IN THE WORKSHOP

by "Duplex"

33—Additions to Machine Tools

(1) Simple Dividing Gear for the Myford ML7 Lathe

WHEN buying a small lathe, the amateur or professional worker naturally selects one which will most nearly meet his requirements.

We say—most nearly — because there can be no such thing as the ideal lathe or one which, when sold at a moderate price, will suit all tastes or will be equipped for undertaking the wide range of machining operations of which the lathe is inherently capable.

From the manufacturer's point of view, any attempt to supply his standard productions with alterations, variations and special adaptations to satisfy the needs or whims of a minority of purchasers would, no doubt, lead to early insolvency.

Lathes can only be produced at a price within the reach of the ordinary user by adhering to a standard design, and adopting efficient manufacturing methods which maintain both the quality and quantity of the output.

As has been so often advocated by those of wide practical experience, the most suitable type of lathe for the great majority of workers is one of relatively simple design, but of really sound construction combined with accurate workmanship. A tool such as this will meet the requirements of many workers and, moreover, they can at any time further equip the lathe, should they so desire, with the special attachments supplied by the makers for carrying out more elaborate machining operations, such, for example, as dividing, gear-cutting and taper-turning.

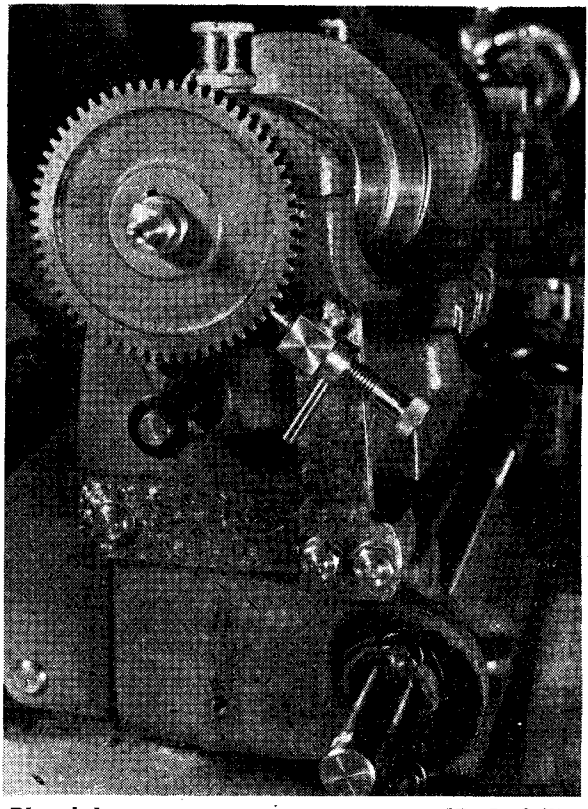

Photo by] [*P. G. Collier*

Fig. 1. Dividing from a single change wheel

Besides these appliances for performing major machining operations, there are minor but important additions which will be found to contribute greatly to the convenience of operating the lathe in the course of ordinary working.

Manufacturers, however, very rightly concentrate on producing a sound and reliable tool at a moderate price rather than offering a lot of detail work and fittings at the expense of the major requirements of good workmanship in the essential parts. There are, moreover, many workers who are not only capable of developing their lathes in this way but who derive great pleasure in carrying out the necessary work, thereby possibly reducing their initial monetary outlay and certainly increasing the utility of the machine.

It is with this in mind that we venture to describe some of the additions that have been made to our own lathes and machine tools, and to those belonging to friends who have sought our advice on this subject. In point of fact, a skilled and experienced fellow worker, who had all too little time to devote to his hobby, recently brought his ML7 lathe to us with the request that we should embellish it as we thought fit, bearing in mind that this lathe is equipped with the full range of attachments and is used for a great variety of work.

It is, therefore, the additions made to this lathe that it is proposed to describe in the first place, but at the same time it should be borne in mind that much of the work is equally applicable to lathes in general, and many of the fittings have been used in connection with lathes of other types.

When making alterations and additions to machine tools, it has always been an important consideration with us that in no case should the general structure of the machine be interfered with in any way, nor even should holes be drilled in any of the main parts if this can be avoided; if this plan is adhered to the machine is not made non-standard, and at any time it can be returned to its exact original form should the alterations not find favour or its disposal be contemplated.

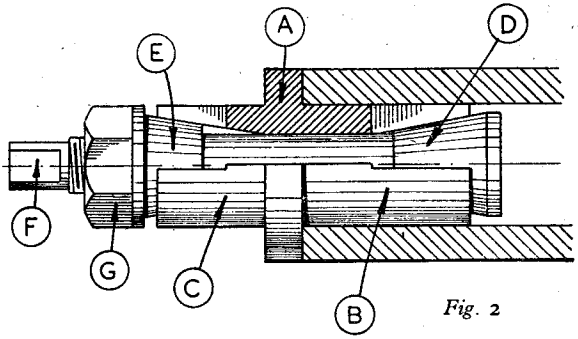

Fig. 2

Simple Dividing Gear

As distinct from dividing by means of a special dividing-head, dividing from a single lathe change wheel, or from a train of wheels, will cover most of the work of the kind usually undertaken in the small general workshop. In the present instance, a form of simple dividing gear will be essential for making some of the additions that are to be described.

Dividing from a Mandrel Wheel.

If any of the lathe change wheels is securely fixed to the tail end of the mandrel and a rigidly-mounted detent is used to engage the tooth spaces, then by making use of the whole series of wheels a wide range of divisions, particularly in the lower numbers can be obtained.

Thus, any number of divisions from one to fifteen and also their lower multiples become available, whilst if care is taken the accuracy of the work produced will be comparable with that of the wheel itself. Further, this arrangement, which is illustrated in Fig. 1, will also serve as a useful lock for the mandrel.

It is, of course, essential that the change wheel so used should be firmly secured to the mandrel so that there is no possibility of its shifting its position during the dividing operation, and at the same time it must be mounted to run truly.

The method adopted for fitting the wheel is that illustrated in the general arrangement drawing, Fig. 2; this shows a two-ended adaptor *A* is used, one end, *B*, fitting into the mandrel bore and the other, *C*, carrying the change wheel. Both ends of the adaptor are split and are expanded when the internal cones *D* and *E* are drawn together by tightening the nut *G* fitted to the central bolt *F*. As these cones have only a moderate degree of taper, they exercise a powerful radial thrust, and in practice it will be found that relatively light tightening pressure applied to the draw-nut will be sufficient to lock the parts securely in place.

Construction

In the first place, the mandrel bore should be examined, and if the tooling marks are prominent it is advisable, but not essential, to employ an adjustable reamer to establish a smooth surface finish.

The body of the adaptor, *A*, is made from a length of 1 in. diameter mild-steel bar which is gripped in the chuck and then faced and bored for its full length with a $\frac{5}{16}$-in. clearing size hole. The top slide is next set over to 10 deg., and the tapered portion of the bore at the end *B* which enters the mandrel bore is formed with a small boring tool in accordance with the working drawing shown in Fig. 3.

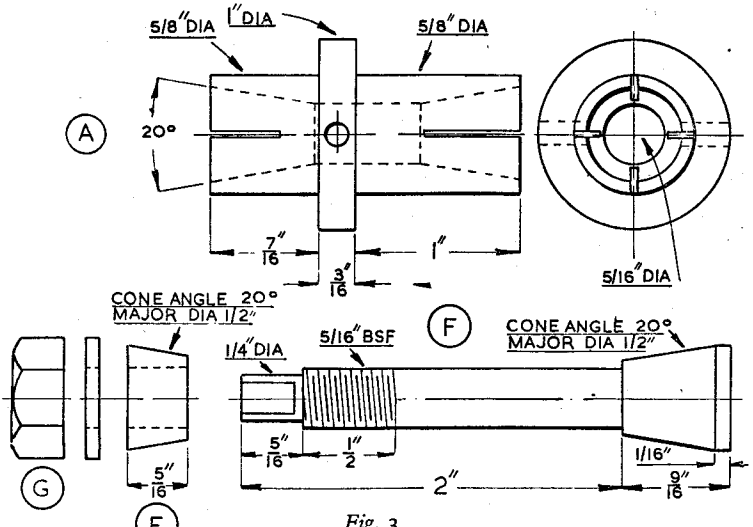

Fig. 3

When a cut has been taken to true the surface of the projecting part of the work, the external diameter is reduced to make the portion *B* a

good push fit in the lathe mandrel. The work is then reversed and set to run truly in the four-jaw chuck so that the other end *C* of the adaptor can be taper bored internally, and then turned on its external diameter to fit closely into the bore of the change wheel.

The work is next removed from the lathe and

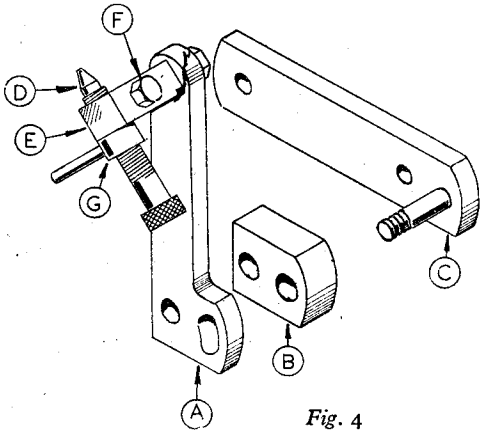

Fig. 4

gripped in the machine vice for drilling two diametrically opposite $\frac{1}{8}$ in. diameter holes in the collar. These holes are to accommodate two short tommy-bars for the purpose of gripping and removing the adaptor from the mandrel bore.

Finally, both ends of the adaptor are slit with a fine hacksaw, by making two cuts crossing at right-angles, to allow the metal to expand when the internal cones are closed on tightening the central bolt.

The expander bolt *F* is turned in accordance with the drawing from a length of $\frac{5}{8}$-in. diameter mild-steel rod supported by the tailstock centre. The coned portion *D* is formed by again setting over the top slide to 10 deg. but in the reverse direction. The correct mating of the internal and external cones should be checked by drawing a series of pencil lines along the male cone, and if the female cone is then applied with a twisting motion, the lines should be evenly obliterated where the fit is correct; should the pencil marks indicate that proper contact is not being made, the top slide must be reset to correct the error.

After the thread has been formed by means of a $\frac{5}{16}$-in. B.S.F. die guided by the tailstock the bolt is parted off to length and two small flats are filed or machined at its outer end.

The purpose of the flats is to afford a hold for a spanner in the unlikely event of the bolt itself rotating when the clamping-nut is turned; if no trouble of this sort is experienced, the end of the bolt can be shortened at a later stage for the sake of appearance.

The small movable cone *E* is turned as in the previous instance, and is then bored to a sliding fit on the shank of the clamp-bolt.

To complete the adaptor, a $\frac{5}{16}$-in. B.S.F. nut *G* and washer are fitted to the end of the bolt. When the parts have been assembled, a change wheel is mounted in place and the adaptor is pushed into the mandrel bore; the clamp-nut is then tightened to secure the parts in position. The adaptor is removed by slackening the clamp-nut a single turn and then tapping the end of the clamp-bolt inwards to free the internal cone.

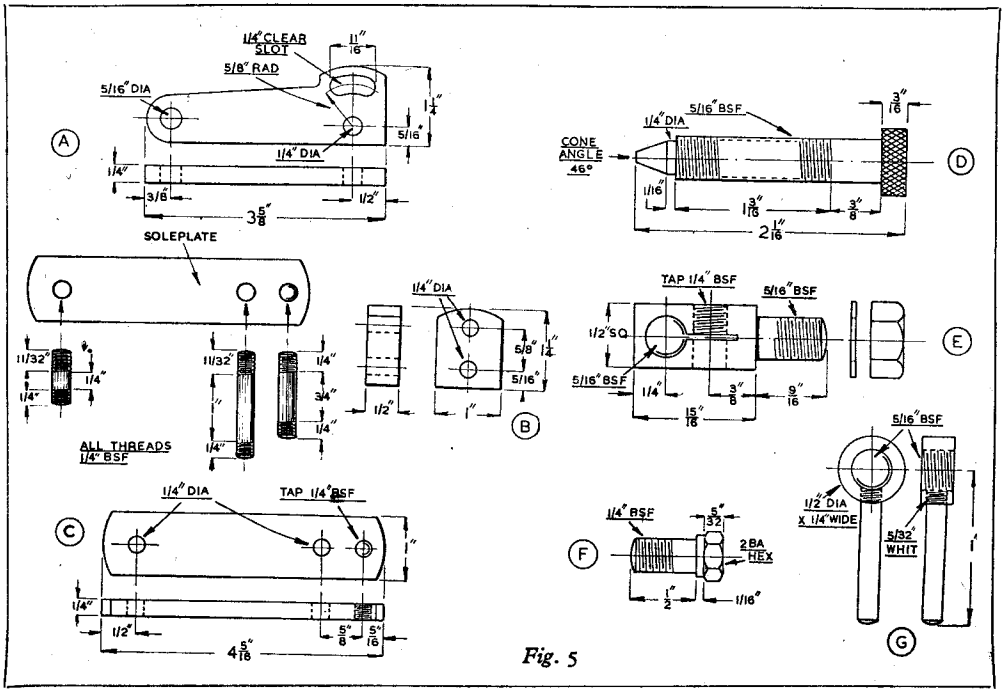

Fig. 5

Where the adaptor has been made a good fit in the mandrel, the two tommy-bars previously mentioned will have to be used to remove the adaptor by applying a twisting motion.

The Mandrel Wheel Detent

To enable the change wheel to be used for indexing when it is attached to the mandrel by means of its adaptor, it is necessary to fit a rigid form of detent that will engage the spaces between the teeth.

The detent shown in Figs. 1 and 4 is secured to the end of the lathe bed by means of studs set in the tapped holes provided for attaching the back cover of the standard wheel guard.

If desired, the cover plate can be retained, but the drawings relate to a detent fitted after this plate has been removed.

In this connection, it will be noted that formerly small lathes designed mainly for amateur use were, as a rule, fitted with guards to the back gear, but the belts and change wheels were not protected in any way. This is understandable, as the amateur worker usually prefers that all parts of the lathe should be readily accessible, and at the same time he generally has the foresight to avoid risking an accident; but now that lathes of this type are used commercially, or can be readily adapted for this purpose, the manufacturers meet the situation by supplying, as part of the standard equipment, the necessary safeguards prescribed by the Factory Acts.

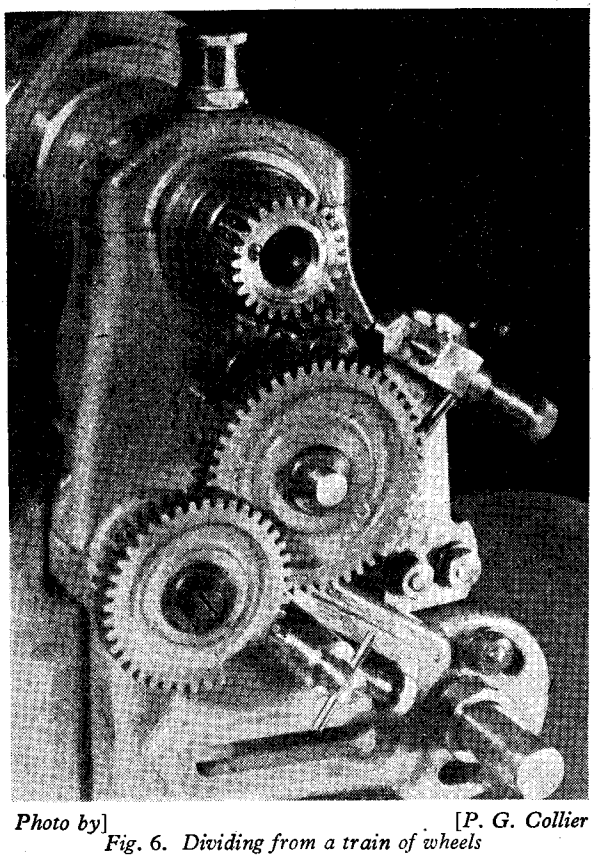

Photo by [*P. G. Collier*

Fig. 6. Dividing from a train of wheels

The actual making of the attachment is quite straightforward and calls for little explanation, for the general arrangement of the components is shown in Fig. 4, and the detailed dimensions of the several parts are given in the working drawings in Fig. 5.

Before fitting the soleplate *C*, it is advisable to pass a file across the end of the lathe bed to remove any irregularities adjacent to the stud holes; a washer is then fitted to each of the two long studs so as to provide an even bearing surface for the plate. To ensure that the parts, *A*, *B* and *C* can be assembled correctly, it is advisable first to drill a single hole in each part and then to drill the second hole right through all the components after they have been bolted together.

It will be seen that the outer bolt-hole in the base of the pillar is slotted; this allows the pillar to be set so that the point of the detent *D* does not project unduly beyond its supporting bracket *E*, when the change wheels of either large or small diameter are in use. The point of the detent should be turned to fit the wheel tooth space, and, if the coned tip is machined to an included angle of 46 deg., it will mate with the 60-tooth wheel, which is the size most generally employed for simple dividing operations.

It will also be observed that the bracket *E* is split so that the fit of the thread can be adjusted as required, by means of the clamp-screw *F*.

When the detent is used either for dividing or for locking the lathe mandrel, it is secured by tightening the handled lock-nut *G*, after the point has been carefully engaged in the required tooth space to eliminate all backlash.

Dividing from the Quadrant Change Wheels

As was previously stated, when dividing from a change wheel correctly mounted on the mandrel, the accuracy of the work produced will be comparable with that of the wheel itself. Where a train of wheels is employed, however, additional errors are introduced, for example, by the presence of the wheel bearings and by the spring in the wheel mountings. Moreover, it is far from easy to mesh all the wheels in the train exactly on their pitch-lines in order to ensure regularity of the turning movement from wheel to wheel.

Cutting gear wheels accurately to pitch can, therefore, hardly be expected when this method is employed, but less exacting dividing operations can be carried out quite satisfactorily in this way.

One advantage of using a wheel train is that division into a large number of spaces is possible, whereas with a wheel mounted on the mandrel,

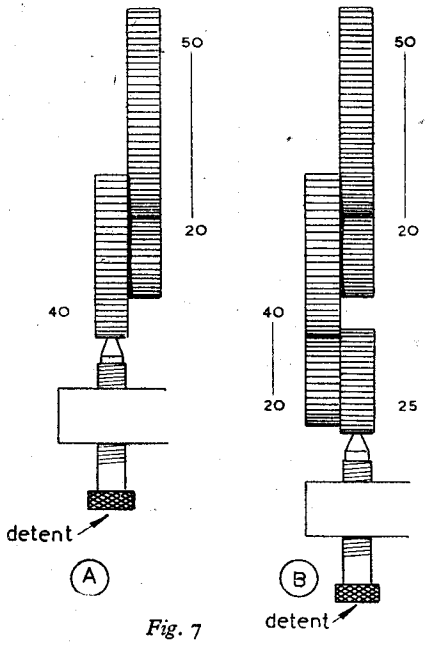

Fig. 7

the number of divisions obtainable is limited by the size of the largest change wheel available.

The method of dividing from change wheels mounted on the quadrant is illustrated in Fig. 6 which shows the arrangement of the wheel train and detent used for indexing the work into 100 divisions. It would, of course, be preferable to mount a 100-tooth wheel directly on the mandrel, but as a wheel of this size is not included in the standard set of change wheels, the alternative method must be adopted.

It will be clear from the drawing in Fig. 7 (A) that a reduction gear of 2 : 1 is employed to obtain 100 division from the 50-tooth wheel. Fig. 7 (B) shows how a compound wheel train can be set up to provide for dividing into 125, as when making an index for a feedscrew of $\frac{1}{8}$ in. pitch. An alternative method of dividing into 125 is to connect a 75-tooth wheel with the mandrel and to obtain a reduction of 5 : 3 by gearing with it a 30-tooth wheel coupled on the same stud to a 50-tooth wheel for meshing with the detent. The set-up is then like that shown in Fig. 7 (A), except, of course, that wheels of different size are employed.

The Detent

The general appearance of the detent used in this instance is shown in Fig. 6, and the constructional details and dimensions are given in Fig. 8.

Where the detent is used only in connection with the wheel arrangement shown in Fig. 7 (A), that is to say, contact is made with the outer of the two wheels mounted on the stud, then the form illustrated in Fig. 8 (A) will be appropriate ; but when indexing from a wheel mounted on the inner end of the stud, as in Fig. 7 (B), a detent with less stand-off is required.

The detent depicted in Fig. 8 (B) has, however, a removable distance-piece so that it can be used with either of the two types of wheel arrangement described.

As was pointed out in a previous article, it is

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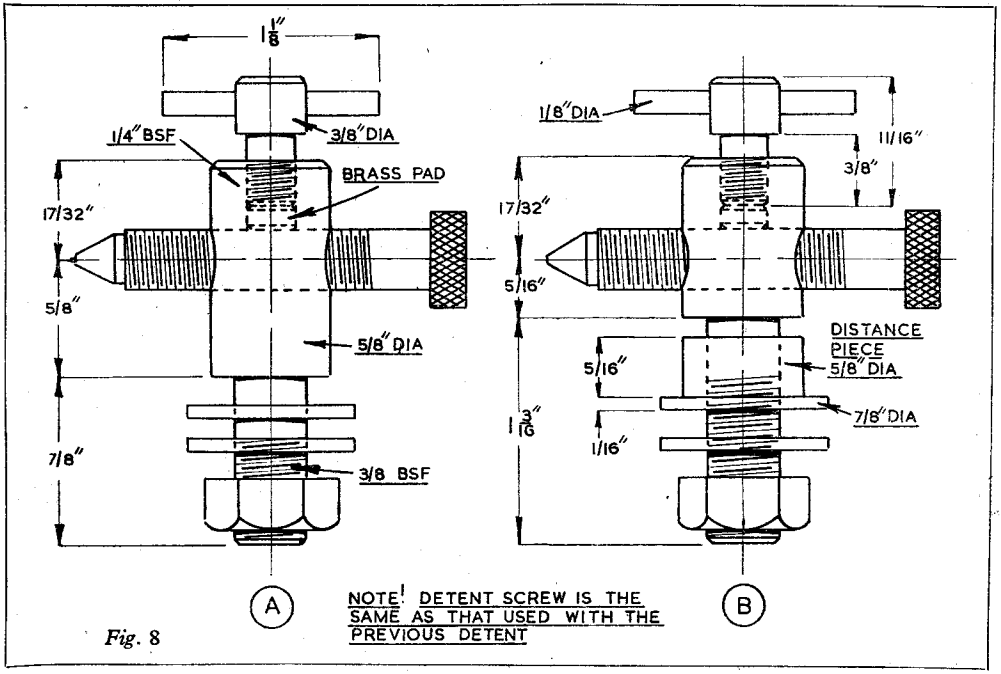

Fig. 8

tive of full-size practice than union joints, though the latter are quite satisfactory from the practical aspect if properly made, and in certain circumstances, are easier to manipulate in cramped spaces.

The displacement lubricator is of orthodox type, but of rather greater capacity than most of those fitted to small engines. It is built up by silver-soldering, but may be partially or entirely made from the solid if preferred. It connects directly into the main steam distribution pipe and is not fitted with an isolating valve, as it is rarely necessary to refill it while under steam, but this refinement may be added if desired.

Few small steam engines are fitted with really adequate arrangments for oiling the bearing, and in this respect the fitting of a large capacity oil box to the engine is a real advantage. The box may be built up from copper sheet by silver-soldering, and the hinge may be of the ready-made type, riveted on, though it is not difficult to make one much neater and more appropriate to the purpose from sheet copper. An angle bracket may be riveted to the back of the box for attaching it to the top of the trunk columns.

Distribution pipes are taken from the box to the trunk crossheads, and to drip pipes over the cranks; further pipes to supply the main and eccentric strap bearings would be useful. The pipes are $\frac{1}{16}$ in. diameter and may be fitted with dummy unions, as real ones would be very delicate to machine and fit. They are carried up inside the box to within $\frac{1}{4}$ in. of the top, and fitted with wicks made from cotton or hemp fibres, obtained by unravelling the strands of soft twine or textile fabric. A short length of fine wire, twisted into an eye at one end, is used for inserting the wick in the pipe, after which it is bent over the top of the pipe and left in position.

Although not specified in the detailed drawings, some form of lagging or "cleading" on the cylinder blocks is desirable not only for the purposes of conserving heat as much as possible, but also to improve the appearance of the engine. The usual form of lagging on these small engines consists of a thin blued iron plate enclosing insulating packing, such as shredded asbestos or slag wool. If desired, the two cylinders may be enclosed in a single casing of this type to give the impression of being made in a solid block, in which case it will be necessary to fit a suitably shaped piece of sheet metal between the two cylinder covers to enclose the top of the lagging. In the event of the blued steel or "Russian" iron generally used for this purpose not being available, it is quite a simple matter to colour a piece of thin sheet steel by heating it in a sand bath until the required colour is obtained. If the metal is clean and bright, it will take on a brilliant blue or purple colour, which may be considered too vivid, but by coating the surface with oil before heating, a brownish colour will be obtained. An alternative to the sheet steel lagging, which further improves the appearance, is to use teak or mahogany staves held in place by two brass bands on each cylinder block.

The bed-plate of the engine incorporates a seating for the purpose of fitting a feed pump on the engine, and this may be either direct driven or geared as shown in the photograph in the February 10th issue. If the engine is to be run at a fairly slow speed, a direct driven pump is preferable, but for high speed engines, reducing the speed in the ratio of 3 or 4 to 1 is advisable. A ready-made pump of the type obtainable from Messrs. Stuart Turner or Bassett-Lowke will serve the purpose quite well.

(*To be continued*)

In the Workshop

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essential, when employing wheel trains for dividing, to take up the backlash in one direction and to maintain the gears in this position during the actual tooling operation on the work.

As mentioned earlier, any spring present in the wheel mountings may, amongst other things, cause inaccuracy; so keep this source of error as far as possible constant, it is essential to apply a constant pressure when eliminating the backlash.

Hand pressure, which is variable, should not, therefore, be used for this purpose, and, instead, a suspended weight should be employed to maintain a constant pressure. Although the practical application of this method has been described on a previous occasion, it may not be out of place, briefly, to recapitulate. The chuck key is inserted in one of its slots, and a loop formed at the end of a length of cord is passed over the key; the cord is then given a couple of turns round the body of the chuck, whence it passes over the edge of the bench and has a weight attached to its free end.

The mass of the weight need not be great, but it must be sufficient to counteract any turning movement imposed on the work by the machining operation. When engaging the detent in a tooth space, the pressure exerted by the weight should be relieved by steadying the chuck key with the hand, so that the point of the detent can enter unobstructed to its full depth.

Where change wheels, attached either to the lathe mandrel or to the quadrant, are employed for dividing, it may save making errors and spoiling work if at the outset the tooth spaces required are clearly marked with chalk or by means of a grease pencil.

Marking-out the teeth in this way will be greatly facilitated, and errors will be avoided, if the dividers are set to the interval required and are then used to step out the circumference of the wheel.

(*To be continued*)