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ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 841

AXIS AND MOTION NOMENCLATURE

FOR NUMERICALLY CONTROLLED MACHINES

1st EDITION

October 1968

For each individual country the only valid standard is the national standard of that country.

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BRIEF HISTORY

The ISO Recommendation R 841, *Axis and motion nomenclature for numerically controlled machines*, was drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, the Secretariat of which is held by the United States of America Standards Institute (USASI).

Detailed work on this question by the Technical Committee led, in 1967, to the adoption of a Draft ISO Recommendation.

In August 1967, this Draft ISO Recommendation (No. 1315) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Italy	Sweden
Belgium	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	Turkey
Denmark	Netherlands	U.A.R.
France	New Zealand	United Kingdom
Germany	Poland	U.S.A.
Iran	Portugal	
Israel	Spain	

No Member Body opposed the approval of the Draft.

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in October 1968, to accept it as an ISO RECOMMENDATION.

ISO Recommendation	R 841	October 1968

AXIS AND MOTION NOMENCLATURE

FOR NUMERICALLY CONTROLLED MACHINES

1. SCOPE

1.1 This ISO Recommendation for axis and motion nomenclature for numerically controlled machines is intended to simplify programming and to facilitate the interchangeability of recorded data.

1.2 This ISO Recommendation applies to all numerically controlled machines.

NOTE. For the sake of simplicity, the majority of the text of this ISO Recommendation is written in terms which are applicable to machine-tools but it is nevertheless applicable to numerically controlled machines in general.

1.3 The technical terms used in this ISO Recommendation are based on the data processing vocabulary ISO/R . . .*.

2. PRINCIPLES USED TO NAME MACHINE MOVEMENTS
BASED ON A STANDARD COORDINATE SYSTEM

2.1 This ISO Recommendation names a coordinate system and the machine movements so that a programmer can describe the machining operations without having to know whether the tool approaches the workpiece or the workpiece approaches the tool. He will always assume that the tool moves relative to the coordinate system of the stationary workpiece as defined in clause 2.2.

2.2 The standard coordinate system is a right-handed rectangular Cartesian one, related to a work-piece mounted in a machine and aligned with the principal linear slideways of that machine.

2.3 The positive direction of movement of a component of a machine is that which causes an increasing positive dimension on the workpiece.

2.4 When the machine is used for drilling or boring (using only its three principal linear movements), movement in the negative Z direction will drill or bore into the workpiece.

2.5 When the machine cannot be so used for drilling or boring, special rules are provided to minimize inconsistencies on multipurpose machines.

2.6 On the schematic drawings of the machines, an unprimed letter is used when a tool movement is being dealt with. When a workpiece movement is being dealt with, a primed letter is used and the positive direction of this movement is opposite to the corresponding unprimed letter movement (see section 10).

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* Now being drafted within Sub-Committee ISO/TC 97/SC 1, *Vocabulary*.

3. THE Z AXIS OF MOTION

3.1   The Z axis of motion is (except as described in clause 3.6) identified by reference to a spindle which imparts cutting power.

   3.1.1   In the case of machines such as milling, boring and tapping machines, this spindle rotates the tool.

   3.1.2   In the case of machines such as lathes, grinding machines and others which generate a surface of revolution, this spindle rotates the work.

3.2   If there are several spindles, one should be selected as the principal spindle, preferably one perpendicular to the work-holding surface.

3.3   If the principal spindle axis remains constantly parallel to one of the three axes of the standard three-axis system, this axis is the Z axis.

3.4   If the principal spindle axis can be swivelled and if the extent of its motion allows it to lie in only one position parallel to one of the axes of the standard three-axis system, this standard axis is the Z axis.

3.5   If the extent of the swivelling motion is such that the principal spindle may lie parallel to two or three axes of the standard three-axis system, the Z axis is the standard axis which is perpendicular to the work-holding surface of the work-table of the machine, ignoring such ancillaries as angles or packing pieces.

3.6   If there is no spindle, the Z axis is perpendicular to the work-holding surface.

3.7   Positive Z motion increases the clearance between the workpiece and the tool-holder.

4. THE X AXIS OF MOTION

4.1   Where it is possible, the X axis of motion is horizontal and parallel to the work-holding surface. It is the principal axis of motion in the positioning plane of the tool or workpiece.

4.2   On machines with non-rotating workpieces and non-rotating tools (e.g. shapers), the X axis is parallel to, and positive in, the principal direction of cutting.

4.3   On machines with rotating workpieces (lathes, grinding machines, etc.), X motion is radial and parallel to the cross slide. Positive X motion occurs when a tool, mounted on the principal tool post position of the cross slide, recedes from the axis of rotation of the workpiece.

4.4   On machines with rotating tools (milling machines, etc.) :

   4.4.1   If the Z axis is horizontal, positive X motion is to the right when looking from the principal tool spindle towards the workpiece.

   4.4.2   If the Z axis is vertical, positive X motion is to the right for single column machines when looking from the principal tool spindle to the column, and for gantry type machines when looking from the principal spindle to the left-hand gantry support.

5. THE Y AXIS OF MOTION

Positive Y motion should be selected to complete with the X and Z motions a right-hand Cartesian coordinate system (see Fig. 1).

6. ROTARY MOTIONS A, B AND C

6.1   A, B and C define rotary motions about axes respectively parallel to X, Y and Z.

6.2   Positive A, B and C are in the directions to advance right-hand screws in the positive X, Y and Z directions respectively (see Fig. 1).

7. THE ORIGIN OF THE STANDARD COORDINATE SYSTEM

7.1   The location of the origin (X = 0, Y = 0, Z = 0) of the standard coordinate system is arbitrary.

7.2   The origins of the A, B and C motions are likewise arbitrary; they are selected, preferably, parallel respectively to the axes Y, Z and X.

8. ADDITIONAL AXES

8.1   Linear motion

8.1.1   If, in addition to the primary slide motions X, Y and Z, there exist secondary slide motions parallel to these, they should be designated U, V and W, respectively. If tertiary motions exist, they should be designated P, Q and R, respectively. If linear motions exist which are not or may not be parallel to X, Y or Z, they may be designated U, V, W, P, Q or R, as is most convenient.

In a boring mill the movement of the cutting-bit with respect to a facing slide is designated U or P, if these letters are available, the movement of the table already having been designated X; in fact, the cutting-bit movement, although close to the spindle, is an oblique movement. The origin and the direction are specified in the same way as that in clause 4.1.

8.1.2   Preferably the primary linear motions are those nearest the principal spindle, the secondary linear motions are those next nearest and the tertiary linear motions are the farthest from the spindle. (But see section 11).

Examples :

(*a*)   Radial drilling machine : motion of the spindle quill and that of the arm on the column are designated by Z and W respectively.

(*b*)   Turret lathe : motion of the tool slide and of the turret slide, which is farther from the spindle, are designated Z and W, respectively.

8.2   Rotary motion

If, in addition to the primary rotary motions A, B and C, there exist secondary rotary motions, whether parallel or not to A, B and C, they should be designated D or E.

9. DIRECTION OF SPINDLE ROTATION

Clockwise spindle rotation is in the direction to advance a right-handed screw into the workpiece.

10. REVERSED DIRECTIONS FOR MOVING WORKPIECES

If a machine element moves the workpiece instead of the tool, it must respond to the tape in the opposite direction to that defined above for moving the tool. In illustrating various machines, an arrow with a primed letter, such as + X', is the direction of motion of a moving workpiece, for a command calling for positive motion, while an arrow with an unprimed letter, such as + X is the direction of motion (for the same positive command) of the tool with respect to the workpiece (see clause 2.6).

11. SCHEMATIC DRAWINGS OF MACHINES

11.1 The schematic drawings of machines appended to this ISO Recommendation are the official interpretation for those machines.

11.2 The schematic drawings indicate by letters the axes of motion and by arrows the positive directions.

11.3 The coordinate system indicated on each schematic drawing makes part programming easier. The coordinates appear there in the same way as on the drawing of the part.
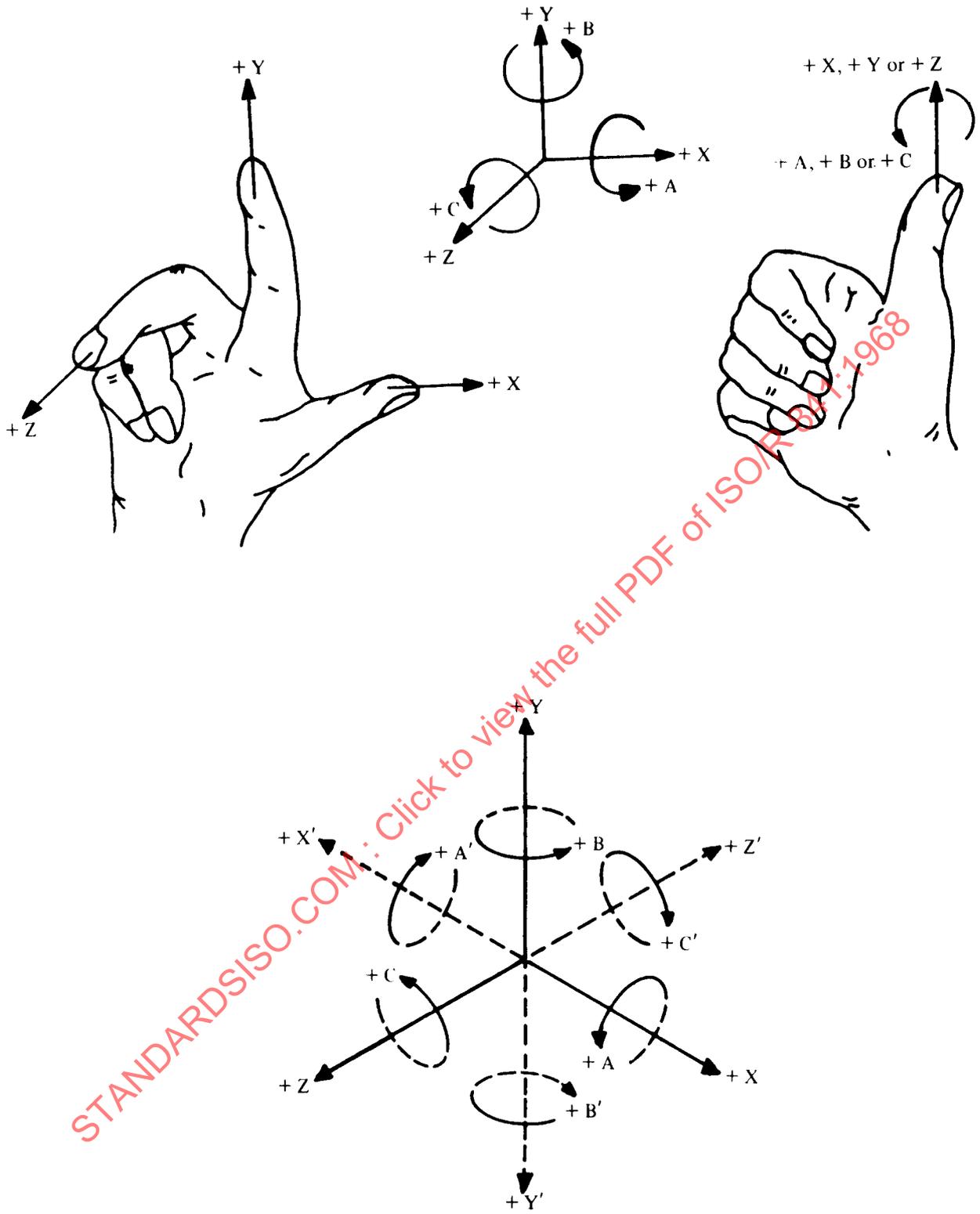
FIG. 1 — Right-hand coordinate system
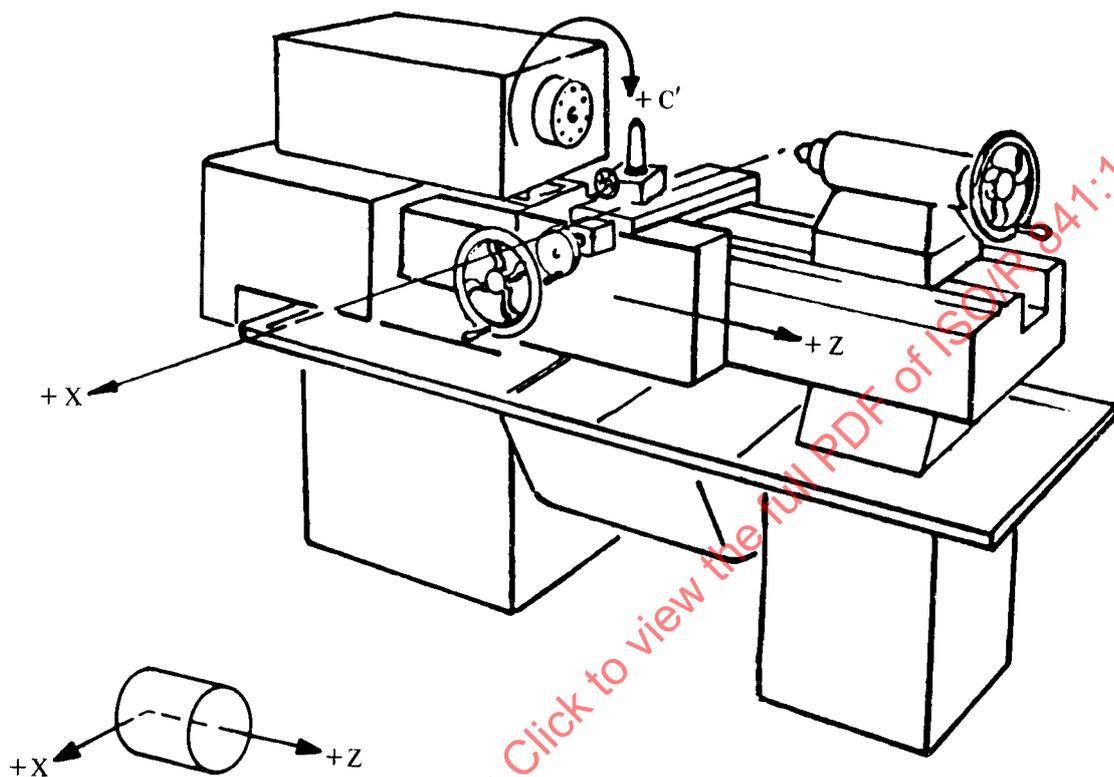
FIG. 2 — Engine lathe
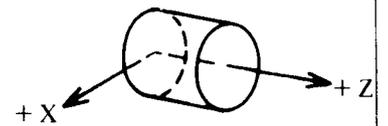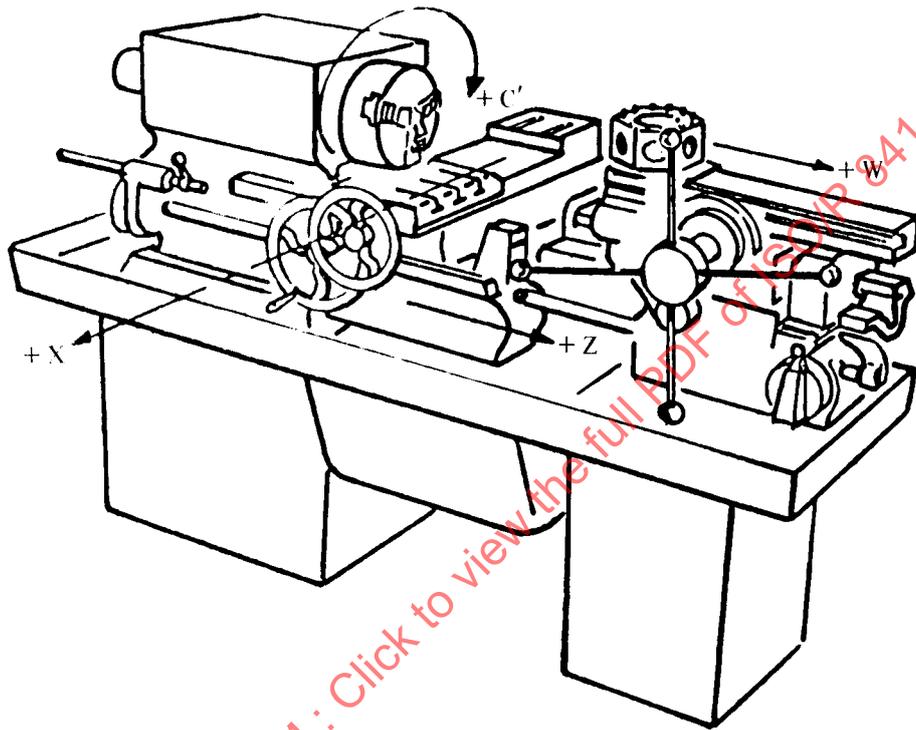
FIG. 3 — Turret lathe
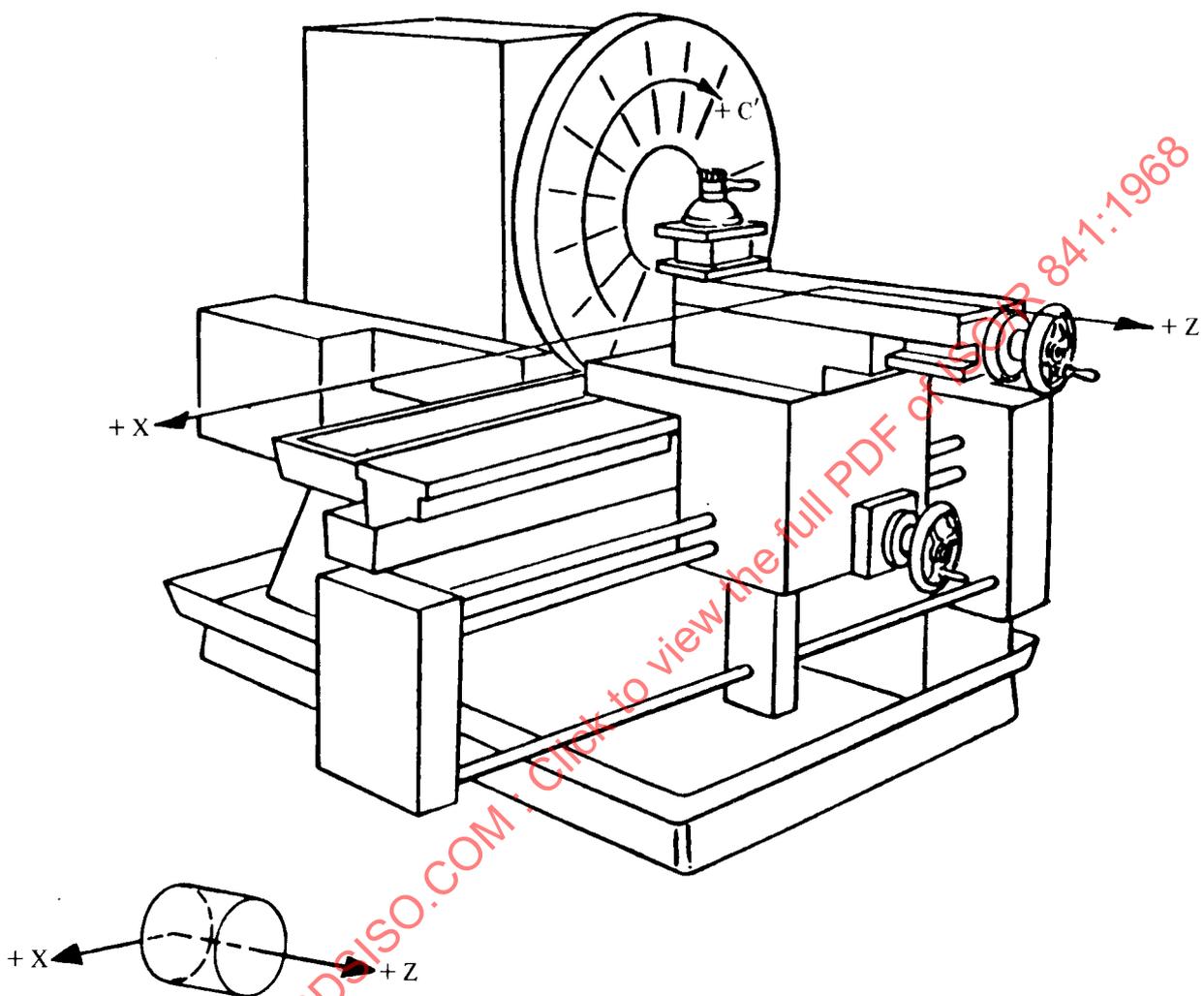
FIG. 4 — **Right angle lathe**
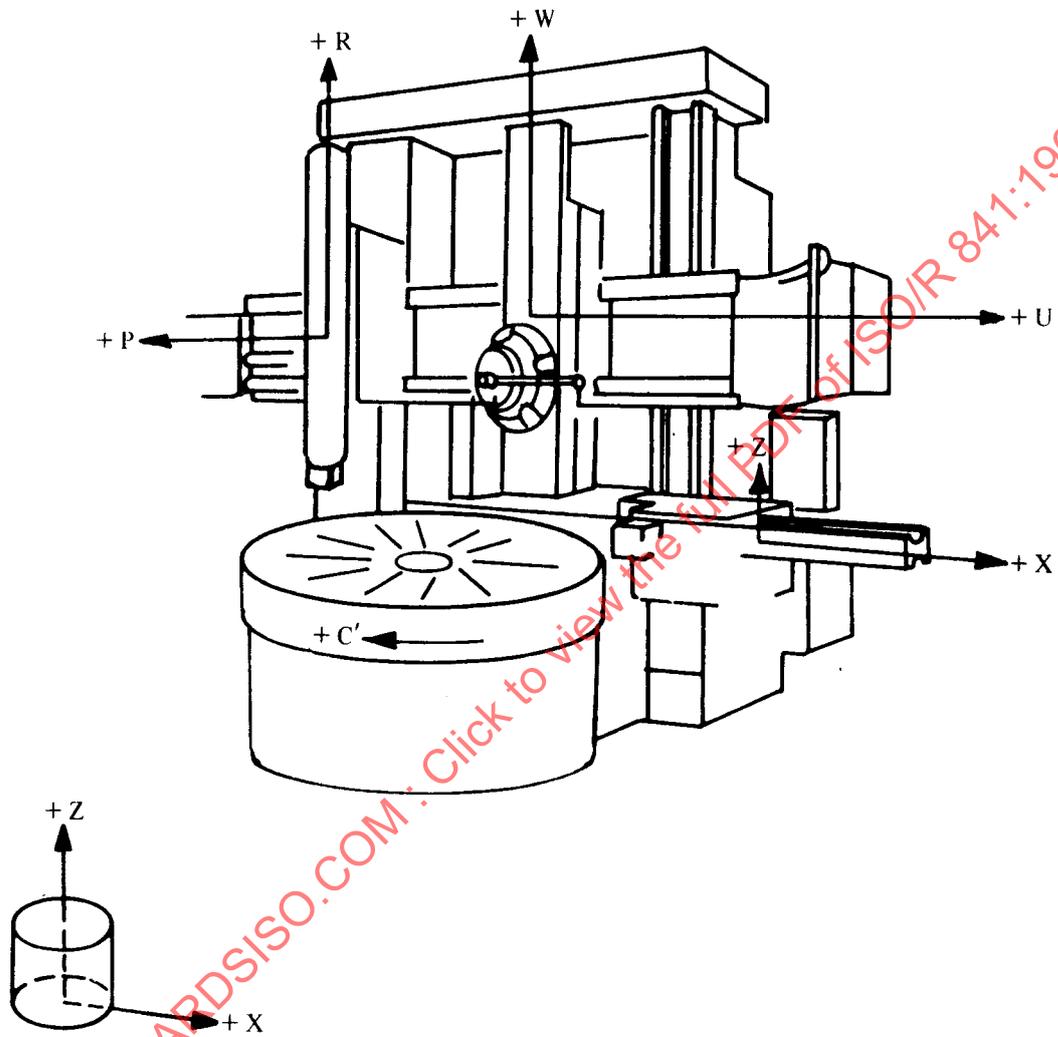
FIG. 5 — Vertical turret lathe or vertical boring mill
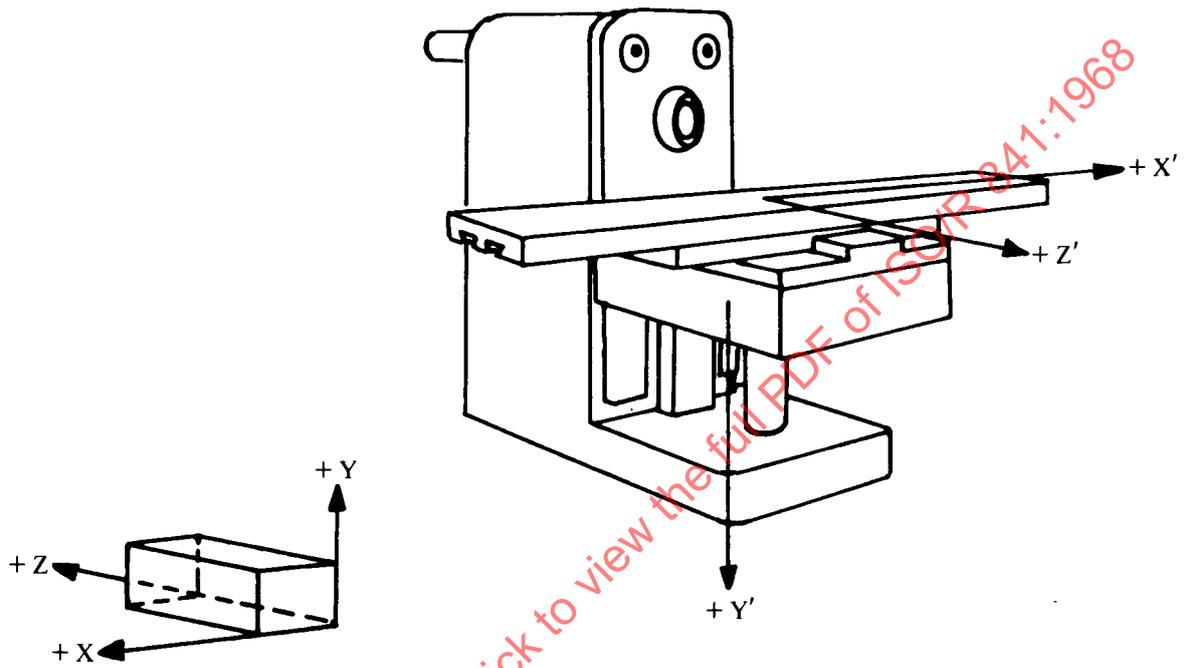
FIG. 6 – Horizontal knee mill
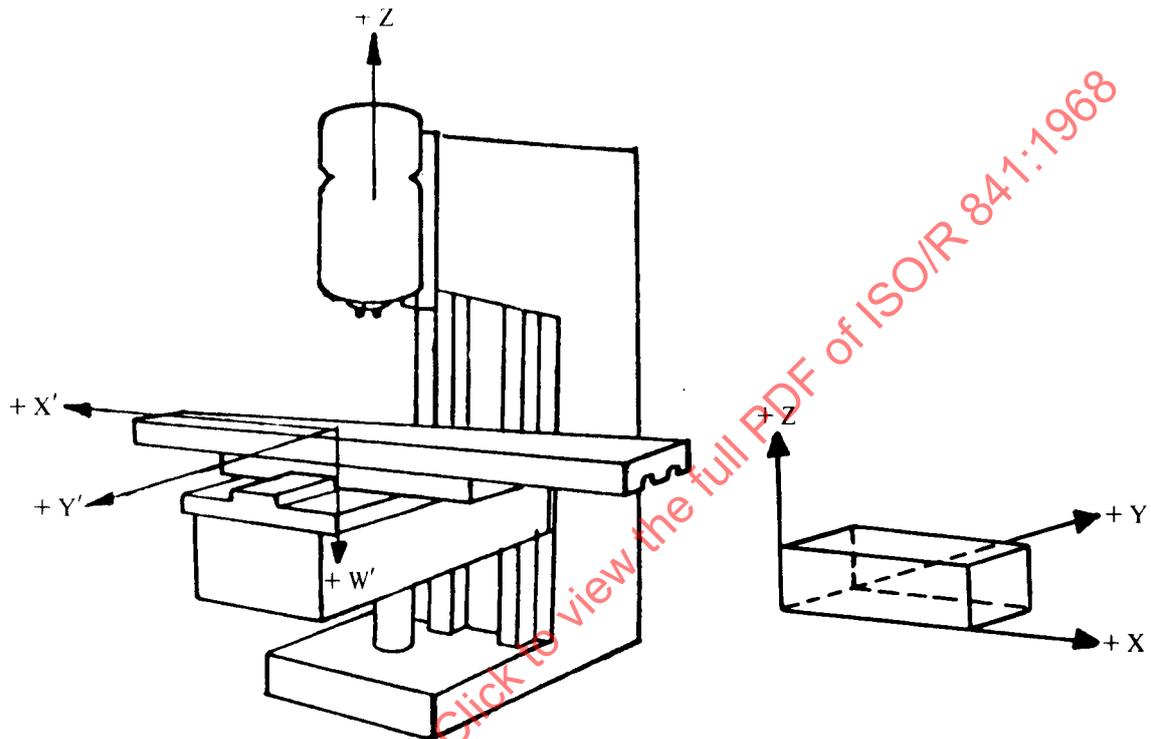
FIG. 7 – Vertical knee mill drilling machine jig borer
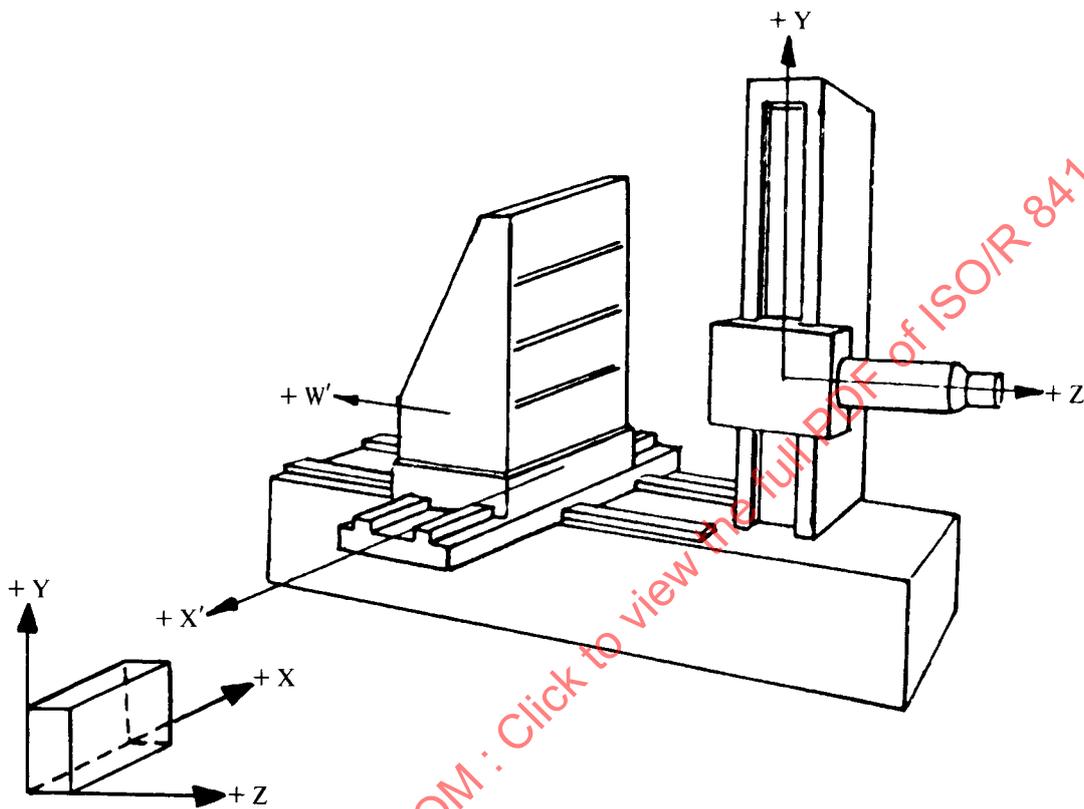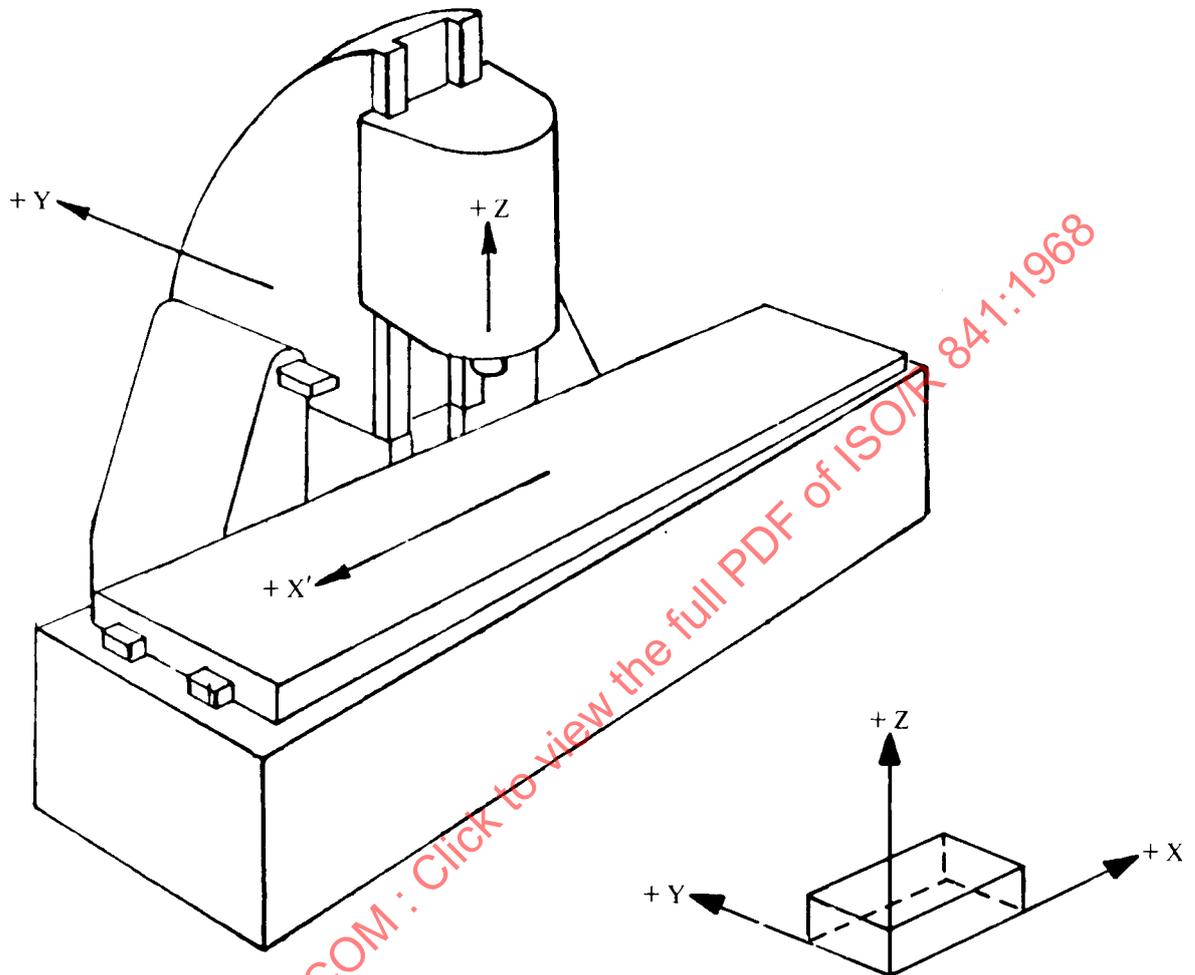
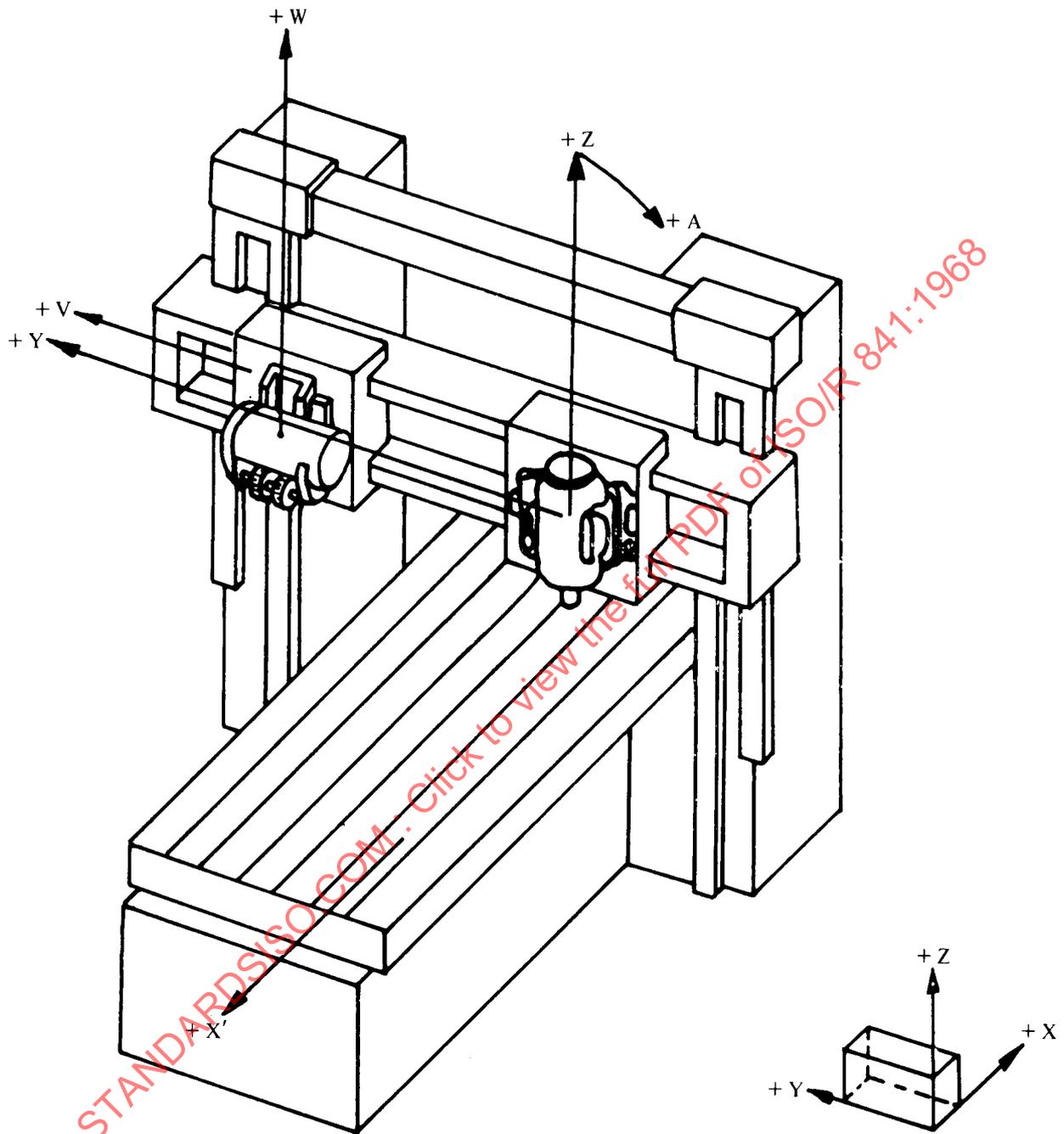FIG. 8 – Horizontal boring mill
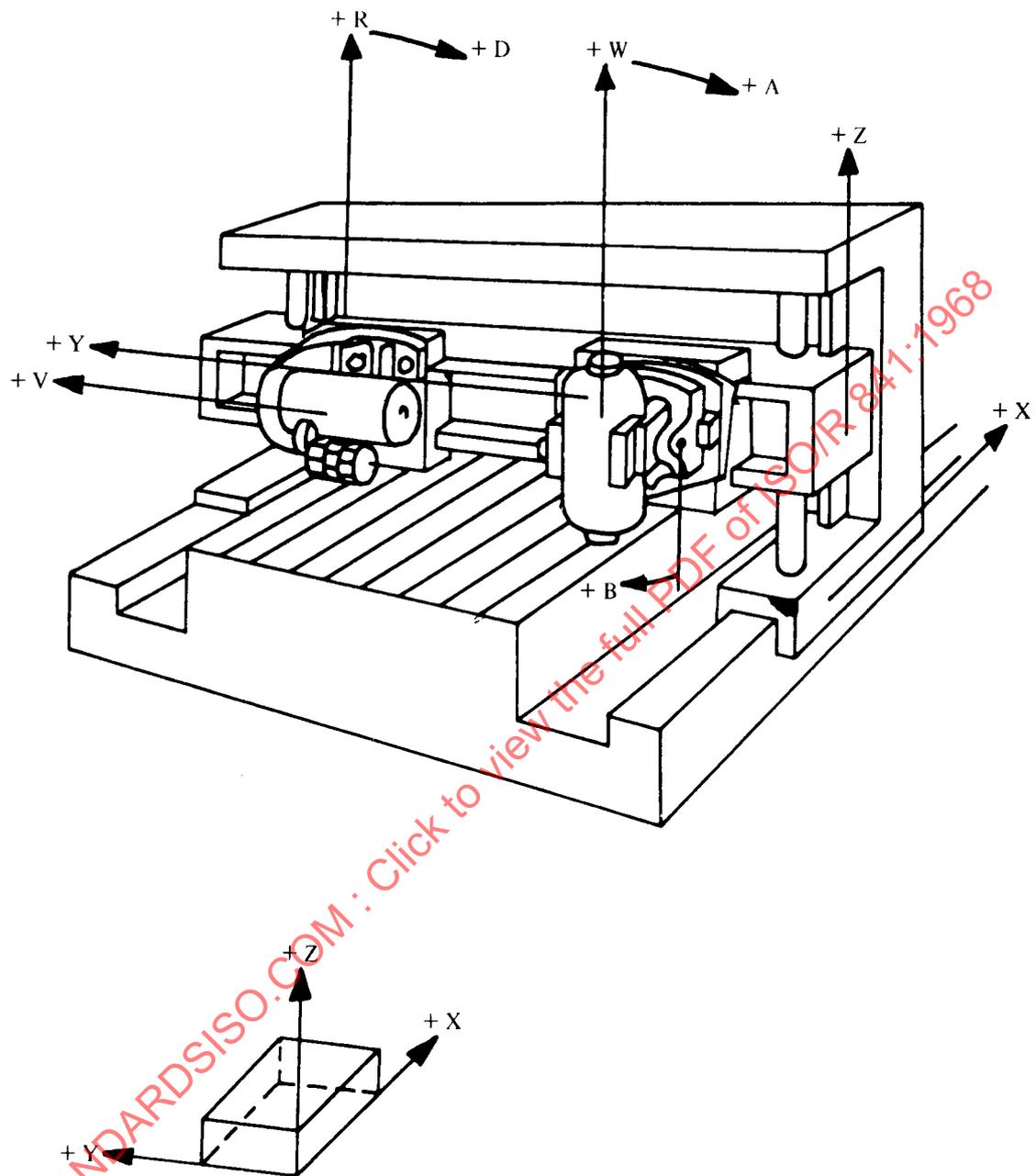
FIG. 9 – Profiling and contour mill

FIG. 10 – Bridge profiler

FIG. 11 — Gantry profiler
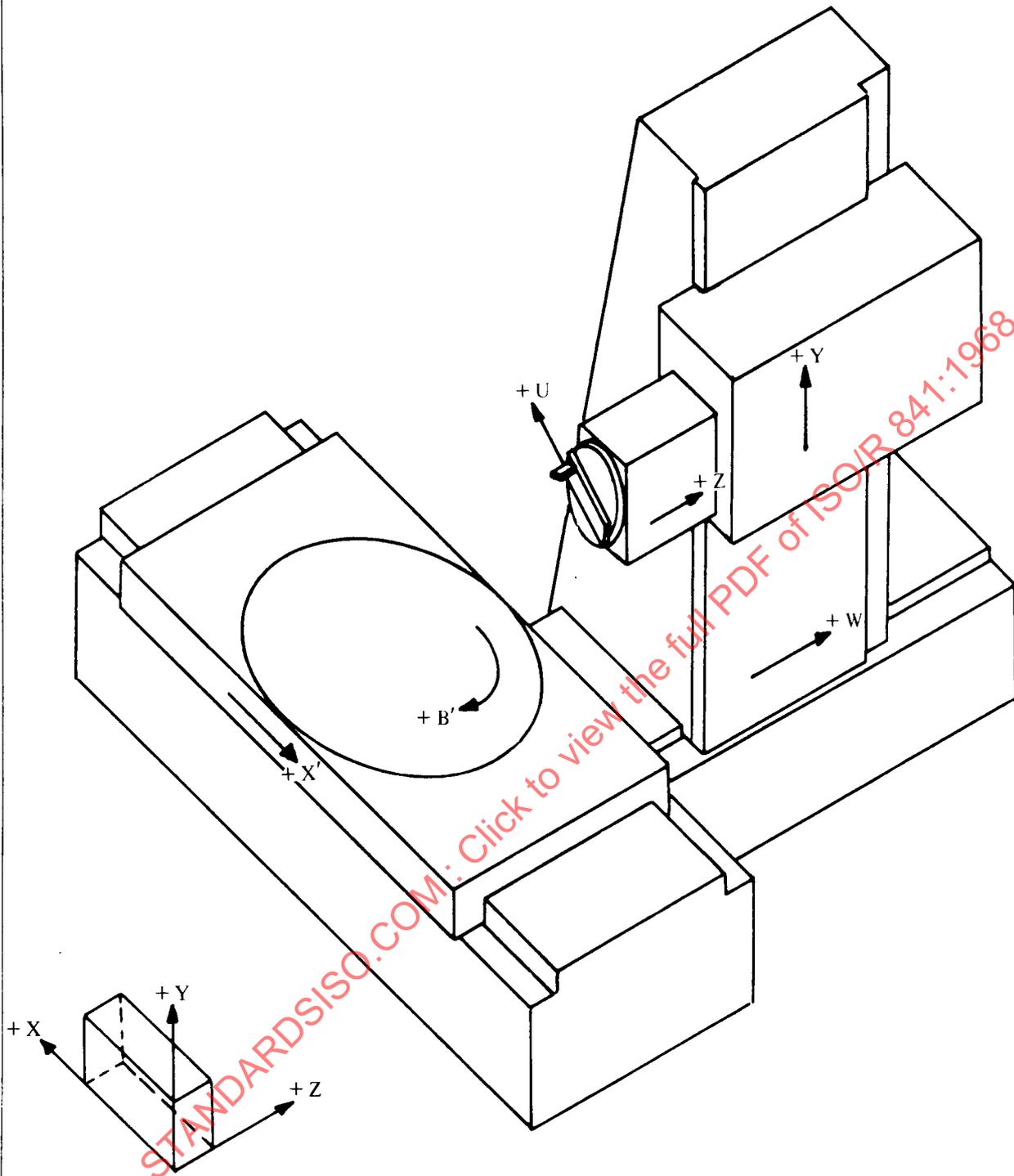
FIG. 12 – Horizontal boring machine
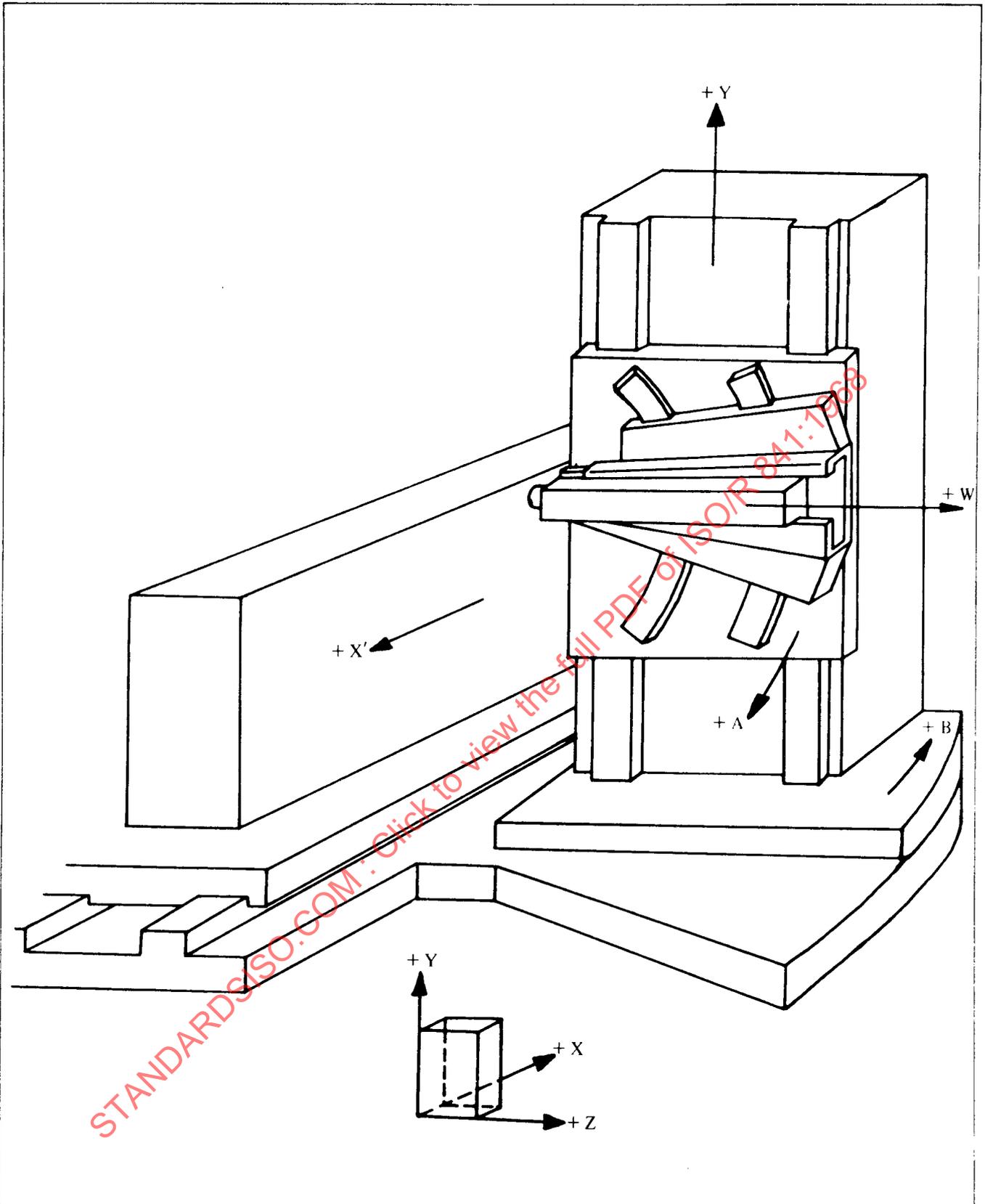
FIG. 13 — Profile and contour milling moving table and 5 axes
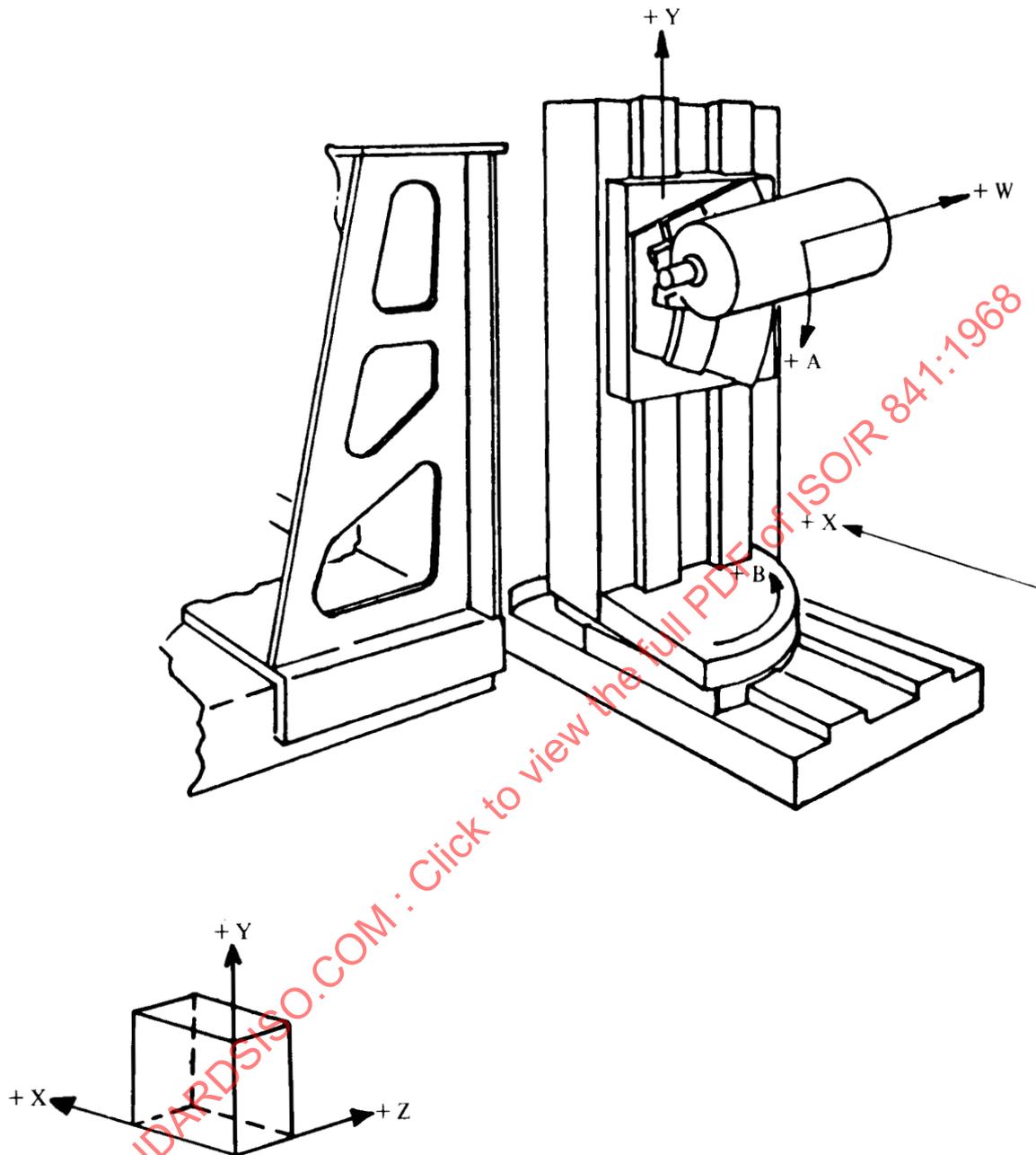
FIG. 14 – Profile and contour mill horizontal spindle and 5 axes
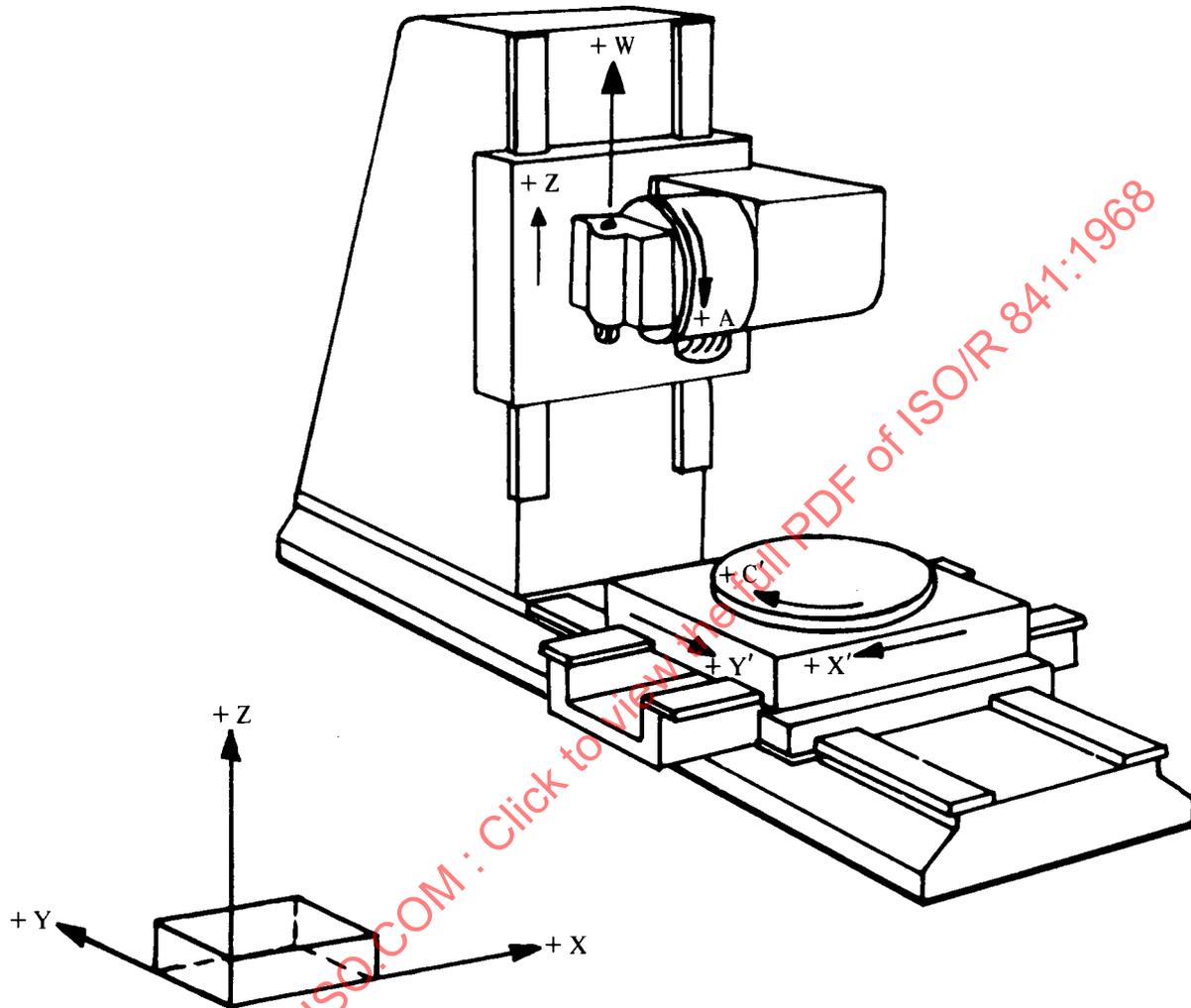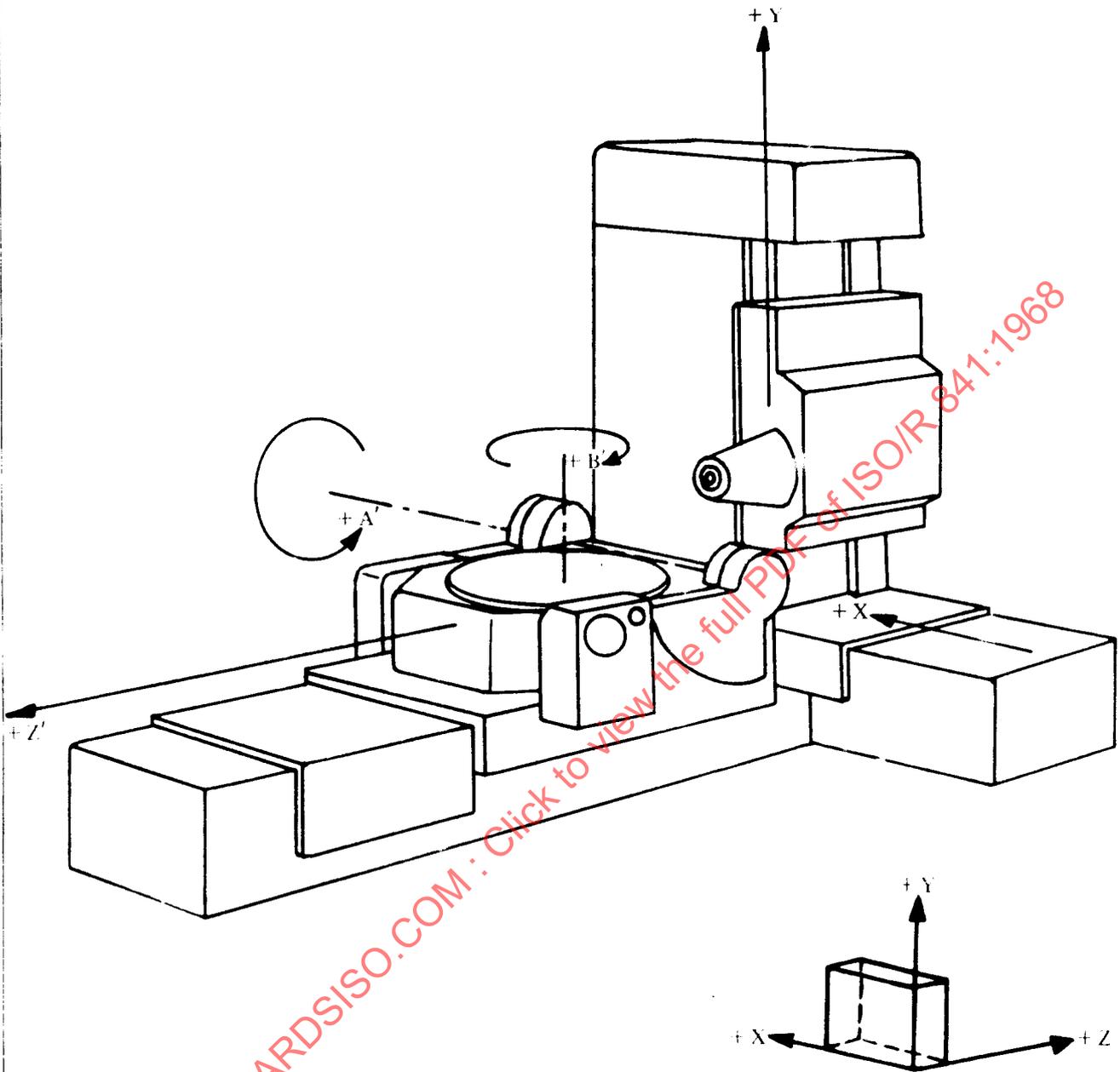
FIG. 15 – Profile and contour mill tilting head and 5 axes

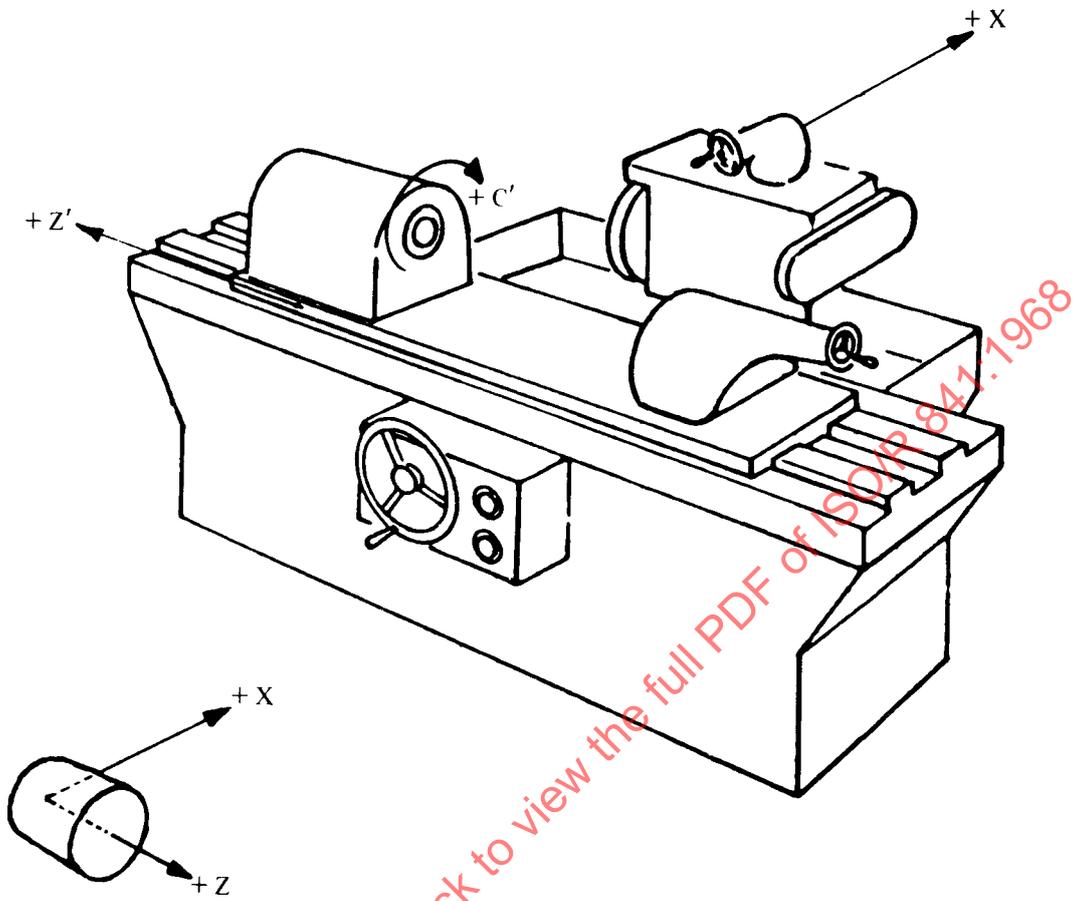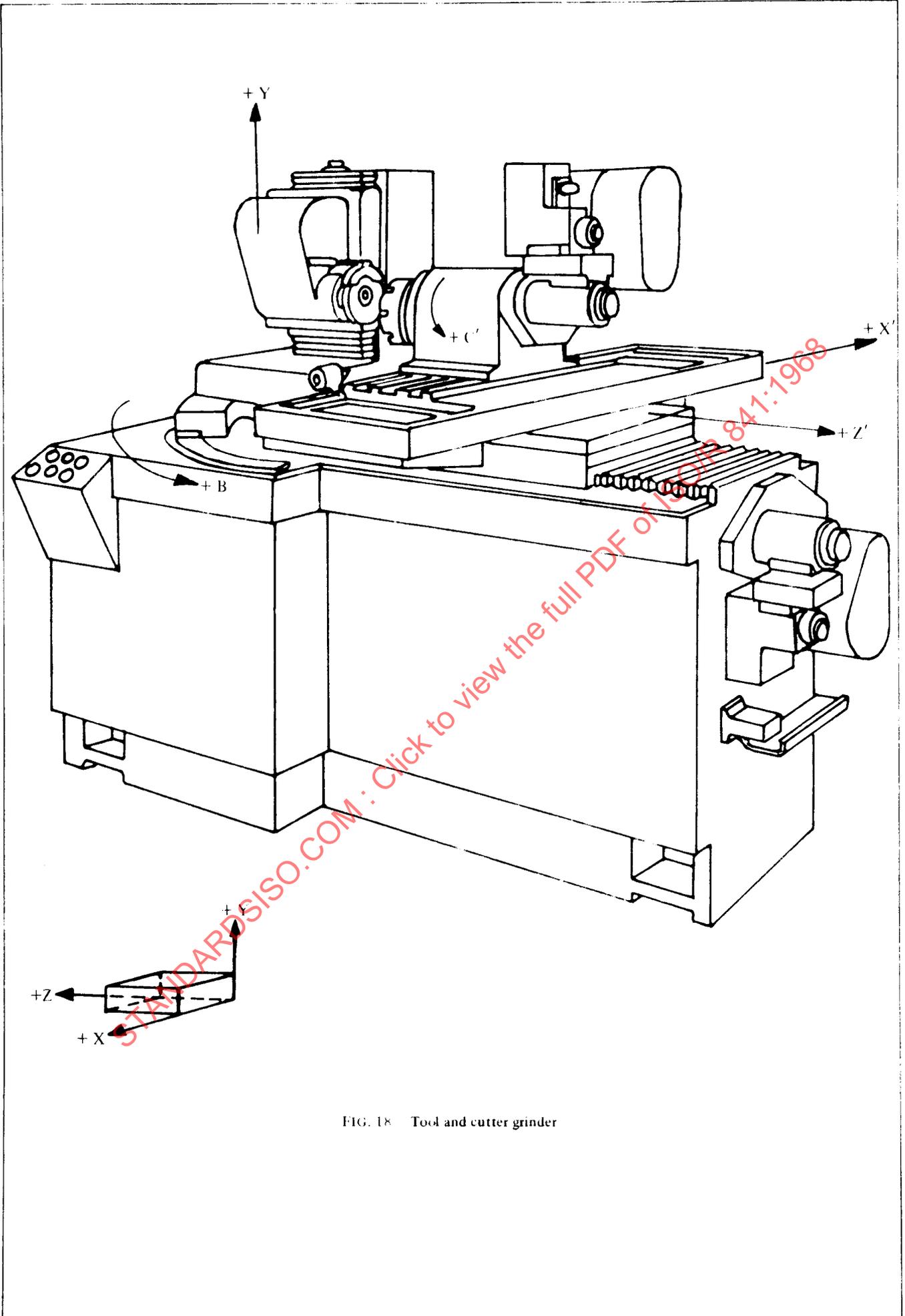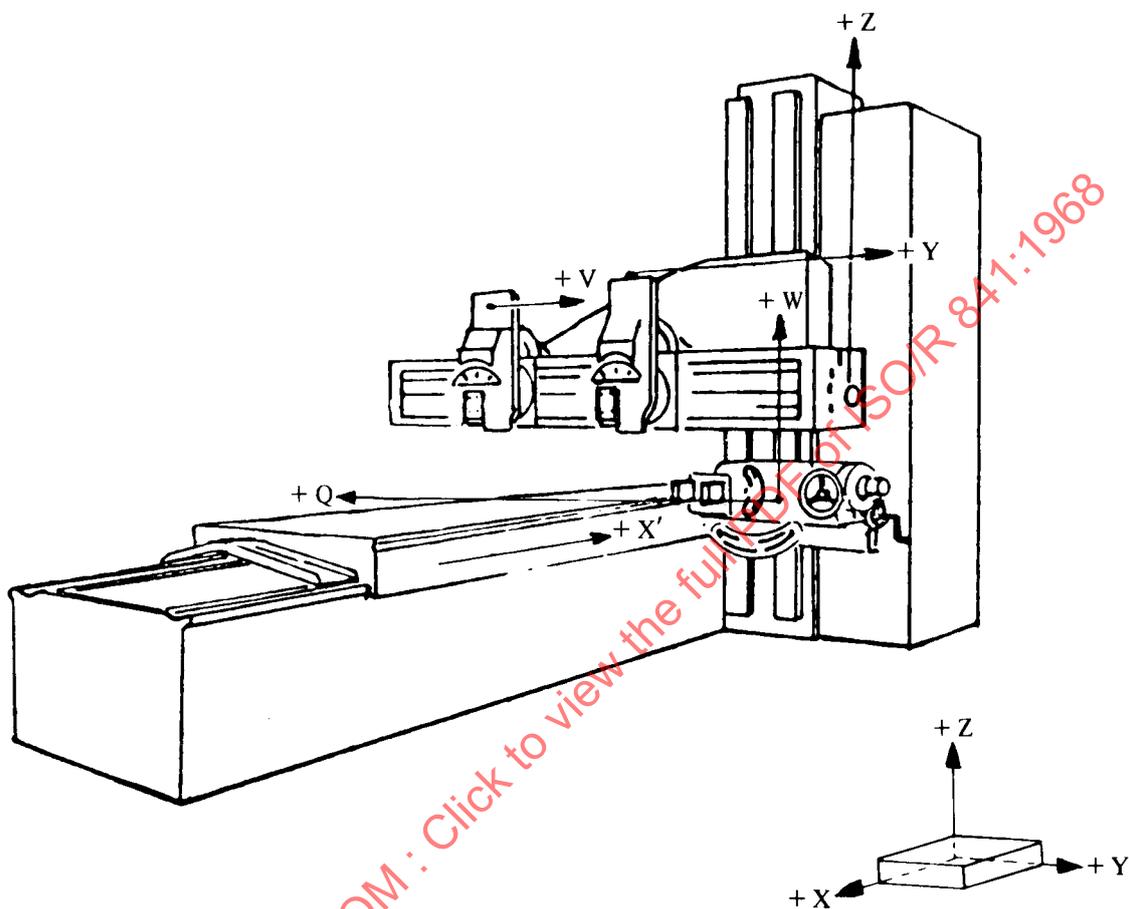FIG. 16 – Profile and contour mill tilting table and 5 axes

FIG. 17 — Universal grinder

FIG. 18   Tool and cutter grinder

FIG. 19 — Openside planer