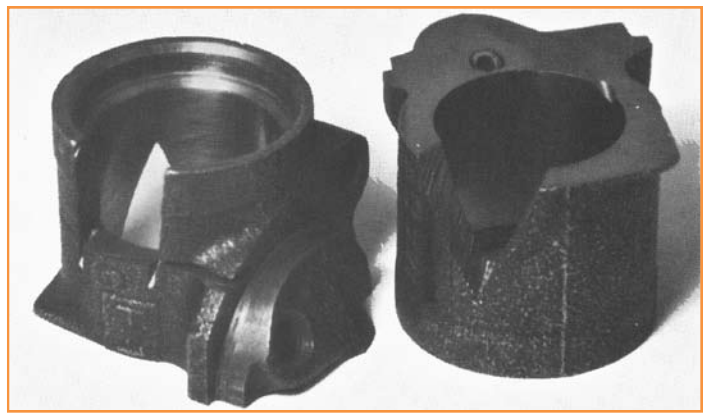
Flex-Honing these finishes presents a problem because we must first remove this "layed-over metal" to get down to the original structure.

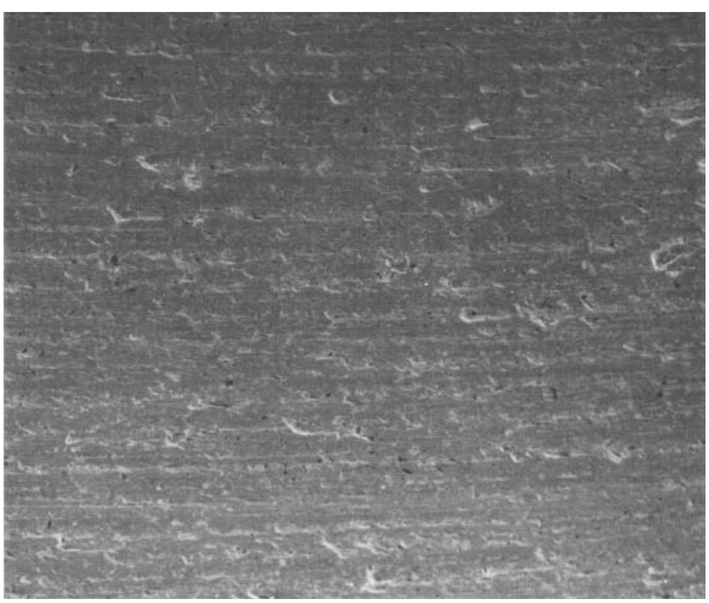
The Flex-Hone will initially develop a higher AA reading as this plastically deformed layer is abraded from the surface. This layer is work-hardened and may be relatively thick. It is common to be able to see the original machin- ing marks with the naked eye beneath the false surface.

If these cylinders that are machined or reamed were left with a relatively good finish (for example a 50#-A micro inch), it would be a simple matter for the Flex- Hone to remove the peaks from the surface, plateau it and remove cut, torn and folded metal, leaving a desirable surface that would greatly enhance sealing characteristics and may extend the cycle time of the seal as much as 10 to perhaps l00 times or more before failure. Higher psi without leakage would be another major advantage.

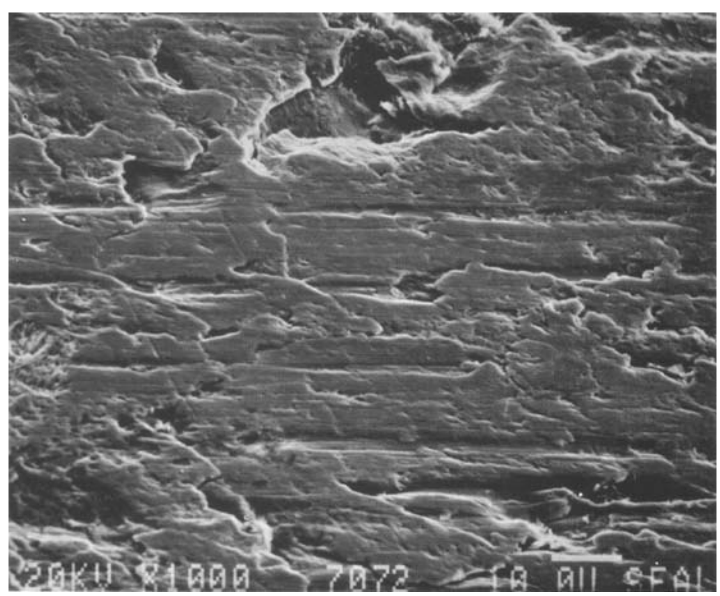
For study purposes we will present SEM photographs of what we have said above. The first example is a new hydraulic automotive brake cylinder, cast iron, made in the USA and Part #2945, roller burnished. The machining marks were clearly visible underneath the burnished finish. The data reading of this cylinder (which was classified as a ''High Performance Product" was 10.55 at the end where the roller burnishing started to a finish at the opposite end of 19.45 micro inch. The tp % at 100 below the highest peak was 98% at the leading end of the cylinder and 2% at the bottom end. So much for consistency of a roller-burnished finish.

This cylinder was cut in half, one end was Flex-Honed. Small sections were cut out of both parts for SEM photos. The cut ends were lapped so SEM could be taken from the ends as well as 90 degrees to the inside surfaces.

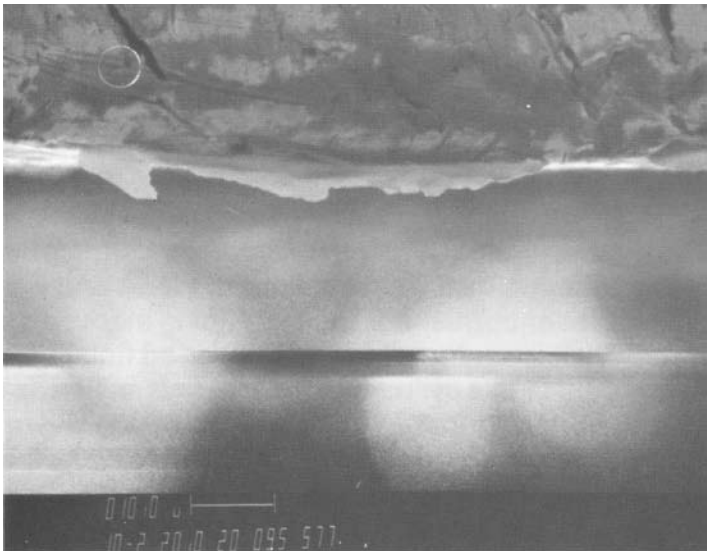




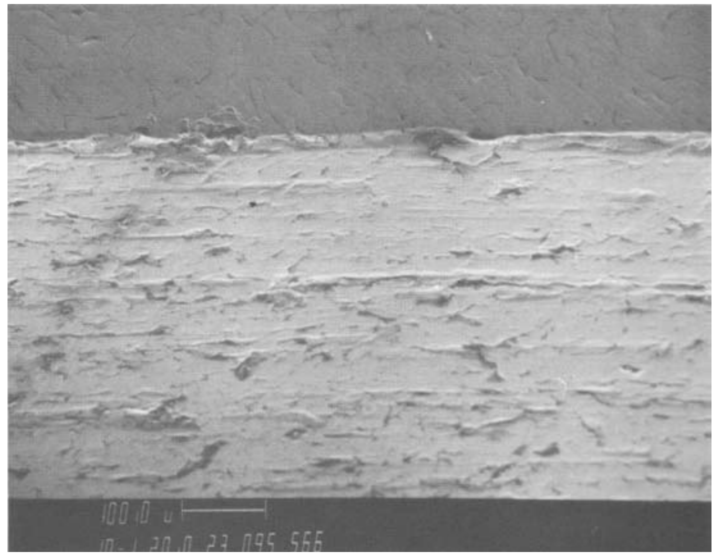
Roller Burnished, 50 Magnification. Machine marks visible.



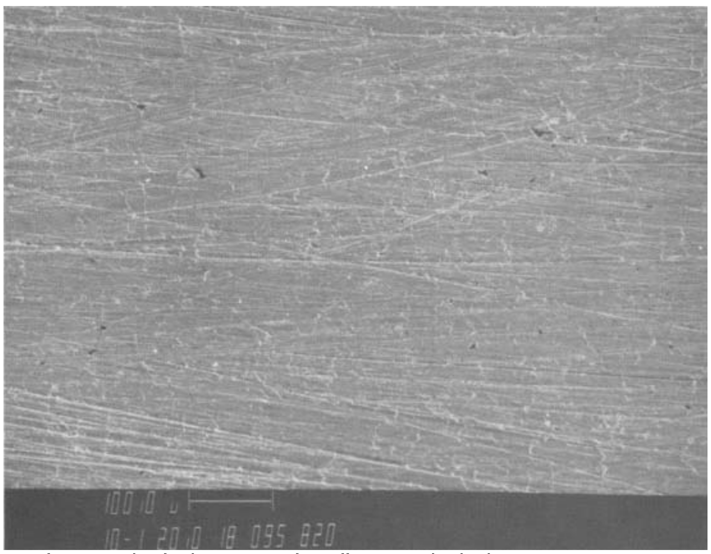
Roller Burnished 1000 Magnification elastically deformed metal surface.



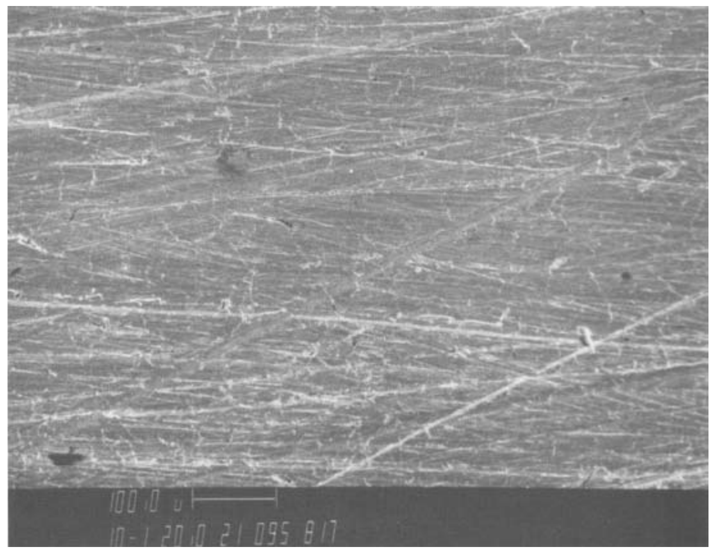
Roller Burnished, shown at 1000X profile 90 degrees to lapped end



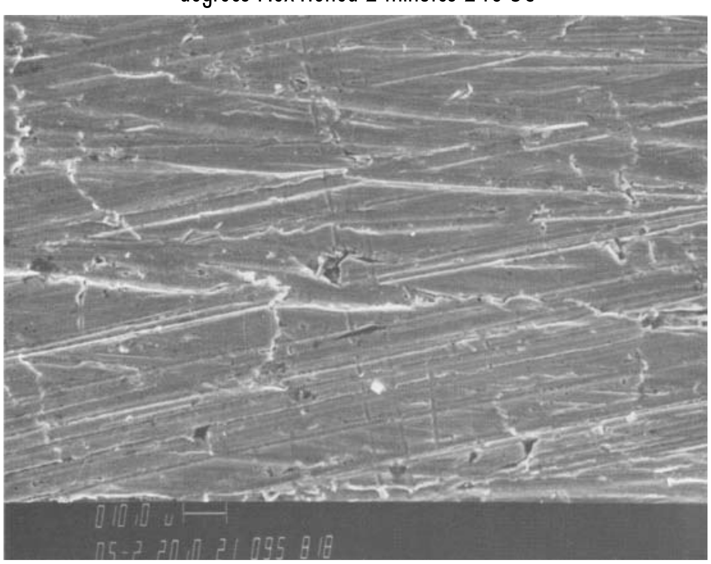
Roller Burnished end view at 100X 45 degrees to I.D. edge



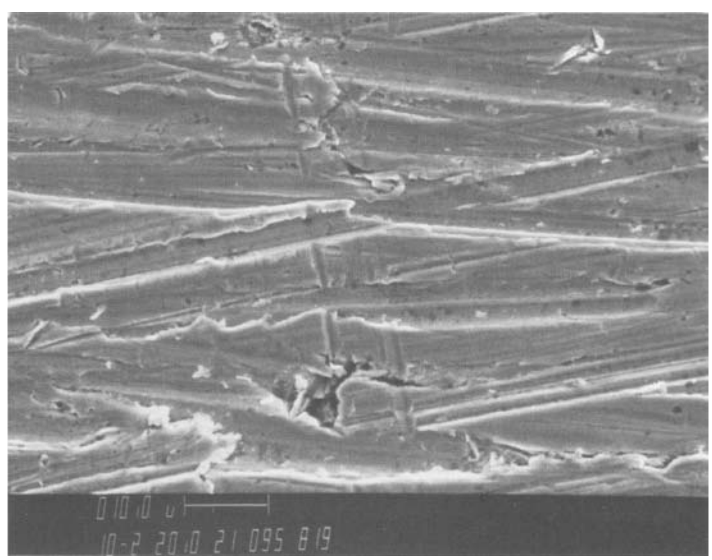
Flex-Honed cylinder previously Roller Burnished, shown at 100X at 45 degrees Flex-Honed 2 minutes 240 SC



Part on left shown 100X but photographed at 90 degrees



Part above at 500X taken at 90 degrees. Same honing time



Same part as on left but 1000X. Same honing time

We cannot expect the Flex-Hone to corrective Roller Burnished finish. It should start from scratch after a proper machining operation. Arithmetic average on the above Flex-Honed surface is 9.9 micro inch. Plateau 100 micro inch below highest peak 100 percent. Compare these to the readings of the original Roller Burnished finish.

MICRO-FINISHING BEARING CASES

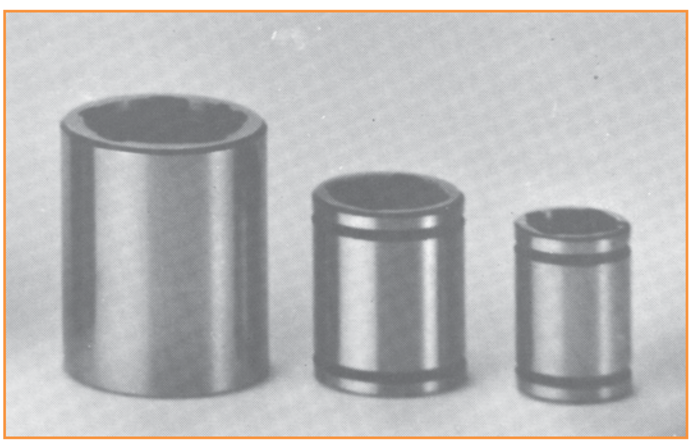
We received 10 bearing housing bodies from Switzerland to see if the ID finish (on which the bearings ride) could be improved.

One typical casing was cut up for SEM photography. The AA finish on this portion measured 12.61 micro inch ground surface characteristics are shown in sequence of 100, 500 and 1000 power.

100 Power

500 Power

1000 Power



Material............................100 Cr6
Hardness......................60 - 62 HRC

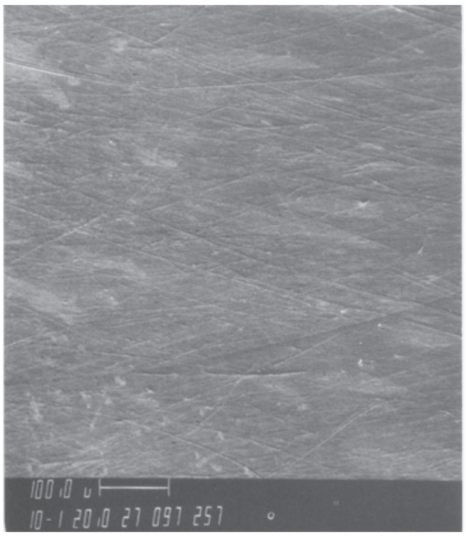
Up to 7% fuel consumption loss has been estimated as a result of friction of the component moving parts of the new or green engine. The heat and wear factors pose uncertain future problems. Might Quality also be Free in this age old situation?

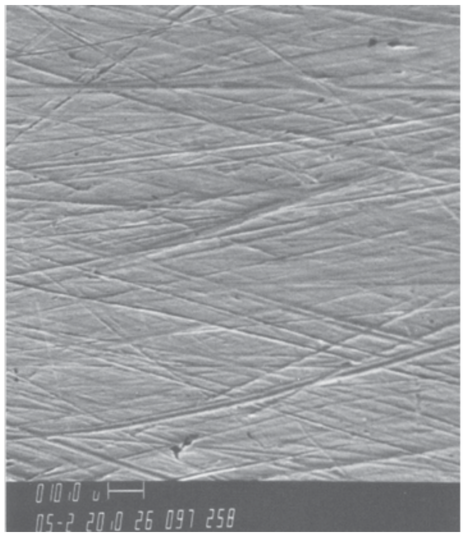
Picking up 3 additional bodies at random and marked #1, #2 and #3 and Flex-Honing them for a total of 30 seconds with 600 grit Boron Carbide the results were remarkable.

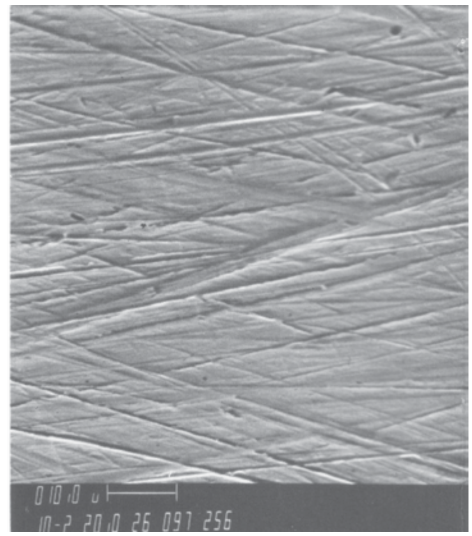
1. original AA 8.646 main. Plateau % 67% @ .050 main. Flex-Honed AA 5.236 main. Too 99% @ .050 main.
2. original AA 1 1.96 main. Plateau % 51% @ .050 main. Flex-Honed AA 6.046 main. Too 95% @ .050 main.
3. original AA 9.195 main. Plateau % 27% @ .050 main. Flex-Honed AA 4.667 main. Too 100% @ .050 main.

Cutting up Bearing Body #2 for SEM photography for comparison they are in sequence of 100, 500 and 1000 power.

It would be interesting to know the increase of performance and life by this improvement in surface finish. The surface finish of the bearings themselves should also be studied.



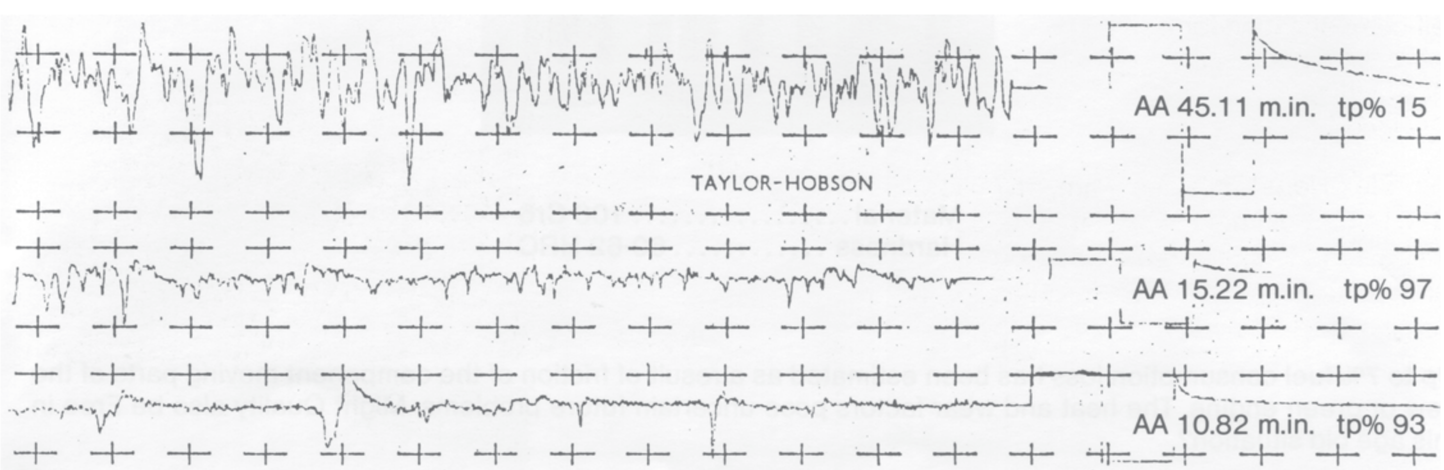




GUN BARRELS

Really an exercise in refinement of hardened steel. A USA manufacturer of shotguns sent in a half dozen barrels for testing and evaluation with our equipment. The leading shotgun manufacturer in Europe has used the Flex-Hone for years and has sent us photographs of the production line being Flex-Honed. One Navy uses the F-H also for their guns and their Army used the FH in their field guns and hydraulics.

We numbered the barrels and picked #3 for this test comparison. Before (as received) AA from open end read 45.1 1 M" with TP% 1 5. After 1 minute Flex- Honing with 800 Aluminum Oxide and Flex-Hone Oil as a lubricant AA from same position read 15.22. M" with tp% 97. After 1 additional minute (total 2 mins) AA refined to 10.82M" and tp% 93. (TP is percentage of plateau measured 100M" below highest peak).



NICKEL BORON COATED CYLINDER

A manufacturer of aircraft servo cylinders phoned us for Flex-Hone information. They reported that they nickel- boron coated their cylinders which raised the Rockwell hardness up to about 74 and made them almost impossible to work with. They also said this coating would out-last chrome by about 4 times. We offered to send them a 6 inch long DOM tubing with a nominal diameter of l ½ for coating and return to us. When received, we cut the cylinder in half to try 2 different abrasives.

Reference the chart below for results:

1. Talysurf 5 readings of cylinder sent for coating.
2. Profile and roughness (AA) of coated cylinder as received. Readings were taken at the top and bottom of cylinders.
3. One half of cylinder Flex-Honed for 30 seconds with 120 grit boron carbide.
4. Other half Flex-Honed for 30 seconds with 120/140 diamond abrasive.

A. tp (percentage of plateau) at 100 micro inches below highest peak.
B. Too reading at 150 micro inch below highest peak.

	AA at Top	AA at Bottom	A (tp %) @ 100	B (tp %) 150 m.in.
1.	19.13		37	95
2.	24.71		66	97
2.		36.79	15	58
3.	20.36		9	80
3.		14.42	90	100
4.	17.95		94	99
4.		15.49	98	99

Results:

The nickel boron coating left a surface roughness of from 25 to 37 m. in. AA It also left a plateaued finish of 15-66% at 100 m. in. depth. Flex-Honing reduced the range to an average of 15-20 m. in .with plateau percentages of 80 to 90% at 100-150 m. in. depths. This demonstrates the Flex-Hone ability to refine nickel-boron coatings.

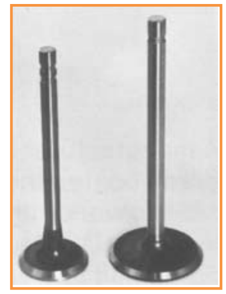
A major US manufacturer of airfoils uses the Flex-Hone in their air cylinders. Until last year they used a US rigid hone and just changed over to the Flex-Hone Process. Last year they reported that they manufactured 86,000 parts and calculated they saved over $22,000 by using the Flex-Hone. Using primarily 240 grit along with some 320 grit they stated that with the GB 1" at approx. 1 600 rpm they're getting 1200 pieces per F-H. They are now changing another operation to the F-H from the rigid hone.

The finest finishing tool in the world today.

A light pressure, - soft application honing device. Abrasive Globules on high density nylon.

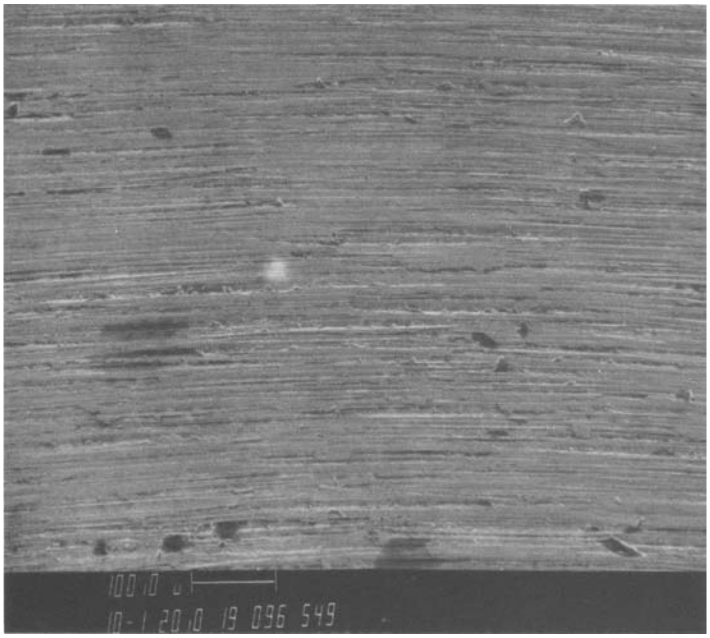
Flexible,
Self Centering,
Self Aligning,
Self-compensating for wear.
Unbreakable stones,
Long lasting, Consistent Finish.
The Flex-Hone in sizes 4mm (.157") to 36" (914mm) diameter. Grits of 20 to 800.
Silicon carbide, aluminum oxide, boron carbide, tungsten carbide. Levigated Alumina. and Zirconia Alumina.

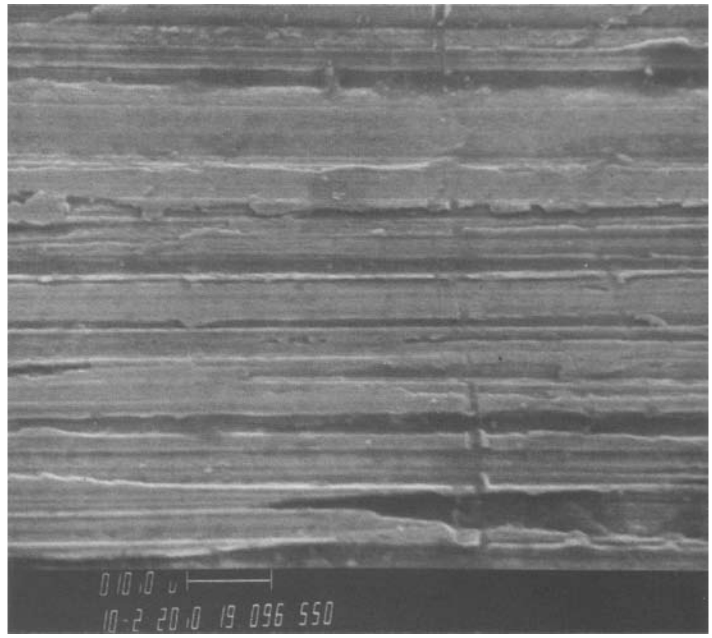
INTAKE AND EXHAUST VALVE STEMS



Because valve stem and valve guide wear has always been a major problem in the efficient performance of combustion engines, excessive oil consumption past the stems into the combustion chamber, poor valve seating due to excessive wear of the guide and the stem, blow - by due to excessive wear of the guide and the stem, burnt stems due to excessive friction and lack of lubrication etc, - we decided to have a closer look:

We bought two new valves from an auto parts store. One intake and one exhaust. One used in Ford and the other in GM. A large and small. Numbers S2090 and the other 2348X.. The stems had been ground. On our Rank surface Analyzer the arithmetic average on the small valve (Chev) S2090 measured from a 29.61 AA with 1% Plateau at 100. The stem on the 2348X large valve measured 1 7.60 AA with 74% Plateau at 100 (Ford).SEM on the Small in magnifications of 100X, and 1000X below:

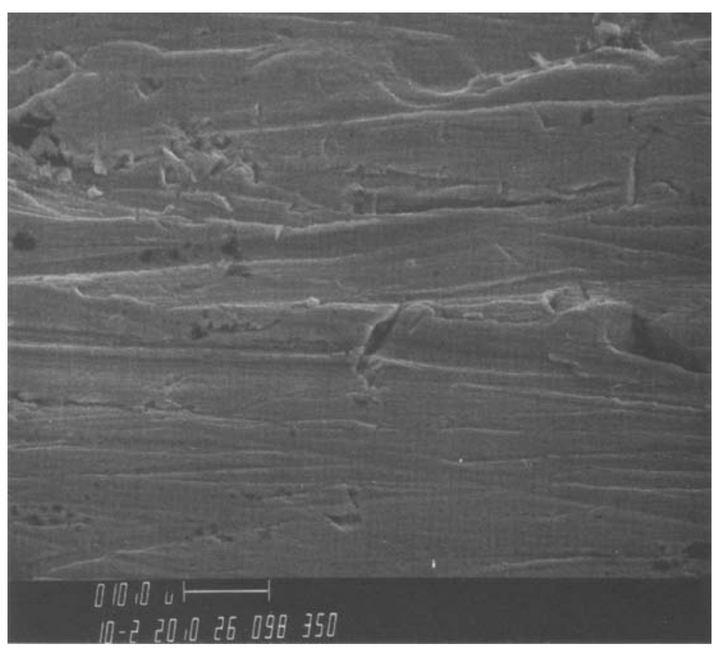




As Received 100 X 1000 X

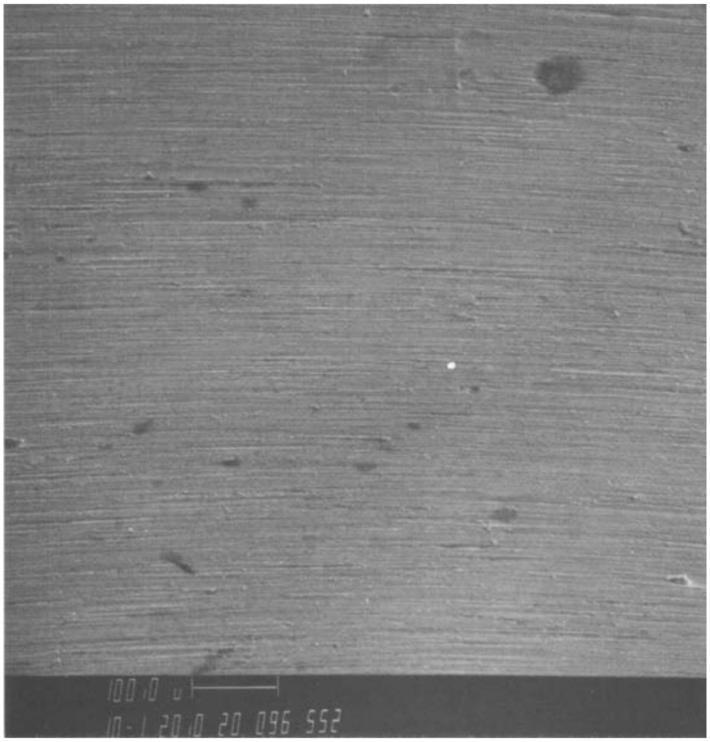
The boring and possibly reaming of the valve guide would then have a similar pattern on the surface with machining or grinding marks in parallel. These patterns would then abrade eachother until they "mated" or had worn one another down until smooth. With no particular surface pattern to hold or retain or spread oil the heat and friction can only be imagined at this point. Or the amount of wear as these rubbed against each other at perhaps 50 or more times a second.

Flex-Honing the OD of these valve stems on our newly designed (and patent applied for) external honing device with a 240 grit boron carbide for 60 seconds the AA on the small valve stem (Chev) was 17.1 AA Plateau 95% at 100. The stem on the large valve read 22.3 AA and 56% Plateau at 100. The grinding horizontal pattern has now been changed to a plateaued finish, free of cut, torn and folded metal and a surface that will retain lubrication. It goes without saying that a compatible surface finish should also exist on the valve guide by Flex-Honing. SEM photos follow for comparisons first on the Small to match the above for comparison:

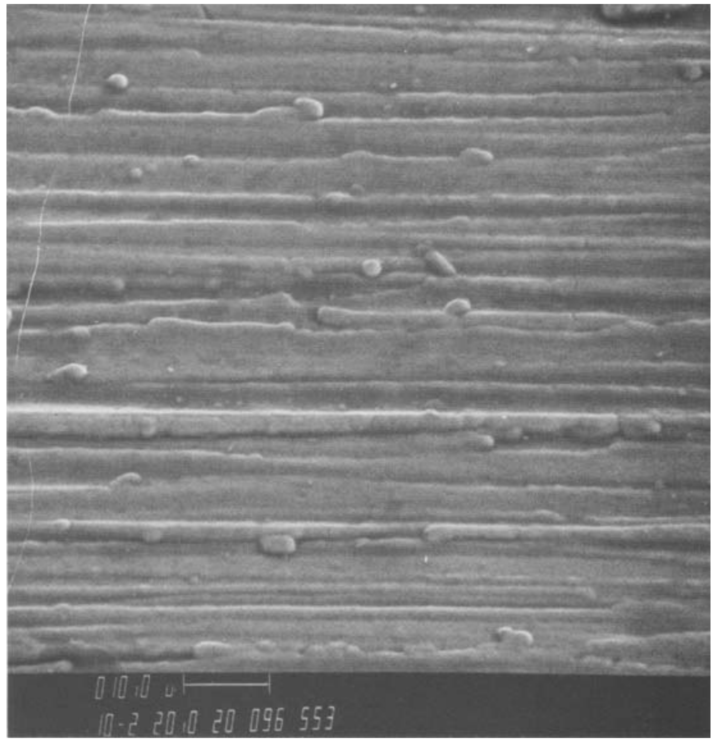


After Flex-Honing 100 X 1000 X

SEM photos of 100X and 1000X on the large valve follows:

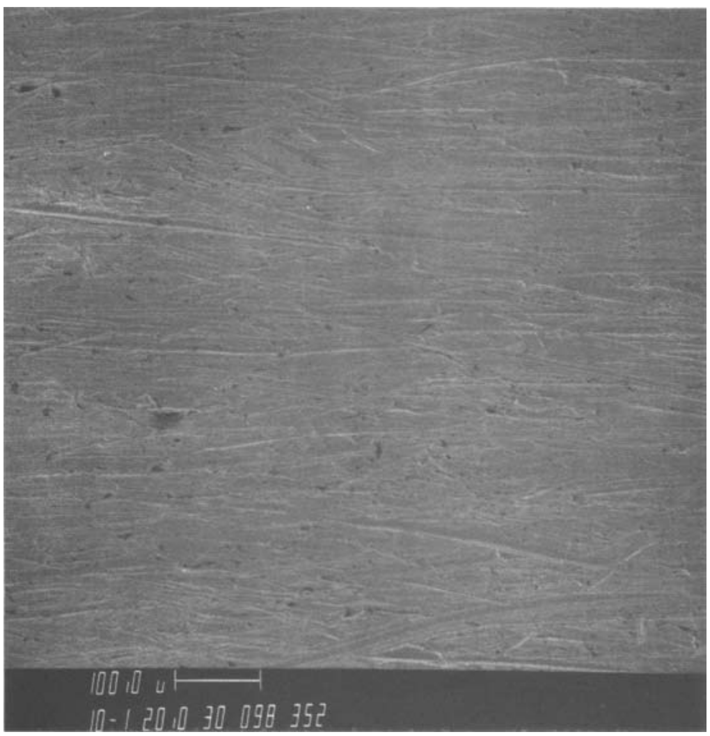


100 X

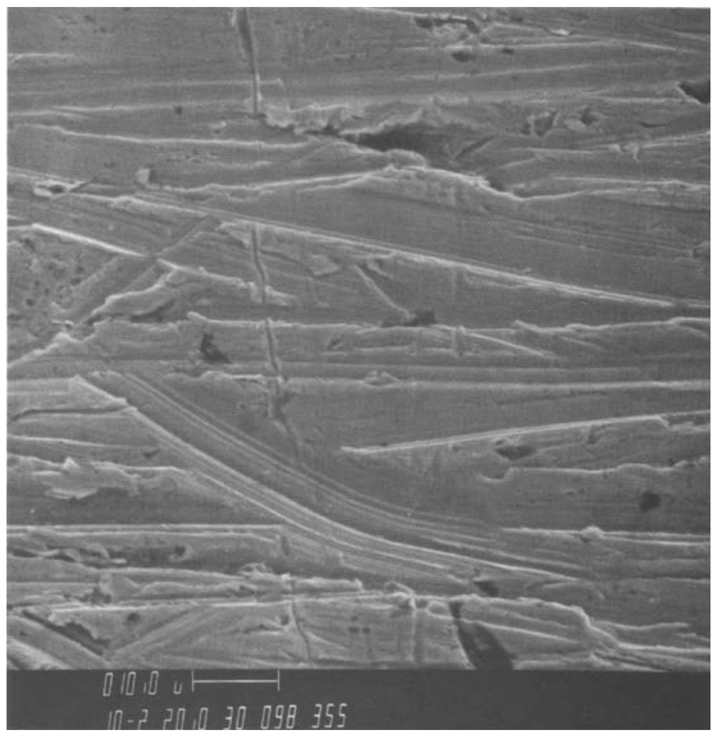


1000 X

And after the Flex-Hone Process:



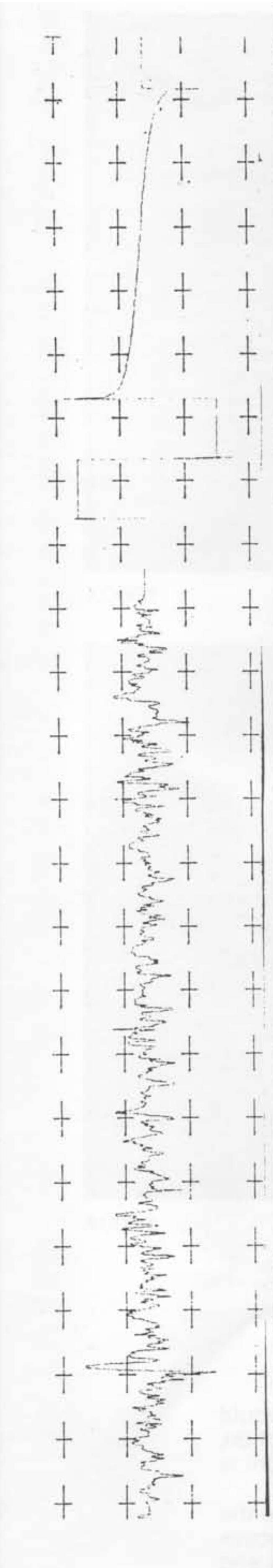
100 X



1000 X

The degree of surface quality was probably great during the days of the Horse and Buggy, or when we plowed our fields with a team of horses and a hand-held plow.
Isn't it time to up-grade and improve to the best possible? We owe it to the consumer. It is long past due.

On cylinder walls every engineer by tradition and from experience demands or would like to see a plateaued finish to aid in rapid ringseating and eliminate heat-killing friction, and he feels that a cross-hatch (that is really a result from the honing operation) is necessary or desirable to hold a reservoir of oil to lubricate the moving parts. We sure agree, and so LET US CONSIDER THE VALVE STEM, - should we have the cross wise machining and roller Darks, - or should we have the Flex-Hone Process Finish, - plateau, and a cross-hatch to hold oil, - to eliminate wear and friction and burning'??



DEPTH(mIN)	TP%	HSC
0.400	100	0
0.350	100	0
0.300	99	5
0.250	91	37
0.200	50	18
0.150	7	25
0.100	1	2
0.050	0	1

RT12	0.164	mIN
RT11	0.232	mIN
RT10	0.202	mIN
RT9	0.163	mIN
RT8	0.141	mIN
RT7	0.204	mIN
RT6	0.189	mIN
RT5	0.193	mIN
RT4	0.189	mIN
RT3	0.227	mIN
RT2	0.421	mIN
RT1	0.166	mIN
RMAX	0.421	mIN
RTM	0.207	mIN
RP	0.200	mIN
RT	0.421	mIN
RSK	0.449	
RA	29.61	µIN

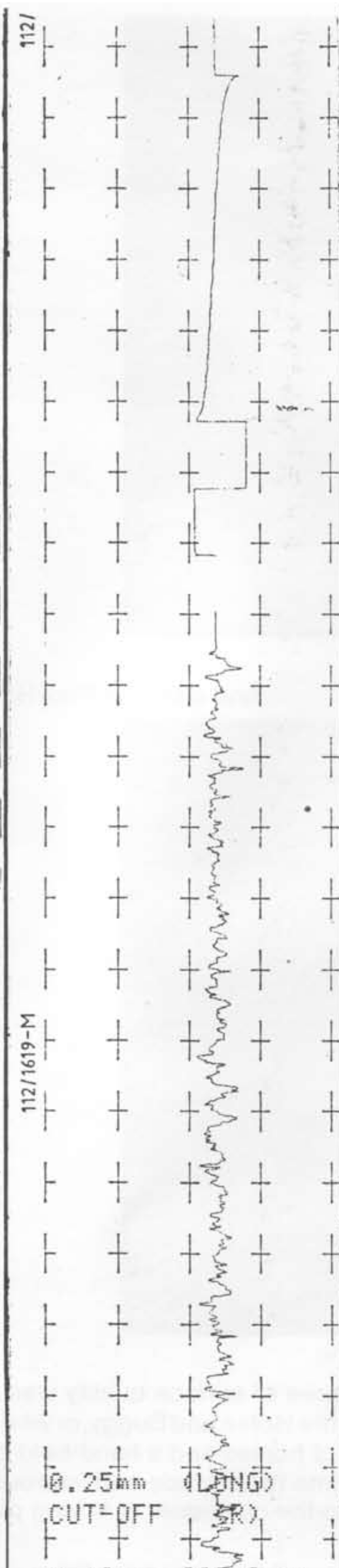
0.25mm (LONG)
CUT-OFF (R)

SKID................
TIP RADIUS..........
IDENT...............
DATE................
RTH TALYSURF 5M

112/1619-M

AR CHEV. VALVE STEM
RA - 29.61

AS RECEIVED
91% PLATEAU @ .250"
FROM SURFACE



DEPTH(mIN)	TP%	HSC
0.100	95	17
0.050	32	64

RT12	0.113	mIN
RT11	0.127	mIN
RT10	0.056	mIN
RT9	0.070	mIN
RT8	0.104	mIN
RT7	0.106	mIN
RT6	0.088	mIN
RT5	0.101	mIN
RT4	0.100	mIN
RT3	0.086	mIN
RT2	0.128	mIN
RT1	0.104	mIN
RMAX	0.128	mIN
RTM	0.098	mIN
RP	0.058	mIN
RT	0.147	mIN
RSK	-0.499	
RA	17.11	µIN

0.25mm (LONG)
CUT-OFF (R)

SKID................
TIP RADIUS..........
IDENT...............
DATE................
RTH TALYSURF 5M

112/1619-M

CHEV. VALVE STEM
(60 SEC. 240 BC)

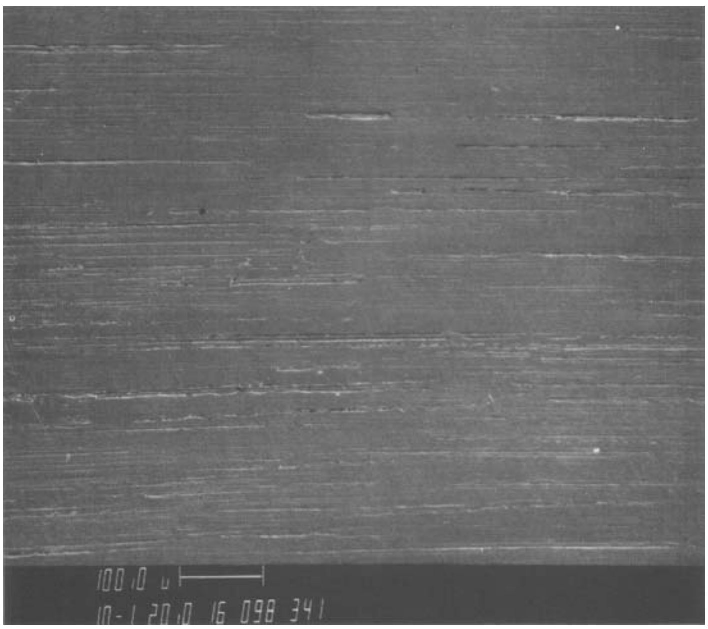
RA - 17.11
95% PLATEAU @ .100"
FROM SURFACE

SHAFTING

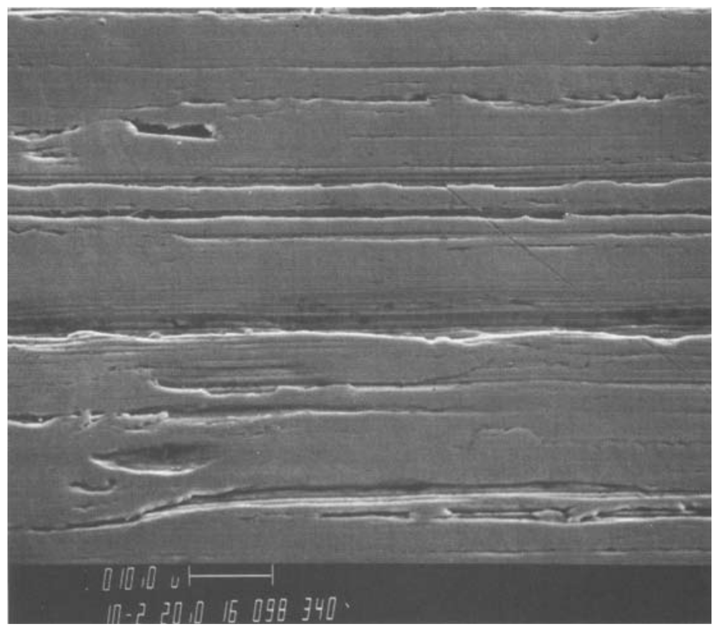
The first time we looked at shafting we reported our observations in a previous booklet on ''A Study of Cylinder-wall MICRO-STRUCTURE" printed Sept. 1, 1979 on page 7. At that time we purchased some C1045 ground and polished shafting. The SEM 1000 power photo shows clearly the grinding masks and the polishing appeared as though the shaft had been rolled. The wear this finish would cause on an alloy bronze bearing or bushing with possible high speed and under load, would very soon cause a bearing failure due to friction wear. Also the surface was not conducive to holding oil or providing full lubrication. We placed the shafting in a lathe and made a fixture to apply the Flex-Hone Process to the OD and photographed the result. Look in this booklet as a prerequisite to the further examinations:

The above encouraged us to build an External Honing Machine (patent applied for) for similar purposes. We again bought a length of C1045 ground and polished shafting. We profiled a section on our Tallysurf 5 profilometer in the "As Received" condition and the AA read 5.969 micro inch. The photos below show the original surface machining Darks and the superficial rolled surface. A very good smoothed AA finish, but not a finish that would hold or distribute oil under working conditions. The top plastically deformed layer of folded-over metal may have pre-mature wear exposing the rough machined surface underneath.

In the OD Flex-Hone machine this final rolled layer had to be removed to get down to the base original metal. It would have been easier, faster, more efficient if we had had a finally machined surface to begin with so that we could have plateaued the surface, removed anymore metal and have developed an oil holding and distributing pattern.

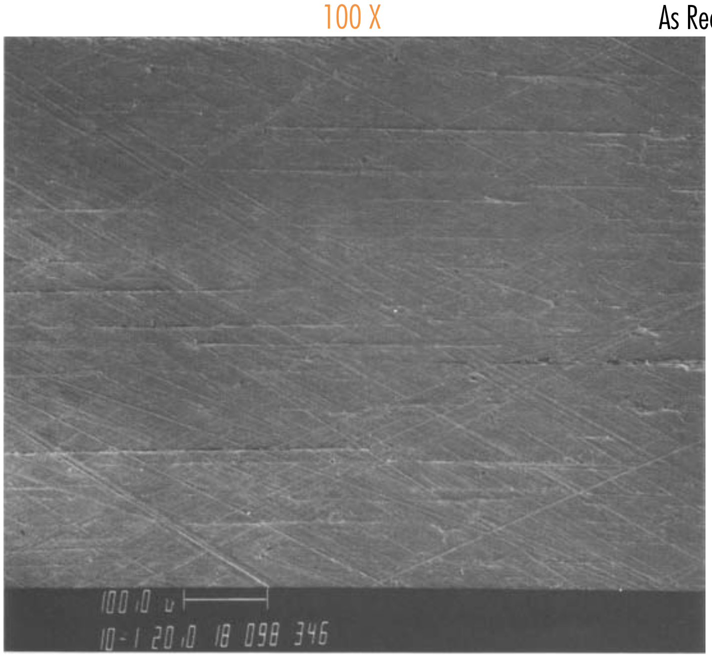


100 X

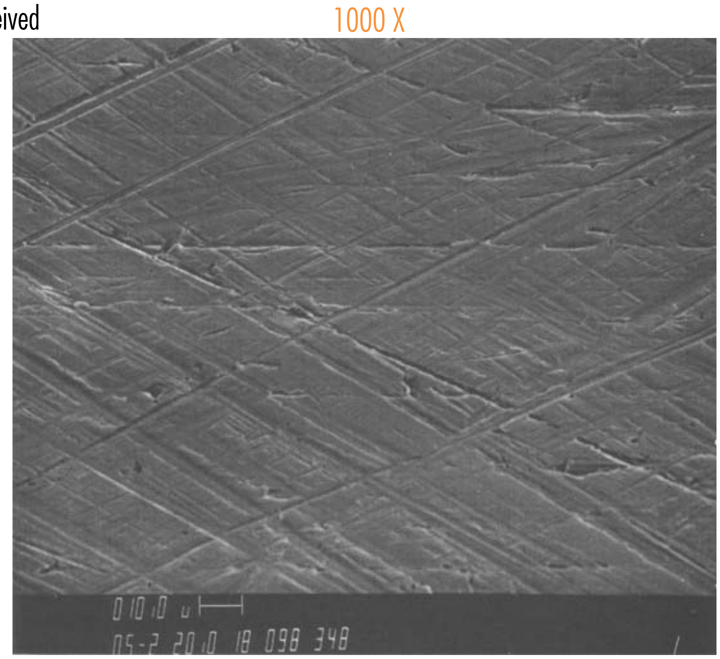


1000 X

As Received



100 X

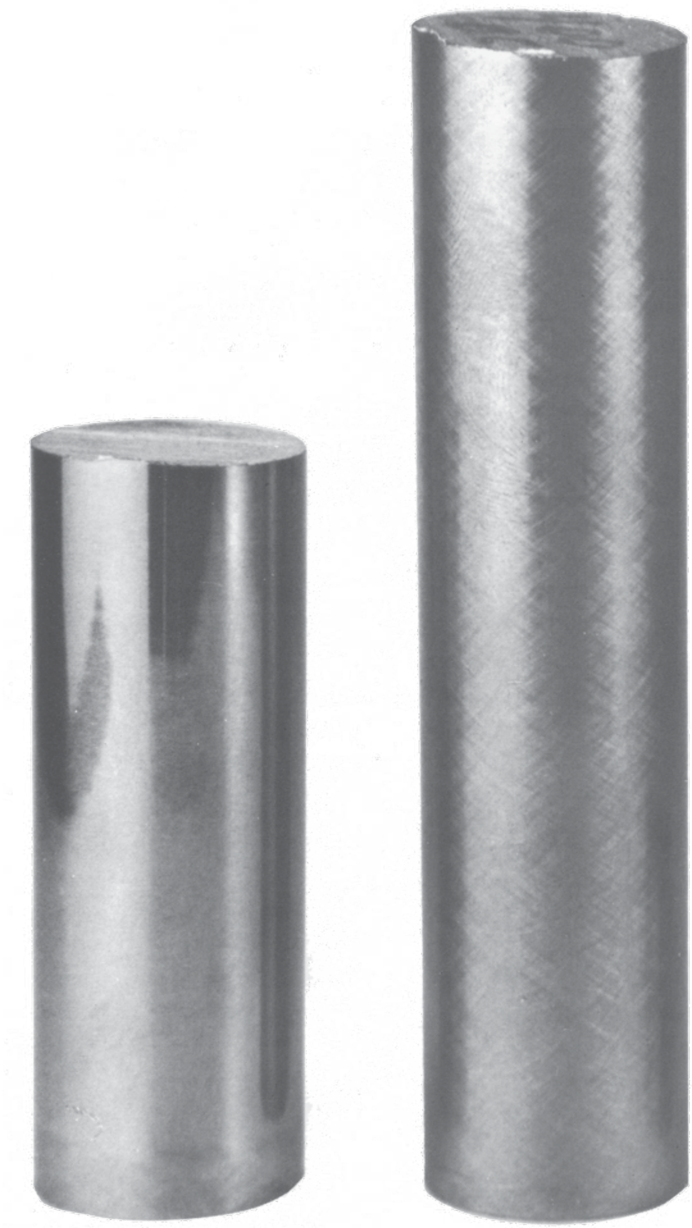


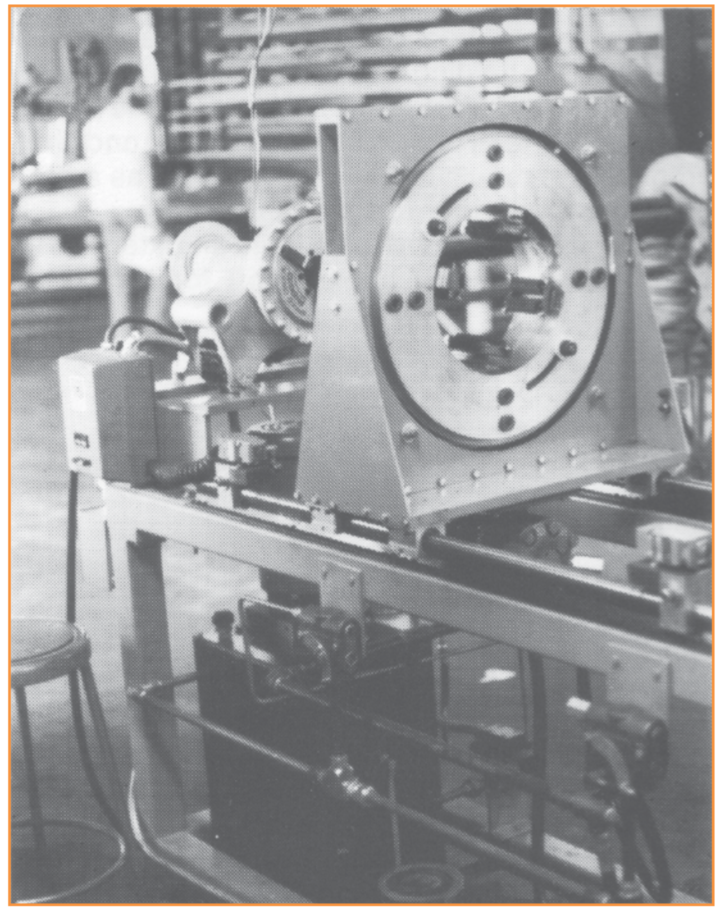
500 X

After Flex-Honing

SHAFTING

Regular photos of the shafting to show the overall exterior appearance. The part finished on the External Honing Machine with the Flex-Hones show the typical Flex-Hone Process Finish that we are accustomed to seeing in the inside of a finished cylinder. If a cross-hatched finish, with a high plateau, and an absence of cut, torn, and folded metal is important, and it is VERY important on a cylinder wall, then it must be equally important on the outside diameter of a shafting particularly where it must be engaged in a sliding bearing. Also to hold and distribute oil particularly from a standing stop such as a crankshaft bearings rest, the original has no surface that would encourage the retention of oil, and would have a tendency to leak out and leave a bearing (such as a crankshaft or piston pin) devoid of sufficient oil for a cold start-up. The common opinion is that most damage is done during the first 10 to 20 seconds of start- up of a cold engine before full flow lubrication is achieved proper oil-holding finish on an OD might eliminate a lot of problems of unnecessary wear.





NEW CONCEPT IN O.B. SURFACE IMPROVEMENT

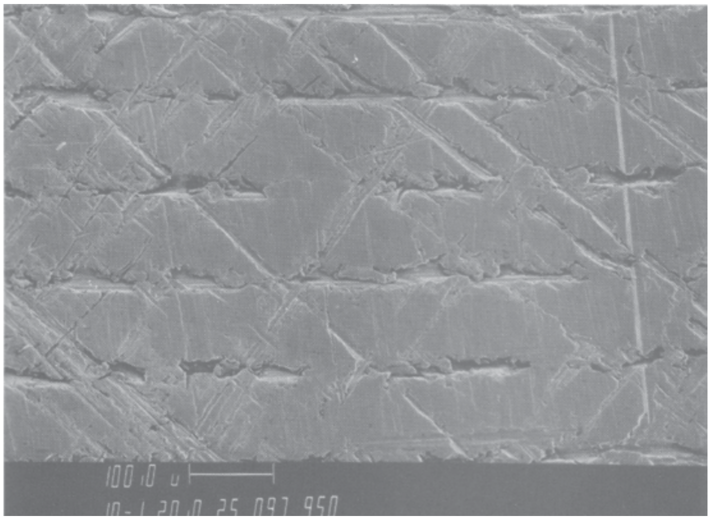
Do you have problems with a high pressure seal-leak around a piston rod, or excessive wear on a sliding bearing due to improper finish on a shafting, or how about achieving compatible finishes on a cylinder wall and piston rings? We have a prototype **O.D. Flex-Hone process** finishing machine ready for experimental work for you. Prototype ready for reproduction. Phone, write or better yet, - send in your shafting. Rank profiles or perhaps SEMS made. Patent applied for.

CALL OR EMAIL BRM FOR FREE LITERATURE

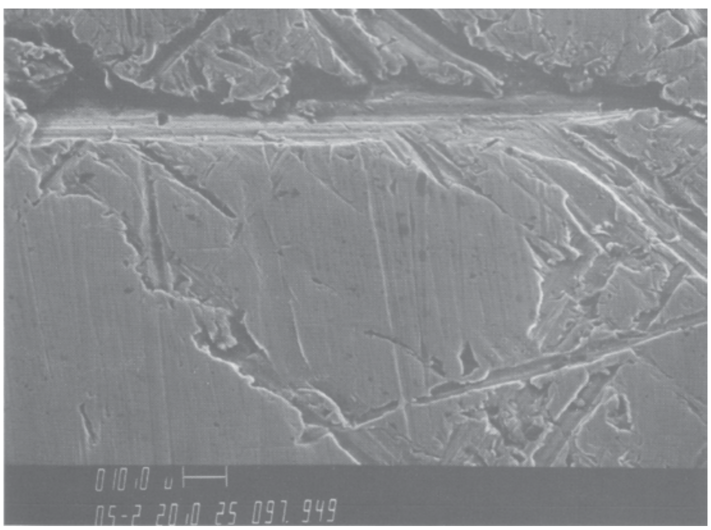
A LEAKER

We purchased a machine to make copper centers from Europe. A country known for engineering advancements. As we did not like the quality of the brushes this machine produced, we reworked the entire concept and so the machine sat idle for 12 to 18 months after receipt while it was being re-engineered. During this time of idleness hydraulic cylinders began to leak hydraulic fluid all over the floor. One that we replaced with a longer domestic one was surplus and we decided to take it apart and saw up for SEM photos as we wanted to see where and why it leaked, - leaked without any pressure, and NOTE this it an expensive unit, - no cheap DOM tubing. A unit that "looked" quality, and "cost" quality. The inside was unbelievable. Like many things, you have to sort about the parts you can't see.

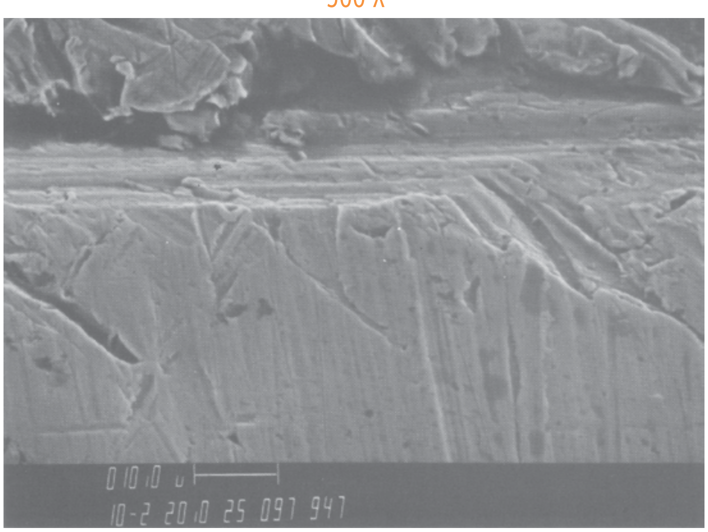
AS RECEIVED



100 X

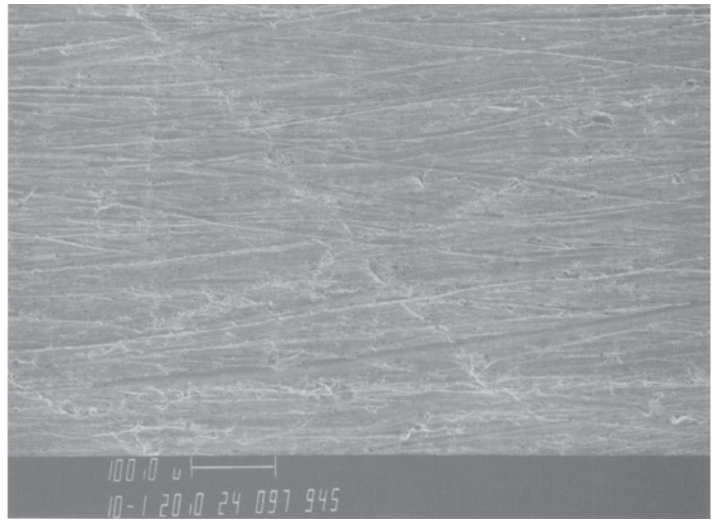


500 X

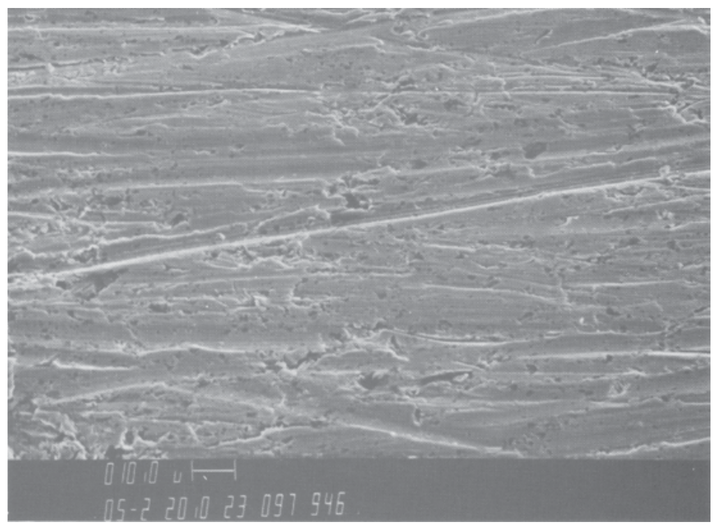


1000 X

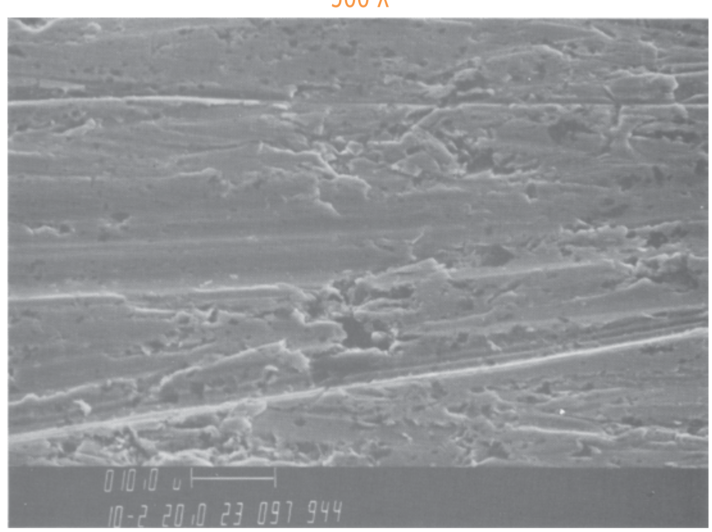
AFTER FLEX-HONING/BC - 20MM/180SC/60 SEC.



100 X

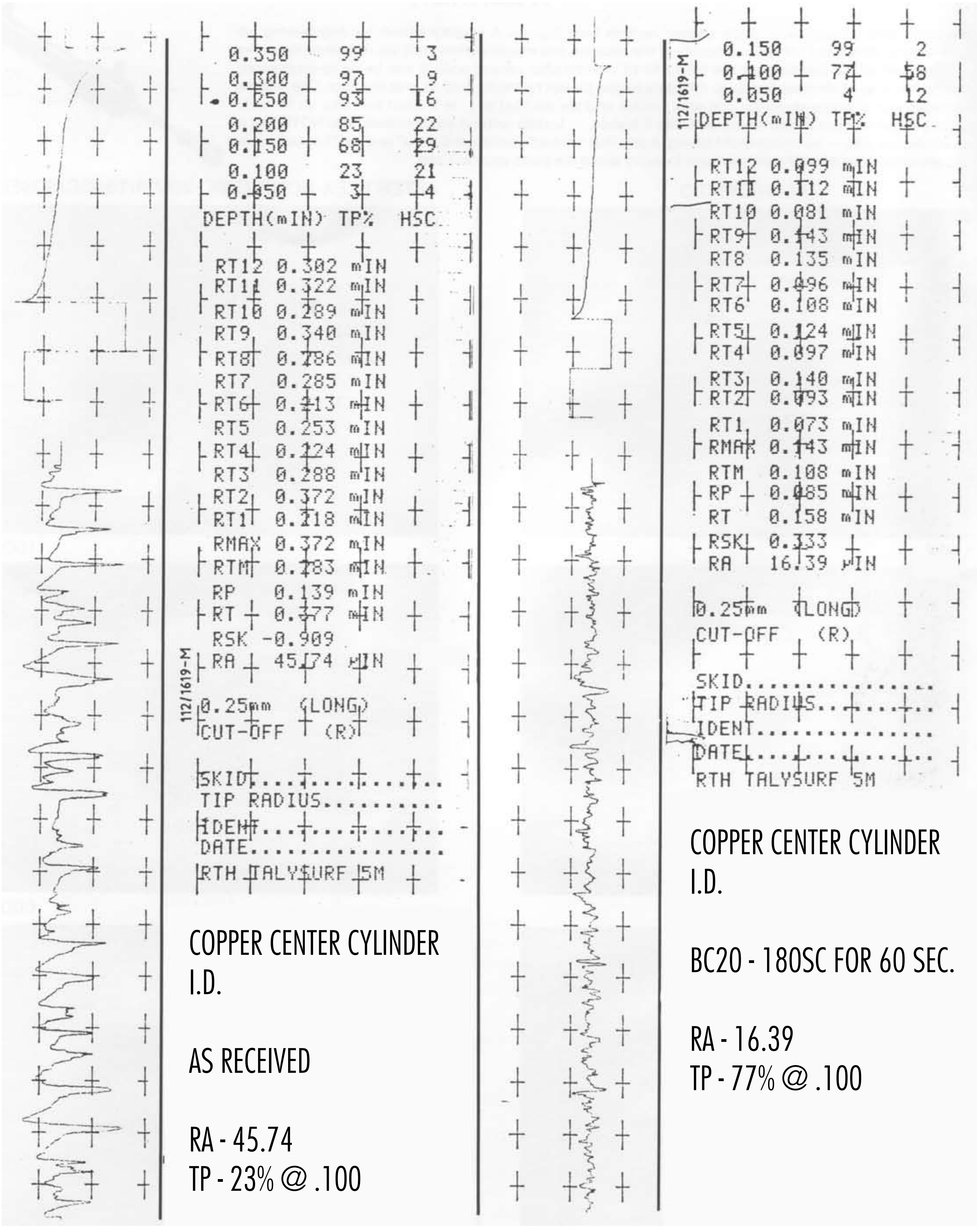


500 X



1000 X

Unfortunately there is nothing in the Criminal Code covering situations like this



Hydraulic Cylinder, Machined and Roller Burnished, finish as received 45.74AA and a Plateau of 23% @ 100. No wonder it leaked fluid all over the floor. Flex-Honed 60 seconds with a 180 silicon carbide refined the finish to 16.39AA and a Plateau of 77% at 100.

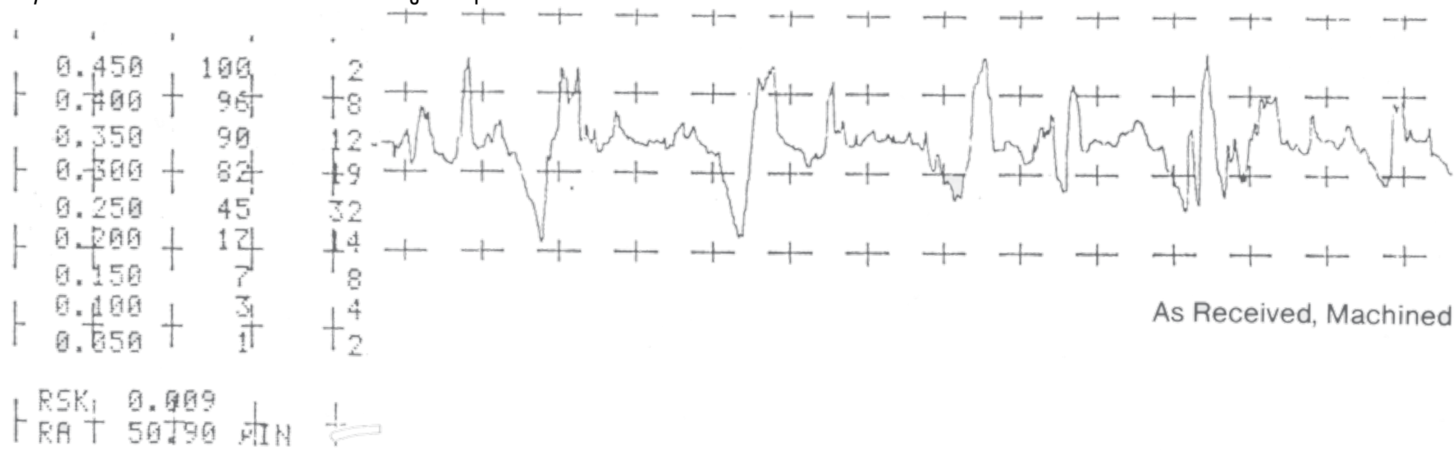
ALUMINUM MASTER CYLINDERS

The member of the Big Three who tells you if you can find a better car to buy it, sent in 9 new master cylinders. Three had been roller burnished and six newly bored.

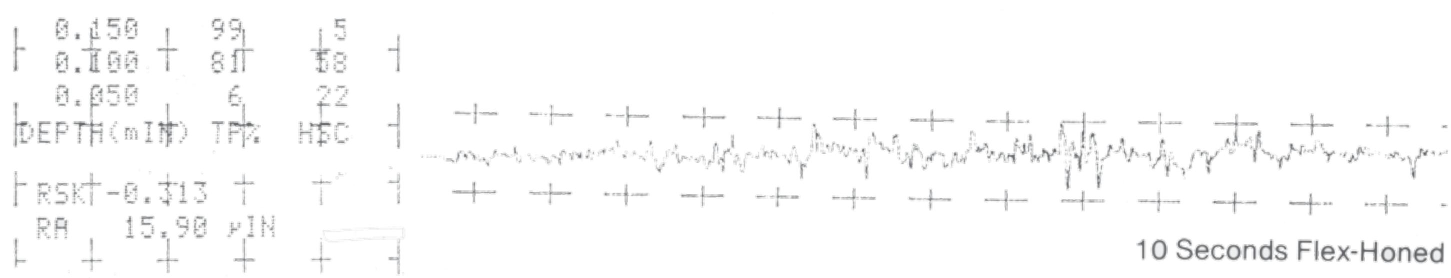
One particular section had to produce 10,000 per day or each station one each every 13 seconds. This allowed three seconds for loading and unloading and 10 seconds for surface finishing. What could we do in 10 seconds and come up with a better finish than the roller burnishing?

Below are the profiles of the first cylindered tackled. "As Received" had an AA reading of 50.9 and a tp of 7% at 150m.in. below highest peak. With a 10 second limit the Flex-Hone of 600 grit aluminum oxide refined the finish to 15.9 AA and a plateau of 99% at 150m.in. And we have no folded over metal or peaks crushed down into the valleys.

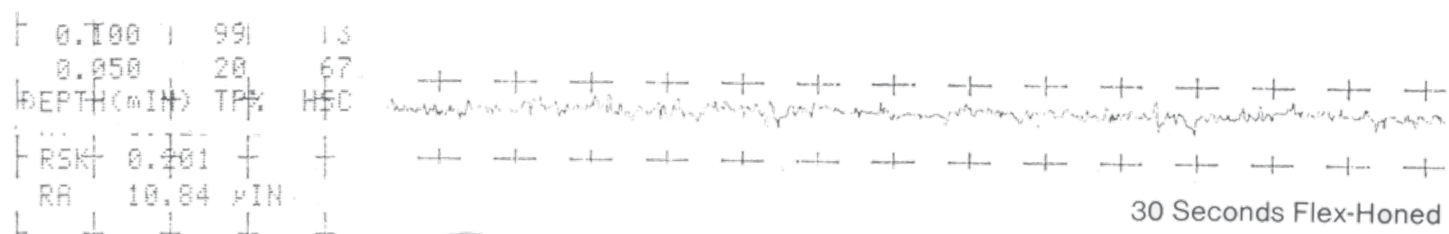
Instead the Flex-Hone cut the tops off the peaks and produced a true profile of a clean basic metal. Increased cycle life of cups would be increased many, many times. Notice the 30 second Flex-Honing time profile. Just beautiful.



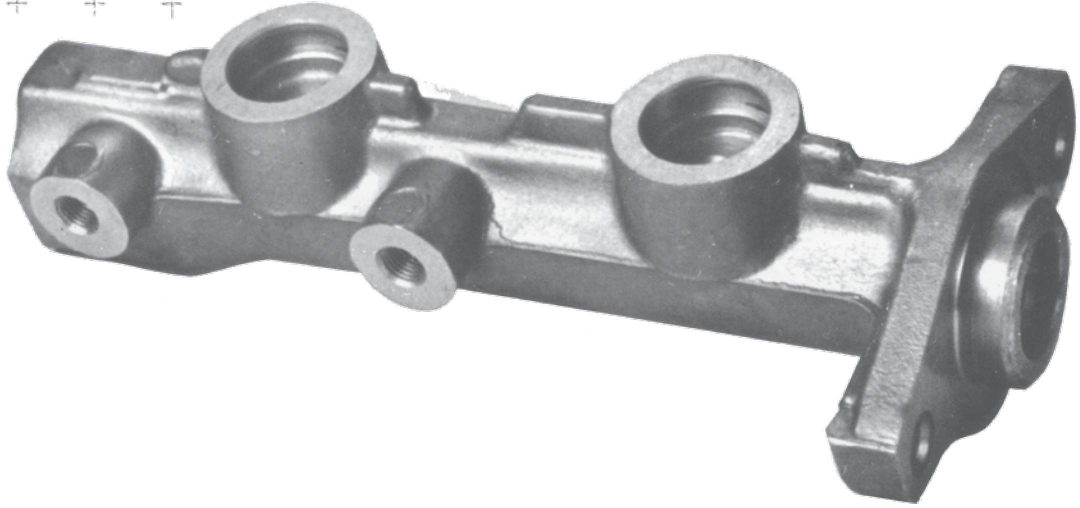
As Received, Machined



10 Seconds Flex-Honed



30 Seconds Flex-Honed



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