UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

by

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AN IMPROVED MULTI-SAMPLE TURRET FOR THE VG MICRO MASS 54E MASS-SPECTROMETER

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INTRODUCTION

The introduction of multi-sample turrets for thermalionization mass spectrometers by Finnigan MAT, and VG Micromass, in 1978-79 was a major advance in the field of isotope measurement. These turrets permitted the computer-controlled, sequential analysis of up to 16 samples with only one pump-down cycle per turret, resulting in increases in throughput for such an instrument of a factor of 2 to 4.

In 1979, the Branch of Isotope Geology of the U.S. Geological Survey acquired a VG Micromass 54E,[1] mass spectrometer with a 16-sample turret. Because this instrument was the first of its generation, we found that the turret and filament-contactor design was less than ideal for our purposes. Most of the problems arose simply from the large number of parts (nearly 900) in the original design (figure 1) and the large number of electrical connections in both the contactor assembly and the filament-carrier assembly. In addition, the original design used Cathodeon glass beads for the filament supports, which seemed inherently incapable of yielding the ionization efficiency required for running refractory elements on triple-filament assemblies. As a result, we decided to completely redesign both the sample turret and the filament contactor assembly, so as fully exploit the other, state-of-the art features of the instrument such as its amenability to sophisticated computer control, its fast magnet, and its excellent ion optics.

GENERAL DESIGN GOALS

Because of the many mass spectrometers of National Bureau of Standards (NBS) design already in use by the Branch of Isotope Geology, we wished to preserve the NBS-style filament block. These filament blocks (figure 2) have the advantages of robustness, long life even with routine acid-washes, suitability for very-high temperature operation, and a high ionization-efficiency geometry for triple-filament operation.

The first design goal was to completely eliminate the presence of any wires or electrical connections from the entire turret/filament-block assembly. In the triple-filament configuration, this would mean the elimination of 256 individual parts. In order to do this, the filament-contactor assembly would have to be designed to make direct, high-current electrical contact with each of the 6 filament-posts of a triple-filament assembly. Though such a design would involve an integrated approach to the design of both the turret and contactor assembly, we found it useful to apportion the major design

[1]Use of manufacturer's name does not constitute endorsement of a product by the USGS.

responsibilities for the contactor to Winegarden, and the turret assembly to Okoren.

PART A: CONTACTOR ASSEMBLY

The contactor assembly must be easily removable and replaceable in the course of changing of turrets, yet retain precise alignment with the filament posts. Currents up to 6 amperes per filament must be reliably transferred to each filament of a sample assembly, so the electrical contacts with the filament posts must be reliable and possess a very low resistance.

Our final design to satisfy these requirements is shown in figures 3, 4, and 5. Electrical contacts are made by passing each of the 6 filament posts between 2 beryllium-copper strips that are rigidly aligned with machinable ceramic pieces. The contact strips are constructed with small flared "ears" on their leading and trailing edges so as to guide any misaligned filament-posts into the correct contact geometry.

The 3 pairs of contact strips all lie on a slightly different radius of rotation so that the the filament posts will pass through them with as little drag as possible (figure 6). The thickness (and so stiffness) and length of protrusion above the ceramic holders are critical parameters in obtaining the best combination of low drag and good contact. As might be expected, the best combination of these parameters was determined by trial-and-error.

The complete filament-contactor assembly slides on and off a rigid, bronze bushed, precisely aligned, 2-pin mount attached to the base-plate for the turret (figures 7, 8), and the electrical contacts from the contactor assembly are made by a 6-pin, push-on assembly. Thus when changing turrets, the contactor assembly is simply pulled away from the base-place without the necessity for the removal or installation of a single nut or bolt.

Though the contactor assembly does have some tolerance for slightly-misaligned filament posts, it is still necessary to have the filament posts be in a reproducible geometry to avoid bending the posts as they pass through the contactor. To avoid subjecting the operator to a tedious process of aligning by eye, we designed an aligning jig to permit rapid and precise filament-post alignment of the filament posts of the filament blocks in a fully-assembled, loaded turret. This jig (figure 9) is used by first performing an approximate straightening by simply rotating the loaded turret through the staggered-pin aligner (figure 10), then a more precises straightening by pressing another aligning tool over each filament block. The latter step is necessary only for triple-filament assemblies.

PART B: THE TURRET ASSEMBLY

The turret assembly (figures 11, 12) is drastically simplified compared to the original design (now 25 parts including the 16 filament blocks, compared to the nearly 900 for the original design). Most of these parts are produced by a computer-controlled milling machine that gives us the capability to integrate many design features into each of the major parts, and also along with shorter manufacturing time, allowed us to hold a very high degree of accuracy in machining tolerances.

The turret itself consists of a shallow cylinder with 16 cylindrical holes in which the filaments are contained, and 2 tapered guide-pins for each filament block. The 16 filament blocks are held rigidly in place by a single retaining plate with 2 spring-loaded fingers for each block. This retaining plate is pressed onto the filament blocks by the same jig (figure 13) used to align the filament posts, then held in place by 2 large L-shaped steel pins. The 16 collimating slits which sit directly above the center filaments were combined into a single ring plate held onto the bottom of the turret by 4 small screws and aligned by two dowell-pins. This plate can be routinely acid-washed between turret-loads, of course.

The result is an extremely simple assembly that requires very little manual dexterity or time on the part of the operator, and consists of a minimum number of parts. Because of the ease with which the computer-controlled milling machine can produced these parts, we have been able to provide each research group involved with the instrument with at least one complete turret-assembly with a minimum amount of shop time.

Detailed drawings by Gary Okoren of all parts of the contactor and turret assembly are provided in Drawings 1-5.

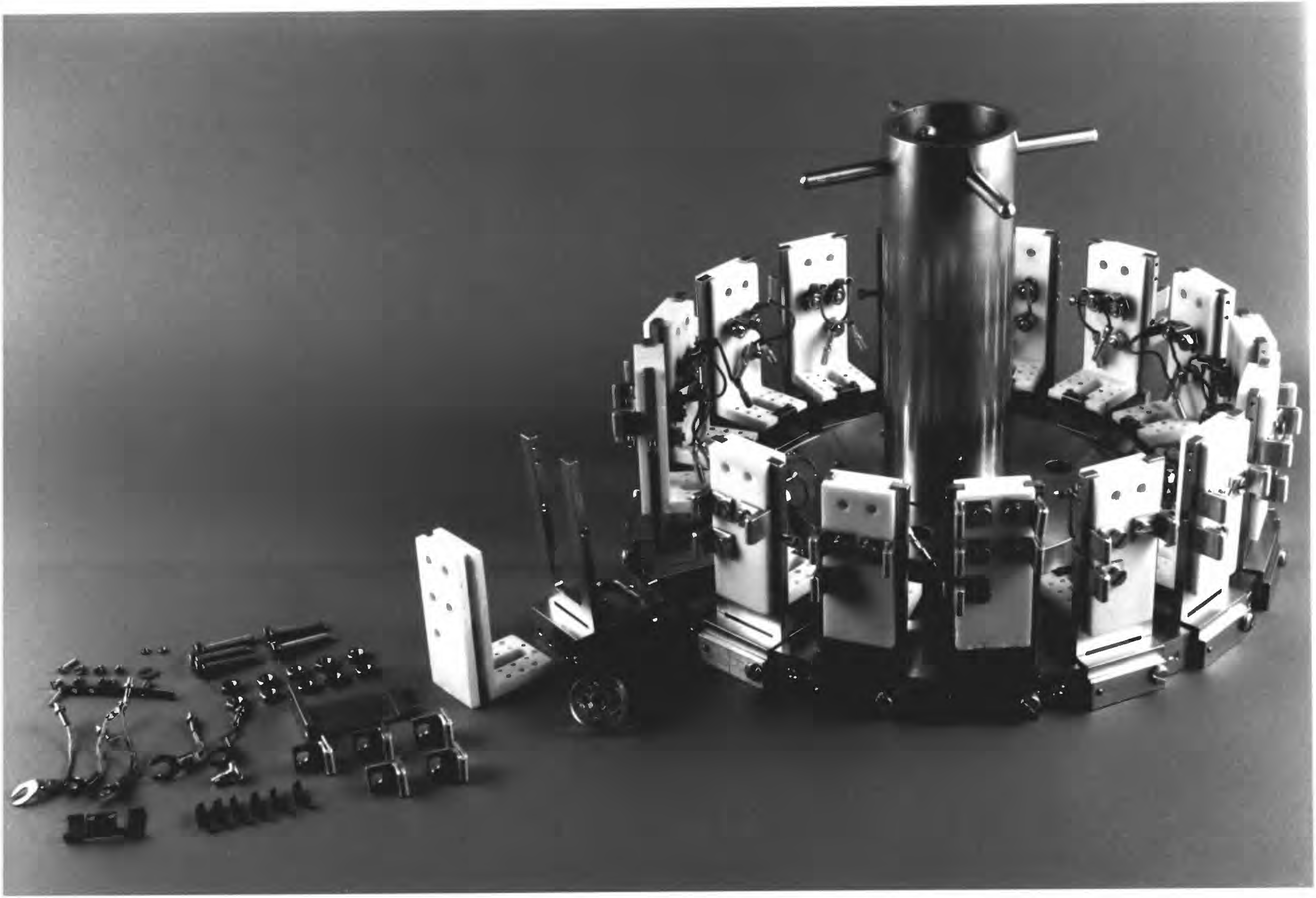

Figure 1. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer
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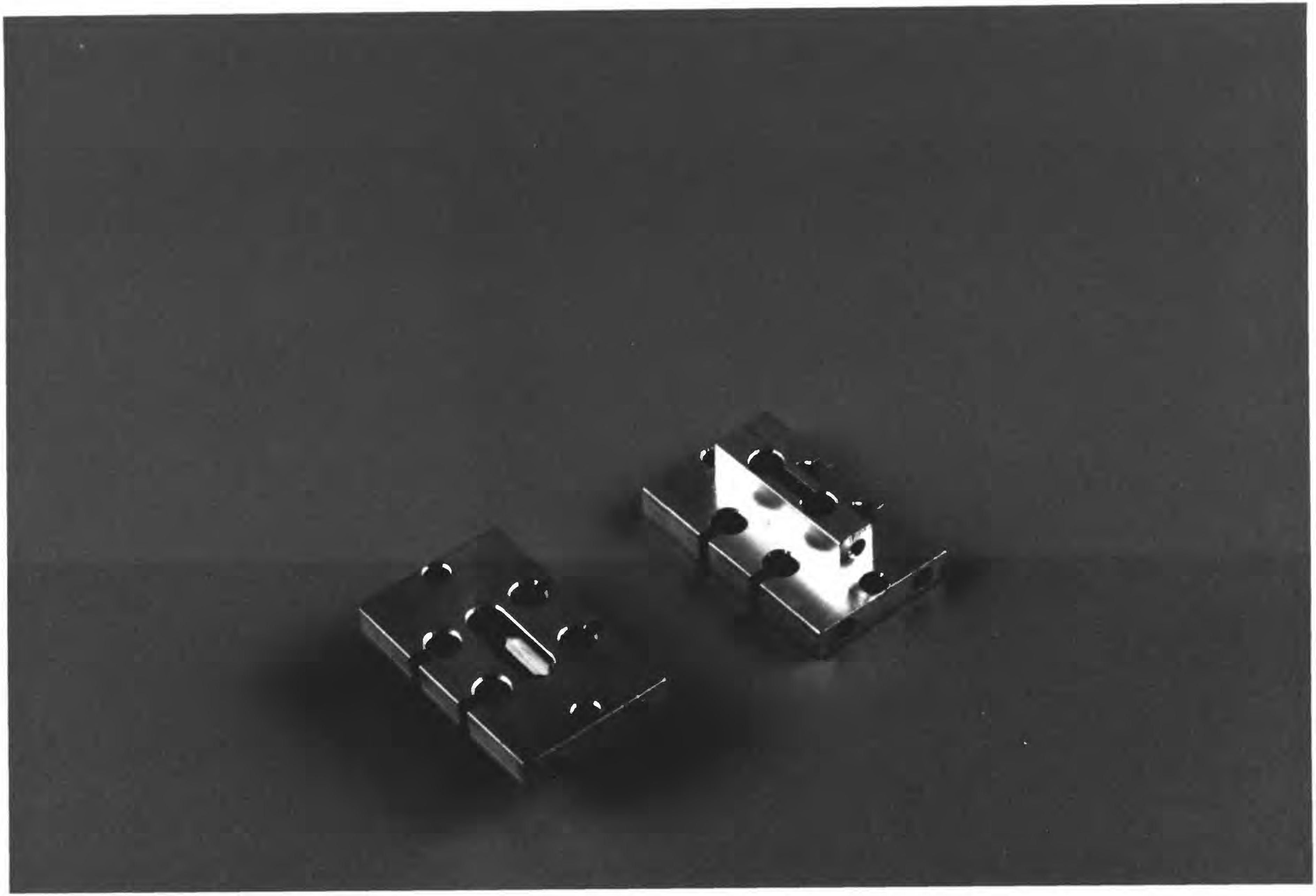

Figure 2. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

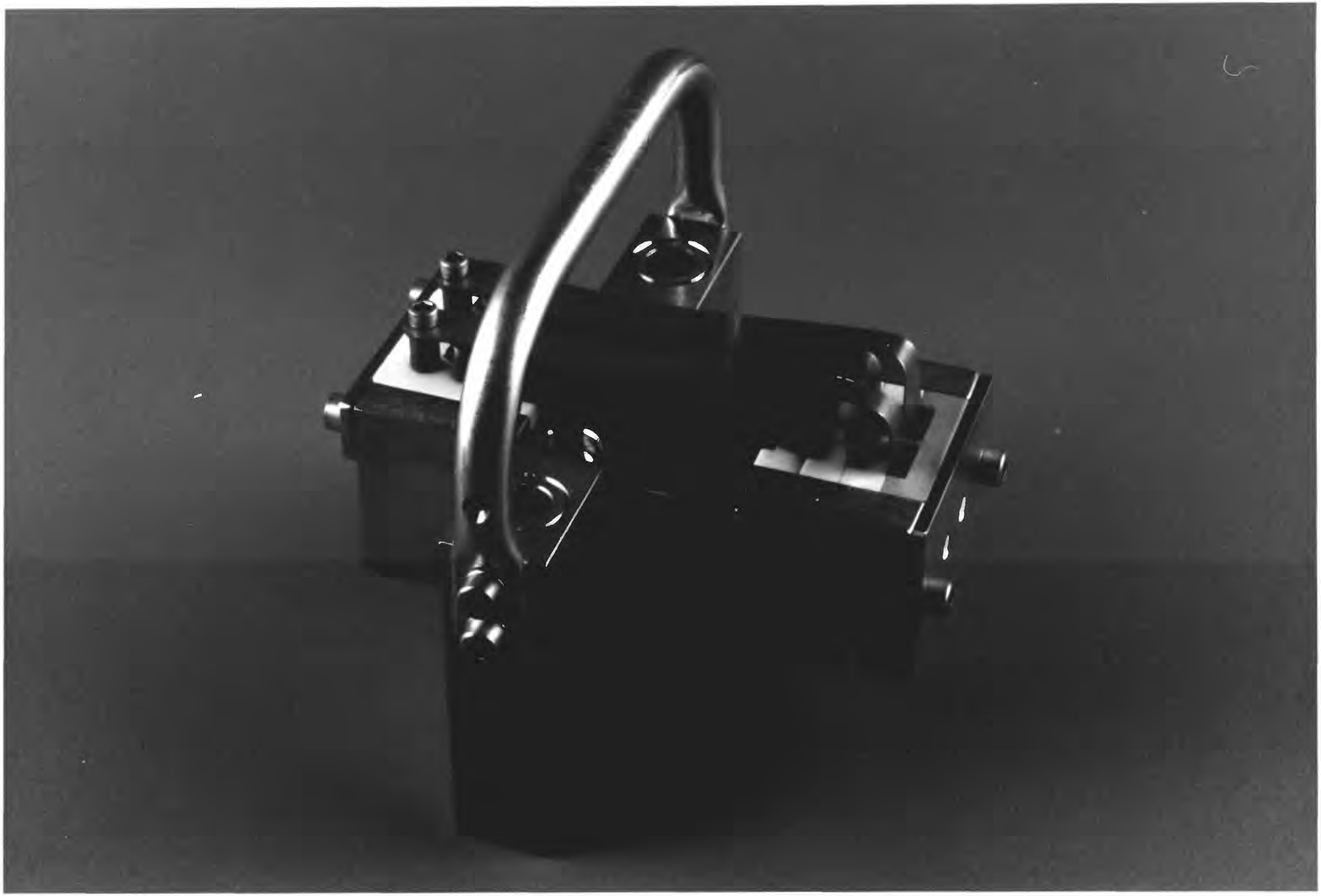

Figure 3. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer
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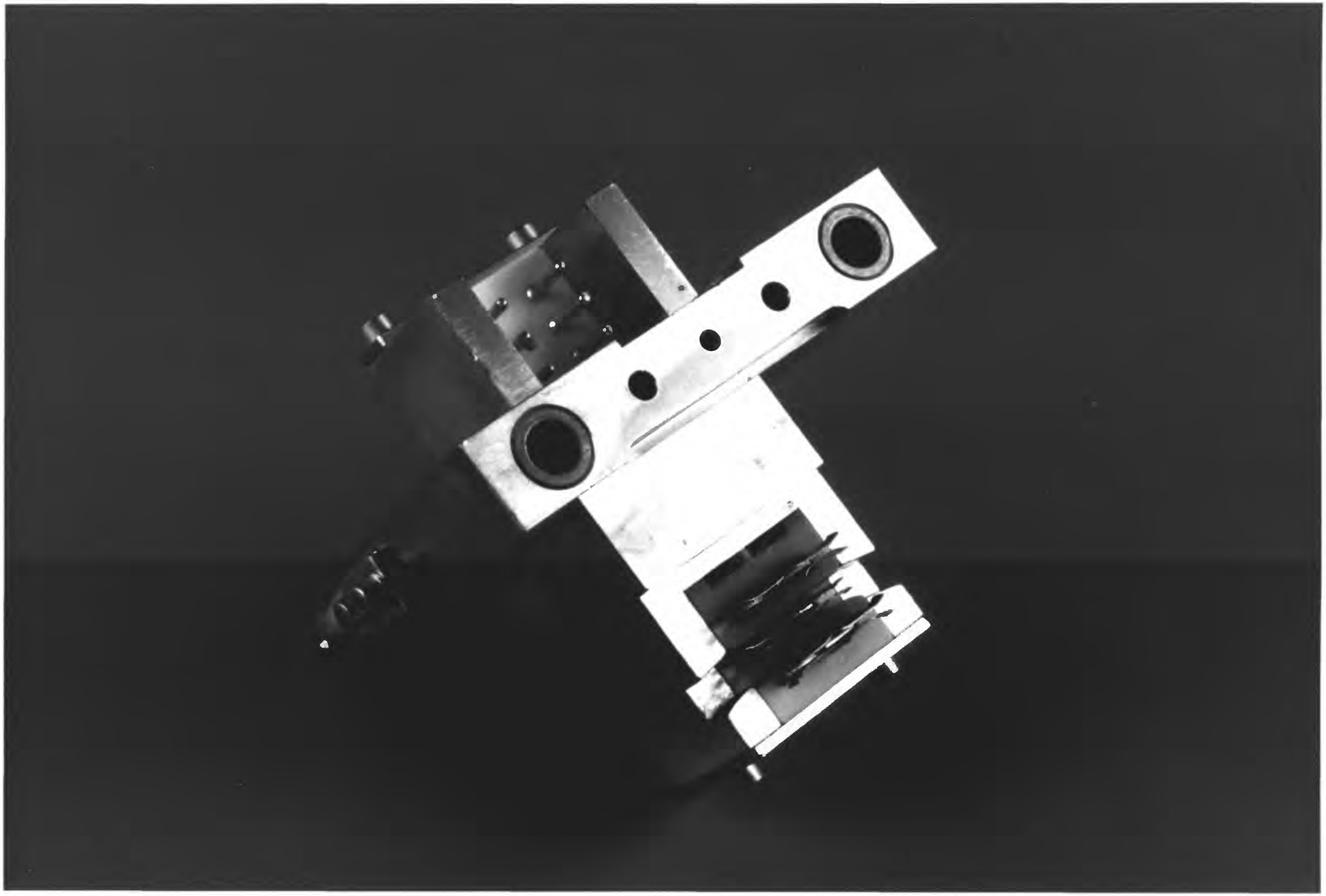

Figure 4. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer
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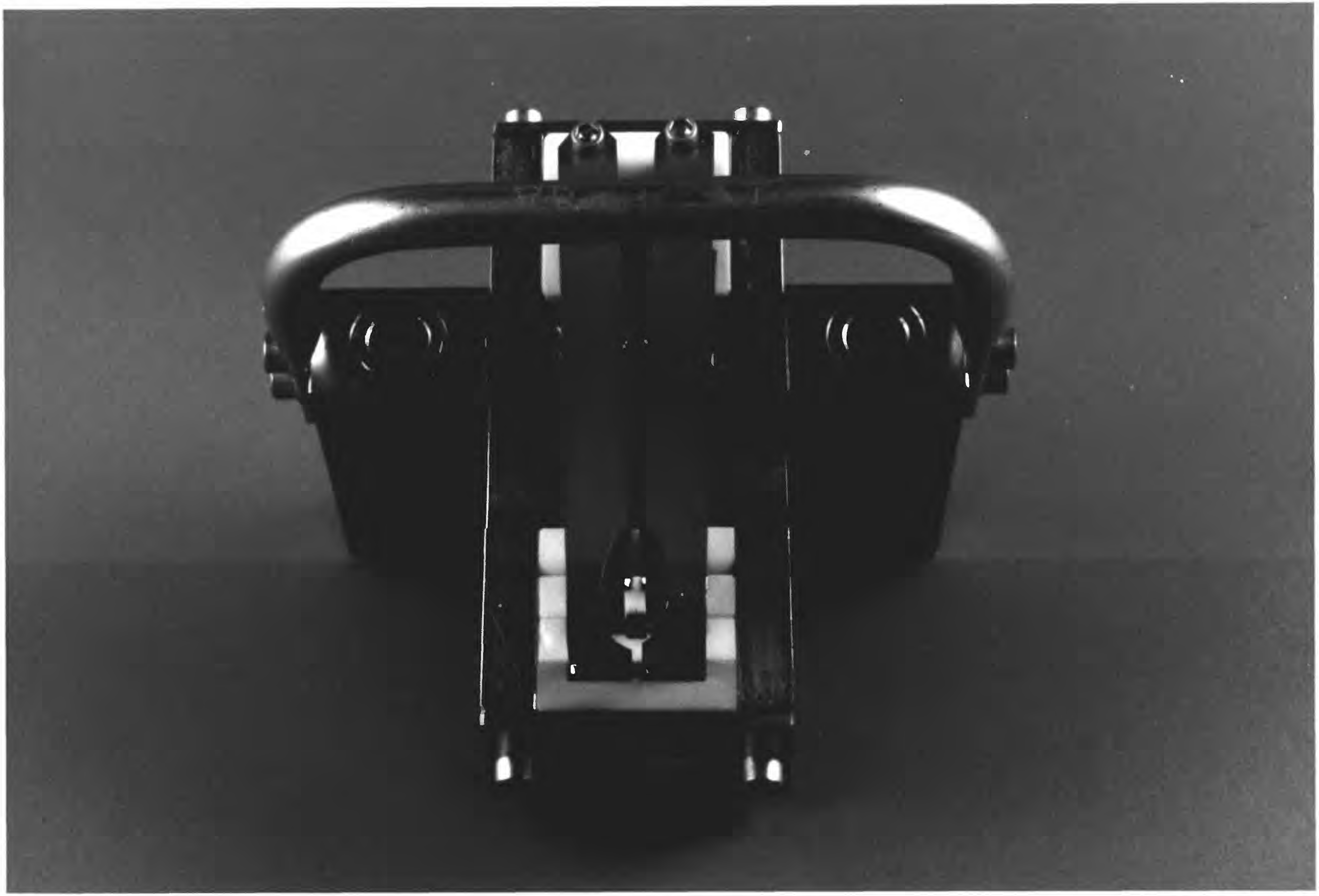

Figure 5. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

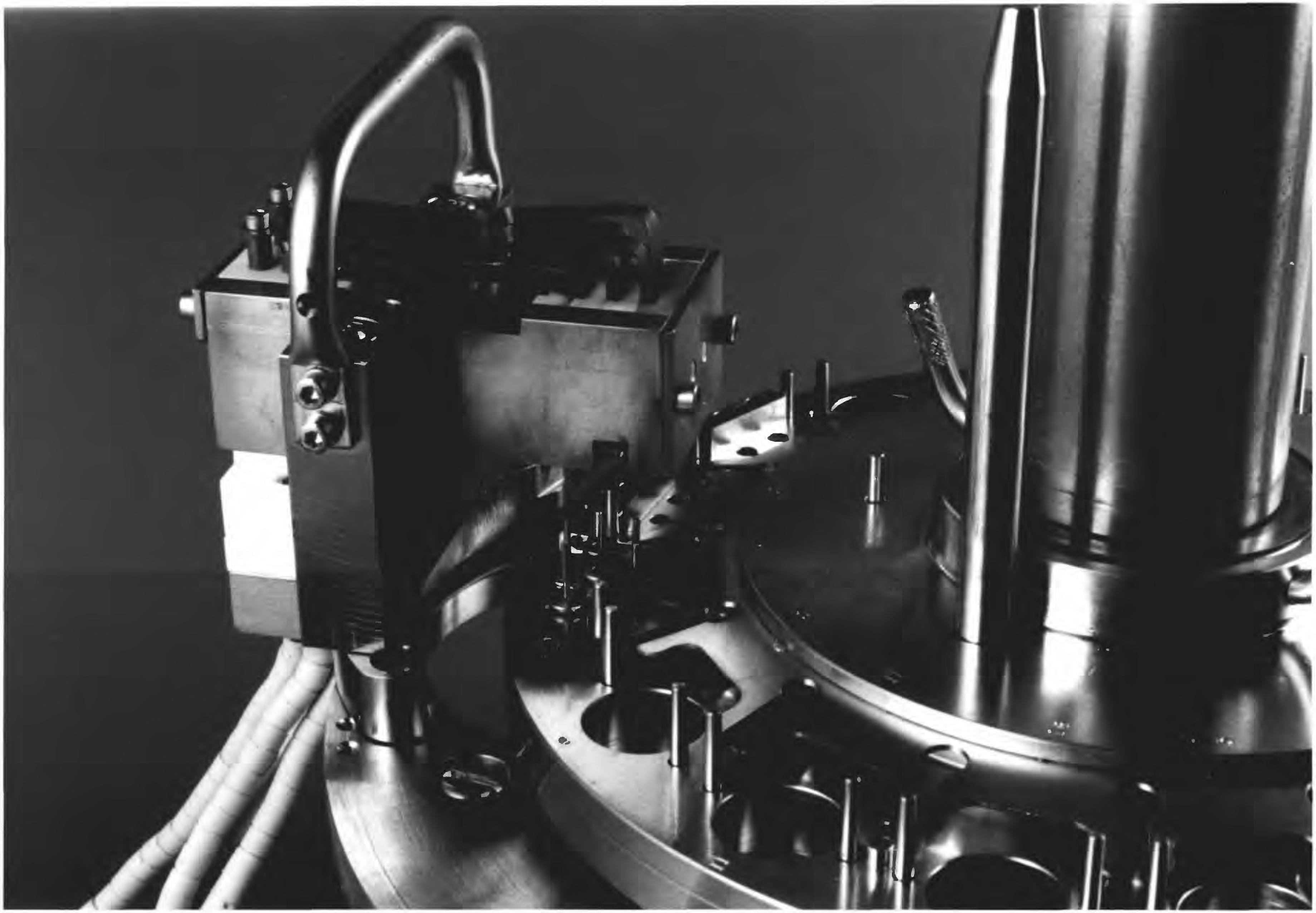

Figure 6. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

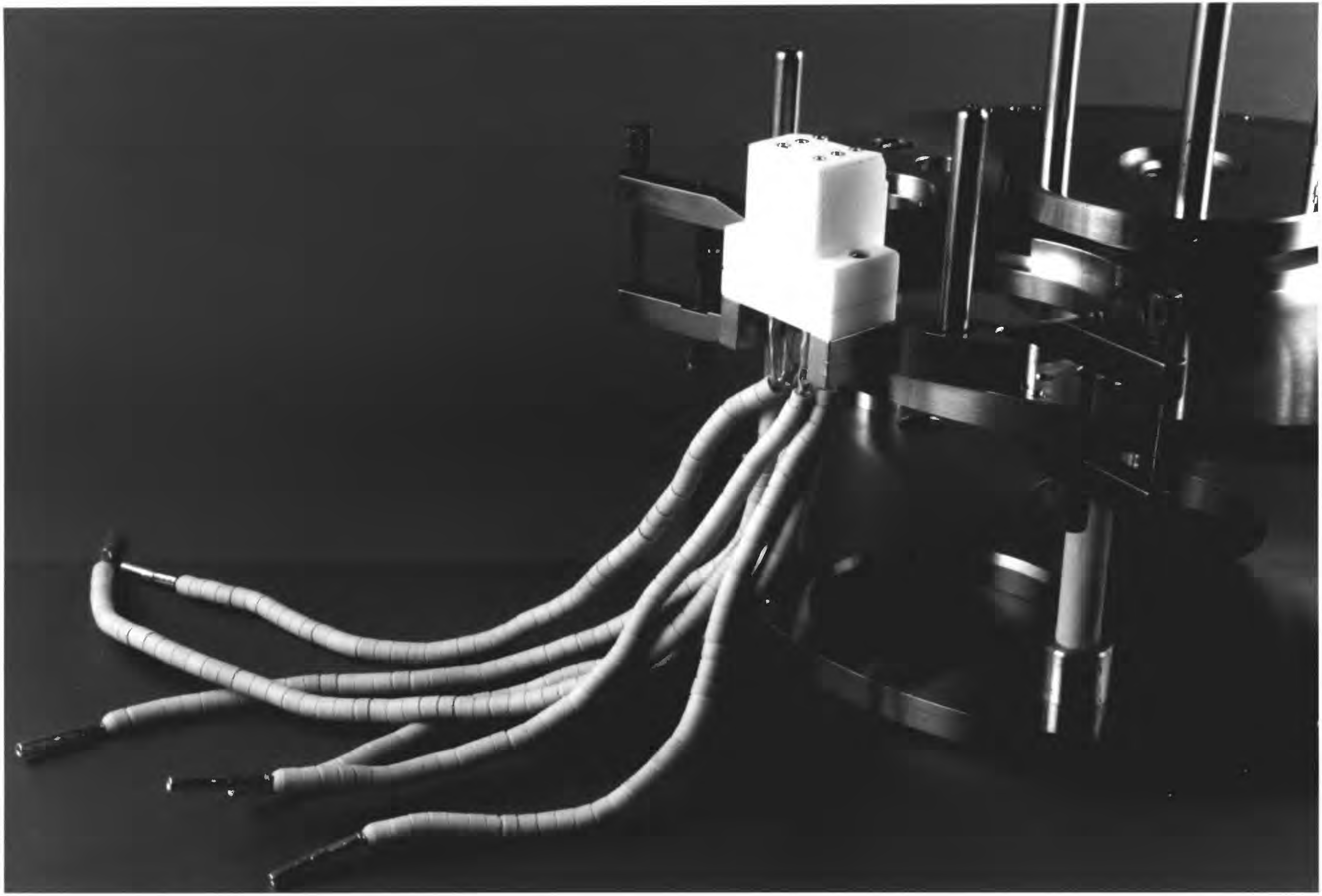

Figure 7. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

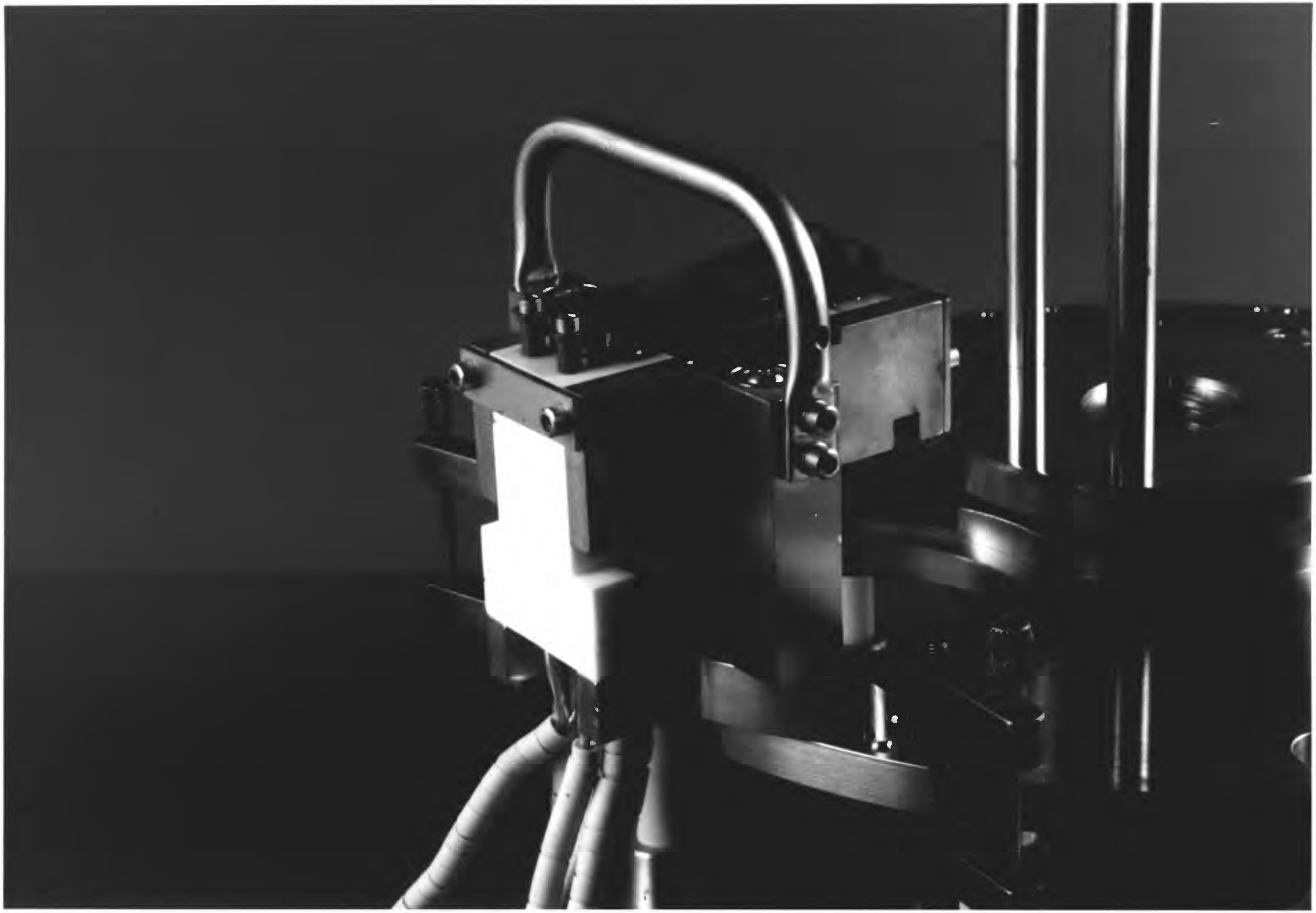

Figure 8. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer
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Figure 9. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

Figure 10. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

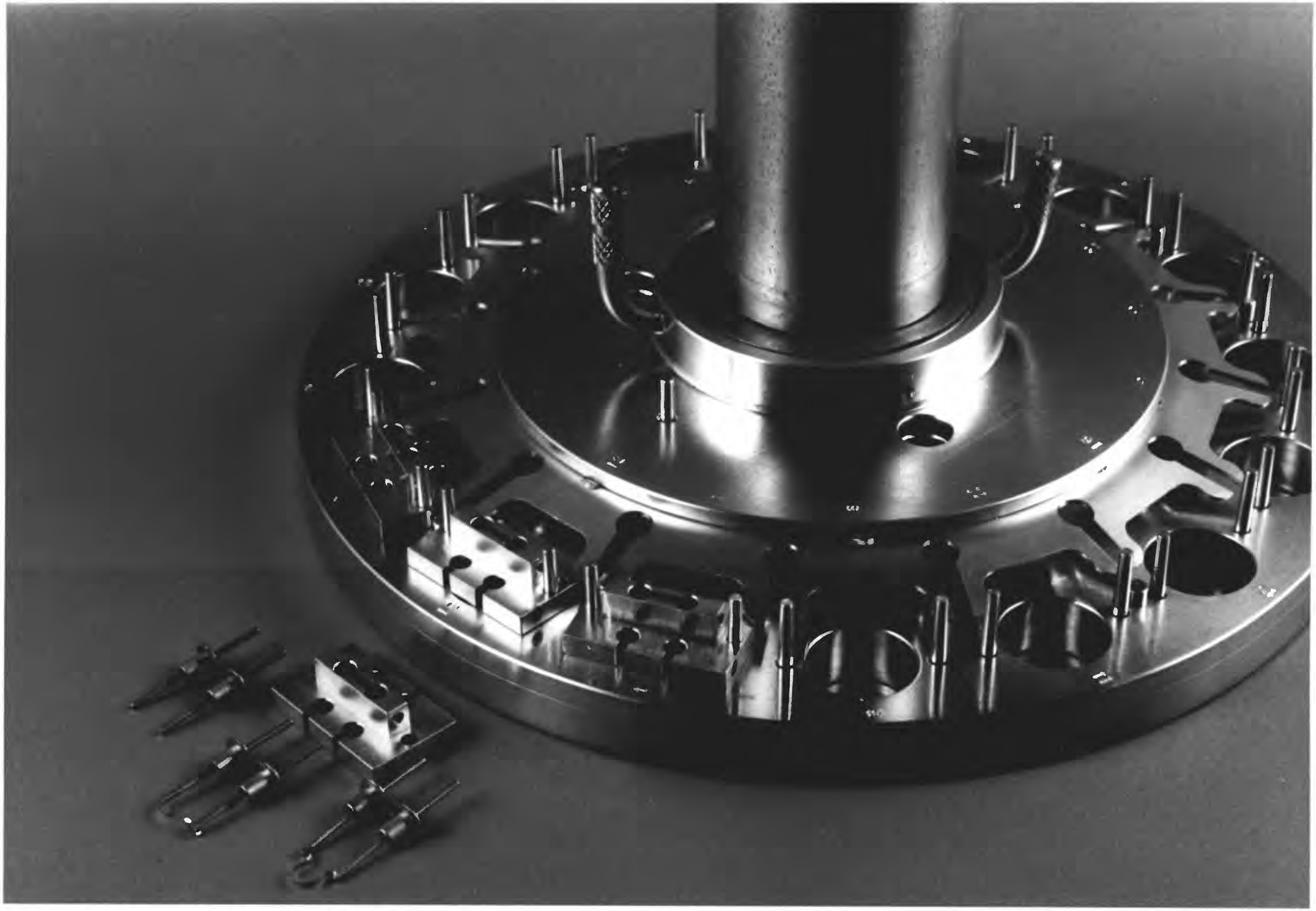

Figure 11. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

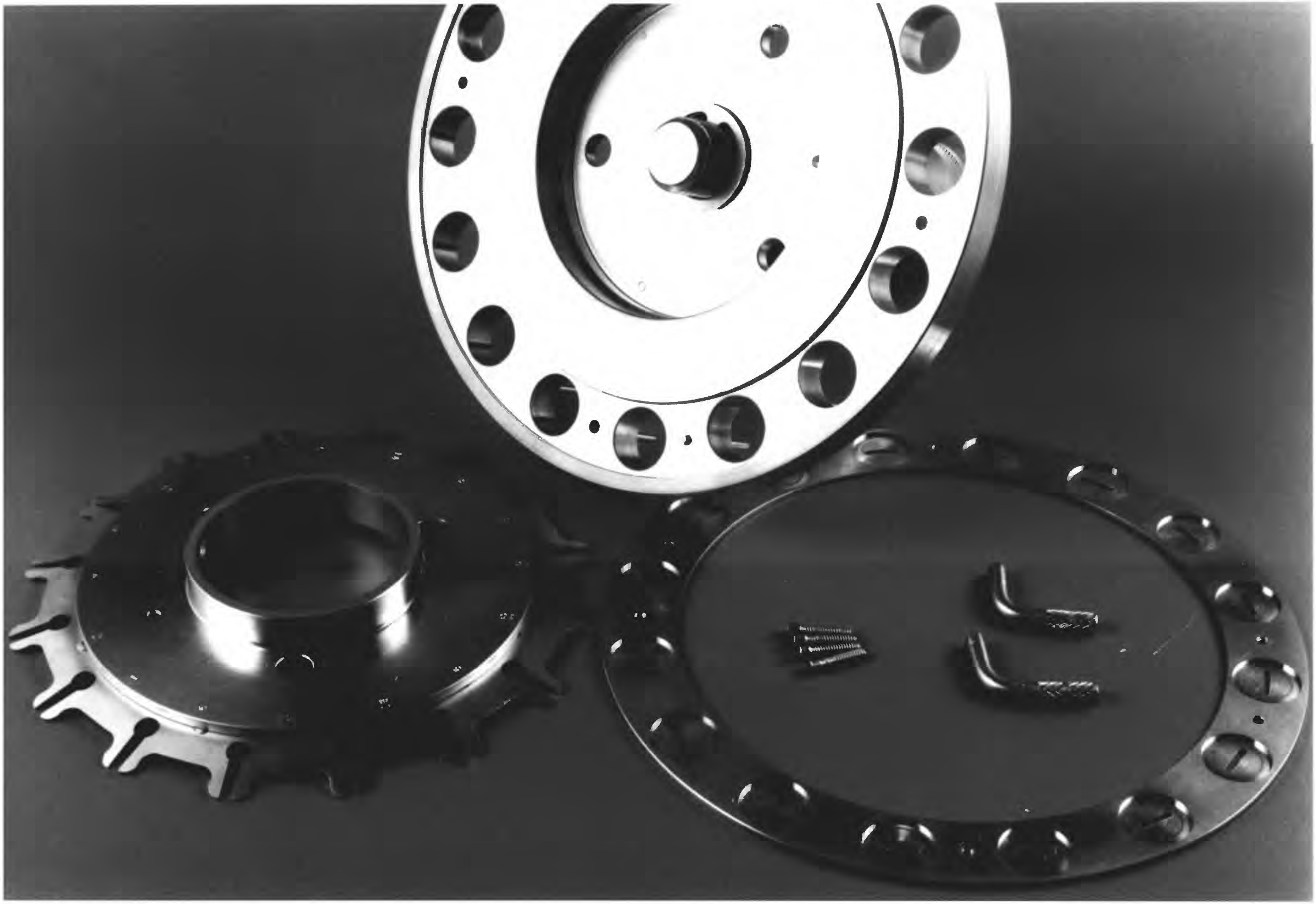

Figure 12. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer

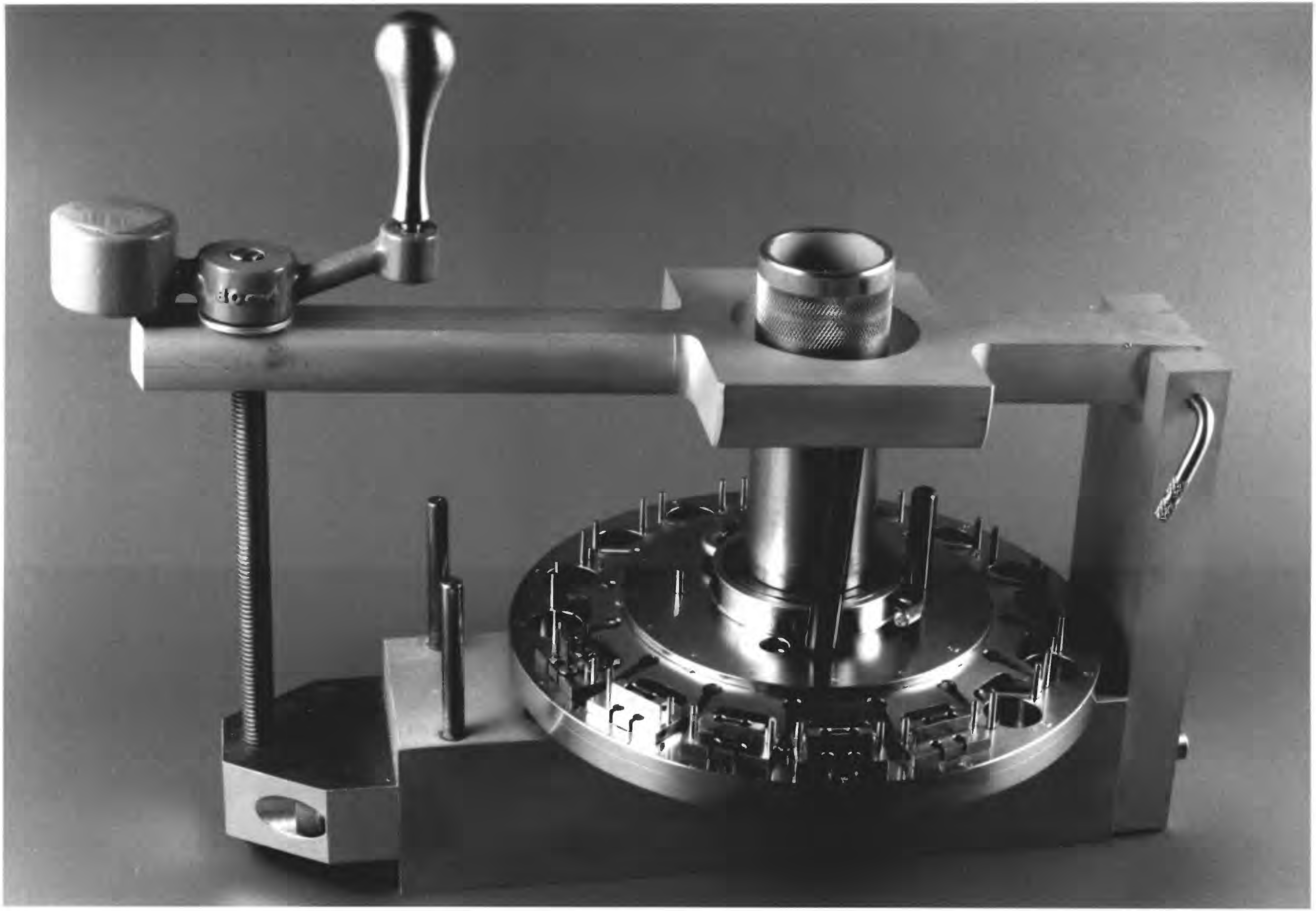

Figure 13. An Improved Multi-Sample Turret for the VG Micro Mass 54E Mass-Spectrometer