TM 02.133
09-20-60

TECHNICAL MEMORANDUM

A
"LIFE OF MACHINE"
TUNGSTEN CARBIDE PUNCH AND DIE UNIT

by
Donald K. Rex
and
Donald W. Brearley

IBM CONFIDENTIAL

IBM
General Products Division
Development Laboratory
San Jose, California

TM 02.133
09-20-60

A

"LIFE OF MACHINE"

TUNGSTEN CARBIDE PUNCH AND DIE UNIT

by

Donald K. Rex & Donald W. Brearley

ABSTRACT

This paper deals with the development of a tungsten-carbide punch and die unit capable of punching 300 million acceptable quality holes before replacement is required. Punch and die units previously used have had an approximate life of only 30 million holes.

CONTENTS

ILLUSTRATIONS

CONTENTS

ILLUSTRATIONS

1.0 INTRODUCTION

A punch and die unit, fabricated of tungsten carbide, has been developed for use in the 11CD Reader/Punch unit presently being released from the San Jose Laboratory. This punch and die unit is capable of punching 300 million acceptable quality holes, and will conceivably last the lifetime of the average machine in which it is used.

Punch and die units used in production machines up to now have been fabricated from hardened steel. This material, hardened to Rockwell C62, has an approximate service life of 30 million holes. In normally anticipated use, this necessitates replacement of punch dies on almost a yearly basis. The resulting cost in machine down-time, labor, and replacement parts is quite significant.

Repeated attempts to fabricate punches and dies of tungsten carbide have been made during the past 25-30 years. The inherent difficulty of machining this material has up to now precluded its use in the fabrication of dies. Despite its characteristic hardness, and obvious application to die use, no practical method for fabrication of dies had been developed.

2.0 THE PROBLEM

The foremost difficulty in fabricating a carbide die lies in producing a die-hole with extremely close tolerance dimensions, having parallel sides and square corners. If the sides of the die are not parallel, the punch will either stick in the die, or the rate of wear will be excessive. If the corners in the die are not perfectly square, it will be extremely difficult to fit a punch to the hole. In working with carbide, it is not possible to "shear-in" either the punch or the die as is often done in steel die fabrication. Carbide, being extremely brittle, will chip if an oversized punch is forced into the hole.

Another problem arises if fillets are left in the die hole corners. In this event, a matching radius on the punch will have to fit the fillet. Such a matching technique would seem to be an impractical production operation. The tolerances in length and width dimensions are +.0002 in. and -.000 in., and a fillet with a radius of .0002 in. would not permit the fitting of a square cornered punch.

3.0 DESCRIPTION

The following is a description of the process used to fabricate a tungsten carbide, twelve-hole, serial punch and die unit, intended to be operated at 4800 punch strokes per minute.

The construction of a tungsten carbide punch has never presented any particular problems. In this case, a tungsten carbide tip was silver brazed to a hardened steel shank in much the same manner as a cutting edge is fastened to a carbide machine tool cutter. It was necessary only to perform final grinding operations after the tip had been brazed to the shank.

In the case of the die however, the old problems involved in attempting to form a die from a single piece of carbide were encountered. These problems were circumvented by avoiding the use of a solid piece of material, and building the die from a series of tungsten carbide blocks, locked by a pair of carbide rails. Careful grinding of the individual pieces made it possible to maintain the extremely close tolerances required in the die's application.

Two methods of final die construction were explored. The first consists of a brazing technique, followed by mechanical clamping of the blocks and rails. The second method involves cementing the blocks and rails together. Although the cementing process

promises to prove more practical for quantity production, the brazed and clamped technique was more thoroughly studied and was used in the 11CD Reader/Punch that was robot evaluated by the product testing department.

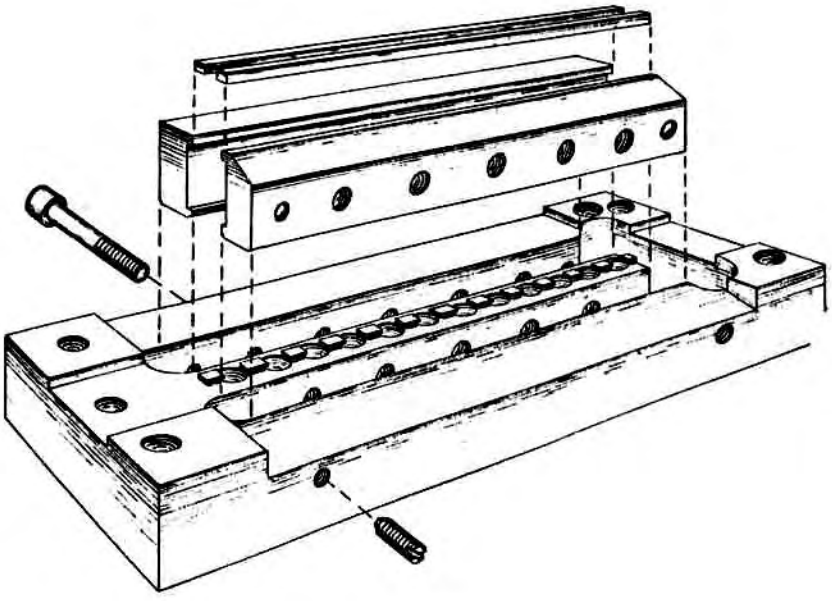
4.0 METHOD

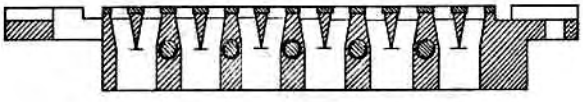
Figure 1 illustrates the silver brazing method of construction. Thirteen blocks of tungsten carbide are brazed to a single raised plateau on the main die block. Openings are ground between the blocks with a diamond wheel, to a dimension of .1250 in., +.0002, -.0000 in. The width of the blocks are similarly ground to a dimension of .0560 in., +.0002, -.0000 in.

Following this grinding operation, a flat bar of carbide is clamped to each side of the plateau. The final grinding operation finishes off the carbide surfaces and the die is complete.

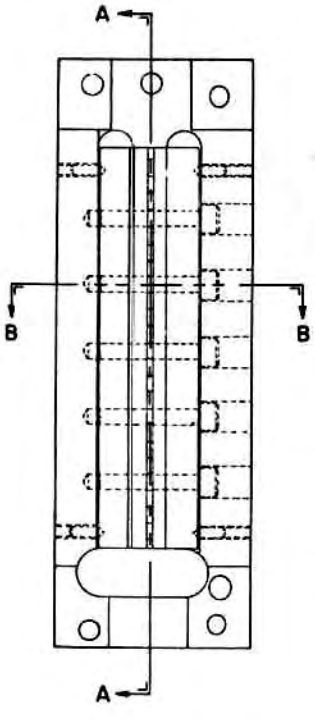
The same technique of fitting a punch to a die-hole that has been used in the past, is used in this type of construction. This is due to the close tolerances that must be maintained in the punch and die dimensions. The punches will be ground in a variety of sizes within the tolerance limits, and each die-hole will be fitted with a punch that will ensure proper clearance. Because of the absence of fillets in the die-hole, it is possible to get a true feel of the proper fitting square cornered punch.

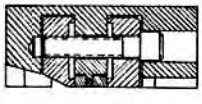
A punch and die unit built in this manner was operated in Product Testing over an extended period of time at 4800 punch strokes per minute. Crown-Zellerbach (tan-tone) card stock was used for the test. After 300 million holes were punched in a single position, the holes were still reasonably free of fuzz around the edges, and the general hole quality was still acceptable. This compares with a die life of only 30 million holes with an 024 key punch hardened steel punch and die unit.





SECTION A-A





SECTION B-B

Figure 1 Brazed and Clamped Method of Construction

Figure 2 illustrates the cemented method of construction. Thirteen carbide blocks are silver brazed to a flat bar of steel, forming a comb-like member. After the blocks are gang-finished to .0560 in., they can be stacked so that the .1250 dimensions can be ground on duplicate pieces as well. The comb member is placed (tines down) in a slot machined into the die base. Flat carbide blocks are then placed on each side of the comb, and a wedge driven between one of the blocks and a wall of the slot in the base. Epoxy adhesive is introduced between each of the mating surfaces during assembly, and the assembly is heat-cured to set the adhesive. The final operation consists of removing the steel back of the comb and grinding flat the outer carbide surface of the die.

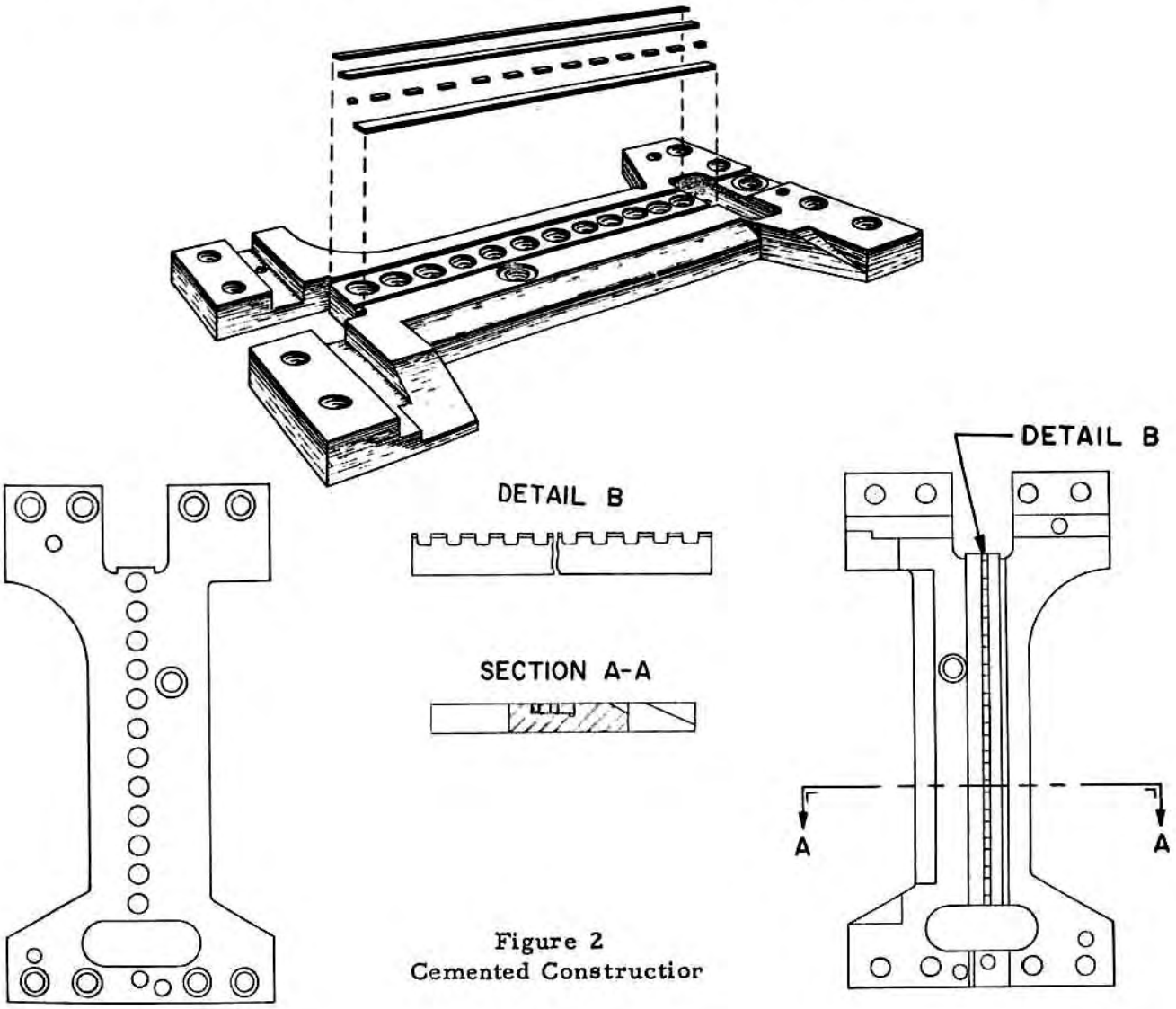


Figure 2
Cemented Constructior

5.0 CONCLUSIONS

Thorough testing has indicated that it is now practical to produce long-life tungsten carbide punch and die units. The anticipated life as shown by test results is approximately 10 times that of punch and die units presently being used. Although no attempt has been made to do so, it is reasonable to assume that an 80 hole parallel die could be practically fabricated in this manner.

It is estimated that cemented dies could be produced for approximately $15.00 each if 5000 were made over a period of 5 years. In the writers' opinion however, this low cost would be the only justification for modifying the brazed construction method.

IBM General Products Division Development Laboratory San Jose, California