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TITLE: "DO IT YOURSELF" UPGRADING OF THE CAMBRIDGE COMPARATOR

Commission II

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ABSTRACT

Cambridge comparators are lying unused in mapping organizations and schools throughout the world.This paper is intended to be a "do-it-yourself" conversion kit to upgrade the old instrument to make it computer compatible. This can be readily accomplished with limited funds,some skill and time at hand.

Illustrations attached to the paper show the necessary alterations, additions and simplifications necessary to convert the original instrument into an encoder fitted,computer compatible comparator.

INTRODUCTION

A number of Cambridge comparators are scattered all over the world. Few of them are put to practical use mainly because of their inability to utilize transparent diapositives and because of tedium of their operation.

A "conversion kit", described in this paper and illustrated with photographs, should be adequate for the owner of such a Cambridge comparator, to modify if for subsequent use in conjunction with an electronic computer.

While the conversion described uses an EK22 as a buffer between the comparator and a computer, there is no reason why a simpler interface directly from the encoders to the computer could not be made.

MODIFICATIONS

1. Raising the bridge.

A block of aluminium (GH, Fig. 1) of 50mm height between the instrument base (A, Fig. 2) and the bridge (B, Fig. 2) to make room for a new lighting system was inserted.

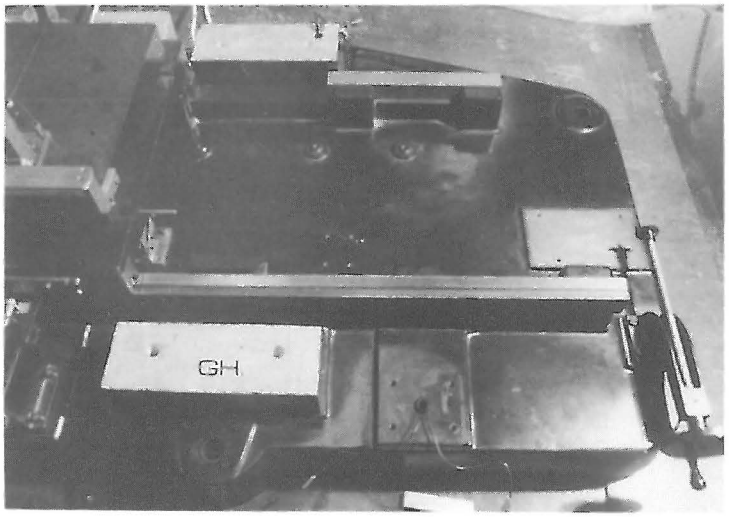


Figure 1.

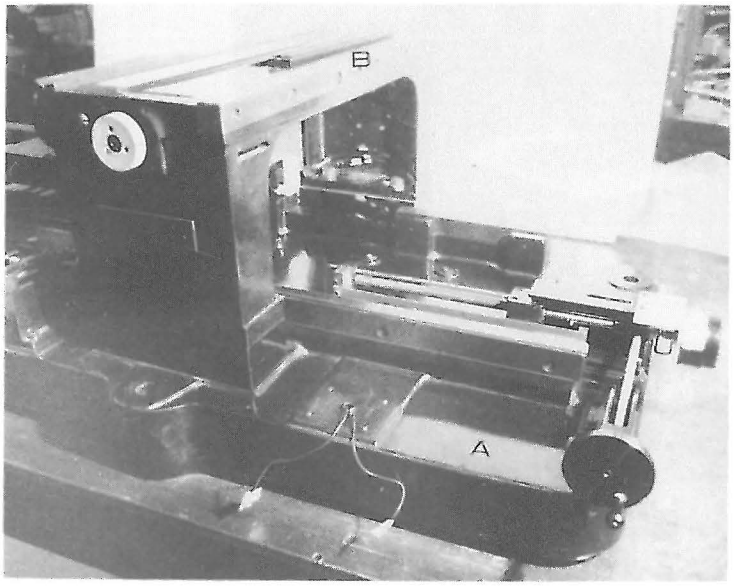


Figure 2.

2. New illumination system.

A new 12 Volt lighting system (DE, Fig. 3) for diapositive illumination gives more efficient lighting.

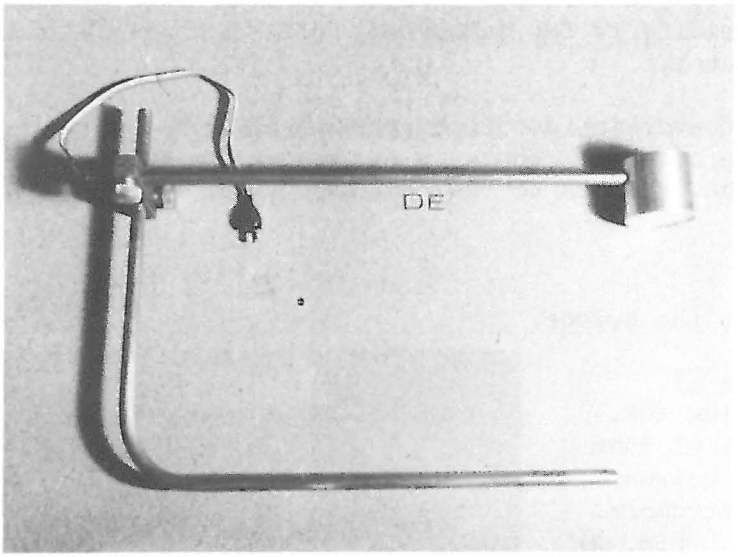


Figure 3.

A new transformer (JL, Fig. 4) and rheostats (C, Fig. 5) replaced the existing electrical system.

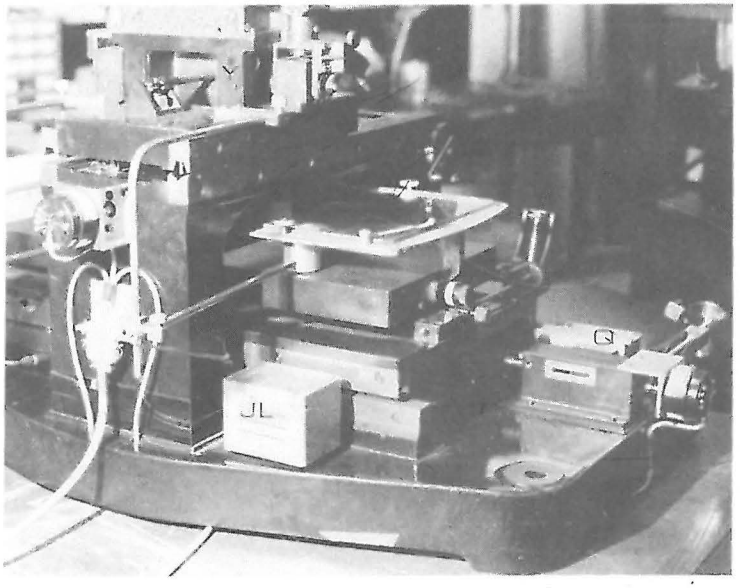


Figure 4.

The light source for use with diapositives was attached to the *Y* carriage (Y, Fig. 4). It illuminates only a small circular area in the optical path of the image and moves with the lens receiving images.

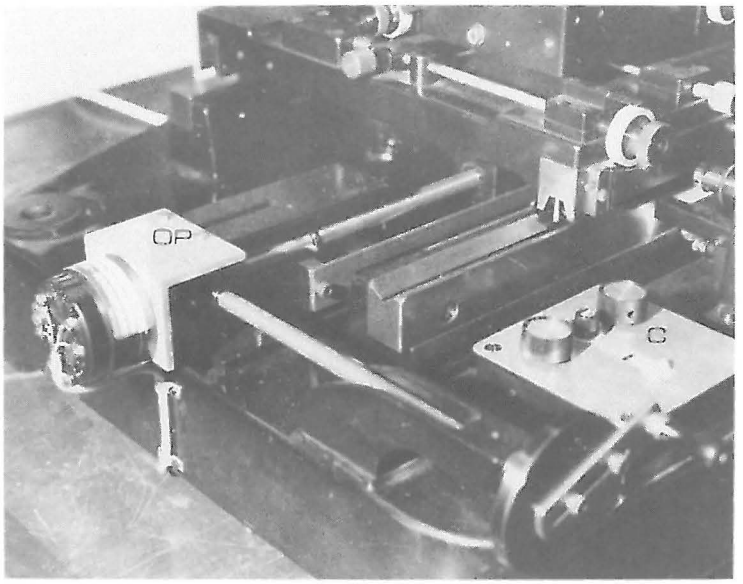


Figure 5.

3. Replacement of spindles.

The original *X* spindles and the common *Y* spindle had only limited movement. The photo-carriers had to be unclamped and by a free-hand movement transported to the reseau intersection nearest the observed image. The arrangement was unsatisfactory for encoder fitted spindles. These need to be of sufficient length to enable the observer to visit all images on the photograph surface without losing datum. New 26 centimeter long *X* spindles (AB, Fig. 6) replaced the existing ones while a *Y* spindle reaching across the total *y* - carriage bridge replaced the old one.

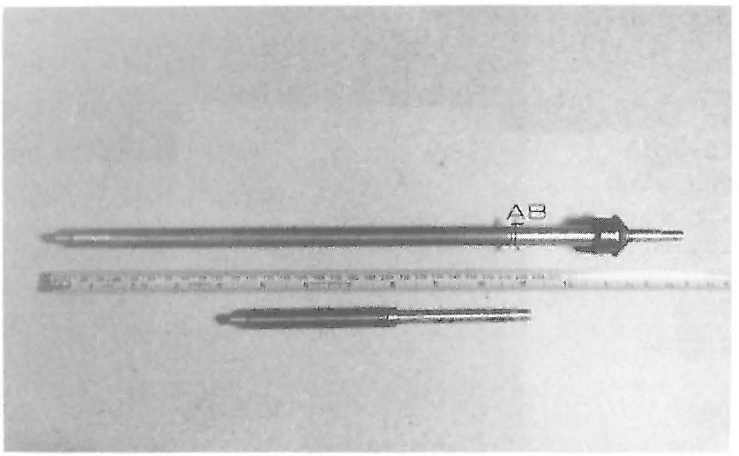
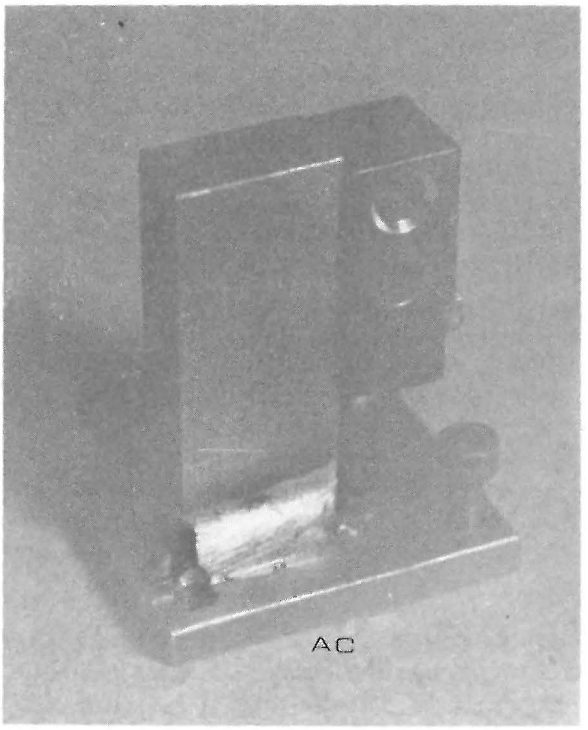


Figure 6.



To fix the extended new spindles into position, two brackets (AC, Fig. 7) had to be made for the inner ends of the spindles.

Figure 7.

The same brackets hold flat rods with a slot in each (AD, Fig. 8). The slot controls a sliding pin.

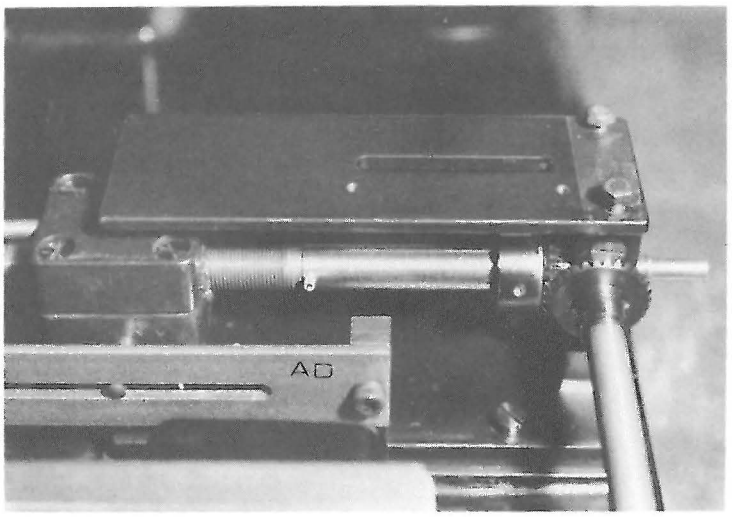


Figure 8.

The whole arrangement is designed to prevent the spindle from bowing. The arrangement assembled is shown on photograph (5, Fig. 9).

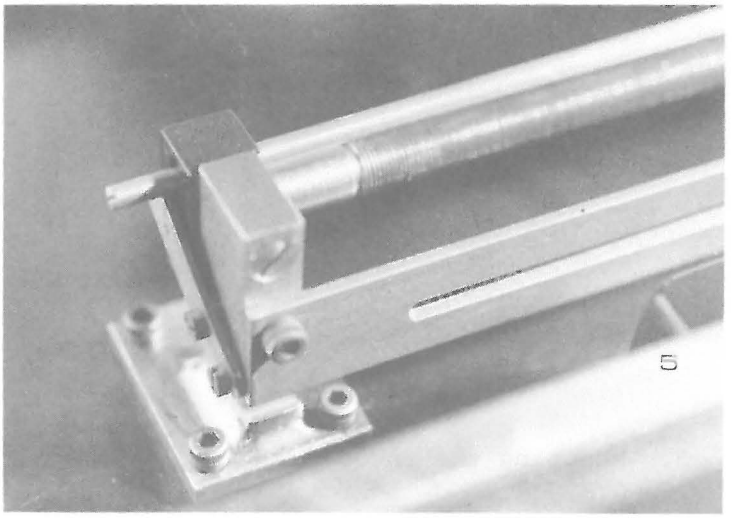


Figure 9.

4. Attachments for the use of diapositives.

Brackets (N, Fig. 10) to fit standard Wild A6 230 x 230 mm plate carriers were constructed. These were attached to the old photo-holders.

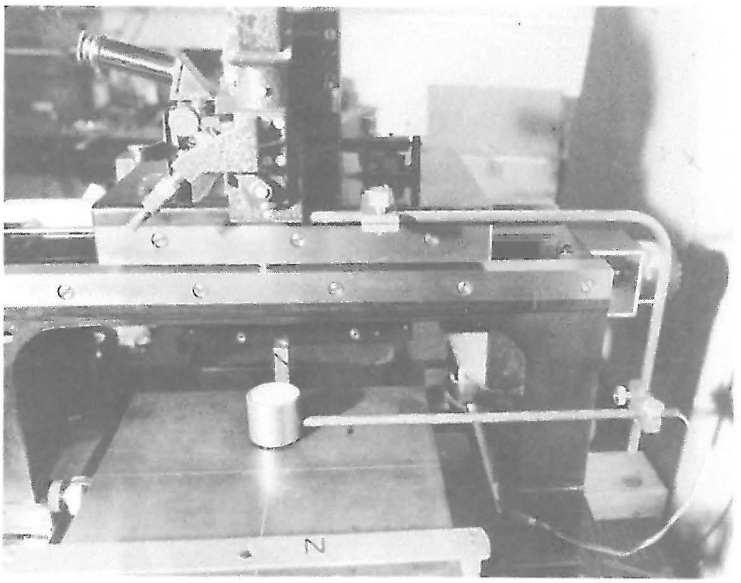
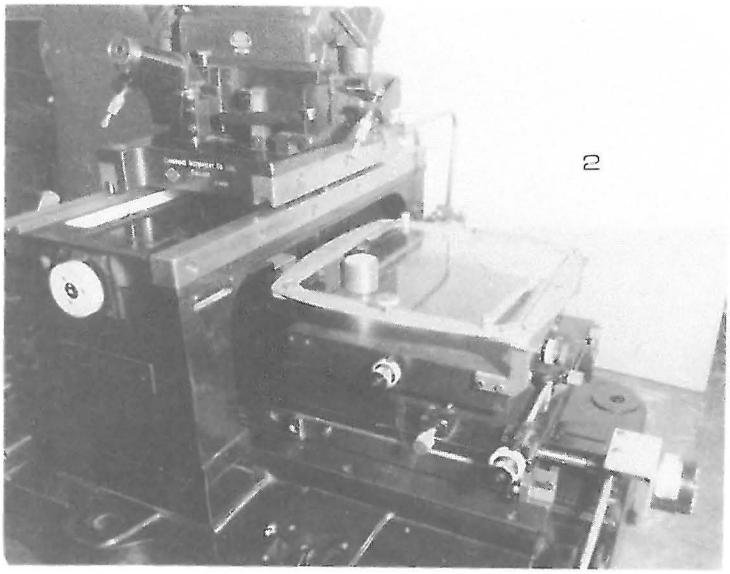


Figure 10.



Photograph (2, Fig. 11) shows the total view of the picture carrier with the new arrangement.

Figure 11.

5. Mounting the encoders.

Encoders giving 500 impulses for each rotation (reversible) were fitted to the ends of the two *X* spindles and the *Y* spindle (Q, Fig. 4 and W, Fig. 12). Each revolution of the spindle is equivalent to a forward movement of 1 mm giving a resolution of 2 micro-metres.

The *X* and *Y* encoders are mounted on the ends of the spindles. The connections are made by a connecting spring on two sleeve fittings in order to reduce lag to a minimum. The *by"* encoder on the right hand camera is coaxially connected to the *by"* screw.

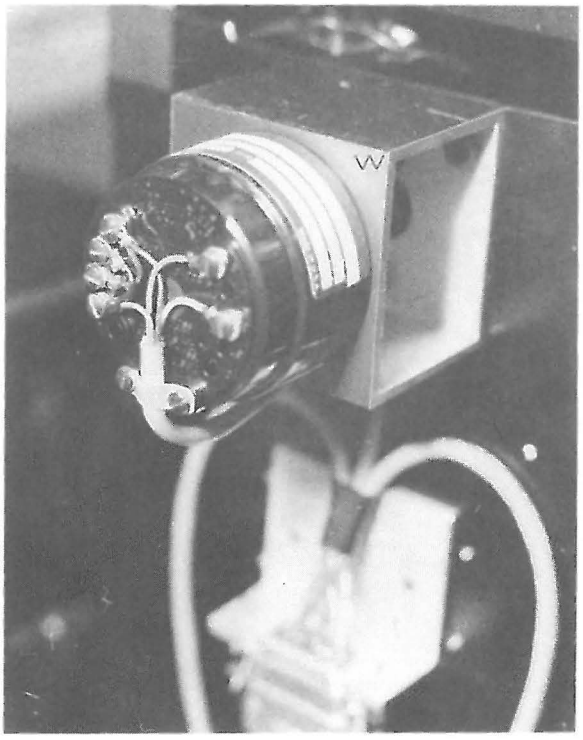


Figure 12.

6. The EK22 junction box.

A junction box (T, Fig. 13) for a plug-in arrangement to the EK22 was constructed. To display and record the *by"* value for the right hand photograph a special adaptation was necessary to make the numbering display slot of the EK22 show the *by"* values.

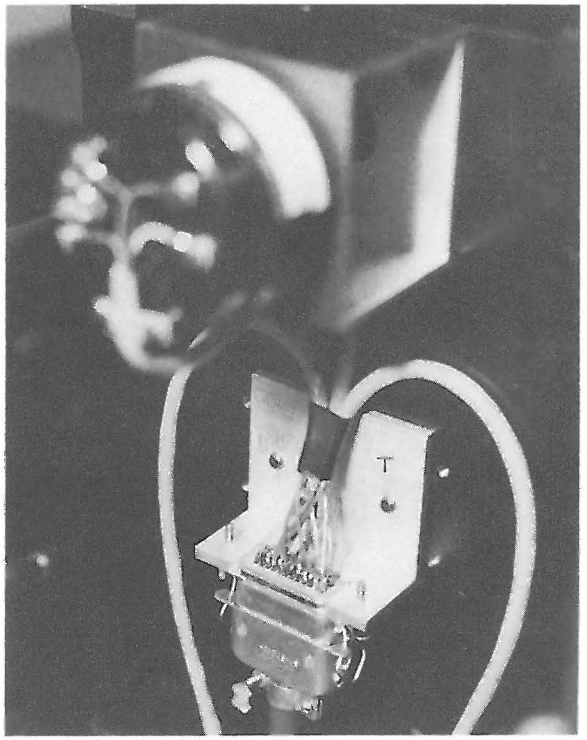


Figure 13.

7. Changes to the viewing system.

The original floating marks, inconvenient for most operators, were replaced by the more popular black floating dot.

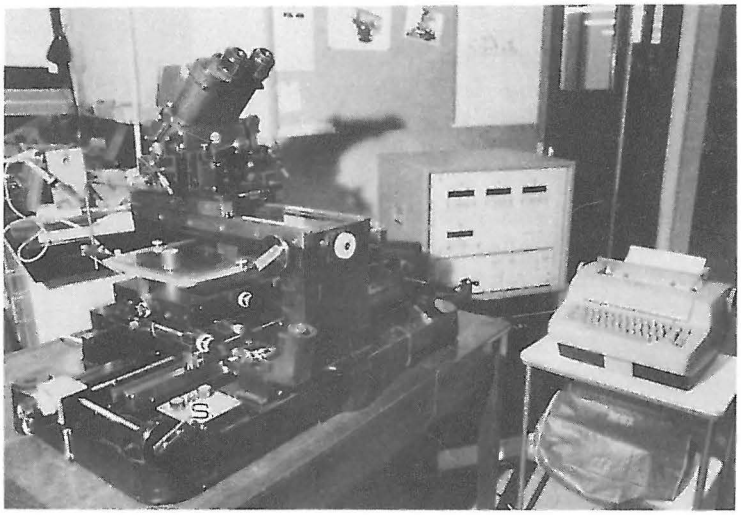
8. Dismantling of redundant parts.

All scales, telescopes and other redundant parts were dismantled. All manual reading devices were eliminated. The two kappa screws were retained and are used for the alignment of the photographs.

9. Increasing the speed of diapositive movement.

Originally the image movement over the surface of the photographs was freehand and only the co-ordinates of the last reseau square had to be accurately observed (adding the co-ordinates of the bottom left hand corner reseau intersection integer centimetres to the accurately observed point co-ordinates). Speed of movement in the last centimetre square was not important. It is now necessary to travel with the *X* and *Y* carriages over the whole surface of the photographs using the handwheels so as to retain the originally set datum. To speed up the movement of the carriages an extension (S, Fig. 14) was mounted onto the *X'*, *X"* and *Y* handwheels.

Figure 14.



OPERATION OF THE INSTRUMENT

The sole aim of the instrument is to obtain cartesian photo co-ordinates from each of the two observed photographs. Systematic deformations, which can be eliminated by the appropriate software, are tolerable; the non-systematic ones should be reduced to a minimum. To reduce operational machine errors to a minimum most of the original rotations and shifts have either been permanently clamped or simply eliminated. The only necessary element is a *y* shift in one camera. The right hand *by"* has been chosen for that purpose and an encoder attached to it.

To facilitate rotation of diapositives, for the purpose of aligning the photographic base, the two kappa screws have been left unaltered. Thus both, the *X'* and *X"* axes can be defined by two consecutive photo centres as one continuous line. The *Y* value is obtained directly from the *Y* encoder and the *by"* encoder value is algebraically added to *Y'* to obtain *Y"*.

It is possible to choose the fiducial systems of the photographs as the Cartesian system for the observations. In such a case the instrument is used as a monocomparator and the right hand camera serves only as a picture carrier for the conjugate photograph.

Other methods of observation may be adopted by the user.

REPEATABILITY OF OBSERVATIONS

The instruments original manual reading capability was to 0.01 mm. The repeatability observation was naturally less. The encoders have enhanced the repeatability to within ± 0.005 mm.