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MACHINE TOOLS LABORATORY

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A report on a series of tests carried out to determine the suitability of the grinding process for evaluating the efficiency of coolants to be used on the metal cutting processes and also to evaluate the relative efficiency of 4 coolant samples for the drilling and turning processes

- by -

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Introduction

A test programme was to be carried out to evaluate a series of additives for use in industrial metal cutting coolants for use initially on the turning, drilling and milling processes. These tests when they take the form of tool life tests are costly in time and material and where a shorter test can be reliably substituted for a life test, this is most desirable. To this end the grinding process was included in a pilot scheme to try to relate the grinding results to the drilling and turning results. Milling was not used in this pilot scheme.

The grinding process has been very extensively studied at the College of Aeronautics during the past 10 years and a reliable method of evaluating the performance of grinding wheels and coolants has been developed and proved in a very wide range of industrial applications. The time required to evaluate a wheel or coolant sample is approximately 1 hour and the material consumed would be a few ounces in weight, hence, the desire to interpret coolant efficiency for the metal cutting processes from tests carried out using the controlled grinding process. (See ref. 1).

Summary

The coolant samples were not identified by their chemical composition, but by numbers from 1 to 4. Each was evaluated for efficiency when used on the grinding process. The results of these tests show the following order of efficiency.

Coolant sample No. 4 was most efficient, with sample No. 3 next best.
Coolant sample No. 2 was more efficient than No. 1.
Coolant sample No. 1 was least efficient.

The summary and results sheets are included at the end of this report.

The coolant samples were then tested on the turning process. Tool life to a flank wear land of 0.017 to 0.020 ins. was taken as the end of a tool life. The tests were carried out under close control and observation and all tools were used once only and preserved after test to afford comparison one with another.

The results are recorded and included at the end of this report and summarised on Results Sheet Fig. 6 from which it is shown that Coolant Samples Nos. 1, 2 and 3 are in the same order of efficiency as for the grinding process. The characteristics of the slope of the curves would appear to confirm the grinding results in that they became more efficient as the surface speed in turning increases, or temperature plays a more critical role. The relative efficiency of the Samples Nos. 1, 2 and 3 change order at speeds below about 40 ft. per minute.

No. 1 would be most efficient. No. 2 next best, and No. 3 would be least efficient.

These results should be reflected in the drilling process results. They should show that failure is more evident on the radial points when coolant sample No. 3 is used, and that point wear radial cutting edge wear and chisel point failure all play a part when coolant No. 2 is used. With Coolant No. 1 showing a more even wear than either No. 3 or No. 2, and this is evident to some extent from the details of drilling test results, which are included at the end of this report. Though the limited time available proved inadequate to produce sufficient drilling results to be reliable for the evaluation on which a development programme for coolant additives can be based, this is not so on the grinding and turning processes. These are completely reliable. Coolant No. 4 is consistently producing performance results which are at variance to the other samples, and from these results it is assumed that this coolant has a different chemical analysis to the others. No. 4 coolant is most efficient when used on the grinding process, and least efficient on the turning and drilling processes, however, it performs with some correlation between the turning and drilling processes in a similar manner to the other samples in that on turning at higher surface speeds it is less efficient than at the lower speeds and the drilling results for Sample No. 4 show that radial corner failure occurs in more prominance than chisel point failure, i.e. the low speed high pressure conditions are coupled with more efficiency.

Conclusions

The results recorded from the limited amount of work carried out during approximately 30 working days, by two development engineers is inadequate to form a rigid conclusion. The results show that the grinding process and turning process can be related for chemically similar products where only the amounts of each element is varied. There would appear to be some confusion when the chemical content is varied, though the results obtained when chemical composition is varied stand logical analysis. This also applies to the results which from the tests carried out show more confusion than turning and grinding, and a valid conclusion to be drawn from the drilling results would be that more time is needed and a wider range of data must be recorded to substantiate the correlation. Work should be carried out on the milling process. The results obtained in all processes used stand up to logical analysis.

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The Test Work

The material

All the test material was purchased at one time from Herringshaw Steels Ltd. of Birmingham. It was taken from one melt. A certificate of analysis was obtained from the suppliers. The details are as follows:

Material 6 inch diameter forged bar in the annealed condition.
To specification EN 24.

Cast LF 1063

Analysis

C	Si	Mu	S	P	Ni	Cr	Mo
0.41	0.28	0.62	0.029	0.013	1.47	1.14	0.26

Signed: R.J. Cantingell dated 5th August, 1965.

Our Order No. 7676.

Photographs of the material structure are included in M1 and M2.

The material was sawn into lengths 2 ft. 9 ins. long. These were used for the turning tests. A 10 inch length was used for the grinding tests. A flat was shaped down the axial length to provide a stable base for mounting on the magnetic chuck. Two 2 ft. 9 in. lengths were sawn into 1 inch thick slices to provide the drilling test pieces. These drilling slices were faced up on the lathe, one of them was also surface ground, and a hardness plot made across the section. The results of this plot are shown in Fig. 1.

The Coolants

Four samples of coolant were supplied by ICI of Runcorn, Cheshire. Approximately 20 gallons of each sample being provided. The identity of the coolants were not revealed. This arrangement avoided any tendency towards bias results, hence on the result sheets reference is made to Coolants Nos. 1, 2, 3 and 4.

Every precaution was taken to avoid any contamination of one coolant sample with another. All containers were wiped clean between tests and a small volume pumped through the system and discarded every time the coolant sample was changed.

Analysis of results from the grinding tests

All conditions other than the coolants remained constant. Full details of the test conditions and grinding wheel specification are recorded on the result sheets which are reproduced at the end of this report. The test method is based on that developed at The College of Aeronautics[1] The significant figure when evaluating coolant efficiency is the surface area ground between each grit row breakdown on the alpha angle. This is because the coolant influences grit wear by way of reducing the coefficient of friction between the chip and the grit. An efficient coolant will reduce the friction and hence grit wear is reduced and a less efficient coolant will allow the friction to reach higher values, resulting in a more rapid rate of wear on the grits.

It is necessary to eliminate any variables in the test runs as far as is practical and to this end the first result in each test are discarded. This has been done because when the wheel is set in cross traverse, it may contact the work differently on the first impact. As this procedure is repeated on all tests analysis the correctness of this is not challenged.

The surface area ground between each grit row failure other than the first are arithmetically averaged. These averages are assumed to reflect the efficiency of the coolants.

The most efficient coolnat will cause the grits to perform the greatest amount of work between grit row failure and the least efficient will result in grit failure occurring more frequently. This is due to the rate of grit wear being higher.

A summary of the results showing the area ground between each grit row failure from which it is seen the relative efficiency of each coolant is included SG.1.

Note the initial corner breakdown and the area ground between this and the first grit row failure is not summarised. The results are recorded on the result sheets G.1 to G.10. * indicates the start of the valid results for coolant evaluation tests.

The tests on the turning process

These tests were carried out on a Colchester Lathe 8 inch centres, in new condition. The lathe tools were $^3/_4$ diameter and taken from the same bar stock as that from which the drills were made, each tool piece was subjected to a hardness test. The Vickers pyramid method was used and the results of these tests are recorded on Test Sheet T.H.1, from which it will be seen that they were very similar in hardness ranging from VPN 840 to VPN 870.

The tools were ground on a surface grinding machine using a tool

grinding jig and ample supply of coolant. The cutting angles were produced on both ends of the 3 inch long tool pieces as follows:

The ground faces were re-checked for hardness after grinding.

British Standard Terms and Definitions for Single Point Cutting Tools[2]1886 1952.

Cutting Edge Side Rake	15°
Plan Approach Angle	5°
Plan Trail Angle	6°
Cutting Edge Back Rake	0°
Front and Side Clearance Angle	6°
Nose Radius	.040 ins.

All tools were hand lapped and examined for quality of the cutting edges under a 25 to 1 microscope.

The tools were used once only. The 48 cutting edges providing 9 for each of the 4 coolant samples and 12 for repeat runs and spot check runs. In this way the worn tools were preserved and can be compared one with another. Typical worn tools are shown in Figs. 2, 3, 4 which shows a cratered tool a chipped cutting edge and flank wear. The Taylor Hobson Talisurf was used to measure top face cratering. A typical trace is shown in Fig. 5. The cutting conditions were as follows:

The tools were located rigidly in a jig which was carried in the lathe tool post.

Feed per revolution remained constant at 0.005 ins. rev.

Depth of cut remained constant at 0.100 inches.

Surface speed was the VARIABLE. This was achieved using the infinitely variable speed 25 h.p. motor which is fitted to the lathe and a tachometer. The speed was checked frequently under cutting conditions.

The results of the turning tests were plotted as $VT^n = C$ curves[3], and are reproduced in Fig. 6. The same results are presented on normal bases in Fig. 7, and the tabulated measurements from which the curves are plotted are included in the test result sheets. TURNING TESTS at the end of this report.

From these test results it is seen that Coolant Sample No. 3 is most efficient. Coolant Sample No. 2 is a close second, and Sample No. 1 is least efficient. Coolant No. 4 is between No. 1 and 2.

This later sample No. 4 is to a different specification from the other samples.

The Drilling Tests

Tests carried out to evaluate the coolants efficiency for the drilling process were carried out on a 4 ft. 6 in. radial arm drilling machine. The workpieces were carried in an indexing 3 jaw chuck. This could be indexed to allow speedy radial spacing of the drilled holes and the movement of the radial arm afforded adjustment for the consecutive rings of holes. In this way the whole of the surface of the test piece could be drilled with the very minimum of waste material and manipulation time.

The radial arm drilling machine is equipped with an integral coolant well contained within the base of the machine casting and no attempt was made to use this due to the difficulty of assuring non-contamination of the coolant samples and a second coolant system which is that fitted to a $^{3}/_{8}$" capacity multi-spindle drilling machine stood next to the radial arm machine.

To achieve the full benefit from this external coolant system with its small square tank the work holding indexing chuck was mounted on the radial arm machine table, stood in a shallow tank (the bottom half of a 10 gallon oil drum), holes being made in the bottom through which the table bolts could pass. Rubber sheet was used to seal the tank on the table, a further outlet hole was arranged to return the coolant from this tank via a $\frac{1}{2}$ in. diameter plastic tube to the supply tank, a further $\frac{1}{2}$ inch tube was fitted over the multi-spindle coolant outlet and arranged to supply the test drill. There was some loss in pressure, but the supply was more than needed.

The time which was available for these tests proved too short to maintain the full range of data records which were described in a previous report on this test work, and after a short time it was realised that the tool wear data must become the only data collected. This was because it may be assumed that the wear criteria is most important, and duplication would consume more time than was available.

The drilling process is more difficult to evaluate than many other processes. This is recognised to be due to the geometry of the drill cutting edges which is infinitely variable between the extreme of the chisel point and the radial corners, and when to this variable geometry the variable cutting speed which is from zero at the drill centre to maximum at the radial corner and the very severe interference from the swarf is taken into account. The results of any test programme will reflect the extent of control and volume of data collected. This is evident in the results included in this report on Drilling test sheets and summarised on SD1. The details of the drill point geometry and drilling conditions are included on the test result sheets. Figures 8, 9 and 10 shows the variety of wear suffered by the drill points and further emphasises the necessity to record all data to enable a comparative conclusion to be made.

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References

1. The College of Aeronautics Report on The numerical analysis of the grinding process.

2. British Standard Specification on Single Point Cutting Tools. 1886 1952.

3. The Art of Metal Cutting by Taylor. VT^n-C.

VPN HARDNESS TRACE ON CROSS SECTION OF 6 INCH DIAMETER BAR OF THE TEST MATERIAL (EN 24 IN THE ANNEALED CONDITION 20 Kg LOAD.)

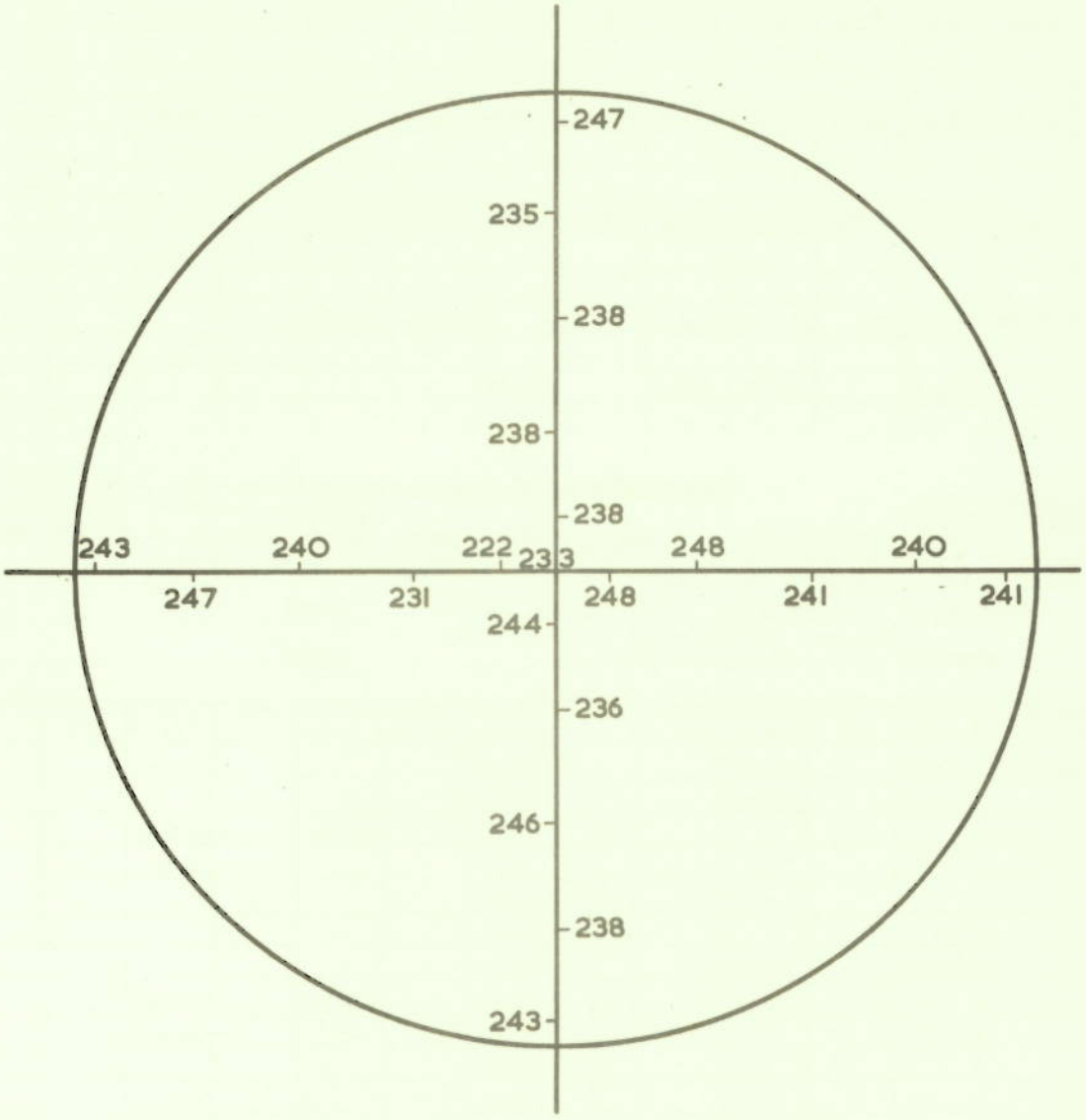

FIG. 1.

60 grit wheel.

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EXPERIMENTAL RECORD
GRINDING TESTS

SG 1

EXPERIMENT: Coolant Evaluation Tests NAME

REMARKS: Summary of Grit Row & Wear. DATE

	Surface area ground between each grit row failure sq ins.													
Coolant Sample												Average		
No 1	140	100	140	120	100	60	140	140	140	100	118			
No 2	140	120	160	140	160	160	120	120	180		144			
No 3	160	160	200	180	140	240	120	140			167			
No 4	200	220	240	200	240	200	200	220	180		211			
	The order of increasing efficiency is.													
		No 1		No 2	No 3		No 4.							

2.

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Coolant Sample No 1
Grinding wheel spec. Uni MA 60-H V
Work piece EN 24 annealed
VPN 246

Conditions
Depth of cut = 0·001 ins
Table speed = 65 ft/min
Cross feed = 0·042 ins/stroke

EXPERIMENTAL RECORD
GRINDING TESTS

G 1

EXPERIMENT: Coolant Efficiency Tests NAME

Results B = 0·100 ins L = 0·054 ins
REMARKS: E = 0·00042 ins DATE

Surface area ground sq ins	Wheel face width ins	Wheel lost ins		Surface area ground sq ins	Wheel face width ins	Wheel lost ins	
Start of test	0·720	None		460	"	None	
40	0·620	0·100		480	"	"	
60	"	"		500	0·570	0·040	
80	"	"		520	"	None	
100	"	"		540	"	"	
120	"	"		560	"	"	
140	0·600	0·020		580	"	"	
160	"	None	*	600	0·490	0·020	
180	"	"		620	"	None	
200	"	"		640	"	"	
220	"	"		680	"	"	
240	0·570	0·030		700	"	"	
260	"	None		720	"	"	
280	"	"		740	0·450	0·052	
300	"	"		760	"	None	
320	"			780	"	"	
340	"			800	"	"	
360	0·550	0·020				"	
380	"	None		End of test			
400	"	"					
420	"	"					
440	"	"					

CONDITIONS
DEPTH OF CUT = 0.001 INS.
TABLE SPEED = 65 FT/MIN
CROSS FEED = 0.042 in/STROKE

The College of Aeronautics

EXPERIMENTAL RECORD
GRINDING TESTS

COOLANT SAMPLE. No 1
GRINDING WHEEL SPEC UNI. MA-60-HV
WORK PIECE EN 2A ANNEALED.
VPN 240

EXPERIMENT: COOLANT EFFICIENCY TESTS.
RESULTS B = 0.100 L = 0.054 INS
REMARKS: E = 0.00042 INS A = 0.1 CUB/INS

NAME J PURCELL T CHATER.

DATE G2

SURFACE AREA GROUND SQ INS		WHEEL FACE WIDTH INS.		WHEEL FACE LOST INS		SURFACE AREA GROUND		WHEEL FACE WIDTH		WHEEL FACE LOST.		SURFACE AREA GROUND	WHEEL FACE WIDTH	WHEEL FACE LOST
START OF TEST 1		0.720		NONE		460		"		NONE		340	0.600	NONE
40		0.620		0.100		480		"		"		360	0.460	0.040
60		"		NONE		500		0.450		0.060		380	"	NONE
80		"		"		520		"		NONE		400	"	"
100		"		"			END	OF	TEST.			420	"	"
120		"		"		START No 2.		0.730		NONE		440		
140		"		"		20		0.630		0.700		460		
160		0.580		0.040		40		"		"				
180		"		NONE	*	60		"		"				
200		"		"		80		"		"				
220		"		"		100		0.590		0.040				
240		"		"		120		"		NONE	*			
260		"		"		140		"		"				
280		"		"		160		"		"				
300		0.560		0.040		180		"		"				
320		"		NONE		200		"		"				
340		"		"		220		"		"				
360		0.510		0.030		240		0.500		0.090				
380		"		NONE		260		"		NONE				
400		"		"		280		"		"				
420		"		"		300		"		"				
440		"		"		320		"		"				

CONTINUED.

CONDITIONS
DEPTH OF CUT = 0.001 INS.
TABLE SPEED = 65 FT/MIN.
CROSS FEED = 0.042 INS/STROKE.

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EXPERIMENTAL RECORD
GRINDING TESTS

COOLANT SAMPLE No 2.
GRINDING WHEEL SPEC UNI.MA-60-Hv.
WORKPIECE EN 24 ANNEALED
VPN 240.

EXPERIMENT: COOLANT EFFICIENCY TESTS
RESULTS B = 0.100 INS L = 0.054 INS
REMARKS: E = 0.00042 INS A. 0.1 TO 0.13 CUB INS

NAME J. PURCELL - T. CHATER
DATE G3

SURFACE AREA GROUND SQ INS		WHEEL FACE WIDTH		WHEEL WIDTH LOST		SURFACE AREA GROUND		WHEEL WIDTH		WHEEL WIDTH LOST.		AREA GROUND	WHEEL FACE WIDTH	WHEEL WIDTH LOST
START	No 1	0.720		NONE		START	No 2	0.730		NONE		320	0.570	NONE
40		0.620		0.100		20		0630		0.100		340	"	"
60		"		NONE		40		"		NONE		360	0.500	0.070
80		"		"		60		"		"		380	"	NONE
100		"		"		80	END OF TEST.			"		400.	"	"
120		"		"								420	"	"
140		"		"		START	No 3	0.730		NONE		440	"	"
160		"		"		20		0.630		0.100		460	"	"
180		0.570		0.050		40		"		NONE		480	"	"
200		"		NONE *		60		"		"		500	"	
220		"		"		80		"		"		520	0460	0.040
240		"		"		100		"		"		540	"	NONE
260		"		"		120		"		"		END OF TEST		
280		"		"		140		"		"				
300		"		"		160		"		"				
320		"		"		180		"		"				
340		0.510		0.060		200		0.570		0.060				
360		"		NONE		220		"		NONE *				
380		"		"		240		"		"				
400		"		"		260		"		"				
420		"		"		280		"		"				
440		END OF TEST				300		"		"				

CONDITIONS.

DEPTH OF CUT. = 0.001"

TABLE SPEED. = 65 FT/MIN.

CROSS FEED. = 0.042 INS/STROKE

COOLANT SAMPLE No 2

GRINDING WHEEL SPEC. UNI.-17A.-60-HV

WORK PIECE = EN 24. ANNEALED.

VPN. = 240.

The College of Aeronautics

EXPERIMENTAL RECORD

EXPERIMENT: COOLANT EFFICIENCY TESTS.

RESULTS. B = 0.100 INS. L = 0.054 INS.

REMARKS: E = 0.00042 INS. A = 0.14 TO 0.22 CUB IN.

NAME J. PURCELL T. CHAFER

DATE 9 4

SURFACE AREA. GROUND SQ INS	WHEEL FACE WIDTH	WHEEL FACE LOSS.	SURFACE AREA. GROUND SQ INS	WHEEL FACE WIDTH	WHEEL FACE LOSS.
START OF TEST.	.720	NONE.	440	.520	NONE
20	.660	0.060	460	"	"
40	.620	0.040	480	"	"
60	"	NONE.	500	"	"
80	"		520	"	"
100	"		540	"	"
120	"		560	.500	0.020
140	.600	0.020	580	"	NONE
160	"	NONE. *	600	"	"
180	"		620	"	"
200	"		640	"	"
220	"		660	"	"
240	"		680	"	"
260	"		700	.450	0.050
280	.550	0.050	720	"	NONE
300	"	NONE	740	"	"
320	"		760	"	"
340	"		780	"	"
360	"		800	"	"
380	"		820	"	"
400	.520	0.030	840	"	"
420	"	NONE	860	.410	0.040

END OF TEST.

CONDITIONS.
DEPTH OF CUT = 0.001 INS
TABLE SPEED = 65 FT/MIN.
CROSS FEED = 0.042 INS/STROKE

The College of Aeronautics

EXPERIMENTAL RECORD

COOLANT SAMPLE No 2
GRINDING WHEEL SIEC UNIMA, 60. HV
WORK PIECE EN 24 ANNEALED
VPN 246

EXPERIMENT: Coolant Efficiency Test
RESULTS B = 0.020 L = 0.054
REMARKS: E = 0.00042

NAME
DATE

G5

SURFACE AREA GROUND SQ INS		WHEEL FACE WIDTH INS		WHEEL FACE LOST INS.			SURFACE AREA GROUND SQ INS.		WHEEL FACE WIDTH		WHEEL FACE LOST			
17.5		.680		.060			START		.730		NONE			
35.0		.620		.060			17.5		.630		0.100			
52.5		"		NONE			35		"		NONE			
70.0		"		"			52		"		"	NOT SUMMARISED		
87.5		"		"			70		"		"			
105.0		"		"			87		"		"			
122.5		"		"										
140.0		"		"			START		.730		NONE		"	
157.5		"		"			17.		.620		0.100			
175.0		"		"			35		"					
192.5		.510		.110			52		"					
210.0		"		NONE	*		70		"					
227.5		"		"										
245.0		"		"			START		.720		NONE			
252.5		"		"			17		.620		0.100		"	
270		"		"			35		"		NONE			
287		"		"			52		"		"			
305		"		"			70		"		"			
322		"		"			THESE TESTS WERE CARRIED OUT TO							
340		.450		.060			CHECK THE PROPORTIONS OF ALPHA.							
							AND E, L, B.							

CONDITIONS
DEPTH OF CUT = 0·001 INS
TABLE SPEED = 65 FT/MIN
CROSS FEED = 0·042 INS/STROKE

The College of Aeronautics

EXPERIMENTAL RECORD
GRINDING TESTS.

COOLANT SAMPLE No 3.
GRINDING WHEEL SPEC UNI.MA-60-H V.
WORK PIECE EN 24 ANNEALED.
VPN = 240

EXPERIMENT: COOLANT EFFICIENCY TESTS
RESULTS B = 0·100 INS L = 0·054 INS
REMARKS: E = 0·00042 INS A = 0·14 TO 0·22 CUB. INS

NAME J PURCELL T CHATER.
DATE 6

SURFACE AREA GROUND SQ INS		WHEEL FACE WIDTH		WHEEL FACE LOSS		SURFACE AREA GROUND	NO 2	WHEEL FACE WIDTH		WHEEL WIDTH LOSS					
START OF TEST		0·690		NONE		START OF TEST		0·680		NONE					
20		0·630		0·060		20		0·590		0·090					
40		0·590		0·040		40		0·580		0·010					
60		"		NONE		60		"		NONE					
80		"		"		80		"		"					
100		0·530		0·060		100		0·530		0·050					
120		"		NONE	*	120		"		NONE	*				
140		"		"		140		"		"					
160		0·500		0·030		160		"		"					
182		"		NONE		180		"		"					
200		"		"		200		"		"					
220		"		"		220		0·490		0·040					
240		"		"		240		"		NONE					
260		"		"		260		"		"					
280		"		"		280		"		"					
300		"		"		300		"		"					
320		"		"		320		"		"					
340		"		"		340		"		"					
360		"		"		360		0·440		0·050					
380		"		"		380		"		NONE					
400		0·430		0·070		400		"		"					
420		END OF TEST		NONE		420		END OF TEST		"					

CONDITIONS.

DEPTH. OF CUT. = 0·001 in/
TABLE SPEED. = 65 ft/min.
CROSS. FEED. = 0·042 in/stroke.

COOLANT. SAMPLE N° 3

GRINDING WHEEL SPEC UN, 17A 60 K V
WORK PIECE EN 24 ANNEALED.
VPN - 240

The College of Aeronautics

EXPERIMENTAL RECORD
GRINDING. TESTS

EXPERIMENT: COOLANT EFFICIENCY TEST.
RESULTS. B = 0·100 INS. L = 0·054 INS.
REMARKS: E = 0·00042 INS A=

NAME J. PURCELL T. CHATTER.

DATE 6 7

SURFACE GROUND	AREA. Sq in.	WHEEL FACE WIDTH.		WHEEL FACE LOSS		SURFACE GROUND Sq in.	AREA.	WHEEL FACE. WIDTH.		WHEEL FACE LOSS				
START OF TEST		0·720		NONE.		440		0·550		NONE				
20		0·670		0·050		460		"		"				
40		0·620		0·050		480		"		"				
60		"		NONE		500		"		"				
80		"		"		520		"		"				
100		"		"		540		"		"				
120		"		"		560		0·520		0·030				
140		"		"		580		"		NONE				
160		"		"		600		"		"				
180		"		"		620		"		"				
200		0·590		0·030		640		"		"				
220		"		NONE	*	660		"		"				
240		"		"		680		"		"				
260		"		"		700		"		"				
280		"		"		720		"		"				
300		"		"		740		0·470		0·050				
320		"		"		760		"		NONE				
340		"		"		780		"		"				
360		0·550		0·040		800		"		"				
380		"		NONE		820		"		"				
400		"		"		840		"		"				
420		"		"		860		0·426		0·050		END OF TEST.		

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CONDITIONS
DEPTH OF CUT = 0.001 INS.
TABLE SPEED = 65 FT/MIN
CROSS FEED = 0.042 INS/STROKE

EXPERIMENTAL RECORD
GRINDING TESTS.

COOLANT SAMPLE No 4
GRINDING WHEEL SPECIFICATION UNI. MA-60-H 8
WORKPIECE EN 24 ANNEALED.
VPN-240
NAME J. PURCELL - T. CHATER.

EXPERIMENT: COOLANT EFFICIENCY TESTS
RESULTS B = 0·1 INS L = 0·054.
~~REMARKS~~: E = 0·00042 INS A = 0·2 TO 0·23 CUB/INS DATE ..... G 8

SURFACE AREA GROUND 50 LBS.	WHEEL FACE WIDTH	WHEEL WIDTH LOST	SURFACE AREA GROUND	WHEEL FACE WIDTH	WHEEL WIDTH LOST	SURFACE AREA GROUND	WHEEL FACE WIDTH	WHEEL WIDTH LOST
START OF TEST	0·700	NONE	300	0·530	NONE	160	0·620	NONE
20	0·630	0·070 = B	320	0·450	0·080	180	"	"
40	0·600	0·030	340	"	NONE	200	0·550	0·070
60	"	NONE	360	"	"	220	"	NONE *
80	"	"	380	"	"	240	"	"
END OF TEST			400	"	"	260	"	"
2ND TEST			420	"	"	280	"	"
START	0·700	NONE	440	"	"	300	"	"
20	0·630 = B	0·080	460	"	"	320	"	"
40	0·600 0·100	0·020	480	"	"	340	"	"
60	"	NONE	500	"	"	360	"	"
80	"	"	520	"	"	380	"	"
100	0·530	0·070	540	0·400	0·050	400	0·500	0·050
120	"	NONE *	3RD TEST	END OF TEST		420	"	NONE
140	"	"	START	0·720	NONE	440	"	"
160	"	"	20	0·640	0·080 = B	460	"	"
180	"	"	40	0·620	0·020 0·100 IN	480	"	"
200	"	"	60	"	NONE	500	"	"
220	"	"	80	"	"	520	"	"
240	"	"	100	"	"	540	"	"
260	"	"	120	"	"	560	"	"
280	"	"	140	"	"	580	"	"

CONTINUED

CONTINUED

END OF TEST

CONDITIONS.

DEPTH OF CUT. = 0.001 INS.
TABLE SPEED. = 65 ft/min.
CROSS FEED. = 0.042 in/STROKE.

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EXPERIMENTAL RECORD
GRINDING TESTS.

COOLANT SAMPLE N° 4
GRINDING WHEEL UNI. HA. 60 K.
SPECIFICATION.
WORKPIECE EN 24 ANNEALED.
VPN — 240.

EXPERIMENT: COOLANT EFFICIENCY TESTS. NAME J. PURCELL T. CHATUP.
R B = 0.1 in. L = 0.054.
REMARKS: E = 0.00042. A = 0.2 To 0.25 cub ins. DATE 6 9

SURFACE AREA. GROUND. SQ INS		WHEEL FACE WIDTH	WHEEL WIDTH. LOSE.			SURFACE AREA. GROUND. SQ INS.		WHEEL FACE. WIDTH.		WHEEL FACE. LOSE					
START OF TEST.		0.730	NONE.			440		〃		〃					
20		0.660	0.070			460		0.640		0.030					
40		0.630	0.030			480		〃		NONE					
60		〃	NONE			500		〃		〃					
80		〃	〃			520		〃		〃					
100		〃	〃			540		〃		〃					
120		〃	〃			560		〃		〃					
140		〃	〃			580		〃		〃					
160		〃	〃			600		〃		〃					
180		〃	〃			620		〃		〃					
200		〃	〃			640		0.560		0.040					
220		〃	〃			660		〃		NONE					
240		0570	0.060			680		〃		〃					
260		〃	NONE	*		700		〃		〃					
280		〃	〃			720		〃		〃					
300		〃	〃			740		〃		〃					
320		〃	〃			760		〃		〃					
340		〃	〃			780		〃		〃					
360		〃	〃			800.		〃		〃					
380		〃	〃			820		〃		〃					
400		〃	〃			840		0450		050					
420		〃	〃				End	of	Test						

The College of Aeronautics

CONDITIONS.
DEPTH OF CUT = 0·001 IN.
TABLE SPEED = 65 FT/MIN.
CROSS FEED = 0·042 INS/STROKE

COOLANT SAMPLE No 4

EXPERIMENTAL RECORD

GRINDING WHEEL SPEC. UNI: MA.-60 HV
WORKPIECE EN 24 ANNEALED
VPN 240

EXPERIMENT: COOLANT EFFICIENCY TESTS

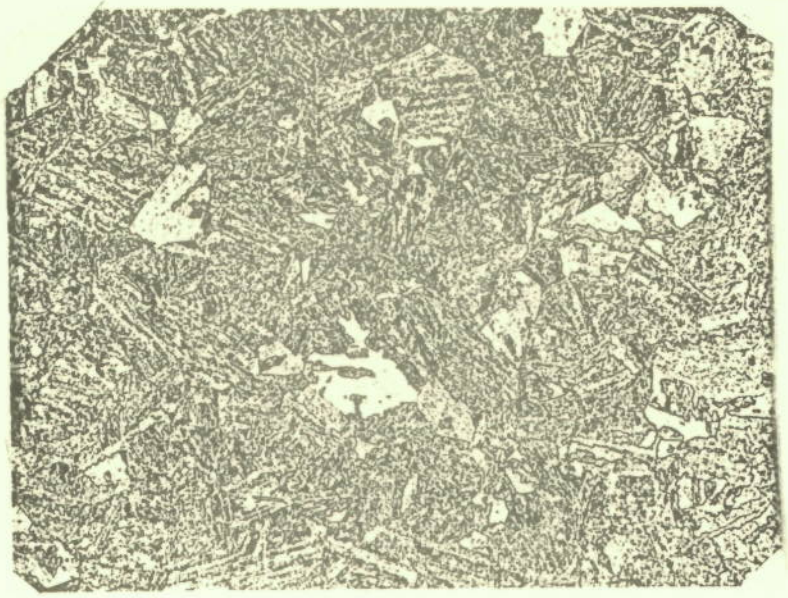
NAME J PURCELL – T CHATER.

RESULTS B = 0·100 INS L = 0·054 INS

REMARKS: E = 0·00042 INS A = 0·2 TO 0·230 ^{2*} c/INS

DATE 6 10

SURFACE AREA GROUND SQ INS.		WHEEL FACE WIDTH INS		WHEEL WIDTH LOSS INS		SURFACE AREA GROUND		WHEEL FACE WIDTH INS		WHEEL WIDTH LOSS INS
START of TEST No 4.		0·700	> B	NONE		440		0·450		NONE
20		0·600	) 0·100 IN	0·100		460		"		"
40		"		NONE		480		"		"
60		"		"		500		"		"
80		"		"		520		"		"
100		"		"		540		"		"
120		"		"		560		"		"
140		"		"		586		"		"
160		0·510		0·900		600		"		"
170		"		NONE	*	620		0·400		0·050
200		"		"			END OF TEST			
220		"		"						
240		"		"						
260		"		"						
280		"		"						
300		"		"						
320		"		"						
340		"		"						
360		0·450		0·060						
380		"		NONE						
400		"		"						
420		CONTINUED		"						



FIGS. M1 and M2

MICRO AND MACRO STRUCTURE OF THE WORK PIECE MATERIAL EN 24 IN THE ANNEALED STATE.

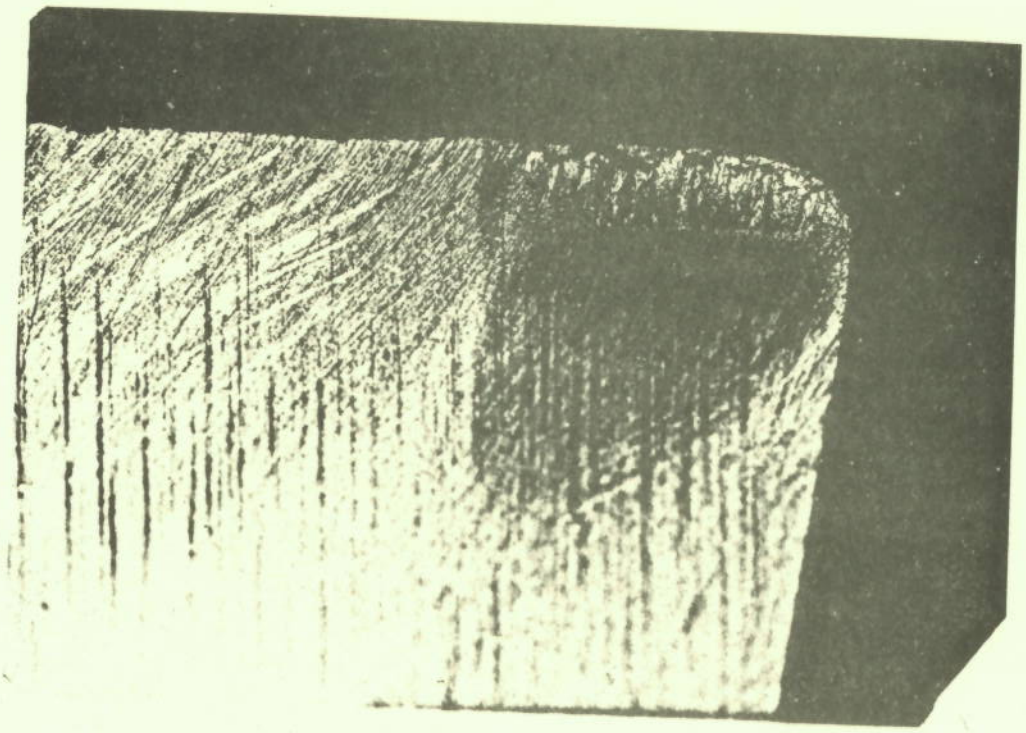


FIG. 2 TYPICAL TOP FACE CRATER ON TURNING TOOL

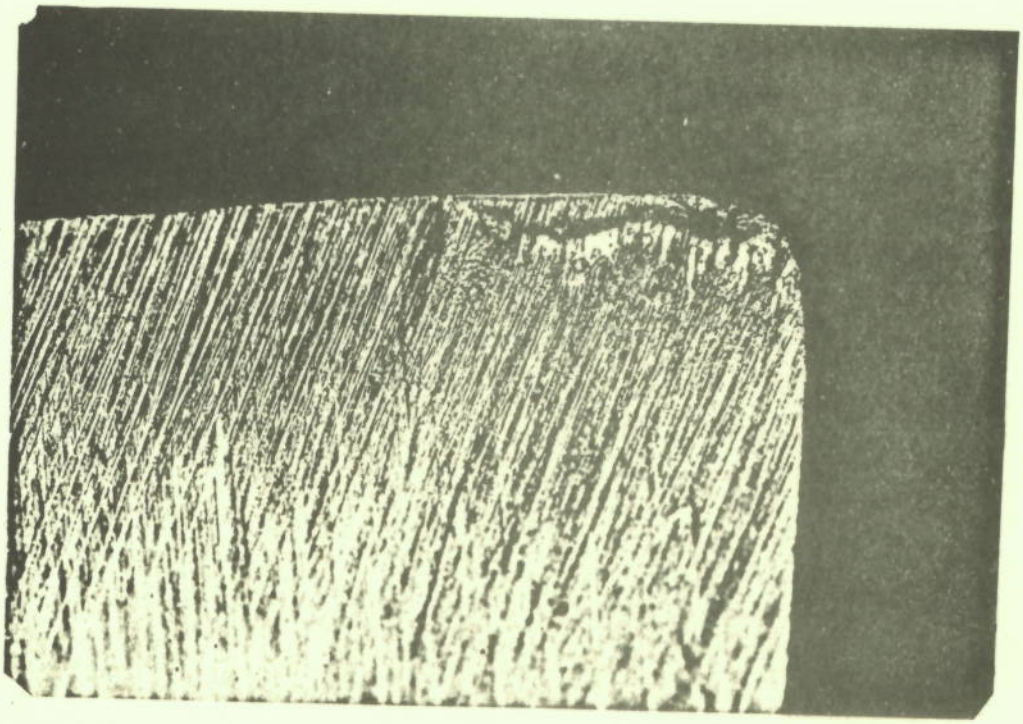


FIG. 3 TOOL FAILING DUE TO CHIPPING

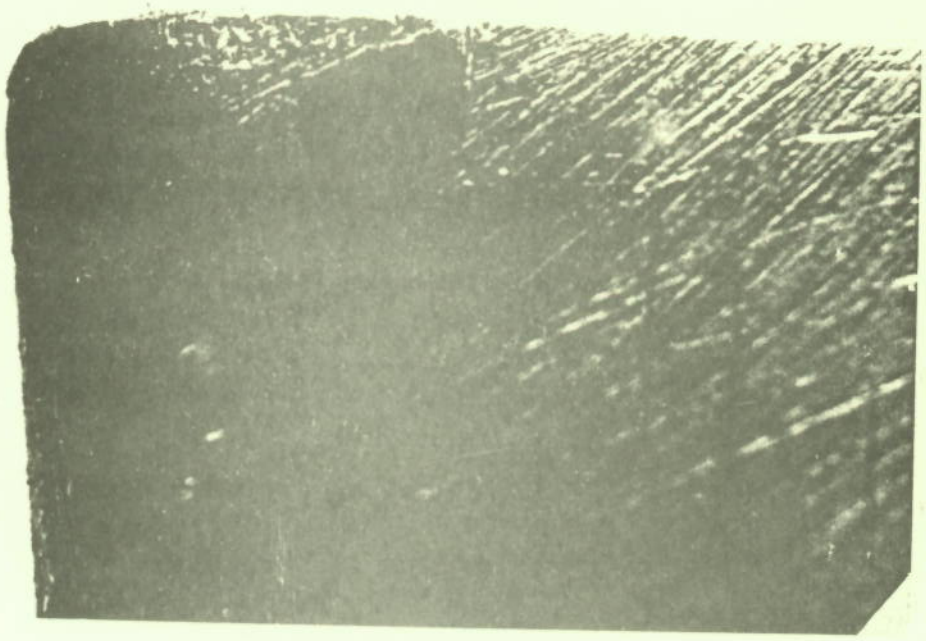


FIG. 4 TYPICAL FLANK AND NOSE WEAR LAND. THE EXTENT OF THE WEAR IS CLEARLY SEEN

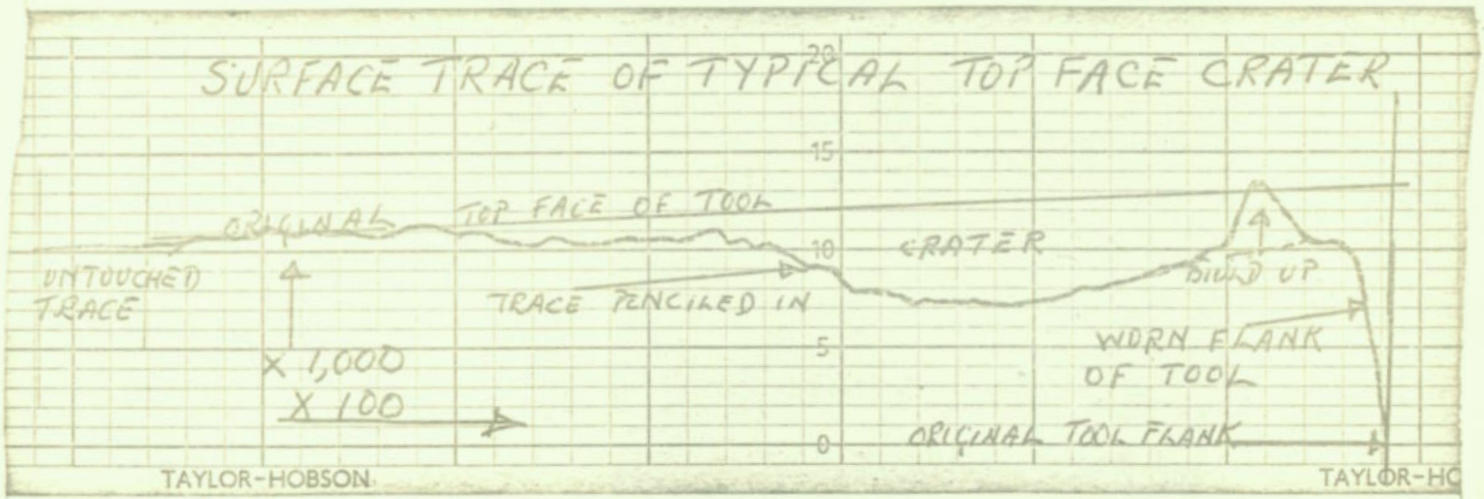


FIG. 5 TALISURF TRACE OF TYPICAL TOP FACE CRATER

SURFACE SPEED IN FEET PER MINUTE
0
40
60
80
100
120
140
160
180
200
10
20
30
40
Cutting
GRAPH

TURNING TESTS. HSS TOOLS.

GRAPH OF SURFACE SPEED Vs CUTTING TIME TO 0·018 ins WEAR LAND

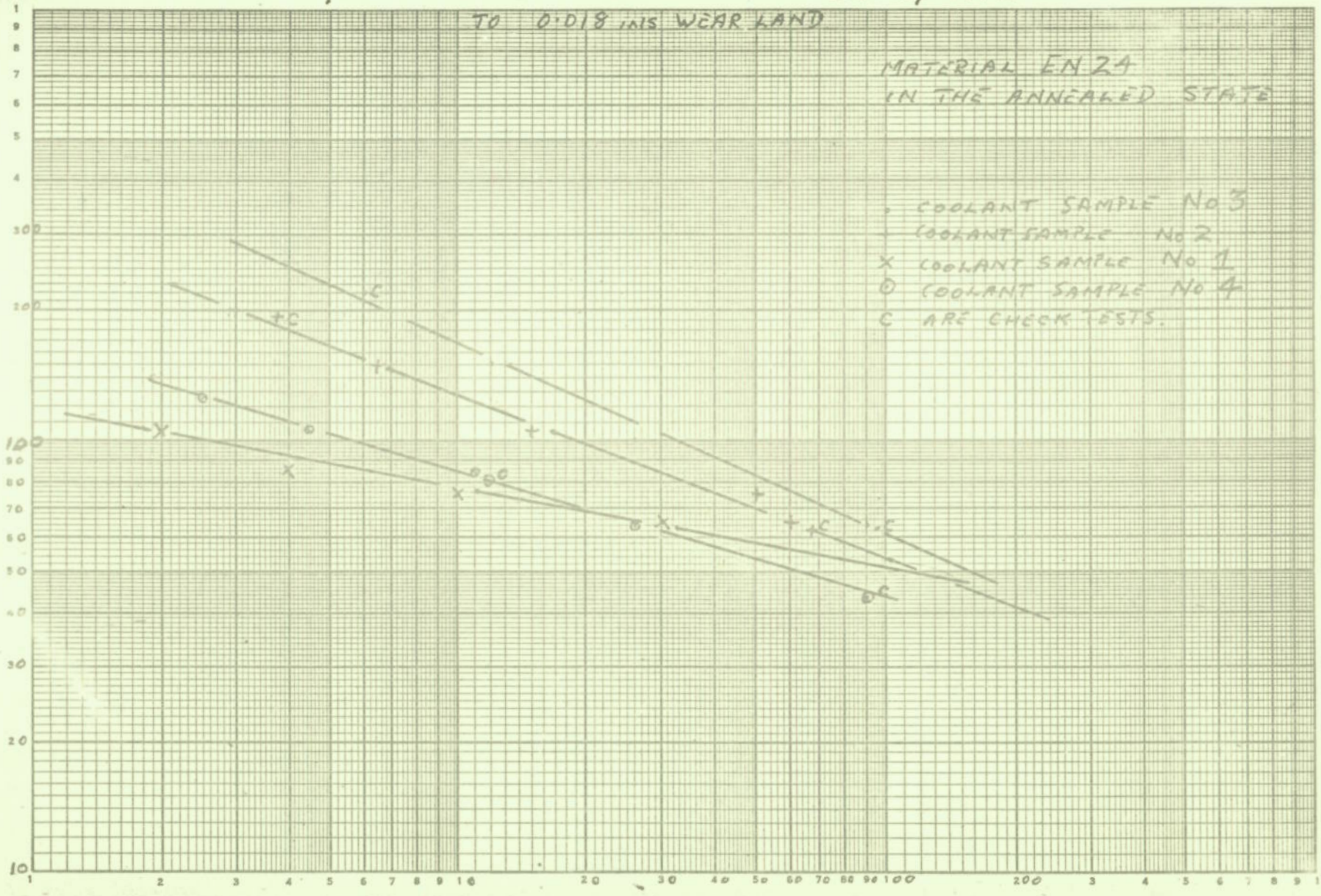


FIG. 6

THE TOOL 3/4" DIA. HSS.
SUPPLIED BY
EASTER BROOK - ALCARD LTD
SHEFFIELD.
REF. MR R.E. DODD.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS.

WORK MATERIAL EN 24 ANNEALED
VPN 264 AV.
CONDITIONS = DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
TOOL ANGLES (ASS 1886-1952) CUTTING EDGE SIDE RAKE = 15°
PLAN APPROACH ANGLE = 5°
FRONT SIDE CLEARANCE = 6°
PLAN TRAIL ANGLE = 6°
NOSE RADIUS = 0·040 INS.
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS.

REMARKS: COOLANT SAMPLE No. 1 ICI.

T1

TOOL No	PLAIN END.	SURFACE SPEED FEET PER MIN.	CUTTING TIME IN MINUTES	FLANK	TOOL WEAR IN INCHES NOSE	CRATER	REMARKS
2.		65	6	0·012	0·014	NONE	SLIGHT CHIP
	CHECK TEST		12	0·013	0·015	"	" "
	TOOL STOPPED		18	0·014	0·015		012" 014"
	LESS FREQUENTLY.		24	0·016	0·021?		
			28	0·017	0·018		CUTTING EDGE FAILING
			30	0·017	0·019		
No 8	MARKED END.	65.	6	0·010	0·012	NONE	SLIGHT CHIP.
	RECORDED EVERY		12	0·015	0·016		" "
	2 MINUTES.		18	0·016	0·016	CHIP WORN AWAY	
	REPRODUCED.		24	0·017	0·016	CHIPPED.	
	RECORD 6 MIN		28	0·018	0·018	" worn out.	
	INTERVALS.		30	0·020	0·020	NOSE FAILING	
No 8	PLAIN END	65	6	0·015	0·010	NONE	
	19 READINGS.		12	0·017	0·015	"	CHIPPED ON FLANK
	OF WEAR TAKEN		18	0·017	0·015	"	" "
	THESE ARE REDUCED.		24	0·020	0·018	"	second chip
	FOR REPORT		28	0·022	0·020	"	both chips joined
	CLARITY.		32	0·032	0·022	ALMOST FAILING	CUTTING EDGE CRUMBLING.

THE TOOL 3/4" DIA HSS
SUPPLIED BY
EASTER BROOK ALCARD LTD
SHEFFIELD.
REF MR R.E. DODD.

WORK PIECE MATERIAL EN 24 ANNEALED

The College of Aeronautics VPN 246 AV

EXPERIMENTAL RECORD
TURNING TESTS

CONDITIONS DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
TOOL ANGLES = CUTTING EDGE SIDE RAKE 15°
BSS 1886-1952 PLAN APPROACH ANGLE 5°
FRONT AND SIDE CLEARANCE 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS 040 INS
SURFACE SPEED THE VARIABLE.

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE NO 1C1

T2

TOOL No	MARK	END	SURFACE SPEED	FT/MIN	CUTTING TIME	MINUTES	TOOL WEAR IN INCHES FLANK	NOSE	CRATER	REMARKS
2			65	FEET	4		004	007	NONE	
					8		010	009	"	
					12		016	013	"	
					18		020	017	"	CHIPPED
					24		022	019	MARKED	
					28		025	022		"
					30		025	030	FAILED.	
No 4	MARK	END	75	FEET	1		006	006		
					3		010	010		
					6		014	DEEP SCRATCH		
					8		016	WORSE		
					10		018	FAILED		
No 3	MARK	END	·105	FEET	1/4		006	003		
					1/2		006	011		
					3/4		007	013		
					1		011	015		
					1 1/4		012	018		
					1 1/2		018	020		
					2		028	FAILED.		

THE TOOL 3/4" DIA HSS SUPPLIED BY EASTERBROOK ALCARD LTD. SHEFFIELD. REF - MR R.E. DODD.

WORK MATERIAL EN 24 ANNEALED VPN 246.AV.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

CONDITIONS.- DEPTH OF CUT = 0.100 INS
FEED/REV = 0.005 INS
TOOL ANGLES = CUTTING EDGE SIDE RAKE 15°
BSS 1886:- 1952 PLAN APPROACH ANGLE 5°
FRONT AND SIDE CLEARANCE 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS .040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 1 ICI

T3

TOOL No	MARK	END	SURFACE SPEED FT/MIN	CUTTING TIME MINUTES	TOOL WEAR: IN INCHES FLANK	NOSE	CRATER	REMARKS
No 4			75 FEET	1	.004	.006		
				3	.010	.010		
				6	.014	DEEP SCRATCH		CHIPPED.
				8	.016	" "	WORSE	
				10	.018	0.023		
No 4	PLAIN	END.	75 FEET	1	006	006		
				3	012	010		
				6	015	DEEP SCRATCH ON NOSE		
				8	016	" " WORSE		
				10	018	FAILED.		
No 22	PLAIN	END.	85 FEET	1	006	008		
				2	012	014	CHIPPED	
				3	018	020	"	
				4	021	023		
No 22	MARK	END	85 FEET	1	009	012		
				2	013	014	CHIPPED	
				3	018	020	CHIPPED	
				4	021	023	CUTTING EDGE CRUMBLED	
No 27	MARKED	END	85 FT.	1	006	009		
				2	010	013		
				3	017	015		
				4	020	023	CHIPPED	

THE TOOL - HSS 3/4" DIA.
SUPPLIED BY
EASTERBROOK ALCARD LTD.
SHEFFIELD
REF MR R.E. DODD.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

WORK MATERIAL = EN 24 ANNEALED VPN 246 AV

CONDITIONS - DEPTH OF CUT = 0·100 INS
FEED/REV/REV = 0·005"

TOOL ANGLES - CUTTING EDGE SIDE RAKE 15°
(BSS 1886 1952) PLAN APPROACH ANGLE 5°
FRONT AND SIDE CLEARANCE ANGLES 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS 0·042 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 2 ICI

T4

TOOL No	PLAIN	END	SURFACE SPEED FEET	MIN.	CUTTING TIME IN MINUTES	FLANK	TOOL	WEAR IN. INS. NOSE	CRATER	REMARKS
31			65		5	0·005		0·004		MARKED OUT · SLIGHT SMOKE
					10	0·006		0·006		NICE EVEN FLANK AND NOSE WEAR SMELLS.
					30	0·010		0·009		" "
					40	0·013		0·014		DEEP MARK ON NOSE
					50	0·015		0·014		WEARING MORE RAPIDLY
No					60	0·017		0·018		APPECIABLE SMOKE & SMELL
31	MARKED	END.	75 FT	MIN.	2	0·003		0·002		
					6	0·005		0·002		NICE EVAN WEAR
					10	0·007		0·008		ONLY SLIGHT CRATERING
					20	0·010		0·010		SMOKE AND SMELL
					30	0·012		0·013		NOTICABLE.
					40	0·015		0·015		
					50	0·017		0·020		
22	PLAIN	END	150	FT	1	0·003		0·002		
					3	0·010		0·007		CRATERING
					5	0·013		0·010		SMOKE & SMELL INCREASED
					6½	0·015		0·019		NOSE FAILED
22	MARKED	END	105		3	0·006		0·008		SMOKE AND SMELL
					6	0·010		0·008		INCREASED FROM SLOWER SPEEDS.
					9	0·013		0·012		SLIGHT CRATER. CHIPPED
					12	0·014		0·014		
					15	0·017		0·015		

THE TOOL - HSS 3/4" DIA.
SUPPLIED BY
EASTERBROOK ALCARD LTD.
SHEFFIELD.
REF MR R.E.DODD.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

WORK MATERIAL EN 24 ANNEALED VPN 246 AV
CONDITIONS DEPTH OF CUT = 0·100 INS
FEED/PER/REV = 0·005 INS
TOOL ANGLES CUTTING EDGE SIDE RAKE 15°
(BSS 1886-1952) PLAN APPROACH ANGLE = 5°
FRONT SIDE CLEARANCE ANGLE = 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS 0·040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 2 ICI

T5

TOOL No	PLAIN END	SURFACE SPEED FEET/MIN	CUTTING TIME IN MINUTES	TOOL WEAR IN INCHES FLANK	NOSE	CRATER	REMARKS
26		65	3	0·004	0·002	NONE	SLIGHT
			6	0·004	0·004	"	SMELL & SMOKE
			10	0·007	0·004	SMALL CHIP.	
			20	0·008	0·006	CHIP WEARING OUT	
			30	0·008	0·013	wear increased	SMOKE "WORSE
			40	0·011	0·013	in chipped area	
			50	0·013	0·015		
No			60	0·016	0·015		
21	PLAIN END	105 FT	1	0·008	0·006	NONE (SMOKING)	
			3	0·008	0·008	SLIGHT CRATER	
			6	0·010	0·009	INCREASE	"
			9	0·012	0·011	"	"
			12	0·015	0·011	"	"
			15	0·016	0·015	CHIPPED.	
No							
20	MARKED END	150 FT	1	0·005	0·003	CRATER MARKED	
			3	0·009	0·007	CRATERING	SLIGHLY
			5	0·014	0·009	"	"
			6½	0·014	0·019	DIRECTION OF CHIP FLOW CHANGED	
27	PLAIN END	200 FT	1	0·006	0·003		
			2	0·013	0·009	SMOKE AND SMELL	
			3		NOSE FAILED		

THE TOOL = HSS — 5/4 DIA, SUPPLIED BY EASTER BROOK ALCARD LTD. SHEFFIELD REF. MR R.E. DODD.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

WORK MATERIAL = E.N. 24. ANNEAL. VPN 246 AV

CONDITIONS: DEPTH OF CUT = 0·100 INS
FEED/PER/REV = 0·005 INS

TOOL ANGLES: CUTTING EDGE SIDE RAKE 15°
(BSS. 1886-1952) PLAN APPROACH ANGLE 5°
FRONT = SIDE CLEARANCE 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS = 0·040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 2 I.C.I.

T6

TOOL No			SURFACE SPEED FT/MIN.	CUTTING TIME MINS	FLANK	TOOL WEAR IN INCHES NOSE	CRATER	REMARKS
19	PLAIN	END.	65 FT/MIN	3	0·003	0·002		
				6	0·003	0·004		
				10	0·004	0·006		SMOKING
				20	0·005	0·006	SMOKING	SLIGHTLY
				30	0·008	0·009	CHIPPED	
				40	0·011	0·011	CHIPPED MORE	" "
				50	0·012	0·015	CHIP WEARING OUT	INCREASED
				60	0·01A	0·015	V GROOVE AT DEPTH OF CUT.	
				70	0·017	0·020	POINT FAILING.	
No 19	MARK	END	75 FT	1	0·002	NONE		SLIGHT
				3	0·002	0·002		SMOKE
				6	0·006	0·002		AND
				10	0·006	0·011		SMELL
				30	0·012	0·016	Very slight crater	
				45	0·017	0·016		
No 20	PLAIN	END	200 FT	1	0·005	0·005	CRATERING +	SMOKING SMELL
				2	0·008	0·006	"	"
				3	0·010	0·014	NOSE WEAR.	
				3½		NOSE FAILED.		

THE TOOL 3/4" DIA HSS
SUPPLIED BY
EASTERBROOK ALCARD LTD
SHEFFIELD
REF MR R.E. DODD.

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

WORK PIECE MATERIAL EN24 ANNEALED
VPN 246 AV
CONDITIONS. DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005
TOOL ANGLES. CUTTING EDGE SIDE RAKE 15°
(BSS 1886-1952) PLAN APPROACH ANGLE 5°
~~NAME~~ FRONT AND SIDE CLEARANCE 6° 6°
PLAN TRAIL ANGLE
NOSE RADIUS 0·040 INS
~~DATE~~ SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 3 ICI

T7

TOOL No	MARK	END	SURFACE SPEED FT/MIN	CUTTING TIME IN MINUTES		TOOL WEAR IN INCHES FLANK		NOSE		CRATER	REMARKS
No 10			65 FEET	6		011		011			
				15		013		014			SOME SMOKE
				30		017		016		DEVELOPING	& SMELL
				60		019		017			
				90		020		018			
No 10	PLAIN	END	65 FEET	6		010		007			
				15		015		012			
				30		017		017			
				60		019		022			
				90		022		FAILED			
No 6	MARK	END	65 FEET	6		011		009			
				15		013		012			
				30		016		015			
				55		018		018			.005
				90		020		NOSE	CHIPPED		
No 6	PLAIN	END	65 FEET	6		005		009			
				20		010		009			
				40		013		013			
				65		017		015			
				85		019		018		CUTTING EDGE	CHIPPED

THE TOOL 3/4" DIA HSS
SUPPLIED BY
EASTERBROOK ALCARD
SHEFFIELD
REF MR R E DODD.

WORK PIECE MATERIAL EN 24 ANNEALED VPN 246 AV

The College of Aeronautics

EXPERIMENTAL RECORD
TURNING TESTS

CONDITIONS - DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
TOOL ANGLES (BSS 1886-1952) CUTTING EDGE SIDE RAKE 15°
PLAN APPROACH ANGLE 5°
FRONT & SIDE CLEARANCE 6°
PLAN TRAIL ANG. 6°
NOSE RADIUS 040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 3 ICI

~~NAME~~

~~DATE~~

T8

TOOL No	MARK	END	SURFACE SPEED FEET MINUTE	CUTTING TIME IN MINUTES	FLANK	TOOL WEAR IN INCHES NOSE	CRATER	REMARKS
No 23			100 FEET	3	006	005		SMOKING
				6	009	008	SLIGHT	SMELL.
				14	011	013	"	STRONGER THAN
				20	014	015	"	NO 2
				26	016	014	GOOD PERFORMANCE	
No 23	PLAIN	END	150 FEET	2	007	005		
				5	009	009	cratering	SMOKE. SMELL.
				8	013	015	" "	
				11	017	020	DEEP CRATER	
No 14	MARK	END	100 FEET	3	007	003		
				6	009	005		SMELL
				14	012	010		AND SMOKE.
				20	015	015	GOOD CUTTING ACTION.	
				26	017	016	SLIGHT CRATER.	
No 14	PLAIN	END	150 FEET	1	003	003		
				2	005	005		SMOKE AND SMELL.
				4	006	008		
				6	008	011	GOOD PERFORMANCE	
				9	010	013	slight crater	
				12	016	017		TOO MUCH SMOKE.

THE TOOL 3/4" DIA HSS SUPPLIED BY EASTERBROOK ALCARD SHEFFIELD REF - MR R E DODD.

WORK PIECE MATERIAL EN 24 ANNEALED VPN 246 AV

The College of Aeronautics

EXPERIMENTAL RECORD ~~TURNING TESTS~~ TOOL ANGLES (BSS 1886-1952)

CONDITIONS - DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
CUTTING EDGE SIDE RAKE 15°
PLAN APPROACH ANGLE 5°
FRONT SIDE CLEARANCE 6°
PLAN TRAIN ANGLE 6°
NOSE RADIUS .040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS

REMARKS: COOLANT SAMPLE No 3 ICI

NAME

DATE

T9

TOOL No	MARK	END	SURFACE SPEED FEET MINUTE		CUTTING TIME IN MINUTES	TOOL WEAR IN INCHES FLANK	NOSE	CRATER	REMARKS.
No 5			200	FEET	1	006	004		
					2	008	006	CRATERING	
					4	012	012	" INCREASING	
					6	016	013	(EDGE FAILING AT DEPTH	
					7	019	DEEP SCRATCH	OF CUT	SMOKE)
No 5	PLAIN	END	200	FEET	1	004	003		SMOKE
					3	009	010		
					5	013	011		
					7	018	016		FLANK FAILING
No 28	PLAIN		65	FEET	RUN FOR	90 MINS.			GOOD PERFORMANCE
						019	019		ONLY ORDINARY CRATERING.
									SEE TALISURF TRACE
									FIG 5 TAKEN FROM
									THIS TOOL.

(THIS SAMPLE WOULD BE DIFFICULT TO INTRODUCE IN A WORK SHOP DUE TO SMOKE AND STRONG SMELL.

THE TOOL 3/4 DIA HSS
SUPPLIED BY
EASTERBROOK ALCARD LTD
SHELFIELD
REF MR R.E.DODD.

WORK PIECE MATERIAL EN 24 ANNEALED

The College of Aeronautics

VPN 246 AV

T.O

EXPERIMENTAL RECORD
(TURNING TESTS)

CONDITIONS. DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
TOOL ANGLES CUTTING EDGE SIDE RAKE 15°
(BSS 1886-1952) PLAN APPROACH ANGLE 5°.
~~NAME~~ FRONT & SIDE CLEARANCE 6°.
PLAN TRAIL ANGLE 6°
~~DATE~~ NOSE RADIUS 0·040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT: COOLANT EVALUATION TESTS.

REMARKS: COOLANT SAMPLE No 4 ICI

TOOL No	MARK	END	SURFACE SPEED FEET	MIN	CUTTING TIME	MINS	TOOL WEAR IN INCHES FLANK	NOSE	CRATER	REMARKS
No 9			65	FEET	6		010	011	NONE	
					12		015	014	"	
					18		017	016	" CHIPPED	
					24		018	018	Cratering	
					26		020	021	increased crater.	
No 12	PLAIN	END	105	FEET	½		009	005		
					2		012	008	CRATERING	
					3		015	009	"	
					3½		017	015	"	
					4		017	016	"	CHIPPED
					4½		022	017	DEEP CRATER	"
No 15	PLAIN	END	105	FEET	½		006	010		
					2		010	010		
					3		013	020	CHIP NOSE	
					3½		015	020	CHIP WEARING OUT	
					4		015			
					4½		020			
No 15	MARK	END	125	FEET	½		015	009		
					1		018	012	CUTTING EDGE	
No 10	TEST	REPEATED			1½		020	015	CRUMBLING	
	RESULTS	SIMILAR.			2		020	018		
					2½		023	020		

THE TOOL 3/4" DIA HSS
SUPPLIED BY
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The College of Aeronautics

WORK PIECE MATERIAL EN 24 ANNEALED
VPN 246 AV

EXPERIMENTAL RECORD (TURNING TESTS)

CONDITIONS DEPTH OF CUT = 0·100 INS
FEED PER REV = 0·005 INS
TOOL ANGLES CUTTING EDGE SIDE RAKE 15°
(BSS 1296 (1952)) PLAN APPROACH ANGLE 5°
FRONT + SIDE CLEARANCE 6°
PLAN TRAIL ANGLE 6°
NOSE RADIUS 0·040 INS
SURFACE SPEED THE VARIABLE

EXPERIMENT Coolant Evaluation Tests

REMARKS Coolant Sample No 4 ICI.

NAME

DATE

TOOL NO	END	SURFACE SPEED FEET MIN		CUTTING TIME MINS	TOOL WEAR IN INCHES FLANK	NOSE	CRATER	REMARKS
7	MARK	65	FEET	3	~~·003~~	003	006	
				6	~~·007~~	007	007	None
				12	~~·012~~	012	009	Slight 0013
				18	~~·014~~	014	012	Chip
				24	0	014	017	increasing
				26		019	Failing	
13	MARK END	65	FEET	3		005	005	None
				6		009	009	"
				12		013	011	Slight
				18		015	013	increased
				24		016	013	" Nose chip
				30		018	016.	"
13	PLAIN END	65	FEET	8		005	008	
				16		012	013	Cratering
				24		016	014	" "
				32		020	014	" "
No 4	PLAIN END	85	FEET	1		006	010	
				3		009	010	
TEST	REPEATED			6		013	013	Cratering
WITH	SIMILAR			8		016	015	" "
RESULTS				10		017	018	increased.
				11		021	020	

H.D. 1

DRILL 3/8 INS STANDARD JOBBER
4° CLEARANCE ANGLE
H.S.S PRESTO BRAND.

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

VPN READINGS
20 Kg LOAD
STANDARD VICKERS MACHINE.

EXPERIMENT: HARDNESS TESTS ON DRILLS TAKEN ON THE CLEARANCE FACE

~~NAME~~

REMARKS: AVERAGE OF 6 READINGS ON EACH FLUTE

DATE

PRESTO BRAND DRILLS BY EASTER BROOK ALLCARD SHEFFIELD.

DRILL	FLUTE No 1	FLUTE No 2		DRILL	FLUTE No 1	FLUTE No 2
No 1	962	960		No 12	962	959
2	965	952		13	965	949
3	949	952		14	952	949
4	960	945		15	961	937
5	961	968		16	949	965
6	969	952		17	953	956
7	953	946		18	943	978
8	937	939		19	937	937
9	949	951		20	971	959
10	959	962		21	962	962
11	931	931		22	953	949

D.1.

DRILL 3/8" STANDARD JOBBER.
7° FRONT CLEARANCE ANGLE
PRESTO BRAND.

The College of Aeronautics

MATERIAL - EN. 24 ANNEALED
VPN 246.

EXPERIMENTAL RECORD
DRILLING TESTS

EXPERIMENT: COOLANT EFFICIENCY TESTS NAME .....

REMARKS: COOLANT SAMPLE ICI No 1 DATE .....

DRILL	VPN	RPM		FEED PER REV		No OF HOLES DRILLED		DRILL WEAR IN INCHES				REMARKS
No	971	920		IN INS.		1 IN JEEP.		CORNERS		CHISEL	POINT	
20	959			·007		10		·002	·003	·006	·004	GOOD CLEAN
						20		·002	·005	·008	·008	PERFORMANCE.
						40		·004	·007	·009	·011	
						60		·007	·008	·016	·017	
						80		·008	·010	·018	·019	
						100		·009	·010	FIALED.		
20	974		2nd run after redress									
	964					10		·004	·003	·003	·005	
						20		·004	·006	·008	·009	
						30		·005	·006	·009	·011	AT 100 HOLES
						40		·006	·006	·010	.011	PERFORMANCE
						50		·006	·007	·013	·012	IS BETTER
						60		·007	·007 CHIPPED	·013	·016	THAN. NO 3
						70		·008	·008	·014	·016	
						80		·008	·009 CHIPPED	·017	·020	
						90		·013	·010	·017	·020	
						100		·016	·014	FAILED.		

D 2

DRILL 3/8" DIA STANDARD JOBBER
Y° FRONT CLEARANCE ANGLE
PRESTO. BRAND

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL EN 24 ANNEALED
VPN 246.

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE ICI No 1

DATE .....

DRILL No	VPN	RPM	FEED PER REV IN INS	No OF HOLES DRILLED 1 INS DEEP	DRILL WEAR IN INCHES CORNERS		CHISEL POINT		REMARKS
20	981	920	.007	10	·004	·002	·003	·003	
				20	·005	·004	·005	·006	
				30	·006	·008	·006	·006	GOOD CLEAN
				40	·008	·010	·010	·006	PERFORMANCE AND
				50	·010	·012	·011	·006	STEADY RATE OF W
				60	·012	·012	·012	·010	WEAR.
				70	·012	·013	·012	·012	
				80	·013	·014	CHIPPED	·018	
				100	·017	·014	CHIPPED	CHIPPED.	
			2nd run new drill						
No 12	931			10	·003	·002	·003	·002	
	931			20	·004	·004	·006	·006	
				30	·006	·008	·007	·011	
				40	·008	·010	·008	·014	
				50	·008	·010	·009	·016	
				60	·009	·010	·010	·017	
				70	·009	·014	·010	·018	
				80	·010	·014	·015	·018	
				90	·013	·014	·015	·019	
				100	CHIPPED	·018	WORN right across		

D
DRILL 3/8 IN DIA STANDARD JOBBER) **The College of Aeronautics**

7° FRONT CLEARANCE ANGLE.
PRESTO BRAND

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL EN 24 ANNEALED.
VPN 246.

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE No 1 ICI.

DATE .....

DRILL	VPN	RPM		FEED PER REV		No OF HOLES DRILLED		DRILL WEAR IN INCHES				REAMRKS.		
No	938	920		IN INS		1 INS JEEP		CORNERS		CHISEL	POINT			
12	932			·007		10		·002	·003	003	003			
						20		·002	·003	·008	·008			
						30		·003	·004	009	0·010			
						40		·004	·005	·009	·011	GOOD	CONSTANT	
						50		·005	·005	·013	·012			
						60		·007	·007	·016	·017		RESUATS.	
						70		·008	·008	·018	·019			
						80		·008	·008	·018	·020		Pressor	
						100		·009	·010	WORN ACROSS	·025		failure	
17	946			2nd run after redress										
	936.					10		002	003	003	002			
						20		002	003	007	003			
						30		004	003	009	006			
						40		004	005	009	008			
						50		004	006	010	011			
						60		005	006	013	011			
						70		006	007	016	012			
						80		006	007	017	013			
						90		007	008	017	013			
						100		010	011	017	CHIPPED.			

DRILL 3/8" DIA STANDARD JOBBER
7° FRONT CLEARANCE ANGLE
H.S.S.
PRESTO BRAND

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN 24 ANNEALED
VPN 246.

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE ICI NO 2

DATE .....

DRILL No	VPN	RPM		FEED PER REV IN INS		No OF HOLES DRILLED 1 in DEEP		DRILL WEAR IN INCHES CORNERS		CHISEL POINT		REMARKS
11	965			.007		10		004	.004	CHIPPED		
						20		005	005	"		
						30		005	009	"		
						40		CHIPPED 004	CHIPPED	TEST RE STARTED.		
16.	988			restart		after redress						
	964					10		.003	.004	.004	.007	
		CONSTANT				24		.003	.006	.007	.008	
				CONSTANT		40		.007	.006	.008	.010	
						60		.013	.010	.010	.011	
						70		.015	.011	.010	.013	
						73		CHIPPED		FAILED		
16.	946.			drill		Re dressed.						
	976					10		003	.002	.004	.003	
						20		003	.004	.004	.006	
						40		005	.004	.008	.007	
						60		007	.005	.009	.007	
						65		008	.005	.009	.010	
						70		014	.010	.014	.016	
						75		019	.010	FAILED	.019	

The College of Aeronautics

D.S.

DRILL 3/8" DIA STANDARD JOBBER
7° CLEARANCE ANGLE
H.S.S PRESTO BRAND

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN 24 ANNEALED
VPN 246

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE ICI No 2

DATE .....

DRILL No	VPN	RPM		FEED PER REV IN INS		No OF HOLES DRILLED 1 IN DEEP		DRILL WEAR IN INCHES CORNERS	CHISEL	POINT	REMARKS
11 NEW	965	920		.007		10		.003	.002	.004	.007 * DEEP GROOVE
						20		.007	.006	.004	.007 NEAR CORNER.
				CONSTANT		40		.008	.010	.005	.007 WOULD CAUSE
						60		.009	.010	.005	.008 DRILL TO BROKE
						70		.010	.014	.006	.010 IF TEST CONTINUED.
						80	*	.015	.015	.007	.010
11	944			2nd	run	after redress				same	drill
	976	CONSTANT				10		002	.003	.007	.003
						20		004	.004	.007	.010
						40		005	.005	.012	.010
						60		007	CHIPPED .007	CHIPPED .016	.014
						80		008	.009	.019	POINT FAILED
17	944			3rd	run	after redress					
	942					10		.003	.006	.004	.004
						20		.007	.010	.004	.007
						40		.004	.011	.005	.007
						60		.007	.016	.008	.009 * WEAR UP SPIRAL
						~~80~~					OF DRILL
						76	*	.015	.019	.008	.010

D. 6.

DRILL 3/8" DIA. STANDARD JOBBER
7° CLEARANCE ANGLE
H.S.S. PRESTO BRAND.

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN 24 ANNEALED
VPN 246.

EXPERIMENT: Coolant Efficiency Tests

NAME .....

REMARKS: Coolant sample ICI No 2

DATE .....

DRILL No	VPN	RPM		FEED PER REV IN INS		No OF HOLES DRILLED 1 INS DEEP		DRILL WEAR IN INCHES CORNERS	CHISEL POINT		REMARKS
17	942	920		·007		10		·003	·002	·005⁻ ·005⁻	
						20		·006	·011	·010 ·005⁻	
						40		·013	·011	·011 ·006	
						60		·014	·014	·017 ·011	
						80		DRILL FAILED		POINT FAILED	
		CONSTANT	2nd run after redress same drill								
17	944			CONSTANT		10		·002	·004	·003 ·005⁻	
	942					20		·003	·005⁻	·006 ·008	
						30		·004	·005⁻	·007 ·010	
						40		·004	·006	·010 ·011	
						50		·004	·008	·012 ·015⁻	
		DRILL VIBRATING				60		·005⁻	·008	·015 ·017	
		UNDER HEAVY		FORCES		70		·009	CORNER FAILED	·019 ·019	
						80					
No 16	488		3rd run			New drill					
	946					20		·005⁻	·006	·006 ·005	
						40		·013	·008	·011 ·006	
						60		·014	·010	·015⁻ ·017	
						80		·019	·021	FAILED FAILED	

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DRILL 3/8" STANDARD JOBBER.
7° FRONT CLEARANCE ANGLE
H.S.S.
PRESTO BRAND

MATERIAL - EN 24 ANNEALED
VPN 246.

EXPERIMENTAL RECORD
DRILLING TESTS

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE No 3 ICI

DATE .....

DRILL	VPN	RPM		FEED PER REV		No OF HOLES DRILLED		DRILL WEAR IN INCHES				REMARKS
No 2	946	920		IN. INS		1 IN. DEEP		CORNERS		CHISEL	POINT	
	956			·007		10		·004	·002	·006	·003	
						20		·005	·006	·006	·012	
						40		·007	·008	·012	·015	
						60		·007	·008	·018	·017	THE DRILL IS
						80		·009	·016	·018	·017	MORE HEAVY LOADED
						100		·010	·016	·019	·023	WITH THIS
				2nd run new drill								COOLANT
No 7	940					10		·002	·004	·006	·003	THAN
	936					20		·004	·005	·009	·004	WHEN
						40		·004		chipped	·025	COOLANT No 1
						60						IS USED
						80		TEST DISCONTINUED				
						100						
No 7	940			DRILL redressed.								
	936					10		·004	·002	·003	·006	
						20		·004	·008	·006	·006	
						40		·006	·008	·006	·006	
						60		·007	·009	·007	·008	
						80		·010	·009	·007	·009	
						100		·032	·014	·010	·015	

D. 8.

DRILL 3/8" STANDARD JOBBER.
7° CLEARANCE ANGLE.
H.S.S.
PRESTO BRAND

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN 24. ANNEALED
VPN 246

EXPERIMENT: COOLANT EFFICIENCY TESTS NAME .....

REMARKS: COOLANT SAMPLE NO 3 ICI DATE .....

DRILL	VPN	RPM		FEED PER REV		NO OF HOLES DRILLED		DRILL WEAR IN INCHES				REMARKS
NO	936	920		IN INS		1 IN DEEP		CORNERS		CHISEL	POINT	
2	965			.007		10		.002	.003	.002	.005	
						20		.002	.006	.010	.007	
						40		.004	.007	.013	.013	THE PERFORMANCE
						60		.006	.007	.014	.014	OF THIS COOLANT
						80		.008	.008	.014	.014	IS NOT EQUAL
						100		.009	.010	.018	.015	TO COOLANT
				2nd run		after redress						NO 1
NO 2	965					10		.003	.003	.010	.005	THE PROCESS
	945					20		.006	.004	.010	.005	IS MUCH MORE
						40		.007	.006	.011	.012	HARSH.
						60		.010	.007	.013	.015	
						80		.013	.007	.016	.016	
						100		.014	.010	.018	.017	
NO 16	988			redressed drill								
	946.					10		.002	.004	.008	.002	
						20		.004	.006	.008	.007	
						30		.004	.006	.008	.009	
						40		.008	.009	.010	.010	
						60		.008	.012	.011	.011	
						80		.012	.012	.011	.015	
						100		Test ended due to heavy forces				

DRILL 3/8" STANDARD JOBBER
7° CLEARANCE ANGLE
H.S.S.
PRESTO BRAND

D. 9.

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN24 ANNEALED
VPN 246.

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE NO 3

DATE .....

DRILL No	VPN	RPM		FEED PER REV		No OF HOLES DRILLED		DRILL WEAR IN INCHES			R	REMARKS	
15	953	920		IN INS		1 INS DEEP		CORNERS		CHISEL	POINT		
	946			·007		10		·002	·005	·003	·003		
						20		·005	·005	·007	·007		
						40		·005	·006	CHIPPED ·008	·009		
						60		·012	·009	·013	·010	PROCESS	SOUNDS
						80		·012	·009	·013	·012	HARSH	
						100		·019	·012	·017	·012		
				2nd	run	after redress							
15	969					10		·006	·002	·003	·002		
	946					20		·012	·003	·005	·007		
						40		·012	·017	CHIPPED			
						60		TEST DISCONTINUED					
				3rd	run	after redress							
15	946					10		·002	·004	·003	·002		
	956					20		·006	·004	·006	·004		
						40		·007	·004	·007	·007		
						60		·007	·008	CHIPPED ·009	·013		
						80		·012	·010	·009	·015		
						100		·012	·013	·009	·016		

D. 10.

DRILL 3/8 INS STANDARD JOBBER.
7° FRONT CLEARANCE ANGLE
H.S.S
PRESTO BRAND

The College of Aeronautics

EXPERIMENTAL RECORD

DRILLING TESTS

MATERIAL - EN.2A. ANNEALED
VPN 246

EXPERIMENT: COOLANT EFFICIENCY TESTS

NAME .....

REMARKS: COOLANT SAMPLE ICI No 4

DATE .....

DRILL No	VPN	RPM	FEED PER REV IN INS.	No OF HOLES DRILLED 1 INS DEEP	DRILL WEAR IN INCHES				REMARKS
					CORNERS		CHISEL	POINT	
18	949		·007	10	·003	·004	·002	·003	
				20	·004	·006	·002	·006	
				30	·007	·009	·003	·006	
				40	·007	·010	·006	·009	
				50	·014	·012	·008	·009	AFTER 50 HOLES
	DRILL VIBRATING			60	·018	·014	·012	·015	RATE OF WEAR
	CUTTING FORCES VERY HIGH			70	·028	·016	·012	·015	INCREASED
	Second run after redress of used drill								RAPIDLY IN ALL
No 16	988			10	·003	·004	·006	·002	TEST WITH THIS
	974			20	·003	·006	·006	·005	COOLANT
				30	·004	·008	·007	·005	
				40	·005	·010	·008	·007	
				50	·006	·014	·011	·008	
				60	·008	·015	·011	·012	
	DRILL VIBRATING			70	·011	·021	·017	·012	
	CUTTING FORCES VERY HIGH			76	·018	·028	·017	FAILED	

D. 11

DRILL 3/8 STANDARD JOBBER
7° FRONT CLEARANCE ANGLE
H S S.
PRESTO BRAND

The College of Aeronautics

EXPERIMENTAL RECORD
DRILLING TESTS

MATERIAL - EN 24 ANNEALED
VPN 246.

EXPERIMENT: COOLANT EFFICIENCY TESTS NAME .....

REMARKS: COOLANT SAMPLE ICI No 4 DATE .....

DRILL No	VPN	RPM		FEED PER REV IN INS		No OF HOLES DRILLED 1. INS DEEP		DRILL WEAR IN INCHES CORNERS		CHISEL	POINT	REMARKS		
16	946	920		007		10		·003	·008	·002	·003			
						20		·004	·009	·003	·003			
						30		·006	·011	·003	·004			
						40		·011	·014	·006	·004			
						50		·013	·015	·006	·006			
			NEAR	FAILURE		60		·016	·017	·009	·014			
		DRILL VIBRATING				69		·018	·021	·009	·017			
			Second	run		after		redress	of	used	drill			
No 14	943					10		·002	·003	·006	·004			
	978					20		·003	·005	·008	·005			
						30		·007	·005	·011	·005			
						40		·007	·066	·011	·006			
						50		·012	·011	·011	·010			
						60		·017	·015	·019	·010			
						70		·021	·019	FAILED.				

D. 12.

DRILL 3/8 DIA STANDARD JOBBER.
7° FRONT CLEARANCE ANGLE
H.S.S.
PRESTO BRAND

The College of Aeronautics

MATERIAL - EN 24 ANNEALED
VPN 246

EXPERIMENTAL RECORD
DRILLING TEST.

EXPERIMENT: COOLANT EFFICIENCY TESTS NAME .....

REMARKS: COOLANT SAMPLE ICI No 4 DATE .....

DRILL No	VPN	RPM	FEED PER REV IN. INS	No OF HOLES DRILLED 1 INS DEEP.	DRILL WEAR IN INCHES. CORNERS		CHISEL	POINT	REMARKS
15	946	920	·007	10	·006.	·003	·002	·002	
				20	·007	·008	·006	·003	
				30	·008	·010	·006	·003	
				40	·010	·012	·009	·005	
				50	·017	·016	·013	·008	
				60	·020	·018	·015	·011	
				70	·038	·042	·015	·019	
			Second run after redress of used drill						
No 16	988			10	·004	·005	·002	·002	
	946			20	·005	·005	·004	·005	
				30	·005	·006	·005	·006	
				40	·006	·007	·008	·006	
				50	·012	·011	·015	·006	
				60	·014	·012	·017	·008	
				70	·015	·017	·015	·009	

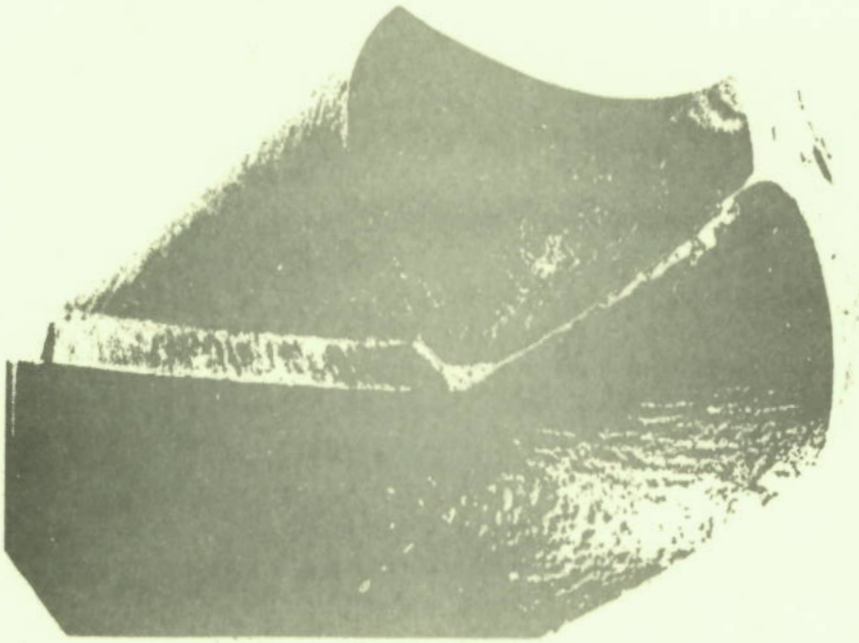

FIG. 8 TYPICAL DRILL RADIAL CORNER WEAR

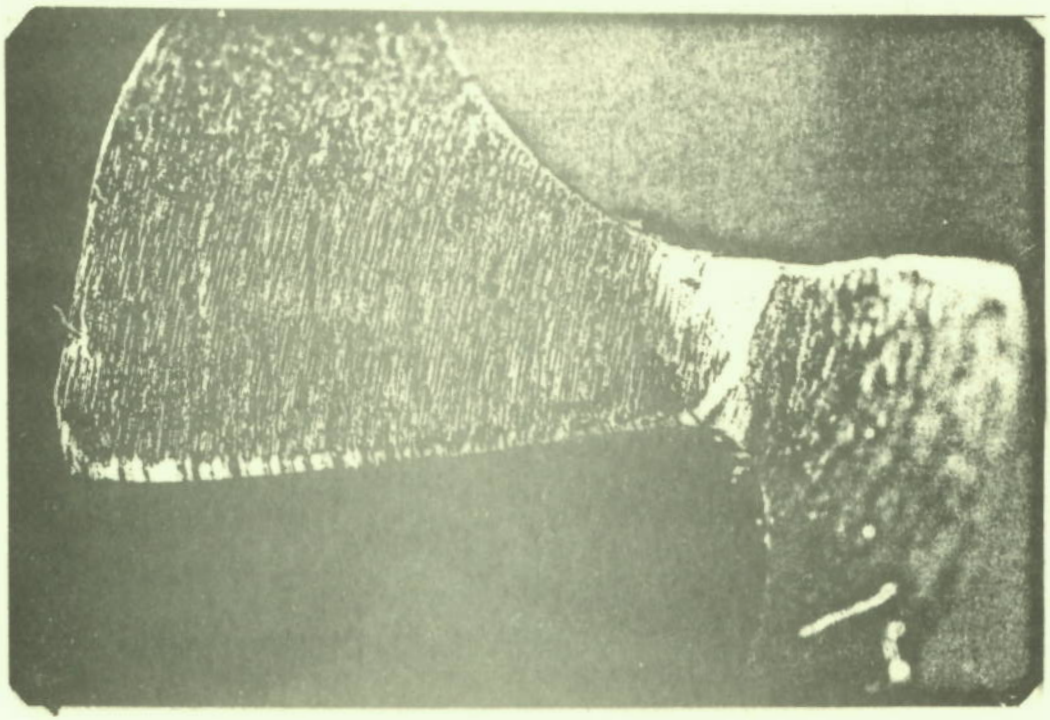

FIG. 9 TYPICAL DRILL CUTTING EDGE WEAR

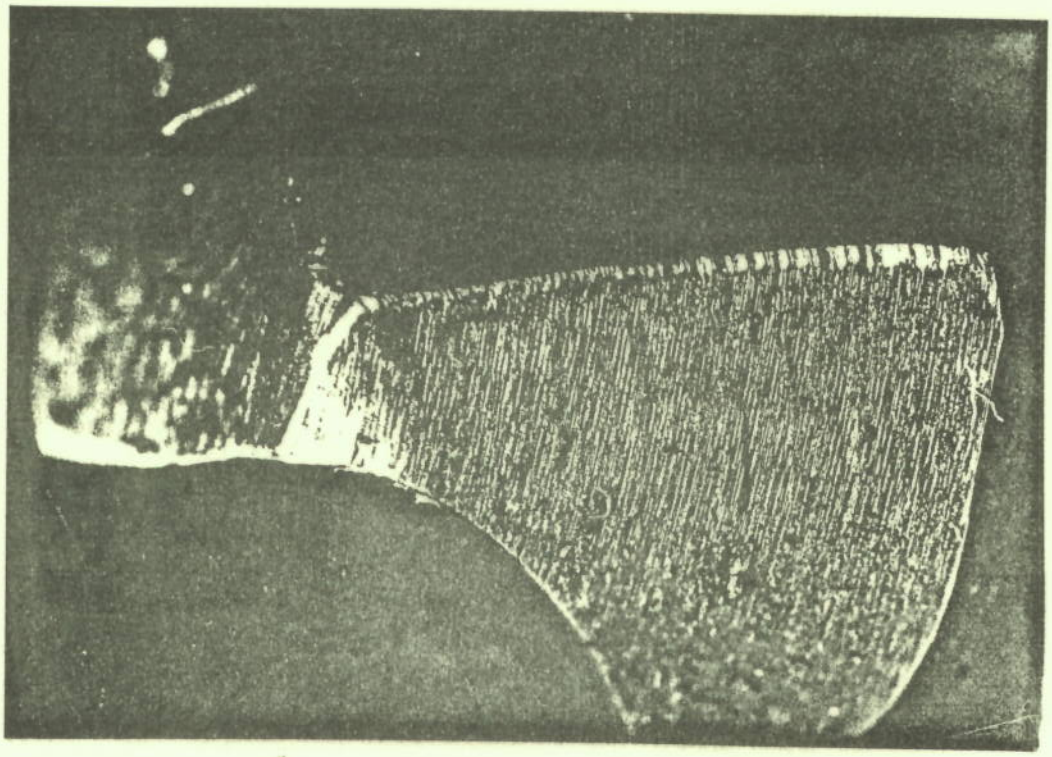

FIG. 10 PHOTOGRAPH OF CHISEL POINT FAILURE