CoA Memo M. and P. No. 27

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THE COLLEGE OF AERONAUTICS

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ADMINISTRATION

TEST REPORT NO. PLBO/10

Reducing flank wear by controlled elastic deflection of the tool holder

SUMMARY

Cutting tests were carried out on tips of RD 92, cutting EN9 at 600 fpm, 0.010 in/rev. feed and 0.10 in. depth of cut, with a standard tool holder and with a tool holder which had been modified in such a way as to reduce the contact between the clearance face of the tool tip and the workpiece when the tool holder deflected elastically. The results of the tests showed that up to 0.030 in. flank wear the modified tool holder gave tool lives which were about 20% better than those obtained using the standard tool holder.

Introduction

The wear on the clearance face of a cutting tool (flank wear) appears to result largely from the rubbing action of the workpiece on the tool. For such rubbing to take place the clearance face must contact the workpiece and a force must be transmitted. If this contact could be reduced then the flank wear could presumably also be reduced. This note describes a method of doing this.

Figure 1(a) shows the position of a throwaway tip in a typical tool holder. Under the action of the cutting force the tool holder will deflect elastically (in this case the torsional deflection will be the most important) and take up a new position (figure 1(b) - greatly exaggerated). This movement will tend to push the clearance face of the tip against the workpiece surface and hence lead to flank wear.

If instead of locating the tip in the tool holder as shown in figure 1, the tip is located as shown in figure 2, then when the tool holder twists the tip is not pushed against the workpiece to the same extent. (With a suitable design the tip could be made to move away from the workpiece as the cutting force is applied.)

With these thoughts in mind a standard tool holder was modified as shown in figure 3. Cutting tests were then made using four tips of nominally the same grade (RD92) with the modified and a standard tool holder.

Test conditions

The following test conditions were used:-

Work material	EN 9
Cutting speed	600 fpm
Depth of cut	0.10 in.
Feed	0.010 in/rev.

and the tools used were:-

TA 2040 RD92 NT175	TA 2040 RD92 'A'
TA 2040 RD92 NT178	TA 2040 RD92 'B'

Test Results

The flank wear was measured in the usual manner and the results are given in Tables 1 - 8.

Figure 4 shows the results graphically for tool NT175 and 'A' in the standard tool holder against tools NT178 and 'B' in the modified tool holder. Figure 5 shows the results for NT178 and 'B' in the standard

holder and NT175 and 'A' in the modified holder. (The results have been shown on two figures because the tests were carried out on two bars of slightly different hardness.)

From the figures it can be seen that the tool life obtained when using the modified tool holder was in all cases between 15% and 20% better than when using the standard tool holder.

Conclusions

As the results with the modified tool holder showed improvements in tool life of up to 20% it is suggested that the principal described namely the use of the elastic deflection of the tool holder to reduce the force between the tool flank and the workpiece could have wider application and is worth further investigation.

Table 1

Tool	NT175	Cutting speed	600 fpm
Holder	Standard	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.0035	.004	.0085
12	.0055	.0075	.0125
18	.0085	.011	.0155
24	.011	.013	.018
30	.013	.016	.022
36	.013	.016	.0245
42	.016	.017	.026
48	.021	.020	.028
54	.025	.022	.0375

Table 2

Tool	RD92A	Cutting speed	600 fpm
Holder	Standard	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.005	.005	.006
12	.0065	.0085	.0105
18	.0085	.010	.0135
24	.010	.0125	.019
30	.0115	.015	.022
36	.015	.015	.024
42	.017	.017	.026
48	.0185	.022	.0315

Table 3

Tool	NT178	Cutting speed	600 fpm
Holder	Modified	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.006	.0055	.005
12	.008	.0065	.008
18	.0095	.0085	.014
24	.012	.010	.016
30	.0135	.011	.020
36	.014	.012	.020
42	.017	.015	.0225
48	.018	.0155	.024
54	.0215	.0185	.0275
60	.023	.019	.032

Table 4

Tool	RD92B	Cutting speed	600 fpm
Holder	Modified	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.004	.004	.007
12	.0055	.0065	.0095
18	.008	.008	.011
24	.0095	.0095	.014
30	.010	.010	.017
36	.0105	.011	.020
42	.012	.0135	.020
48	.013	.0145	.0245
54	.0165	.017	.0265
60	.0165	.018	.029
66	.0175	.019	.036

Table 5

Tool	NT178	Cutting speed	600 fpm
Holder	Standard	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.009	.009	.010
12	.011	.011	.019
18	.0115	.0115	.0235
24	.013	.0135	.0265
30	.0145	.0145	.028
36	.015	.0165	.030
42	.017	.017	.032

Table 6

Tool	RD92B	Cutting speed	600 fpm
Holder	Standard	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.005	.007	.009
12	.008	.010	.014
18	.010	.0115	.018
24	.011	.0135	.021
30	.012	.015	.025
36	.0135	.017	.031

Table 7

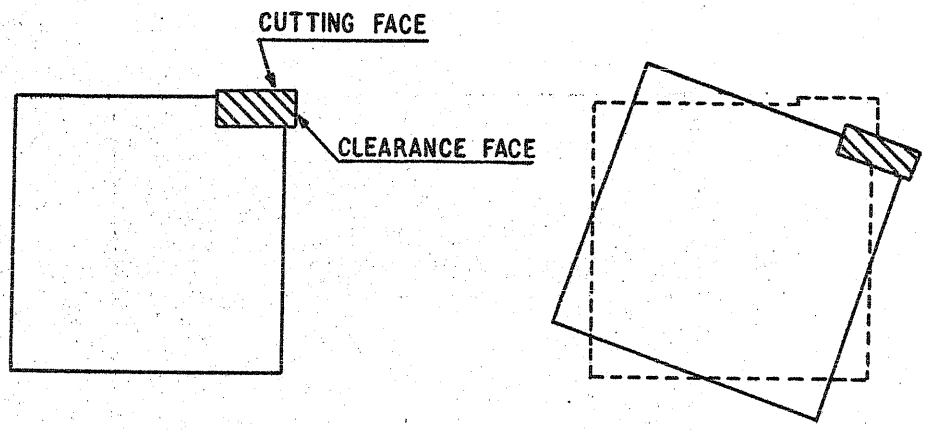
Tool	NT175	Cutting speed	600 fpm
Holder	Modified	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.0045	.0045	.005
12	.0075	.0075	.0105
18	.008	.009	.014
24	.0115	.011	.0165
30	.0125	.013	.018
36	.0135	.0175	.020
42	.015	.018	.029
48	.0195	.0205	.039

Table 8

Tool	RD92A	Cutting speed	600 fpm
Holder	Modified	Depth of cut	0.10 in.
Material	EN9	Feed	0.010 in/rev.

TIME min.	FLANK WEAR Fa	Fb	Fc
6	.004	.004	.0085
12	.0055	.0055	.0105
18	.008	.009	.016
24	.0105	.011	.0165
30	.0115	.013	.021
36	.014	.014	.029
42	.0155	.0155	.031



(a) UNDEFLECTED (b) DEFLECTED

FIG. 1.

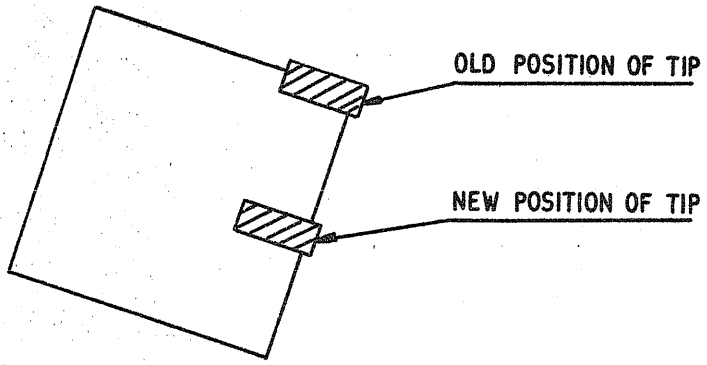
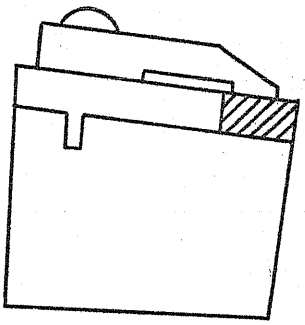
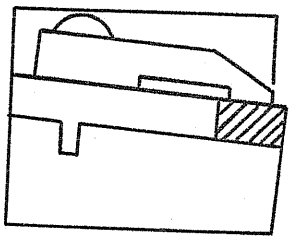


FIG. 2.



(a) STANDARD TOOL HOLDER



(b) MODIFIED TOOL HOLDER

FIG. 3.

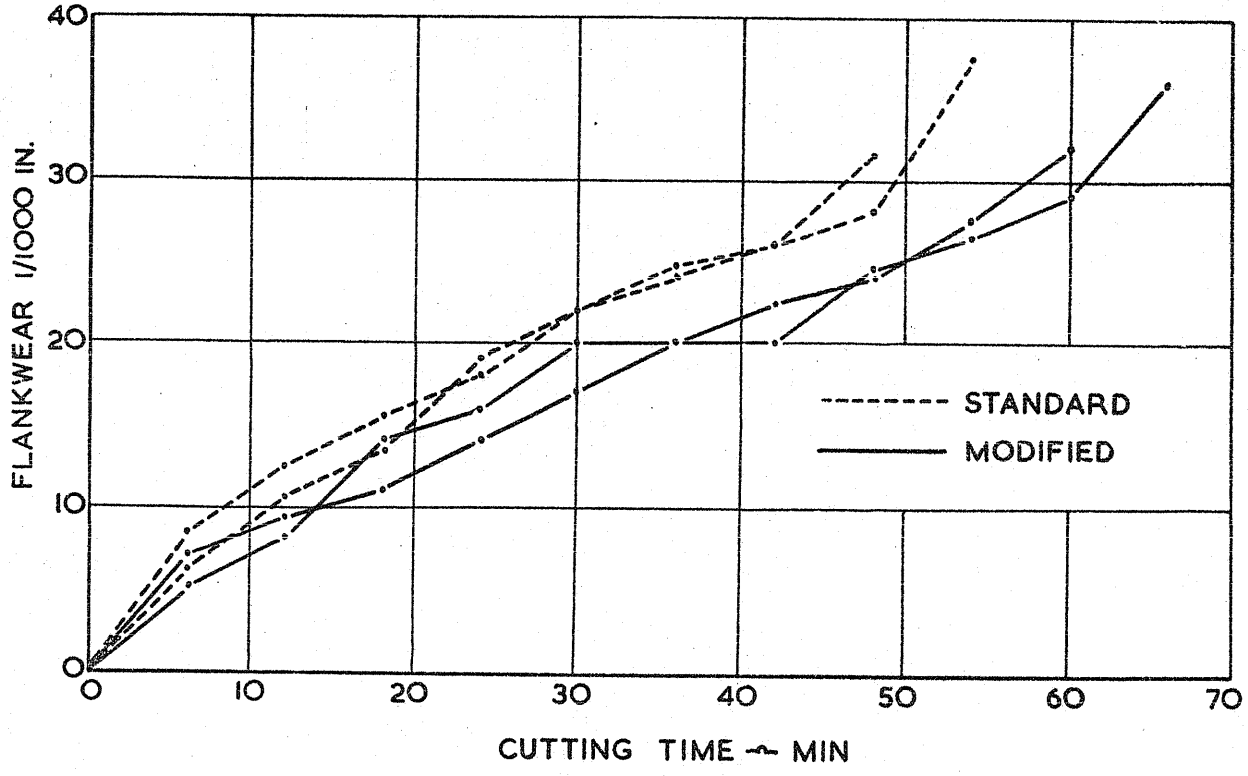

FLANKWEAR 1/1000 IN.
0
10
20
30
40
0
10
20
30
40
50
60
70
STANDARD
MODIFIED
CUTTING TIME — MIN

FIG. 4

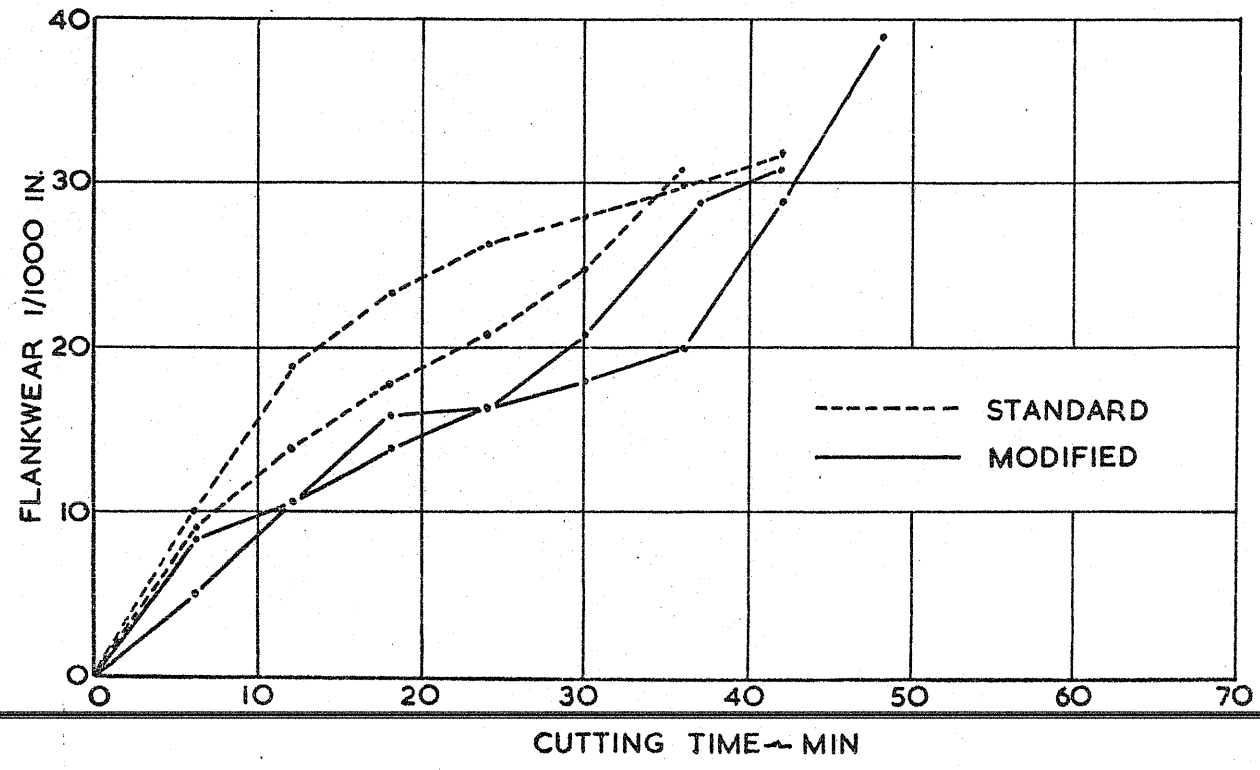

FLANKWEAR 1/1000 IN.
0
10
20
30
40
0
10
20
30
40
50
60
70
STANDARD
MODIFIED
CUTTING TIME — MIN

FIG. 5