DESIGN OF A KINEMATIC TRANSLATION STAGE

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ABSTRACT

Design aspects of a kinematic translation stage with a maximum travel of 25 mm is described.

INTRODUCTION

In many experimental works using an optical system there is a need to provide a precise linear motion to an optical component with respect to other in the system. This paper describes the design of a simple, inexpensive, kinematic translation stage which provides a maximum travel of 25 mm.

PRINCIPLE

It is well known that a body in space has six degrees of freedom—three of translation and three of rotation relative to the three axes. With suitable constraints it is possible to obtain the desired type of motion in any direction. For example, five constraints are required in order to obtain a pure translation of an object.

DESCRIPTION

The translation stage (Fig. 1) consists of an accurately machined and ground steel guide which is screwed to an aluminium alloy base. The carriage (Fig. 2) which carries the required optical component consists of three aluminium alloy plates which are screwed together as shown in the figure. The top plate is provided with three teflon pads and a side plate with two teflon pads. The other side plate is provided with a teflon pad mounted on a spring strip. The bottom plate is also provided with two such spring strips with teflon pads. Thus the carriage is constrained to have a linear motion by having five point contacts on the guide. The teflon pads provide smooth motion to the carriage.

A magnet (may be one from a cycle dynamo) is fitted at the centre of the carriage. It moves in the slot of the guide along with the carriage.

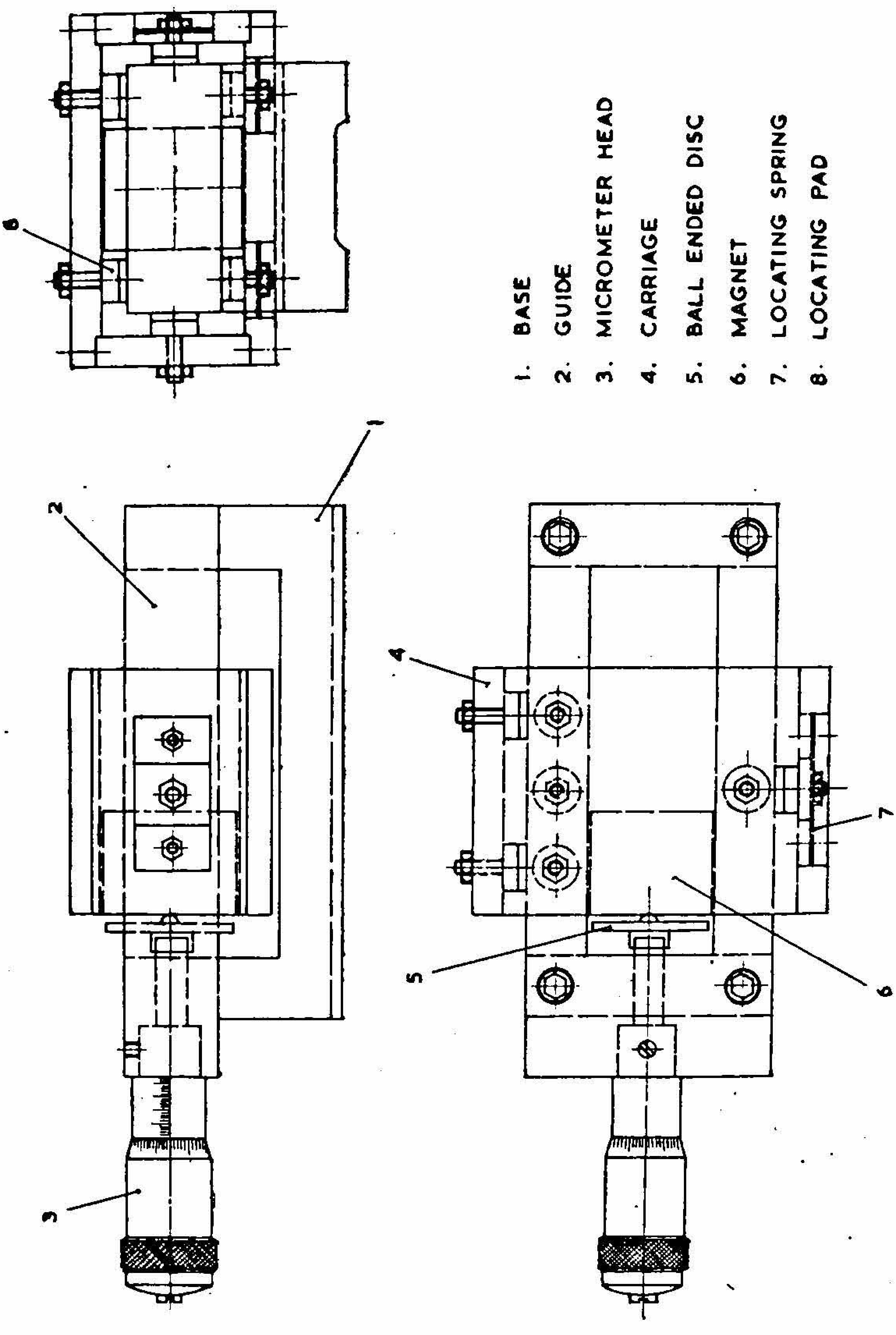
1. BASE
2. GUIDE
3. MICROMETER HEAD
4. CARRIAGE
5. BALL ENDED DISC
6. MAGNET
7. LOCATING SPRING
8. LOCATING PAD

FIG. 1

A micrometer head is fixed on the base as shown in Fig. 1. A mild steel disc having a 3 mm dia steel ball at its centre is mounted on its spindle. The ball projects out of the disc only to a length of about 0·05 mm (in the figure a large projection is shown for clarity). When the micrometer spindle moves it pushes or pulls the carriage along the axis which passes through its centre of gravity and thus the possibilities of its rotation on any axes are minimized.

DETAILS OF CARRIAGE

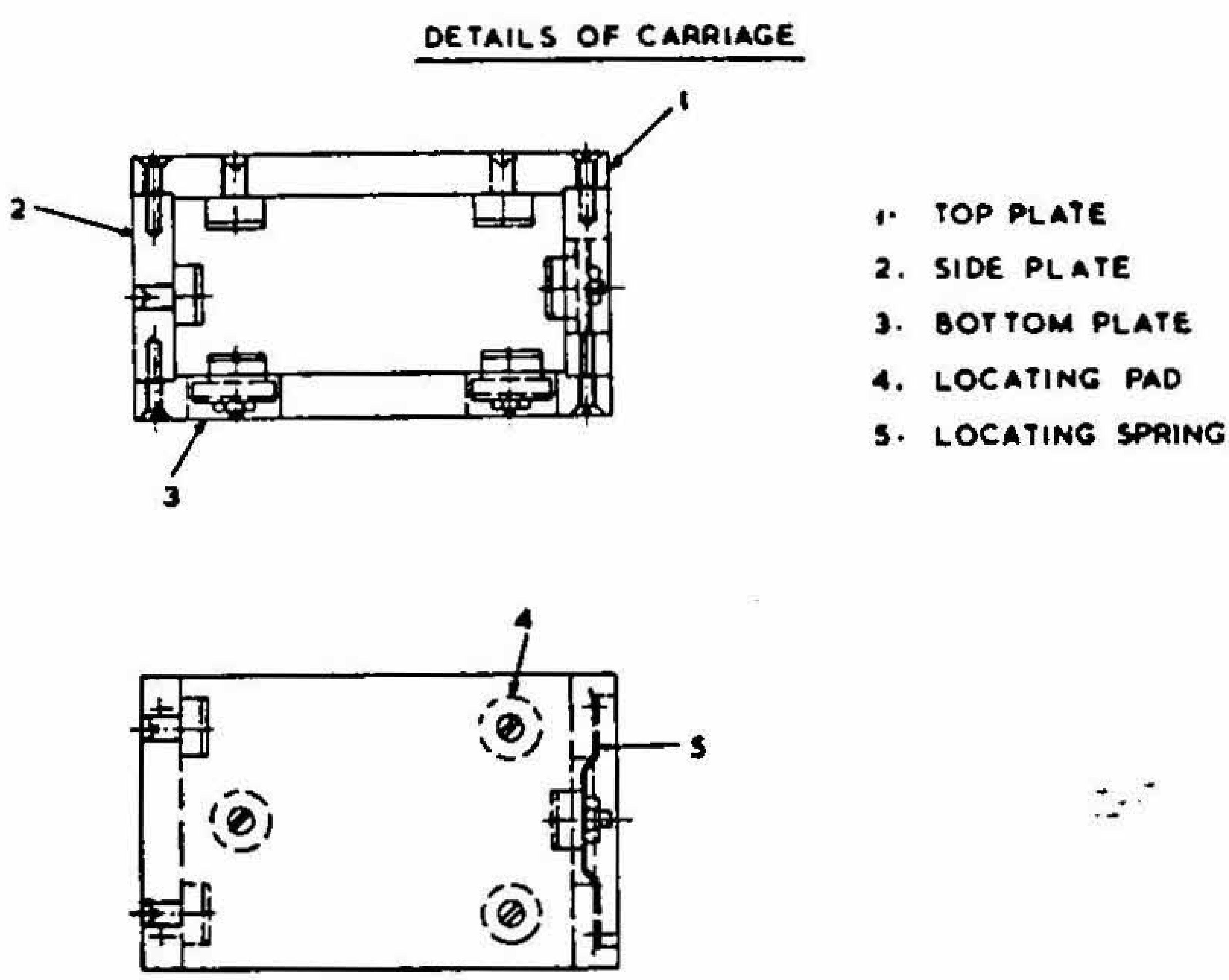

FIG. 2

Note:—Locating springs at the bottom plate are not shown in the plan view to avoid confusion

EXPERIMENTAL ARRANGEMENT

The translation stage has been tested using Hilger and Watt's Angle Dekkor. A front surface mirror is stuck on the carriage with wax. The Angle Dekkor is adjusted in such a way as to get the reflected image from the mirror to fall at the centre of the graticule.

The carriage is moved from one end to the other in steps of 1 mm. The Angle Dekkor readings are taken and are given in Table I (here the values are given for a step of 5 mm).

TABLE I

Micrometer Reading	Angle Dekkor Reading	
	Rotation on X-axis	Rotation on Y-axis
0	11′ 29″	9′ 36″
5	11′ 26″	9′ 32″
10	11′ 22″	9′ 29″
15	11′ 16″	9′ 25″
20	11′ 12″	9′ 21″
25	11′ 9″	9′ 17″

For the entire travel it is found that the carriage has a maximum rotation of 20 sec. of an arc on the two perpendicular axes other than the axis of the micrometer.

CONCLUSION

The well-known principles of kinematic design is effectively employed in the design of translation stage. The adoptation of magnetic coupling is simple, efficient and new in its usage.

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