The main field of application of the pantograph is accurate transformation drawing of land register plans, maps, aerial photographs, systems of curves, etc., or alternatively the partial transferance of same to the identical or to different scales, whereby stretching of the paper, or even shrinking, can be allowed for. The transferance ratios of the instrument can be varied at will between 1:20 and 3:2. The verniers provided, in conjunction with the setting wheels, permit the most accurate possible adjustment of the transferance ratio required.

The table on which the instrument is used must be quite flat and free from distortion; an exactly horizontal working board is not, however, necessary. The size of the working table is governed by the size of the originals and reduction drawings to be handled. In order to make full use of the working range, a working area of, say, 40" x 80" up to 47" x 87" is required. Where the pantograph is used frequently and has its own permanent place, we recommend that a special pantograph table be bought or made, with a working surface of strong plywood with linden or poplar wood outer layers and strengthened on the underside by a wooden frame.

"Pole at the end" arrangement for scale ratios between 1/20 and 2/3 (see Fig.2).

The pole stand (1) is set up at the end of the table and weighted down by the weight (2). If the instrument is to be a permanent fixture, the stand can be securely fixed to the table by means of the wing-nut (3) provided. The carrier arm (V), which is connected in the instrument box with the rod (II), is obviously (similar to Fig.4) separated from the rod (II), its forked part being placed in the annular groove in the pole-cup. Its suspender (4) is connected with the single, top eyelet of the pole stand by the long wire with the hook at the end (5).

The three rods (I, III and IV) which are interconnected are taken out of the case and opened out as shown in the sketch in Fig.5. This U-shaped arrangement of rods is placed in position with its ball-pole (6) in the pole-cup of the pole stand and with the wheel (7) on the rod (V), ~~care being taken that the wheel bracket is pushed right up against the joint~~ (Fig.2). Once the hook-ended wire (8) has been slung between the suspender (9) and in one of the still available eyelets on the pole stand, the rods are brought to the horizontal with the help of the setting gauge (10) provided, as follows:

1.) By adjusting the screw on the suspender (4), set the carrier arm or rod (V) so that near the pole it is the same distance from the table as it is at the suspender end.

2.) By adjusting the screw on the suspender (9), bring the rod(III) parallel to the surface of the table by the same method.

3.) By adjusting the supporting wheel (11) by means of the two nuts, bring the rod (I) to the same height at the handle as it is at the joint.

Now fit the still open sleeve portions of rod (II) into the open U in such a way that the sleeve (12) fits over rod (I) and sleeve (13) over rod (III). By inserting the locking pieces (Fig.4), the rods become joined to form a parallelogram. Once the sleeves (12,13,14) have been set to the desired ratio and the milled nuts on the sleeves have been tightened, setting-up and alignment of the pantograph is complete.

"Pole in the centre" arrangement (Fig.3) for scale ratios between 2/3 - 1/1 - 3/2.

The pole stand (1) is set up in the middle of the table in such a way that the two side flanges of the base are roughly diagonal to the table. The carrier arm (V) must be placed with its forked portion in the annular groove of the pole-cup, but not yet secured. The parallelogram of the pantograph is set up as already described. By undoing the nuts, take the ball-pole (6) out of its sleeve (32), slip it into sleeve (14) and screw up tight. The second supporting wheel (15) supplied is slipped into the corresponding hole in the rod (III) and secured by tightening the nut. It is most convenient, even at this early stage, to set the outfit to the desired ratio in the manner described at the three sleeves. Afterwards, the pantograph, its ball-pole now in the sleeve (14), is placed in the pole-cup on the pole stand. ~~The wheel bracket for the wheel (7) is~~ pushed into the centre of the rod (IV) against the stop provided ~~and secured by the milled screw~~. The wheel is placed on the carrier arm (V). Now, using the longest hook-ended wire (5), connect the end of the carrier arm to the topmost eyelet on the pole stand and align the arm by means of the adjustment angle. Using the variable suspension wire~~s~~ (28) connect the suspender~~s~~ (16 ~~and 17~~) to the two eyelets by first connecting one side and setting to the correct position approximately by selecting an appropriate hole in the perforated sheet. Accurate alignment of the rod is effected by coarse and fine adjustment at the adjustable hook or at the screw~~s~~ of the suspender~~s~~ (16 ~~and 17~~), to bring the ends of the rod (II) to the same height as the rod is in the vicinity of the pole. ~~Care must be taken in this respect that the ball-pole is not lifted out of its correct seating in the pole-cup by too much tension on the suspension wires~~.

It is always recommended that exact adjustment of the ratio be checked once more before the pantograph is used.

Readjustment of the height of the supporting wheel (11) is then necessary only when working from a fairly thick document or when the instrument has just been used with a thickish document.

Self-supporting frame.

Where the pantograph is not used with the straightforward pole stands, as shown in Figs. 2 and 3, but with the "self-supporting frame", then, once this has been securely clamped to the table, the point of suspension in the head of the frame must be set exactly vertical or perpendicular to the surface of the table through the pole point. This is done as follows:

1.) The carrier arm (V) is, as described on Page 2, connected up and the fixing screw raised vertically (perpendicularly) above the frame head which is provided with 4 setscrews.

2.) The carrier arm is swivelled so that it lies under two opposite setscrews in the frame head. Using a setting gauge(10), the height of the top edge of the rod is ascertained from the cross-line on the rod and then the rod is swivelled through 180°.

If the rod is not at the same height above the table in both positions, then half the difference is eliminated by the two setscrews above the rod and the experiment repeated.

3.) The rod (V) is swung under the second pair of setscrews and the same experiment and adjustment repeated in this position. After this, the fixing screw in the frame head must be tightened.

After this alignment of the axis of the frame, the pantograph is set up as described on Pages 1 and 2 and the parallel position of the rods to the table surface checked.

The self-supporting frame and the pole stand (weighted foot) are interchangeable, since the point of rotation for the suspension wires is at exactly the same height in both cases.

Use.

For reducing when the pole is at the end, unscrew the milled nut (19) on sleeve (14) and insert the tracing stylus (24), accurately sharpened with the sharpener (31) or, alternatively, the dotting stylus (20) or the drawing pen (22) into the sleeve. To the drawing stylus or pen, as the case may be, fasten the pencil clamp (23) above the milled nut and screw into this the short cable release (18). This serves to raise the stylus or pen from the paper for dotting. Only when using the drawing stylus are weights (25) fitted. When using the dotting stylus, the pencil clamp (23) is replaced by the dotting stylus holder (21) with its threaded portion to take the cable release. If there is no dotting stylus holder or cable release, dotting can be done directly by hand.

The tracing stylus (29) with its pen housing, is fitted into the tracing stylus holder (26) and is adjusted by screwing the housing up or down, so that its point is poised just above the paper. With wrinkled drawings, the use of tracing stylus support (30) is recommended, together with a tracing stylus having a rounded point. In place of the tracing stylus, the tracing lens (27) can also be used. This facilitates accurate parallax-free tracing of lines and close setting to points. In conjunction with the tracing lens, an insertable orientation lens (33) fitted in place of the drawing stylus serves for accurate and rapid orientation of two drawings in respect of each other.

For enlarging when the pole is at the end, unscrew the milled nut (19) on the tracing stylus sleeve (26), insert the drawing stylus (24), dotting stylus (20) or drawing pen (22) in the tracing stylus sleeve, the tracing stylus (29) or lens (27) being placed in the sleeve (14).

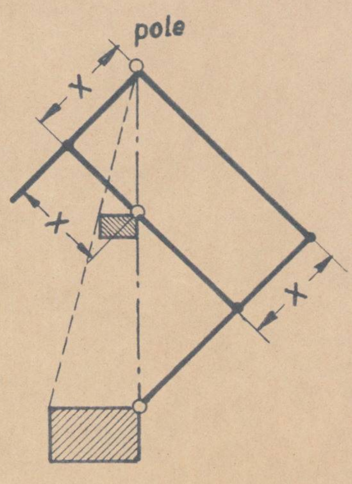
With the pole positioned in the centre, enlarged or reduced scale drawings are possible, according to the setting of the sleeves on the rods.

The original always lies underneath the tracing stylus sleeve (26), in which either a tracing stylus or a lens can be fitted, as desired. Drawing stylus, dotting stylus or drawing pen are fitted into the pole sleeve (32). For dotting or raising the dotting unit from the paper, the long cable release (34) is used.

Setting to unusual scale ratios, map reduction.

Let M be the denominator of the smaller and m the denominator of the larger scale of the map, x the setting values at the sleeves and L the length of the pantograph rods (1000 mm), and the setting value at the sleeves becomes

$$x = \frac{m \cdot L}{M}$$



This formula apples to both enlargements and reductions when the pole is at the end.

Example: Using the pantograph with a rod length of 1000 mm, we wish to convert a drawing to the scale 1:1500 to one to the scale 1:2880

$$L = 1000 \text{ mm}; \quad M = 2880; \quad m = 1500$$

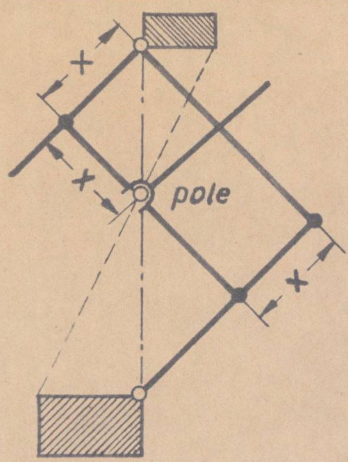
$$x = \frac{1500 \cdot 1000}{2880} = 520.83 \text{ mm}$$

As this drawing is to be reduced, the drawing to scale 1:1500 is placed underneath the tracing stylus sleeve.

For the "pole in the centre" arrangement, where the tracing stylus is always inserted in the tracing stylus sleeve, the formulae for enlarging and reducing are different:

for reducing $\quad x = \frac{m \cdot L}{M + m}$ $\quad$ and

for enlarging $\quad x = \frac{M \cdot L}{M + m}$



Example: With the scales indicated in the previous example, the setting for enlarging would be:

$$x = \frac{2880 \cdot 1000}{2880 + 1500} = 657.53 \text{ mm;}$$

for reducing:

$$x = \frac{1500 \cdot 1000}{2880 + 1500} = 342.47 \text{ mm.}$$

If, due to alteration of the paper, the drawing which is to be transformed is not strictly to scale, so that the distances no longer conform to their desired values, then this fact must be taken into account when calculating the setting. The true scale is then ascertained by measuring the network of squares, or, if the document is not squared, by ascertaining the length of several lines, the natural length of which is known.

Example: A map drawn to the scale 1:25000 is to be converted into one to scale 1:100000. Due to shrinkage of the paper, however, the cross-lines, originally 40 mm apart (=1000 m. ground measurement), are now only 39.8 mm apart.

With the "pole at the end", therefore, the setting is:

$$x = \frac{25000 \cdot 1000}{100000} \cdot \frac{40}{39.8} = 251.26 \text{ mm (instead of 250 mm).}$$

Treatment and Care.

The Precision Pantograph is a top flight product of fine precision instrument engineering and demands proper care and attention if it is to retain its high accuracy.

Follow the instructions closely when placing it in or removing it from the case and when setting it up. After about a year's use, oil the joints slightly. For this purpose, use a fine spindle oil, applied to the cylindrical spindles with a wooden rod. The guides of the sleeves (12, 13 and 14) for the pantograph rods should be cleaned with a rag as required, to avoid scratching. The shanks of the drawing, dotting and tracing devices and the holes to take them must always be kept dry and free from dust. The holes are cleaned from time to time with a strip of cloth about 1½" wide, rolled up and pulled through. The styli must always drop without pressure on to the drawing surface. Protect the points of the dotting and drawing styli from damage, for working is possible only if the point of the inserted unit is central. It is therefore a good idea to check the centricity of the tip of the stylus being used before every job, by making a dot and seeing whether, after the stylus has made a ¼, then a ½ and then a 3/4-turn, the respective dots are still exactly on this same spot. With proper use, the life of the pantograph, with its accuracy unimpaired, is practically unlimited, since there is no wear and tear worth mentioning.

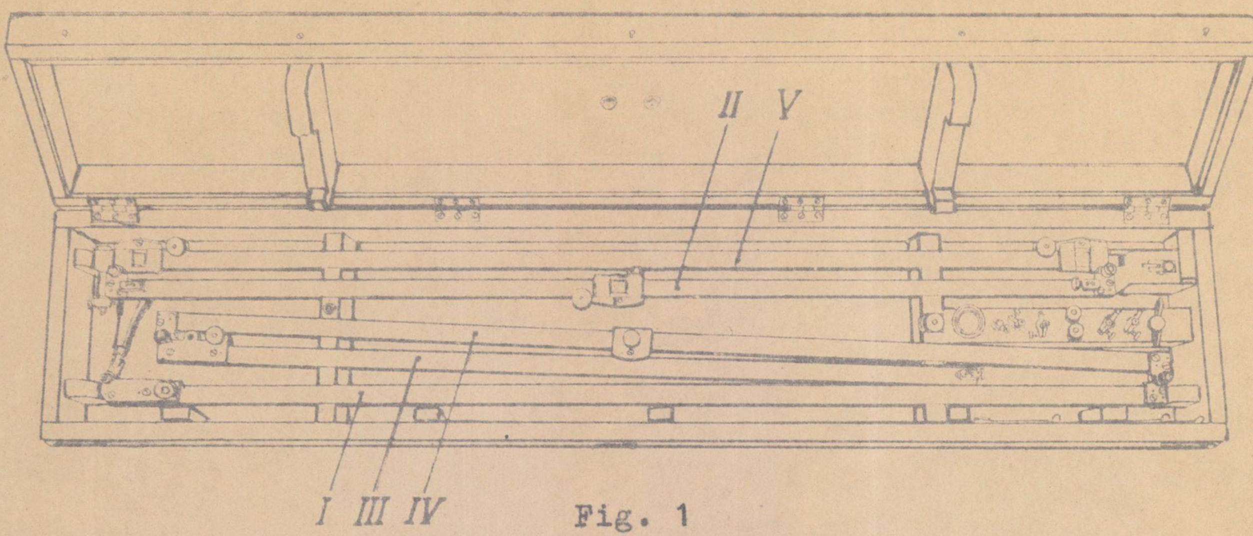


Fig. 1
Pantograph in fitted case

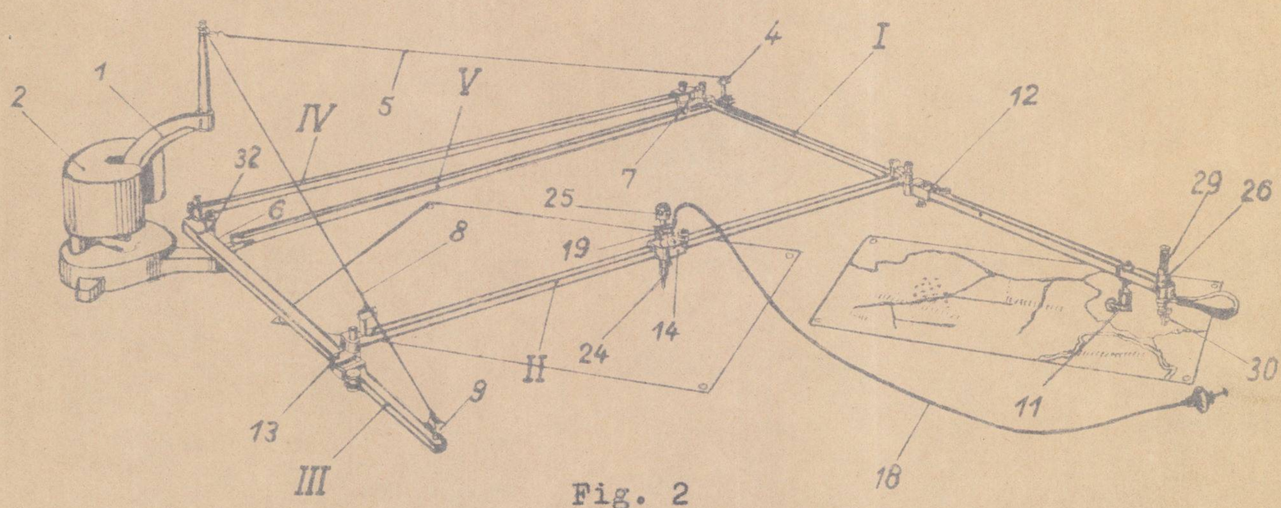


Fig. 2
"Pole at the end" arrangement

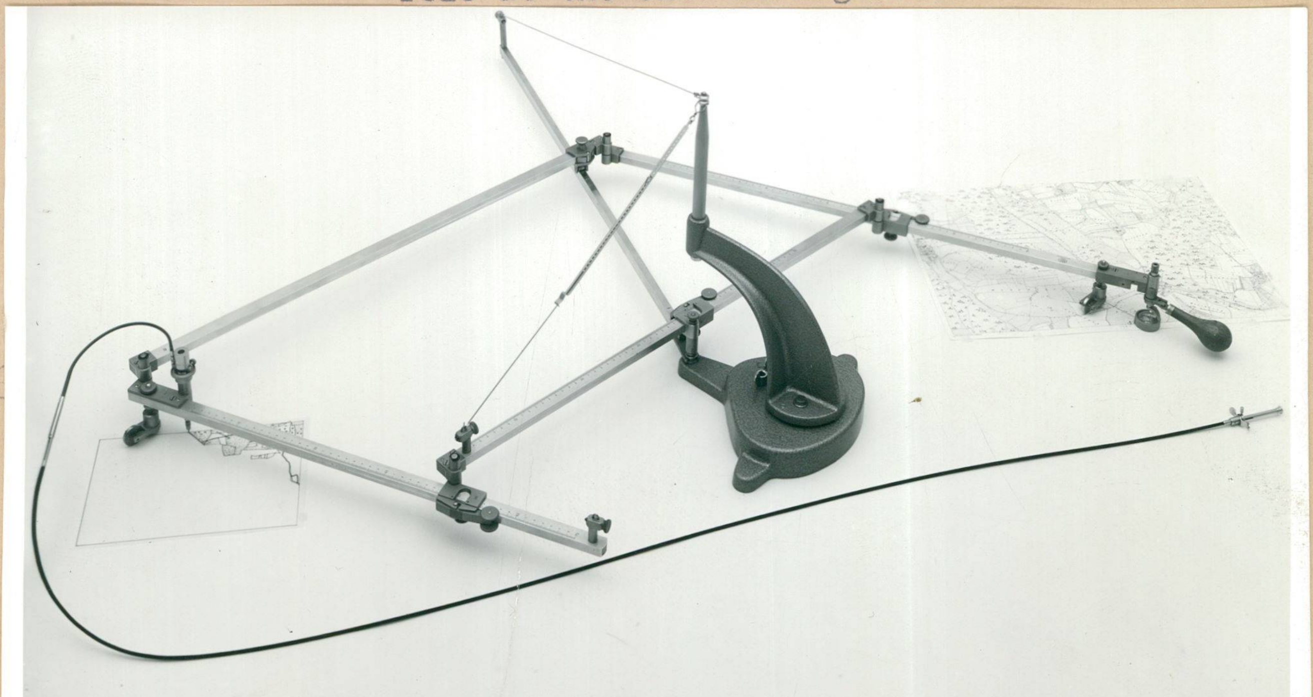


Fig. 3
"Pole in the centre" arrangement

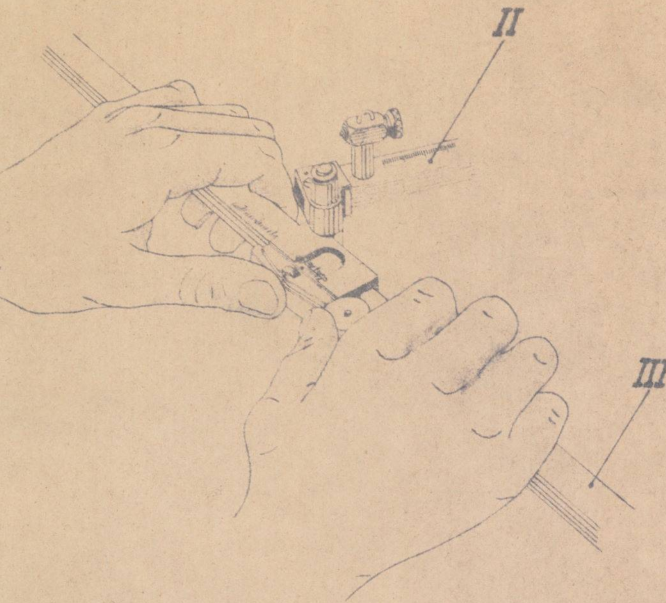


Fig. 4

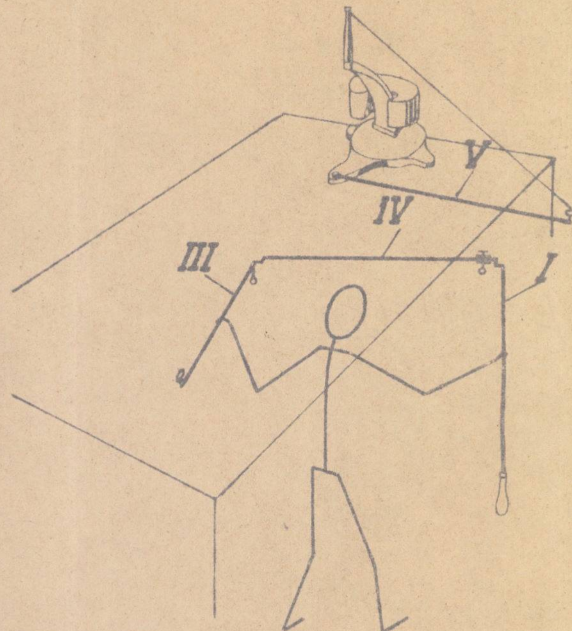


Fig. 5

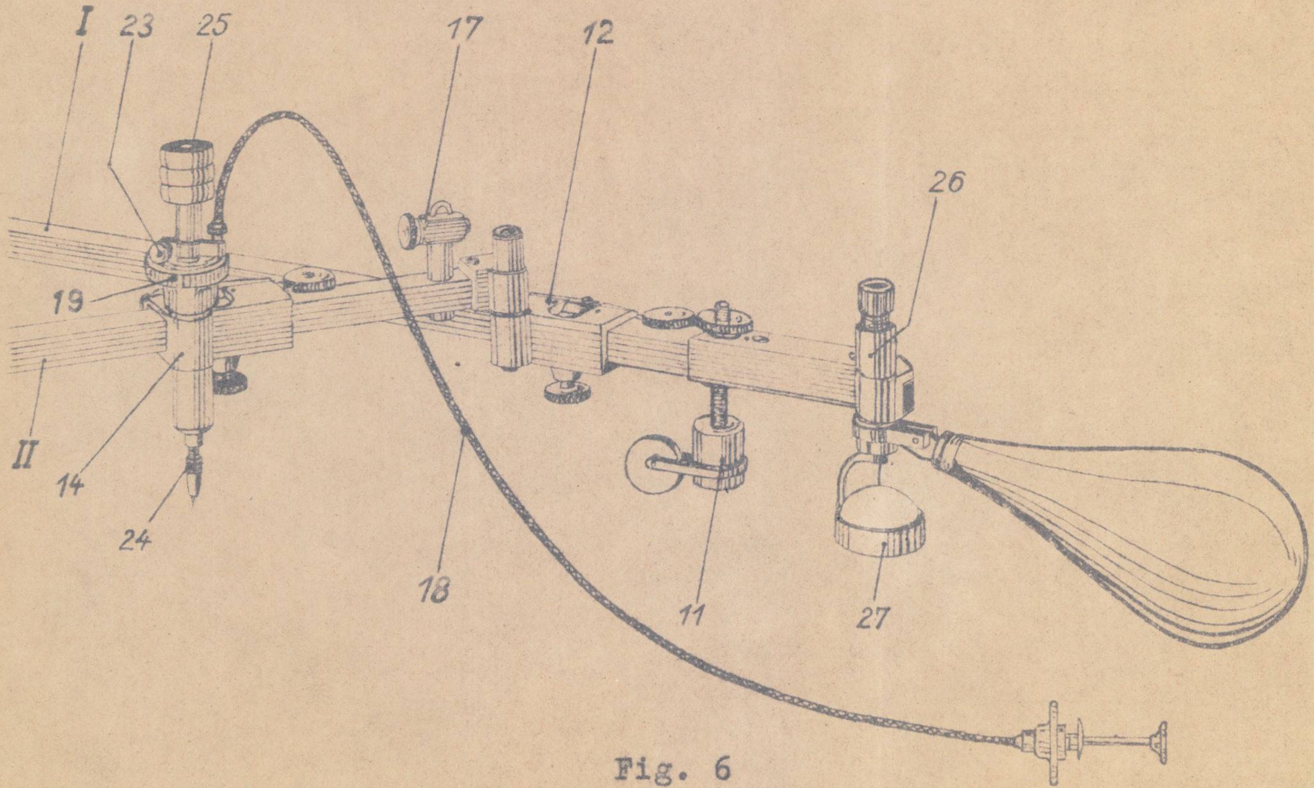


Fig. 6

The Additional Equipment:

Tracer lens	PHASA
Drawing pen	PHEGI
Orientation lens	POVOX
Tracer stylus with blunt point ..	PHIGO
Spare dotting stylus	PHIOL
Spare drawing stylus	PHOTO
Box in which to keep the weighted foot	POSAR

does not belong to the standard equipment of the Pantograph. These parts must be ordered separately.