Meccano 7 Roll Roller Leveller

Les Pook
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Industrially, roller levellers are used to flatten coiled metal strips in preparation for subsequent manufacturing operations. Descriptions of various types of roller leveller are given in http://www.apdesign.co.za/levelling.html together with comments on practical aspects of their use. The principle is that the sheet is bent alternately in both directions in decreasing amounts by a set of rolls. For theoretical background see: Morris J W, Hardy S J and Thomas J T. ‘Some fundamental considerations for the control of residual flatness in tension levelling.’ Journal of Materials Process Technology, 2002, 120, 385-396.

The Meccano 7 roll roller leveller, shown in Figure 1, was not based on any particular prototype. Somewhat to my surprise, the roller leveller worked first go. I have used it to flatten some of my bent flexible sheets. In the picture a 5½ × 2½ inch flexible sheet is emerging. For convenience in descriptions this is called the output end. In use the rolls have to be adjusted by trial and error. Those on the input end need to be set closer than those on the output end. Meccano flexible sheets sometimes need to be passed through the roller leveller more than once, with adjustment between passes. They sometimes have to be pushed and pulled to help them through the rolls. This is reminiscent of industrial practice where tension is sometimes applied. Figures 2 and 3 show 2½ × 2½ inch flexible sheets before and after flattening. Final minor adjustments were made by hand. The flattened flexible sheets are not perfect but they are substantially improved. The roller leveller has also been used to flatten 5½ × 2½ inch, 5½ × 1½ inch and 2½ × 1½ inch flexible sheets. The flexible sheets flattened all had initial curvatures comparable with that of a Part 200 curved plate. Sharp curves, such as that in Part 199 curved plate U-section, and creases such as that shown in Figure 4 cannot be removed. Theoretically, the diameter of the rolls is a limiting factor.

The four lower rolls are driven through appropriate gearing by turning the 2 inch pulley with tyre. The three upper rolls are not driven. The upper rolls are mounted on a suitably restrained floating plate whose height and angle can be adjusted by turning the 1 inch pulleys with tyres. These alter the height near the edges of the plate. Precise adjustment is needed, and this has to be matched to individual flexible sheets. One turn of a 1 inch pulley with tyre changes the height near an edge of the plate by about 0.006 inch (0.15 mm).

The rolls used are commercially available in sets of three, and are intended for use in Meccano bending rollers. A set is shown in Figure 5, and a typical Meccano bending roller in Figure 6. The rolls are ⅜ inch diameter by 3½ inch long. Stubs at the ends are sized to fit Meccano holes, and on two of the rolls they are ⅛ inch long. On the third roll one stub is ⅜ inch long and the other 1 inch long. All the stubs have flats for firm mounting of pinions. Five rolls with ⅜ inch long stubs are needed for the roller leveller, and two with one ⅛ inch long stub and one 1 inch long stub.
General views are shown in Figures 1, 7 and 8. In constructing the roller leveller load paths were considered to ensure adequate rigidity. Care was taken to ensure that all moving parts could move freely with no binding anywhere. This included the judicious addition of washers and the exploitation of slotted holes. Figure 9 is a view from underneath, and Figures 10 and 11 are detail views. The latter shows a modification that experience showed was needed. This is the addition of strips above the plastic gears.

The leveller was built from the base upwards. The base consists of two $5\frac{1}{2} \times 2\frac{1}{2}$ inch flanged plates, connected by four $12\frac{1}{2}$ inch girders, and stiffened by two $3\frac{1}{2} \times 2\frac{1}{2}$ inch flanged plates (Figures 1, 7 and 8).

The four lower rolls are journalled in two $2\frac{1}{2}$ inch flat girders bolted to the centres of the two upper $12\frac{1}{2}$ inch girders. Washers, two at one end and one at the other are placed at the ends of the rolls to ensure clearance for the upper roll mountings. The second and third rolls have a 1 inch stub. (The rolls are numbered from the input end). The input shaft is a $6\frac{1}{2}$ inch rod journalled in the input end of the $2\frac{1}{2}$ inch flat girders, and with a 2 inch pulley with tyre at one end (Figures 9, 10 and 11). The first and second rolls are driven from the input shaft by pairs of $\frac{1}{2}$ inch pinions and 1 inch pinions respectively. The third roll is driven from the first roll by a train of three $\frac{1}{2}$ inch pinions. The middle $\frac{1}{2}$ inch pinion is an idler that is free to rotate on the 1 inch stub of the second roll. Similarly, the fourth roll is driven from the second roll.

The three upper rolls all have $\frac{3}{8}$ inch stubs. They are mounted on a $4\frac{1}{2} \times 2\frac{1}{2}$ inch plate using the arrangement shown in Figures 11 and 12. The outer rollers are journalled in small triangular plates which are bolted to two $2\frac{1}{2}$ inch girders, which in turn are bolted to the $4\frac{1}{2} \times 2\frac{1}{2}$ inch plate. The middle roll is journalled in the middle holes of two $1\frac{1}{2}$ inch narrow strips fitted onto the outer rolls before they are fitted into the triangular plates (Figure 12). The $2\frac{1}{2}$ inch girders are adjusted so that the triangular plates fit between the flat girders used to mount the lower rolls (Figure 10). This locates the upper rolls laterally. They are located longitudinally by $4\frac{1}{2}$ inch narrow strips. These are pivotted, using $4\frac{1}{2}$ inch rods, to holes at the input end of the $2\frac{1}{2}$ inch girders and to flat trunnions bolted to the two upper $12\frac{1}{2}$ inch girders. (Figure 8). Washers are added so that the $4\frac{1}{2}$ inch narrow strips clear the vertical strips shown in Figure 10, left. A $5\frac{1}{2}$ strip, bolted to the $4\frac{1}{2} \times 2\frac{1}{2}$ inch plate, with $\frac{3}{4}$ bolts at the ends pointing downwards, provides attachments for elastic bands (Figure 10).

The twin mechanisms for adjusting the upper rollers, shown in Figures 10 and 11, are mounted at the input and output edges of a $4\frac{1}{2} \times 2\frac{1}{2}$ inch plate. Double bent strips are bolted underneath the centre of the input and output edges. The plate is bolted to the centres of two $5\frac{1}{2}$ inch girders ($4\frac{1}{2}$ inch girders could be used). These are bolted to vertical strips which in turn are bolted to flat trunnions. These are bolted to the two upper $12\frac{1}{2}$ inch girders. Three inch strips are used at the input end and $2\frac{1}{2}$ inch strips at the output end. Bolts holding the 3 inch strips must be positioned so that they do not foul the $4\frac{1}{2}$ inch narrow strips. A $5\frac{1}{2}$ strip, bolted to the plate, with $\frac{3}{4}$ bolts at the ends pointing upwards, provides attachments for elastic bands.

Each mechanism has a $\frac{1}{2}$ inch plastic pinion mounted on a central 3 inch rod, with a 1 inch pulley with tyre mounted at its upper end. The pinion drives two $2\frac{1}{2}$ inch plastic gears mounted on threaded pins made by cutting threads at one end of $2\frac{1}{2}$ inch rods (2
inch rods could be used). Collars beneath the plate locate the threaded pins endways. Elastic bands are used to eliminate end float. Plastic gears and pinions are used because they are more tolerant of inevitable misalignment. As shown in Figure 1, correct centre spacings are maintained by loose 2½ inch strips above the pinions and gears (2 inch strips could be used). Without these strips gears occasionally jump out of mesh. Each threaded pin is screwed into a threaded crank. The threaded crank sits on an Allen head bolt selected to suit the recess in the boss of the crank (Figure 13). The crank is loosely located by ⅜ inch bolts fitted with lock nuts. The gears and pinion at the output edge are spaced from the 4½ × 2½ inch plate by washers and at the input end they are spaced by plastic spacers. The arrangement of the mechanisms means that the input and output edges of the 4½ × 2½ inch plate on which the upper rolls are mounted can be raised and lowered precisely and without binding.

The mechanisms have to be set up to ensure that the upper and lower rolls remain parallel during operation. This is done with the gears and collars initially loose on the threaded pins and without the elastic bands. Place the upper rolls in contact with the lower rolls, and then adjust the threaded pins so that they are just clear of the grub screw holes in the threaded cranks. Push the collars as far as possible up under the plate and lock them in position. Lock the 2½ inch gears, and install the elastic bands. The roller leveller is now ready for use.

Figure 1