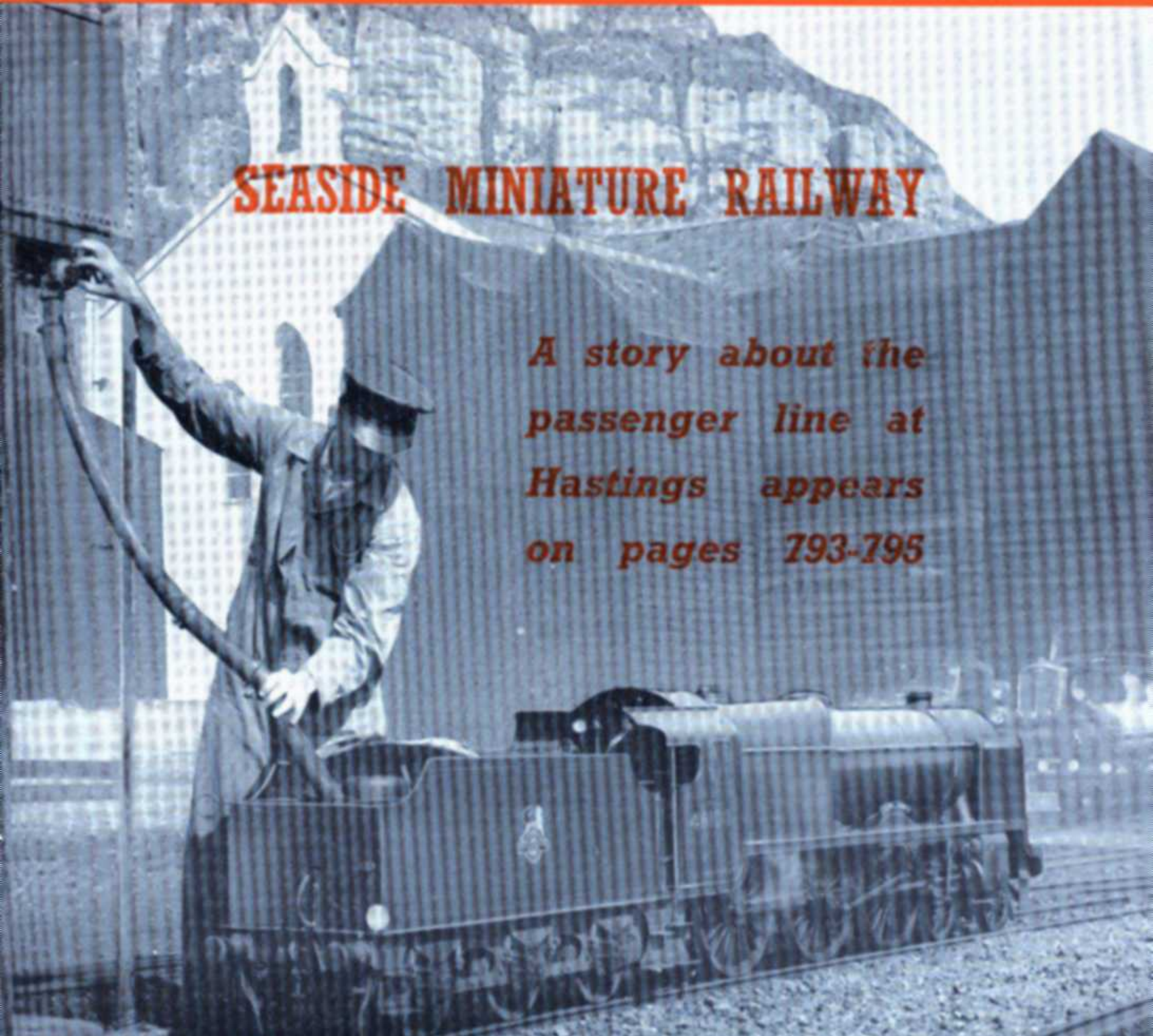
Model Engineer

THE MAGAZINE FOR THE MECHANICALLY MINDED



ONE SHILLING 25 DECEMBER 1958 VOL 119 NO 3005

Model Engineer

IN THIS ISSUE

NEXT WEEK

ME musical clock case
RMS Himalaya
Ultra miniature models
Ship modelling for beginners

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A WEEKLY COMMENTARY

smoke rings

BY VULCAN

LOOKING back over the past twelve months, 1958 emerges as an important year in the annals of MODEL ENGINEER and one not without significance to model engineers in general.

The big event of the ME's year was the production of the Diamond Jubilee number in May celebrating 60 years' continuous publication of the magazine. This was very well received and even today an occasional congratulatory letter from far distant readers—there was one from an engineer in the Outback of Australia just over a week ago—reaches this office.

The editorial staff greatly enjoyed the preparation of this number. It cost a lot of time in research and in organising the contents, but its appreciation by the reader was reward enough.

Britain's premier model engineering society, the SMEE, also celebrated its diamond jubilee this year and I was pleased to be present at the get-together at their Wanless Road headquarters, to drink their health at the dinner held at the Piccadilly Hotel, and to wish them many happy and successful years in the future.

Successful series

This year, too, saw the production of several outstanding constructional series. Following the conclusion of the spirit-fired gauge 1 steam engine *Newbury*, Martin Evans applied his skill to the building of a 3½ in. gauge reproduction of the handsome 2-6-4 tank engines which operate on the Midland Region of British Railways. A great many readers are building this model—*Jubilee*—and as the series progresses it is becoming increasingly popular. Many visitors to Noel Street have called at our basement workshop and have been favourably impressed with the workmanlike job that Evans is making of this model.

From the pen of another Martin—this time Joseph Martin—came the excellent series on the Science Museum commemorating the centenary of this world famous institution. Later in the year, as many American friends will recall, he spent six weeks in the States, returning with a splendid crop of articles, two of which—The America Cup and the David Taylor Model Testing Basin—have already appeared.

On the nautical side Edward Bowness described in detail how to build a model of the incomparable *Cutty Sark*, a series made topical by the success of the famous ship as a museum. In the traction engine field, the evergreen Model Engineer Traction Engine was revived by Ernest A. Steel and for the locomotive enthusiasts LBSC came up with a winner in the form of *Pansy*, the 5 in. gauge model of a GWR pannier tank engine.

Our regulars

Of our regular contributors Edgar T. Westbury, among many other valuable articles, dealt with two important series during the year—the 10 c.c. Cherub and Power for Model Boats; and J. N. Maskelyne continued his popular fortnightly serial on Locomotives I Have Known.

One item of news which passed almost unnoticed in model engineering circles was the relaxation of hire purchase controls which permitted goods to be bought on a small deposit. It is early yet to assess how much this will affect the movement but without a doubt it makes much easier the purchase of lathes, drilling machines and the larger type of home workshop equipment to the craftsman of limited means.

Of the Exhibition, there were one or two complaints—and justifiable ones to my mind—that the models in the mechanical section were too crowded. This was due, of course, to the division of the hall into two distinct exhibitions, model aircraft and model engineering, and I am assured that at the next show, whether this segregation persists or not, there will be no cramping of the exhibits.

A satisfying year

This criticism aside, I found the Exhibition a lively, stimulating show with plenty to interest the veteran and the tyro, the general standard of workmanship being well up to its customary level.

On the whole we at MODEL ENGINEER have found 1958 a satisfying year and one on which we can consolidate our efforts and shape encouraging plans for the future.

It is on this note, a note of hope and encouragement, that I convey the seasonal greetings of the Editor and staff to readers of MODEL ENGINEER in all parts of the world.

Locomotive photographs

THROUGH the generosity of Mr H. Murray Taylor, of Dunbartonshire, a fine collection of photographs of historic locomotives has come into my possession.

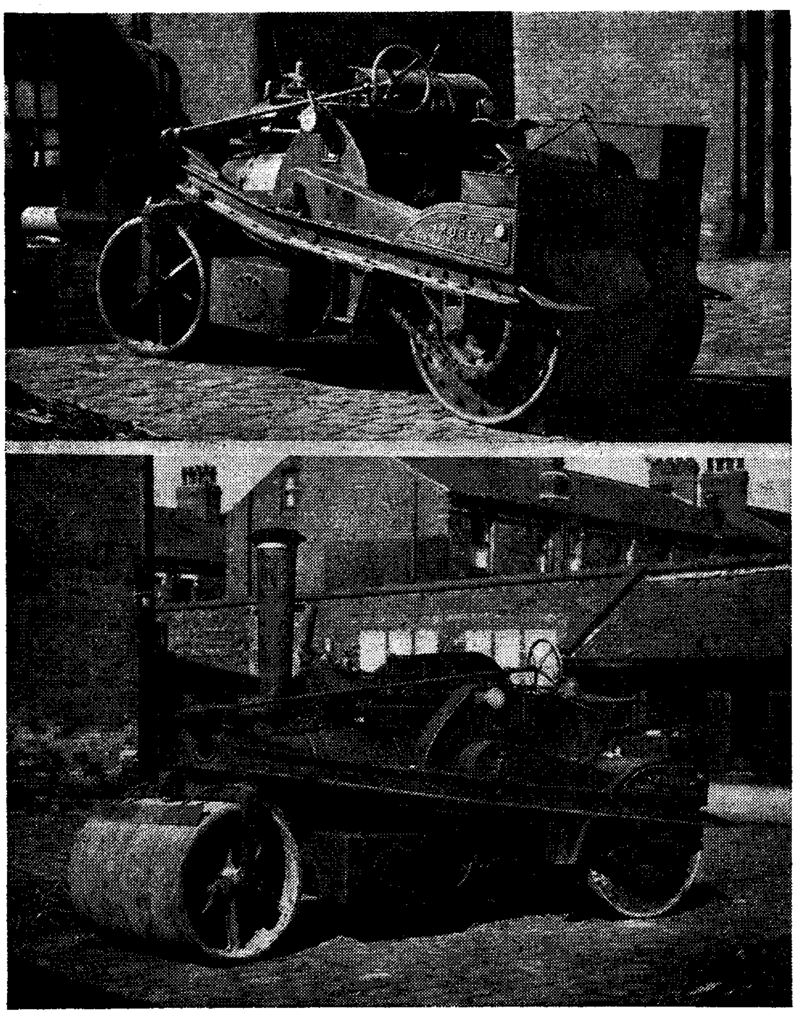
The collection was put together by Mr Taylor's brother. It covers a wide range of railway locomotive power, and includes pictures of such diverse and interesting engines as *Tiger*, an early broad gauge single-wheeler express engine of the GWR; the ten-coupled *Decapod* of the Great Eastern, most powerful engine in the world at its time; and the 2-4-0 *Atalanta* of the 1860s with its inordinate stovepipe chimney. I hope to feature several of the pictures from this collection in the pages of MODEL ENGINEER.

Cover picture

No 46100 of the Hastings miniature railway taking on water. Martin Cleeve writes about this sea-front narrow-gauge line on pages 793 to 795.

Mr H. Murray Taylor, who is an executive with a marine salvage company, has been interested in model engineering for many years. He has a King Arthur class locomotive which he tells me is still not quite finished, although it was begun many years ago. In fact, in 1945 it had a successful trial run on LBSC's track.

The king pin of his workshop is "a very fine Pittler 3½ in. B2 lathe, No 1257" on which all the machine work for the King Arthur was done.



Two views of the Robey steam roller in the grounds of the North Street hospital, Leeds. See "Unusual boiler"

Unusual boiler

THE pictures of the Robey steam roller were sent to me by Dr Peter Lockwood, who is attached to the hospital in North Street, Leeds. He had them taken when the roller was used recently for re-laying the drives.

He says that it is a compound engine, built in 1924, and appears to be about 5 to 6 in. bore for the high pressure and 8 to 9 in. for the low pressure, with a stroke of 8 in. The driver was unable to offer any reliable information about its mechanism.

Dr Lockwood says that the boiler is of unusual shape in that it has a hemispherical firebox top and circular grate.

Next week

I HAVE heard recently from several readers who are nearing completion of the ME Musical Clock and their thoughts will inevitably turn to the construction of a suitable case for this fine mechanism. In the January 1 issue Mr C. B. Reeve, well known for his clock models and for the original series about the Musical Clock, will begin the first article about a suitable case. This has been designed so that it is well within the compass of model engineers who, despite their considerable skill with metals, have been observed to shiver when confronted with a task in timber !

In this issue, too, we welcome back A. A. Sherwood, the authority on ultra miniature modelling, who deals with some of the problems encountered and maintenance of ultra miniature mechanisms.

DRIVING THE HASTINGS MINIATURE

Even professionals need a special skill when driving a model loco. And a 12-hour stretch is a back-breaking job, says MARTIN CLEEVE

IT may surprise readers to know that, although I am not a locomotive builder, I enjoy engine driving and the pleasant smell of hot oil and steam. Much of the fascination, I think, stems from my younger days, and is associated with the fact that the monster machine was not only capable of a wonderful show of power and speed: it used to take us for holidays.

In later years, one's attitude is conditioned by circumstances. I always get a thrill from seeing an engine hauling an express at high speed, or working hard pulling a heavy goods train up a gradient. But sometimes when the same engine bars my way it is apt to be regarded as a cumbersome nuisance to be circumnavigated with the least delay.

It was in 1947 that I first heard that Hastings was to have a miniature railway. It was sited at the bathing pool, and run as a sideline by the Romney, Hythe and Dymchurch Railway Company. I spent many a wistful half-hour watching it in operation and thinking how much I should like to drive—little thinking that the wild dream was to be fulfilled !

Moved to east end

It so happened that after the first season's operation, residents in the vicinity strongly objected to the smoke and noise of the engines (despite the fact that the full size railway was hard by). The result was that the site of the railway had to be transferred to the east end of Hastings: a locality where the residents were found to be more co-operative.

Strange to relate, during the move the railway acquired new owners, and when I found that an old friend had taken over the management, within a short time I was driving.

Perhaps that is not strictly true. My friend, knowing I worked on the railway, assumed I knew how to manage a locomotive, and handed me the driving swab, mumbling something about the left-hand injector being the better.

Admittedly I was familiar with the rudiments and knew, for instance, that the water must not be allowed to disappear from the gauge glasses. I also judged that it would be advisable not to let the fire go out, especially as passengers (*my* passengers !) were queuing for a trip. On this occasion the locomotive was *Firefly* and I was astonished at the amount of fuel and water needed to keep her going. It was only later that I discovered she was due for an overhaul.

"Keep on at 'er"

The run in those days consisted of about 230 yds of track and we used to pull the train one way and push back: after each trip the water all but vanished from sight. This called for frequent use of the injectors and almost continuous firing. My friend, Mr J. B. Hughes, used to employ a retired Hastings-London BR driver and he did not take too kindly to *Firefly*. "You have to keep all on at 'er" was his quaint way of putting it.

On one occasion when this driver was in charge he called: "She won't go either backarrds or forrarrds, sir !" This was found to be due to a poor design of the valve gear and motion, some of which had been merely pinned together: one of these pins had worked loose and fallen out.

During the following winter *Firefly* was given a thorough overhaul after which she was a pleasure to drive, although the boiler began to leak and had to be renewed in 1951. Before reboilering, Mr C. Parslow, of the Hastings SMEE, actually kept *Firefly* working for a day with water continually spraying the fire—no mean feat. These incidents, however, rather anticipate the story—so now for some facts about the railway as it is today.

In 1950 the run was extended to its present length of 400 yds and it now includes a tunnel, level crossing, and a run-round at each terminal station so that the locomotives may always operate at the head of the train.

Of the two engines, *Firefly* was built originally by Mr Bullock, as a Great Western pannier tank for the Surrey Border and Camberley Railway. It was acquired (together with the *Royal Scot*) by Captain Howey who converted it in 1946 to a tender locomotive before running it alongside his 15 in. railway at New Romney in the same year. The *Royal Scot* was built by Bassett-Lowke for Lord Downshire in 1938.

In 1947, both engines ran at St Leonards and a year later the railway was moved to its present site, known as "The Stade, Fishmarket."

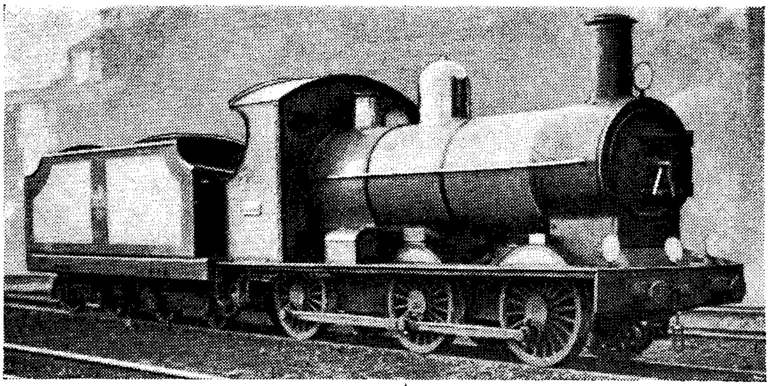
Firefly is a two-cylinder locomotive, $2\frac{5}{16}$ in. bore, 4 in. stroke with 12 in. dia. drivers. It has Walschaerts slide valve gear and lever reverse.

The boiler is made from steel plate, $\frac{1}{4}$ in. thick. It has 29 tubes of $\frac{7}{8}$ in. bore and three superheater tubes of $1\frac{1}{8}$ in. bore. Working pressure is 125 p.s.i., tractive effort 150 lb. Weight in working order is approximately 12 cwt and water capacity of the tender, 40 gallons.

Easier to maintain

Although the full size version of the *Royal Scot* has three cylinders, the model has only two, each of 3 in. bore, 5 in. stroke and 15 in. dia. drivers. The fact is a sore point with some, but the absence of the middle cylinder makes for easier maintenance. The valve gear is Walschaerts, piston type, with screw reverse. The boiler was made of $\frac{3}{16}$ in. thick steel plate which now entails extra work to keep it steam-tight.

It has 31 tubes of $\frac{7}{8}$ in. bore and a Greenly grid superheater in the smokebox—an arrangement of doubtful value, according to some. The working pressure is 90 p.s.i., tractive



FIREFLY *has more than* 10,000 *miles to her credit*

effort 215 lb., weight 18 cwt, water capacity of tender 10 gallons.

Both engines have steam brakes but in addition the *Scot* has a screw-operated handbraking system fitted to the tender.

The rolling stock consists of one articulated set of five coaches, one articulated set of two and a single coach. The seating capacity is 34 adults, although as many as 70 adults and children have been carried.

Buffer brakes

The articulated set of five coaches is fitted with buffer brakes. This is an ingenious arrangement whereby a retarding of the locomotive by steam or handbrake compresses the special buffers, the compression being transmitted to the brake-blocks on the coach wheels. With this system the braking intensity depends on and increases with the load—an important point in miniature work where loading often exceeds coach weight, as it eliminates wheel lock and skidding on unladen coaches.

As a fully loaded train weighs about four tons and speeds of 12 m.p.h. are often exceeded, the question of adequate braking power is quite important. It recalls an incident that occurred about five years ago in the days before we had run-round tracks.

I had the *Scot* with a complete train but only two passengers, and I was "pushing back." For some reason the steam brake was not functioning as well as usual and we were using the tender handbrake. At the customary point I shut the throttle and commenced to "wind up" the handbrake. I passed the usual four turns, but without effect . . . five turns . . . six . . . still no brake . . . seven . . . station and buffer stops getting nearer . . ." Hell ! " I thought, " the nut's come off."

I quickly wound into full forward gear and opened the regulator, taking care not to open it too wide for fear of locking the wheels. I still didn't know what to expect: a sickening thud into the stops, or a plain pull-up ? Well, she stopped—with two coach lengths to spare !

Further investigation showed that the brake was in order after all. I had unthinkingly "unwound" it an abnormal number of turns before starting away. Poor enginemanship, but there you are.

That reminds me of the time Mr Hughes was pushing back with *Firefly*. When he applied the steam brake, the engine-tender coupling parted and left the engine standing—with him on the tender. Fortunately he had only an incomplete and lightly loaded train. Even so, he swears he wore out a good pair of shoes skidding to a stop !

In those days some difficulty was experienced in finding a regular and experienced driver, and, from one cause or another the buffer stops were frequently uprooted.

One day I found Mr Hughes making a really deep excavation among the debris from clouted stops. "I've had enough," he said, "this time I'm going to put them in so that they'll never come out."

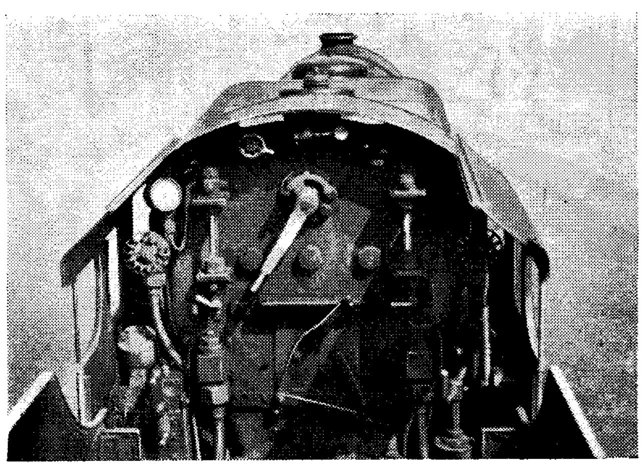
I don't remember if it was the same day or the next that a certain gentleman, well known in the railway photographic world, informed him: "I'm afraid I've gently patted your buffers ducky " He had too—they were effectively demolished !

People often show amused surprise over the fact that a guard always rides with the train, but actually he performs quite important duties. He speeds the filling of the train, sees that passengers clothing and feet are not exposed to danger, checks tickets, advises on the disposition of luggage (suit-cases and perambulators are not uncommon) and, by coupling and uncoupling, saves the driver the trouble of repeatedly getting down from the engine. In the "pushing back" days he was also invaluable as a forward lookout as the train is 75 ft in length, and it was not always easy to see that the track was clear.

Blocked line

On one occasion during a busy holiday period I was pushing back with the *Scot* and had just reached the tunnel when there were three blasts from the guard's whistle. Although at that time we had no pre-arranged signal, something warned me that he was not merely having a practice blow.

I immediately shut off and applied steam and hand-brakes. It was lucky I did so, because on looking round after stopping, I saw a London excursion coach half across the line and my train but a few yards away. Apart from the minor excitement of the incident, what sticks in my mind



The ROYAL SCOT *from the driver's point of view* after all those years are the wonderful "engine noises," magnified by the confined tunnel space, as it lumbered to a stand.

When the run was extended, the new station, East Hastings, was provided with a turntable branch—a most useful accessory which enables engines to be worked back to the wind, so that smoke is blown away from the driver irrespective of the direction in which he is travelling. Using the turntable, by the way, involves the not-so-obvious point of *not* reversing to run off after being turned.

To provide the turntable branch and run-round facilities Mr Hughes had to make four additional pairs of points and he made excellent jobs of them although in 10¼ in. gauge the work was comparatively heavy, each pair taking the best part of a week to complete.

Sometimes the railway is honoured by visits from British Railways drivers and it is always a pleasure to hand over and to note these extra professional touches which complete the picture. Some of them, when driving for the first time, are surprised at the frequent use which has to be made of the injectors: they have a natural tendency to regard our run as a mere shunting movement.

Actually, when the engines are in good working order the average evaporation per loaded trip works out at one gallon.

Professional drivers have also expressed surprise that the engines may be notched up in the normal way: this is, of course, our usual practice although sometimes there are so many obstructions on the line that we have to drive on the throttle. Again, one may "get caught" with a full load of passengers after a slack period and with only 75 lb on the clock. If the wind is against the train it then requires full gear all the way—like a goods train.

Talking of professional movements, a pro. was having a session and while coming on to the train (after running round) he stopped short. In such cases the guards, who are not railway-minded, merely pull the train up to the engine.

To my mind, this is not entering into the spirit of the thing and as I happened to be there for coupling, I said: "Ease up." Whereupon our pro. executed one of the most spectacular movements I had seen there: with a gentle hiss of steam, the motion work very slowly turned over, the engine moved forward, the buffers compressed to the exact amount.

"That was jolly good," I said, "how did you do it?"

"Little bit of throttle with little bit of brake," he replied.

Mention of the brake reminds me that I used to grumble about the plain "three-way cock" type of steam brake valve and the way in which it pulled up the train with a series of jerks—unless an undue amount of time and care was exercised. Pulling up, in my view, should be a continuous and smooth deceleration, as in full size. I suggested that a new brake valve was required whereby steam could be admitted through a series of holes of increasing diameter, starting with the smallest.

"If you like to make it, I'll fit it," said Mr Hughes one day.

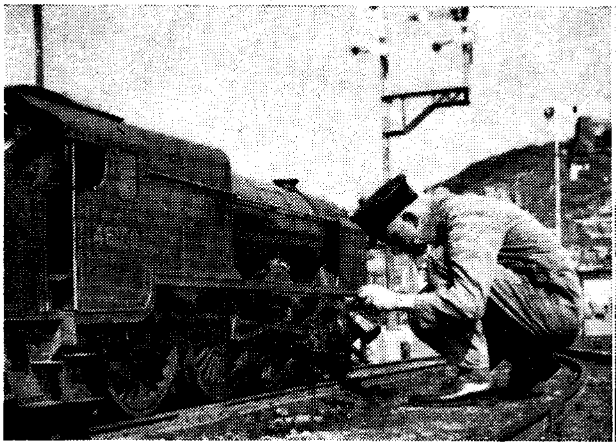
"Fair enough," I replied and the outcome was a brake valve with four steam inlet holes starting with No 80 drill size and finishing at 5/32 in. for full or emergency use. Although this valve was worn out after one season's use, it was satisfying to handle; and with experience it was possible to bring the train to a stand with just that smooth deceleration that I wanted and, except for the absolute final, all on the No 80 hole. Subsequently, both engines were fitted with similar brake valves of improved design. The *Scot* also has a steam brake pressure-gauge which is of further assistance in getting professional stops.

During the busiest days of the season there is the additional interest of having two engines in steam. The arrangement is that immediately the train enters the station, the waiting engine runs on and takes over. This leaves the other free for four or five minutes to take water, oil up or give the driver a rest.

The idea of taking a rest may sound strange for such a small railway but I've had some 12-hour stretches on busy days with only one engine in steam—coal and water on the run and hardly time to eat a sandwich: marvellous fun, but oh, how my back ached at night!

Both engines are now fitted with milometers; beautifully executed mechanisms made and presented by the director of a Brighton firm of precision engineers. From these, it is interesting to learn that the train runs an average of 2,000 miles a season.

Now this winter Mr Hughes has acquired an addition to his fleet—a GWR Saint, 2900 class, *Hampton Court*, No 2943. As this had not been built to scale he is making the necessary modifications. Drawings (dated 1911) have been obtained from the GWR Swindon works and every detail is receiving attention. To hear the first exhaust beats of No 2943 is a pleasure to which we all look forward next summer. ▣



Left: *A spell of driving makes a pleasant change from the workshop, says Martin Cleeve.*
Right: *The* SCOT *ready to go. She is said to have travelled at* 35 *m.p.h. on her trials*

Floating boring cutters for finishing

By Roland V. Hutchinson

THIS account of floating finish-boring cutters systematically covers a range of sizes between ⅜ in. and 2½ in. dia. holes, the latter being by no means an upper size-limit. A typical arrangement is shown in Fig. 1. When used with bar rotating, the cutter, which is a slip fit in the cross-slot, may be kept in place by two light rubber bands. When the bar is fixed, and the slot horizontal, these are not needed.

A typical piloted bar is shown in Fig. 2. Often pilot and slot overlap as they do in the illustration, when the indicated zone is finished after slotting.

A supplementary support enabling use of longer tools for larger holes and smaller bars is shown in Fig. 3. For brevity, this phase is not expanded.

The tools are essentially finishers —ordinarily they have no size-adjustment—hence hole sizes ahead of their use should be fairly uniformly close to final size, and excessive cutting speeds avoided.

Ranges of sizes of cutters used in a given bar are set by: (*a*) difficulty of slotting the bar, (*b*) minimum chip clearance, and (*c*) maximum cutter-overhang.

The first depends on personal whim. Usually I have had to drill, block out, chip and file or drift the slots, and under these conditions have limited the bar diameter to about six times cutter thickness. Minimum chip clearance has been held about 1/16 in., but for smallest sizes may be less. Maximum cutter-overhang beyond the bar has been limited to twice the cutter thickness, though this is not necessarily a proven maximum.

A good dimensioning scheme is based on cutter thickness, t, which at present is taken between 1/16 in. and ¼ in. Cutter width is between 3.0 and 4.3 times t. Though some degree of loose fitting between cutter thickness and slot width has little effect on hole-size control, a snug slip-fit has obvious merit.

Drilled, chipped and filed slots may be made a little more easily after most of the excess metal has been drilled out, and suitable families of such drilled holes are dimensioned in Table 1. Intermediate holes of these families are about 10 per cent larger than the end holes, which in turn are slightly larger than the nominal thickness of the cutters. Thus a practical maximum of material is drilled out, and the end holes, used as witness marks when filing, are not "lost."

Length of slot should parallel the axis of the bored hole and the slot-width preferably be centred on it. Small bars are quite readily made from coldfinished square steel, centred and cross-drilled while mounted on the lathe carriage, the slot finished and the bar finally turned. Obviously the slot could be worked out with a small endmill or slot drill, either completely, or to a degree enabling starting a finishing drift, when facilities exist.

The rear, or "pushing" end of the slot either should be dead square with the hole axis, or double tapered, proud in the centre, permitting the cutter to position itself with respect to its leading chamfers.

Basic dimensions of typical symmetrical cutters are shown in Fig. 4. Notches for rubber bands may be added to the trailing chamfers if desired. Combining maximum bar sizes and cutter overhangs gives a maximum cutter size of ten times cutter thickness. Minimum nominal cutter sizes have been set at ⅝ in. less than this maximum for cutter thicknesses between ⅛ in. and ¼ in. inclusive.

Material may be carbon or high speed steel. One listed size, 0.072 in. thick, is had by cutting blanks from discarded power-hacksaw blades, using a thin rubber-bonded abrasive cut-off wheel, well guarded and *not freehand*. Key dimensions appear as Table 2.

In action, the cutters are scrapers, material is removed by the entering chamfers cutting with negative top rake. Hence they best suit brittle materials, as cast irons, brasses and bronzes cut dry, and light alloys with kerosene. For steels they are not recommended.

Prefinish bores should be accurate and uniform. If H inches be the diameter of the finished hole, a finish allowance, on diameter, between $0.005\ H + 0.008$ and $0.005\ H + 0.004$ has given no trouble. Cutting speeds have been held to about 40 surface ft per min., and feeds fairly coarse, between $H/16$ and $H/24$ in. per rev. The cutter should be run straight through the bore and immediately removed, not pulled back through the finished hole, unless this be blind or shouldered.

Cutters, as indicated in Fig. 4, should be symmetrical. Symmetrical cutters produce minimum size holes matching their "over-edge" dimension C, only when the plane containing the size-zone edges contains the axis of the hole being bored. If this be desaxé, indicated by distance oa in Fig. 5, then the diameter H of the hole produced is larger than the

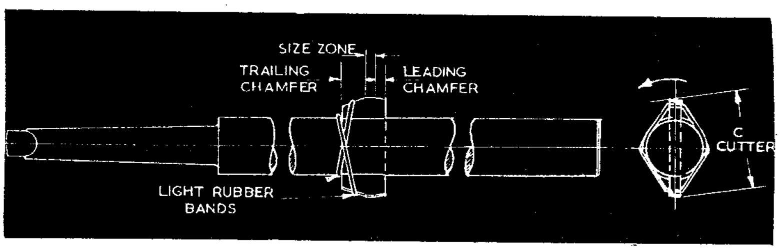


Fig. 1: Section drawing showing typical arrangement of a floating finish boring cutter in rotating bar

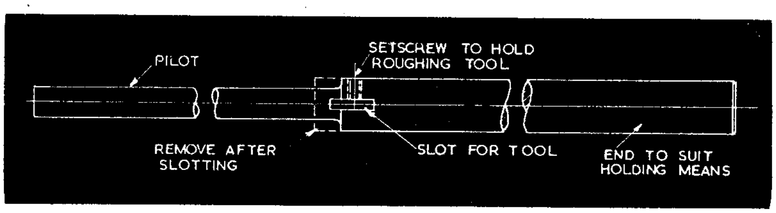


Fig. 2: Typical piloted bar

cutter diameter C.

The desaxé may be negligibly small, or at times may be adjusted to control this oversize. In any event it should be known and stamped on the bar for reference. It is best found by measuring a trial hole finished with a given symmetrical cutter, and computed thus:

Let C = " over-edge " cutter dimension.

H = size of finished hole as bored therewith

then d = effective desaxé

$= \frac{1}{2} \times \sqrt{[(H + C)(H - C)]}$

Once d is known for a given set up, we know (a) the size H a given symmetrical cutter, similarly held, will produce, and (b) the cutter-size C needed to produce a hole of H diameter. The first is $H = \sqrt{(C^2 + 4d^2)}$ and the second, $C = \sqrt{(H^2 - 4d^2)}$.

Once d is found, it is advantageous to consider it as a percentage of either C or H, and to call the " relative-excess " of hole with respect to cutter the fraction $(H—C)/C$, or the " relative defect " of cutter with respect to hole the fraction $(H—C)/H$. It turns out, for small percentage values of desaxé, that both " relative-excess " and " relative-defect " have numerical values of about 0.0002 for a 1 per cent value of ratio d/C or d/H, and these numerical values increase with the *square* of the percentage desaxé.

When the cutter is *not* symmetrical, as shown exaggeratedly in Fig. 6, the cutter, being positioned by equalisation of radial forces acting at each end, cuts oversize to an extent controlled in a complex manner by differences of chamfer angles and chamfer lengths, effective differences in negative top rake, and relative dullness of the two ends.

It is not too difficult to freehand grind the medium and larger sized cutters listed, carefully gauging with protractor, small graduated-blade try-square and micrometers. Smaller ones should be machine-ground. One way is to hold them in a tiltable machine vice and grind with a cup wheel held in a high speed drill press spindle, sliding the vice on the table, under the wheel.

A better way for all sizes, when the equivalent of a lathe overhead drive exists, is to fit the cutters tightly in their bars using paper shims and circular grinding their size zones and leading chamfers while held in the bar on centres. In this instance they are next relief ground, leaving lands 0.003 in. to 0.005 in. wide on the size zone (as on a hand reamer) but relieving the leading chamfers about 7 deg. without lands. Again, a cup wheel is recommended, the cutter being positioned with the usual spring finger.

Neglecting the narrow land just

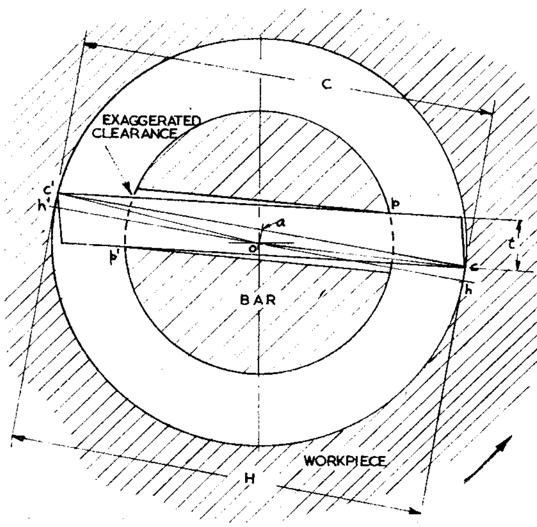


Fig. 5: *Effect of desaxé tool-slot.* O *is centre of work rotation with respect to the bar.* OA *is desaxé of the cutter with respect to axis of rotation. Note the unequal top rake angles*

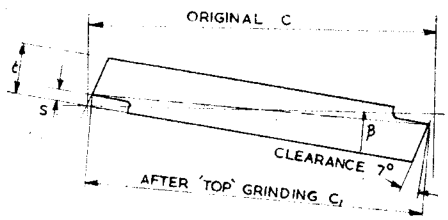
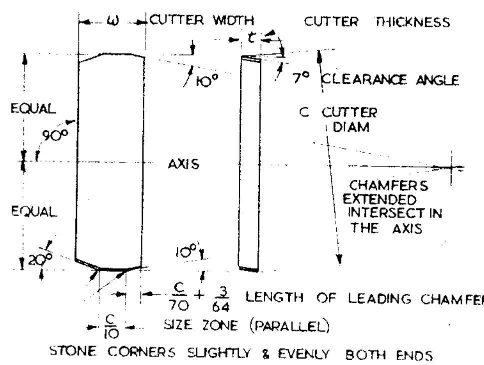


Fig. 3: (*right*) *Supplementary support on regular bar for finishing larger holes*



Bottom right Fig. 4: *Basic dimensions of typical symmetrical cutter. Notches for rubber bands may be added if required*

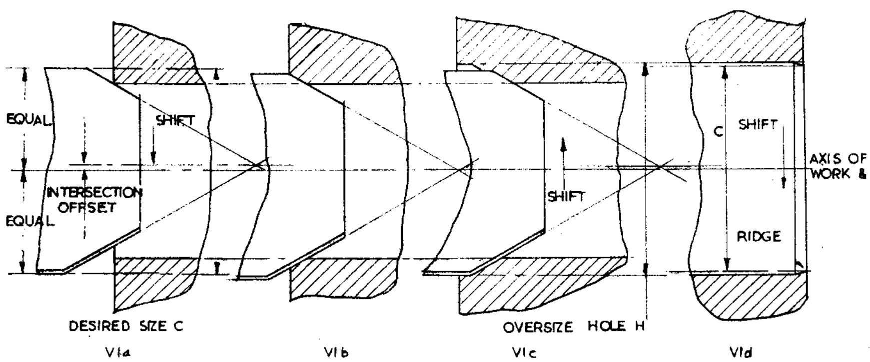


Fig. 6: *Magnified effect of asymmetrical leading chamfer (bar not shown). (a) cutter centre line is centred on that of the bar. Cutting edge touches. The downward arrow shows direction of cutter (b) cutter centred on chamfer countersinks and returns (c) cutter position set by equality of radial forces at cutting edges (d) as cutter passes through the work, radial forces reequalise and small internal ridge is the outcome*

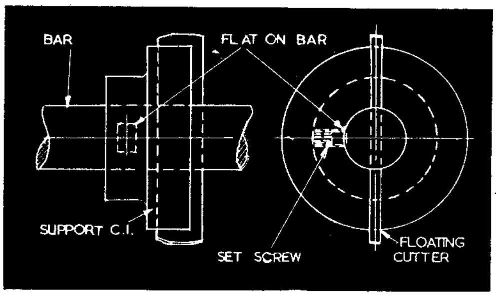


Fig. 7: Face or top-ground cutter

TABLE 3

Ratio of cutter size to thickness C/t	*Material removed* s	*Approximate change in cutter size* $\frac{8t + \sqrt{(C^2 - t^2)} \times s}{4C}$
5	s	0.645 x s
6	s	0.58 x s
7	s	0.53 x s
8	s	0.50 x s
9	s	0.47 x s
10	s	0.45 x s

TABLE 2

Section of Cutter		*Range of H Hole Sizes*			*Range of Bar Sizes*		*Diametral Finish Allowance*	
Thickness t	Width w	Min.	Range	Max = 10t	Max for H Min	Max = 6t	Min	Max
1/16	9/32	3/8	1/4	5/8	9/32	3/8	0.0065	0.0105
0.072*	5/16	7/16	9/32	23/32	11/32	7/16	0.007	0.011
3/32	13/32	1/2**	7/16	15/16	3/8	9/16	0.0076	0.0116
1/8	17/32	5/8**	5/8	1 1/4	1/2	3/4	0.0087	0.0127
5/32	1/2	15/16**	5/8	1 9/16	13/16	15/16	0.0102	0.0142
3/16	9/16	1¼**	5/8	1 7/8	1 1/8P	1 1/8	0.0118	0.0158
7/32	11/16	17/16**	3/4	2 3/16	1 5/16P	1 5/16	0.013	0.107
1/4	13/16	1 5/8**	7/8	2 1/2	1 1/2P	1 1/2	0.0143	0.0183

* *Power hacksaw material thickness.*
** *Hole 1/8 in. larger than min. bar size.*
P *Only one suggested bar size.*

mentioned, if both top faces be equally ground, thus reducing t locally, the effect on desaxé is almost nil, but the change in C depends jointly upon s the amount removed and the ratio C/t, and varies about as per Table 3, for 7 deg. clearance angle. Fig. 7 illustrates this. If top faces be unequally ground, desaxé is changed by about one-half the difference of the amounts removed. If the slot be off centre as in Fig. 5, the effective cutter-desaxé can be made zero by grinding off twice the experimentally determined value of desaxé from one end only, reducing C, and limiting use of the cutter to only one relative position in the bar slot, as will be readily seen by examining Fig. 5.

If the bar be fixed and overhung (not piloted) hole-size may be restored by changing packing under the bar, enabling adjustment of d, to restore H after C may have been reduced by "top-grinding" the cutter.

A few examples illustrate the foregoing:

1. Determination of d from boring test.

$C = 1.250$ $H = 1.2505$ $d = ? = 0.0176$.

$d = \frac{1}{2} \times \sqrt{[(H + C)(H - C)]} = \frac{1}{2} \times \sqrt{(2.5005 \times 0.0005)} = \frac{1}{2}\sqrt{0.00125025} = 0.0176$.

2. Given C and d find hole size H.

$C = 1.500$ $d = 0.02$ $H = ? = 1.50053$.

Per cent cutter desaxé $= \frac{100 \times 0.02}{1.5}$ = 1 1/3 per cent.

"Relative-excess" $= (1\ 1/3)^2 \times 0.0002 = \frac{16}{9} \times 0.0002 = 0.00035 = (H - C)/C$

Hole/cutter size ratio = 1 + "relative excess" = 1.00035.

Hole size $H = 1.00035 \times C = 1.50053$.

3. Find C to bore size H when d is given.

$H = 1.250$ $d = 0.020$ $C = ? = 1.2494$.

Per cent hole desaxé $= \frac{100 \times 0.02}{1.250}$ = 1.6 per cent.

"Relative-defect" $= 1.6^2 \times 0.0002 = 0.000512$.

Cutter/hole size ratio = 1 — 0.000512 = 0.999488.

Cutter size $C = 1.250 \times 0.999488 = 1.2494$.

4. Find increase of desaxé to provide given increase in hole size as bored in example (3) above.

$C = 1.2494$ $d = 0.02$ $H = 1.250$ H_1 (new) $= 1.255$.

$H_1 - H = 0.005$ = increase in hole size.

$d_1 - d = ? = 0.039$ = change in packing thickness.

$d_1 = \frac{1}{2} \times \sqrt{[(1.255 + 1.2494)(1.255 - 1.2494)]} = \frac{1}{2} \times \sqrt{0.0140446} = 0.059$.

$d_1 - d = 0.059 - 0.020 = 0.039$.

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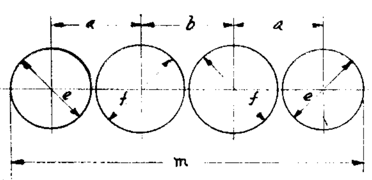


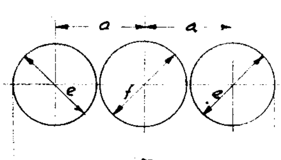


TABLE I

Cutter		*Centres*		*Drills*		*Length over Holes*
t	*w*	*a*	*b*	*e*	*f*	*m*
1/16	9/32	0.0735	0.075	≠51(0.067)	≠50(0.070)	0.289
0.072	5/16	0.084	0.087	≠48(0.076)	≠45(0.082)	0.331
3/32	13/32	0.105	0.109	≠42(0.096)	≠37(0.104)	0.415
1/8	17/32	0.137	0.141	≠30(0.128)	≠29(0.136)	0.543
5/32	1/2	0.174	—	≠21(0.159)	≠16(0.177)	0.507
3/16	9/16	0.204	—	≠12(0.189)	≠5 (0.205)	0.597
7/32	11/16	0.2395	—	≠2 (0.221)	C (0.242)	0.700
1/4	13/16	0.279	—	F (0.257)	K (0.281)	0.815

Locating HOLE POSITIONS

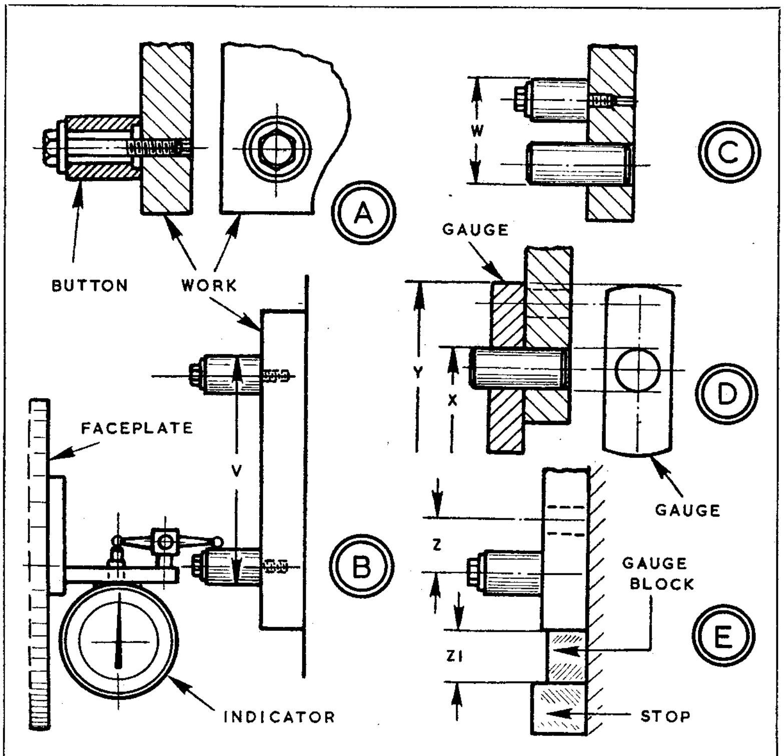
WORKSHOP HINTS and TIPS

When the lathe is used on a jig-boring principle, spinning the boring tool in the work clamped to the vertical slide, there are several possible ways of locating the positions of holes.

Given that the centre distances of the furthest holes are within the range of movement of the vertical slide and cross slide, and that these slides have accurate micrometer collars, the jig-boring principle can be continued even to the locating of holes. That is, having settled the position of one hole by any method, the positions of others can be obtained by appropriate feeds on the screws—afterwards clamping the vertical slide and cross slide.

Where centres of holes are beyond the movement of slides, or where feedscrews are without micrometer collars—or insufficiently accurate, other methods are necessary.

If it is simply range that is lacking, or if feed screws are inaccurate overall but sufficiently accurate locally, the principle of setting to marked-off centres can be employed. Cross lines will locate each hole-centre on the work, and can be set to a spinning needle-point by reference to the micrometer collars. Naturally, this involves somewhat more preparation of the work than where locating can be done from feed screws and collars; but it is straightforward, and with care accuracy should be equal to that of the marking-off.



If, however, it is impossible to rely on the feeds crews, then the toolmaker's button method is essential, using a dial indicator for the actual setting. Accuracy in locating the hole positions will then depend on the precision with which the buttons are set on the work. This can be done in the normal way with micrometers, vernier gauges, block or end gauges, before coming to the lathe.

Each button is as at *A*, a short, parallel, thick-walled sleeve with a truly square end abutting to the face of the work—which, of course, must be flat. The bore is clearance for the holding screw; and the hole in the work having been approximately located, drilled and tapped, and the button fitted with washer and screw, the button can then be adjusted for position and held by tightening the screw.

Where there are two buttons, as at *B*, measurement *V* over them, gives the centres of the holes. The work can then be adjusted on the vertical slide, or by the feed screws, for the indicator to show a steady reading when its lever arm is turned round a button. With the hole finished, the procedure is repeated for the second one—and for any more there may be. A small mirror is useful for checking the setting-up reading, at positions where the indicator is upsidedown or facing backwards.

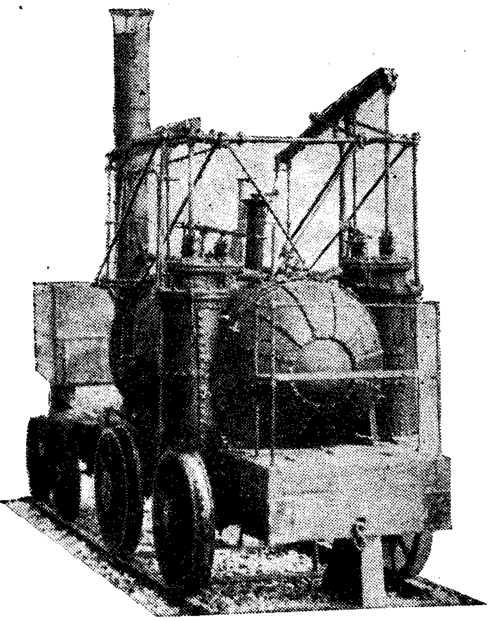
When holes conflict

When two button-located holes come close together, the second button if fitted with the first, may prove an obstruction for tool or swarf, as the first hole is bored. In these cases, fitting the second button afterwards is possible, using a plug in the finished hole, as at *C*, when measurement, *W*, over plug and button will locate the centre of the second hole.

The procedure may involve removing the work for setting the button; and this can be avoided by employing a prepared gauge, as at *D*. Such a gauge can be made from flat bar, drilling and boring or reaming a central hole, mounting by this bore on a spigot on the faceplate, clamping, then turning the ends to radius—when any error of measurement will be halved at the functional centres.

Having bored the first hole, a reading is taken over the plug by dial indicator, as dimension *X*. Then feed gives a similar reading over the gauge, as dimension *Y*. The work is initially set, of course, so the hole centres lie on the line of feed.

Alternatively, as at *E*, a second hole at centres *Z* may be located by removing a gauge block of the same thickness, *Z1*, from between a stop and the work, then moving this to the stop. ■



Modelling the one and only "Puffing Billy" had snags

Says J. S. YOUNGMAN

In the early years of the 19th century Christopher Blackett, owner of the colliery at Wylam near Newcastle, depended on draught-horses for drawing coal trucks to the staithes at Lemington-on-Tyne. But the demands of the Napoleonic wars made draught animals and fodder increasingly expensive and Blackett looked round for an alternative.

Hearing of experiments with steam traction at a neighbouring colliery at Killingworth, he tried to get help from his former engine boy, George Stephenson, but there is no record that he was able to do so. He therefore consulted William Hedley, his "viewer" at the colliery, and told him to carry out experiments on adhesion between smooth wheels and rails. The model used by Hedley for this purpose is exhibited in the Science Museum, London.

50 years' work

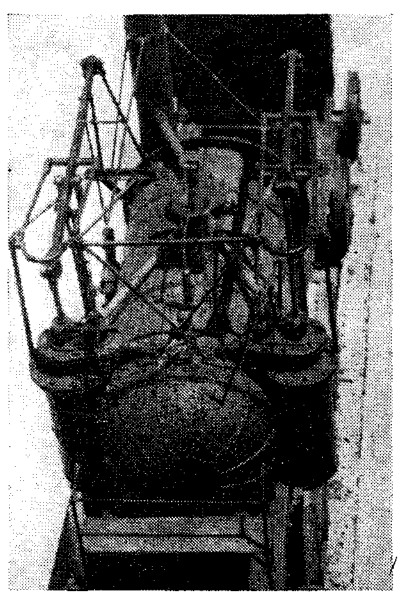
The tests were satisfactory and Hedley then made a full size wagon driven by gearing and a crankhandle turned by men on the wagon. Hedley later mounted a steam boiler and cylinder on the wagon, and this was the inception of *Puffing Billy* and his sister engine *Wylam Dilly*.

These engines were put to work on the wagon-way in 1813 and continued working until 1863, when *Puffing Billy* was removed to South Kensington, *Wylam Dilly* being sent to the Royal Scottish Museum, Edinburgh. The gauge of these engines is 5 ft, which was the distance separating the oaken timbers of the Wylam wagon-way.

The timbers were protected from excessive wear by cast iron plates and the wagon-way is sometimes referred to in books of the period as a " plate-way," from which is derived the current term platelayer. The cast iron plates, however, proved too weak to support the eight tons weight of the locomotives and *Puffing Billy* was altered to the eight-wheel arrangement. When the wagon-way was relaid with fish-bellied rails, the original four-wheel arrangement was again adopted.

As a descendant on the distaff side of Blackett, I have always taken a keen interest in *Puffing Billy* and felt that it would make a worthy prototype for a model. An approach was made to the Science Museum, who were able to supply two sheets of fully dimensioned blue-prints of the engine. These were to the scale of $1\frac{1}{2}$ in. : 1 ft, but as this was felt to be too large, a scale of 1 in. was decided on.

I should perhaps mention that I have built two models of the engine. The first in 1 in. scale was exhibited at the ME Exhibition in 1953 and is now in the Newcastle Museum, the second in $\frac{3}{4}$ in. scale was exhibited recently. In these notes it is proposed to describe the smaller model, though the methods employed apply equally to the larger effort.



Top of the boiler with fittings

After some thought, I decided to build a working show-case model rather than a live steam model. It was felt that only an exceptional model engineer could build a steam-tight boiler of thin steel plate with some 800 rivets and the hundred 12 and 14 BA bolts which were used to secure fittings to the boiler. It was also thought that if such a boiler were made, rust would soon make it unsafe. Brazing up the boiler was out of the question for that would not be *Puffing Billy* fashion.

The frame

A close grained wood was used for the frame as it was thought that the open grain of oak as used on the prototype would appear out of scale. The frame has three cross-members tenoned into the sides with through bolts clamping the whole together.

The engine, it will be remembered, is driven by a central crankshaft with overhung cranks which carries a large gearwheel. This meshes with intermediate gears and from these with smaller gears mounted on the axles. The five shafts run in brasses bolted to the underside of the frame with " top " brasses below to allow them to be dropped. They are of $\frac{3}{16}$ in. sq. silver steel turned in way of the journals to $\frac{1}{8}$ in., with the gears a drive fit on the square shafts. The spokes of the three larger gears were fretted out. The prototype, incidentally, has no springing on the road wheels.

The egg-end of the boiler is situated at the front and was made of 12 segments and a central disc. These were cut from an oil drum of suitable gauge and beaten to shape in a hollow turned in a block of oak, and riveted with 3/64 in. iron rivets. The boiler barrel consists of five rings. The one carrying the cylinder-jackets is parallel and the remainder are slightly tapered to fit inside the previous ring.

The cylinder-jackets are recessed into the first boiler ring and secured by 4 BA bolts. They have flanges at their upper ends to which corresponding flanges on the cylinder castings and two vertical members of the overhead gear are bolted with 14 BA bolts. The boiler is supported on the frame by six brackets held in place by the bolts securing the gearshaft bearings.

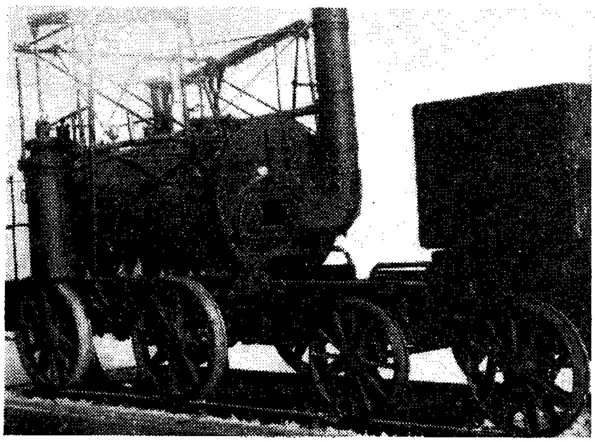
As it was impossible to insert 1/32 in. rivets in the end of the boiler to fix the egg-end, it was secured by small screws. Dummy rivets were fitted and, as it might be necessary to have access to the interior for tightening bolts, the flat end of the boiler was similarly treated.

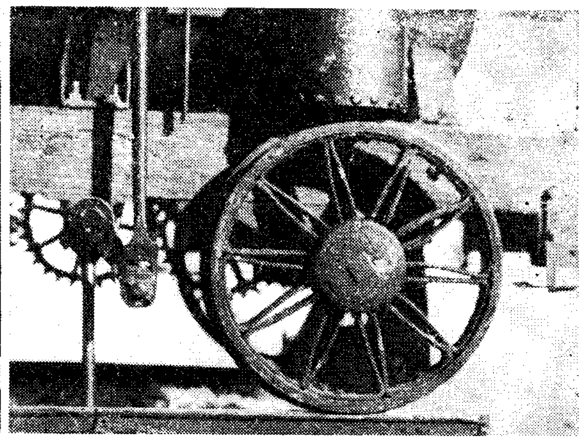
Much thought was given to a method of turning the many slender straight-line movement in the piston rods. Valves are operated by tappet rod, connected at their upper ends with the beams and carrying adjustable fingers which strike the valve-operating levers at top and bottom of the stroke. To cushion the blow the ends of the valve levers were split and tapered. The other end of the lever was extended to within reach of the driver's hand to enable him to trip the valves for reversing.

The wheels are of the "sector-spoke" kind and built with eight and ten spokes as in the prototype. A close examination of the wheels on the original failed to show whether no way could be found of holding up for the closing of rivets through a ⅜ in. square hole.

The tank contains about five gross of 1/32 in. rivets. From the bottom of the tank a turncock leads through pipes and a flexible leather hose to the feed pump on the boiler, with test cocks within reach of the stoker, a similar pair of test cocks being at the front of the boiler for the use of the driver.

The model stands on fish-bellied rails which were cast in Hoyt metal in a brass mould machined out to the required shape, the chairs being cut from brass. To enhance its educative

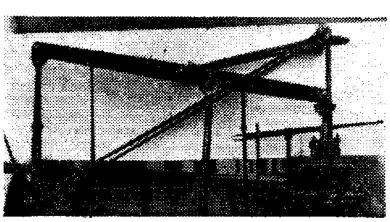




Left: *A rear view of the model.* *Right*: *The build-up of the sector-spoke wheel*

round rods of the motion work until it was remembered that as the prototype was finished on the anvil in the colliery workshop, truly circular work was not called for and the rods were filed by hand. Some 25 of these rods were fitted with the correct gib and cotter bearings, but in only four cases where it was essential were split bearings fitted. In the remaining instances the brasses were drilled in the solid.

The slots for the cotters were made by drilling three closely spaced No 75 holes and cutting through into a slot with a chisel made from a piece of 6 in. Eclipse hacksaw blade, the same material being used for gibs and cotters. The rather complicated overhead gear is for maintaining the



Geometry of grasshopper beams

the ends of the spokes had been cast into the hub, so it was decided to let them into slots machined in the hubs.

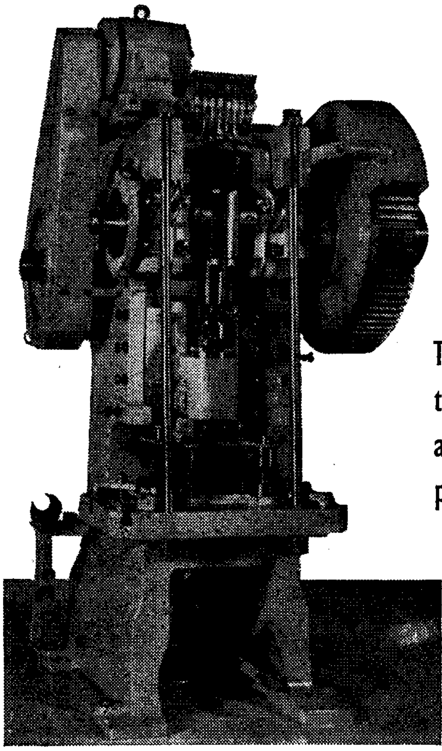
The spokes were then bent up on a former to fit closely to the rim of the wheel, the ends inserted in the slots in the hubs and with rings riveted back and front and assisted by rivets through the tread as in the original they made a firm wheel. In the prototype the wheels, like the wheels of the gear train, were secured on the shafts by four double wedges but on the 1 in. scale model this was found to be too uncertain and they were made a driving fit.

As mentioned earlier the blueprints supplied by the Science Museum dealt only with the engine and it was necessary to make a further approach to Mr Westcott, then keeper of the transport section, who gave me access to the drawings made in 1864 when the locomotive arrived at the museum. Details of the tender were taken from these.

The frame is similar to the engine but the wheels which have 12 single spokes let into the hubs are simpler. The water tank is riveted except for the bottom which has dummy rivets and is fastened by a few screws, for value it was mounted so that by turning a handle in the base, the wheels revolved to demonstrate the operation of the grasshopper beams. This was accomplished by large discs mounted on axles which took the weight of the model and lifted it clear of the rails.

Sprockets on the axles were connected by an 8 mm. chain and geared down to give the scale equivalent of five miles an hour, which was the speed at which the locomotive worked. The discs were recessed into the rails and adjusted for height to leave the edges slightly proud of the running surface of the rails, and are quite invisible from the front.

Much time was wasted by taking a dimension from the blue-print, reducing this to the scale equivalent and setting the caliper-gauge to the required size. To obviate this, a table was made showing every dimension from ¼ in. to 2 in. with its decimal equivalent and corresponding drill size. It was a simple matter to take the necessary dimension from the blueprint and gauge the drill size. This hint proved valuable when dimensions were expressed, as they so often were, in eighths of an inch. ■



A model with plenty of punch

This power press took 600 hours to build. The job weighs 1 cwt. and yields about half a ton of pressure at the business end

By R. Berry

MY idea for building this model came from a new 70-ton power press delivered to the firm for which I work. The press has a rigid frame, is fitted with an adjustable stroke assembly, 1 in.-4 in., and is capable of punching a 3 in. dia. hole through 0.300 in. mild steel plate.

I decided on 1/5 scale. A number of rough sketches and many sizes were obtained from the full size job, and the manufacturers—Sweeney and Blocksidge, of Birmingham—loaned me drawings for the more inaccessible parts.

I started with a general assembly drawing to give me an idea on construction, where to fabricate, and the materials needed. To construct the frame in one piece would have made it virtually impossible to carry out subsequent machining, even if I could have got it cast. It can be seen from Fig. 1 how I split the main frame into a number of smaller castings, which could then be screwed together.

The patterns were made from 12 mm. plywood, supplemented with various other sections and some plastic wood filling to build up the webs, projections and corner radii, etc. Two patterns for the side members were profiled together to ensure uniformity. They were painted and varnished and handed over to a local foundry for casting.

The connecting rod was made in the usual way by splitting across the bore of the rough blank piece of mild steel, fitting the end cap with four fixing bolts, mounting on the faceplate and finish boring across the join faces for the phosphor-bronze liner bush. The rest was completely profiled between centres, and then set up in the four-jaw chuck and bored and screwed for the Pitman screw.

The crankshaft is of mild steel turned from a piece of $1\frac{3}{4}$ in. dia. × 12 in. long bar. This was a fairly straightforward job turned between centres and a $\frac{1}{4}$ in. wide slot machined through the largest diameter. This was milled on the vertical slide using a 7/32 in. dia. endmill and carefully worked out until a small piece of $\frac{1}{4}$ in. ground stock just entered.

By this time the castings arrived—73 lb. of them. I tried to design them with a view to minimising the amount of accurate machining. This was reduced to the levelling of the feet, boring for countershaft bushes, fitting the table and the crankshaft bearings.

The table rests on a solid support with plenty of metal underneath it as Fig. 1 shows. The support was filed out the hard way and checked with square and scribing block on a flat piece of steel which serves as my surface plate. In between the two sides an H-shaped casting is fitted. This constitutes the slideways for the ram and is finally bolted in position with $\frac{1}{4}$ in. dia. Allen cap screws.

The table was faced and bored on a friend's 5 in. lathe, as were the six T-slots, for which I made a T-cutter from silver steel hardened in oil and tempered to a dark straw colour. The cutter was used after six plain slots had been milled in the table. Taking the feed steady, each slot was completed in one cut.

The bosses for the countershaft bearings were also fitted separately. This made it fairly easy to line up the two bores and also the correct mesh for the gearwheel and pinion. When in line they were screwed up tight and dowelled to the frame.

Smaller fabrications and filling in pieces were then made and fitted, thus completing the frame. The main bearings were also fitted to the frame separately and fixed with Allen screws. There was no brazing or welding of any kind used in the make up of the frame at all.

The crankshaft was next fitted and the countershaft, which is a piece of $\frac{9}{16}$ in. dia. silver steel $12\frac{1}{4}$ in. long, was milled at each end for keyways and also fitted into position. By this time I was keen to see some of the moving parts in operation so the next biggest single item was tackled. This can be seen in section in Fig. 2, namely, the rather hefty gearwheel at the right-hand end of the crankshaft, which also acts as a flywheel and meshes with a small pinion on the countershaft at a 5 : 1 reduction.

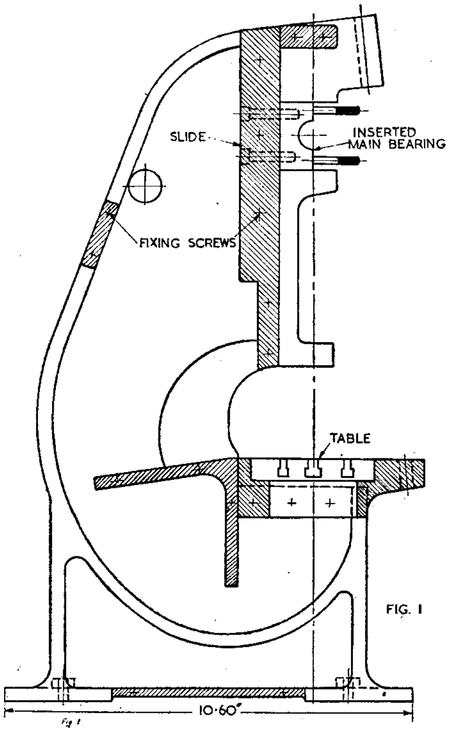
Forming the gears

To make this gearwheel, a piece of mild steel about 8 in. dia. × $3\frac{1}{2}$ in. thick was needed and by the time the job was finished I was ankle deep in swarf. A mild steel insert was shrunk into the flywheel counterbore and dowelled just to make sure it didn't come loose. This insert has three equi-spaced $\frac{1}{4}$ in. wide keyways for the clutch key to operate in.

Next came the gear cutting, and not having the necessary equipment I "farmed" this out.

The teeth are of 12 d.p., there being 90 on the flywheel and 18 on the pinion. A friction brake is fitted on the left of the crankshaft. Its function is to stop the crankshaft on the top of its stroke when the drive is taken from it. Made from $\frac{1}{4}$ in. thick mild steel plate, it has two brake linings diametrically opposed and bearing on a boss keyed to the crankshaft.

The ram and slides came next. The ram is of mild steel throughout



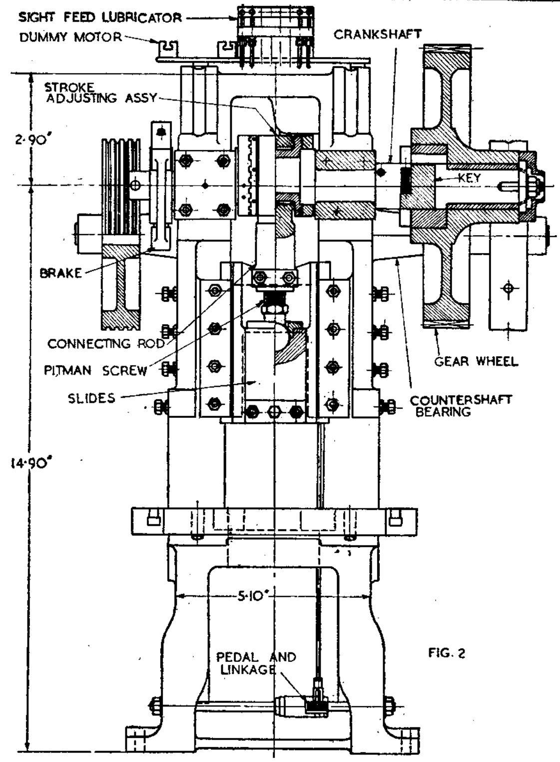


Fig. 1: (*Left*) *Cross section of the frame. Shading represents separate areas. Fig.* 2: (*Right*) *Front elevation, part sectioned, shows clutch and stroke adjustment assembly*

and was machined from a solid piece. The lower end was bored and faced in the four-jaw chuck for the tool clamp, and the top end was profiled and spherical bored to 0.800 in. dia. to form a seating for the ball end of the Pitman screw.

Making the stroke adjustment assembly was the most tricky job, requiring some fairly accurate setting up and machining.

The crank of the crankshaft is offset by 0.25 in. giving a throw of 0.500 in. A split eccentric bush *A* shown in Fig. 3, is coupled round the crank about which is fixed the connecting rod big end with its phosphor-bronze liner bush. Fitted to the crank webs are two locking collars *B*1 and *B*2 which engage with the eccentric bush by clutch teeth disposed radially round the contact faces, there being 20 teeth on each face.

To alter the stroke of the connecting rod, the grubscrews are slacked off, the locking collars are pushed right and left, by a sufficient amount to disengage the teeth, a tommy bar is inserted in one of the holes round the periphery of the eccentric bush flange, and the eccentric bush rotated above or below the crank centre line to the appropriate marks to give the required stroke. It was the milling of these teeth that enabled me to develop the following ideas.

Looking at Figs 3, 4 and 5, it will be realised that an accurate method was necessary to machine these teeth, using a lathe only, as, owing to the adjustment of the stroke the teeth in the collars would have to engage in any one of 20 positions round the eccentric bush. Endmilling was the way out with some accurate indexing fixture.

A fairly substantial angleplate was fixed to the lathe cross-slide mounted on two packing pieces of a predetermined thickness and clocked true with the faceplate. The slide was then locked in position on the lathe bed.

In the centre of the angleplate a 0.625 in. dia. hole was bored straight through by pilot drilling, using a boring tool in an independent four-jaw chuck and altering the tool for every cut. This method produced a locating hole dead true in all respects to the lathe centres.

Before this the eccentric bush *A* was rough-machined all over and then split across the bore centre. The two halves were machined flat on their respective joint faces and soldered together. Turning and boring completed the bush, which was then ready for milling the teeth. It was mounted on a mandrel, Fig. 8, and locked with a grubscrew to prevent movement.

On the other end of the mandrel a 40-tooth changewheel was keyed and the whole pulled tight to the angleplate with a ½ in. nut. A spring-loaded detent pin was then fixed to the top

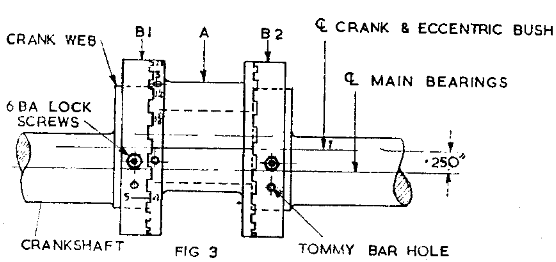
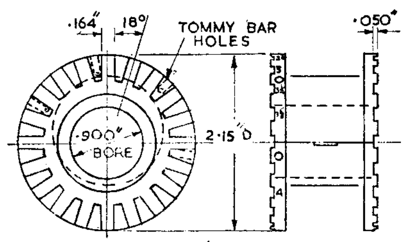


Fig. 3, (*left*): *General assembly adjusted for maximum stroke*

Fig. 4, (*right*): *Split eccentric bush*



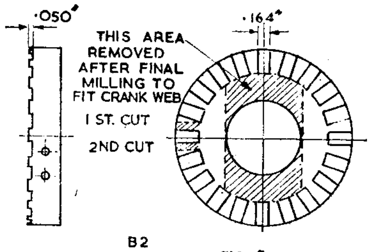


FIG. 5

Fig. 5: Locking collars

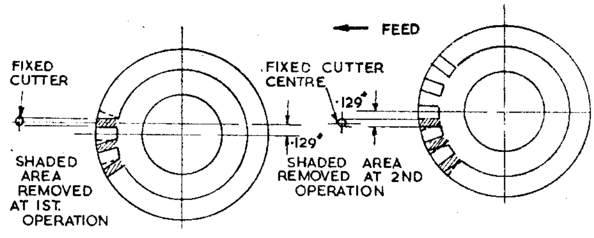
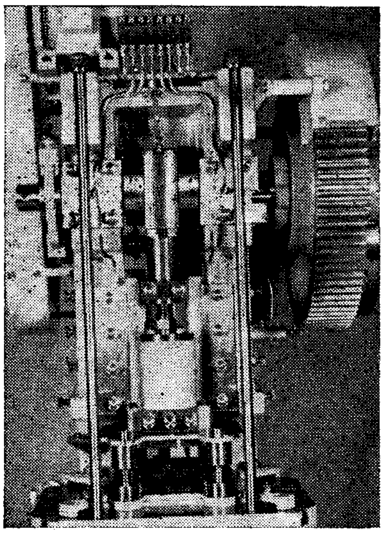


FIG. 6 FIG. 7

Fig. 6: (Left) Position of work in relation to cutter for first operation, 0.129 *in. packing removed. Fig. 7: (Right) Position of the work in relation to the cutter for second operation with the* 0.258 *in. packing added*



of the angleplate to engage with the teeth of the changewheel. An end-mill, which, with a trial cut produced a slot of 0.164 in. wide, was fixed in a drill-chuck and mounted in the lathe headstock.

Operating the lathe at its top speed, about 630 r.p.m. (hardly fast enough), and unlocking the slide, a cut was taken to half the total depth of the required slot. This was repeated 20 times by slacking off the ½ in. nut and indexing the mandrel every two teeth after each cut. When all positions had been dealt with the saddle was advanced along the lathe bed to give the required 0.050 in. depth of slot and the sequence repeated.

This method proved accurate enough to enable the work to be removed from the angleplate, checked for size with a " mike," and returned to its previous position—provided the work was not removed from the mandrel, and that the key fastening the changewheel to the mandrel was a good fit. The other side of the eccentric bush was milled in a like manner, making sure that the slots in one side came opposite slots in the other. The finished bush is shown in Fig. 4. It was, of course, parted to enable it to be fixed on the crank during assembly.

I realise that, so far, there is nothing really new about this method. But now came the tricky bit. I had produced a face with 20 parallel slots radially disposed about its centre. To mate up with this, I needed to mill 20 parallel teeth in the locking collars, radially the same, but with corresponding tapered slots narrowing off towards the centres of the collars.

A plain circular hole the same size as the width of the crank webs had been previously bored in the collar blanks *B*1 and *B*2. A mandrel was made to suit and set up on the angleplate in the 0.625 in. hole used before. The idea was to mill away a portion of the tapered slots by using a smaller cutter, which would then form one side of each slot, as shown in Fig. 6.

A 3/32 in. dia. cutter was used for this operation. The packing mentioned earlier was then removed from the angleplate, which was rechecked for squareness. This brought the work centre down to a predetermined distance below the cutter centre, i.e. lathe centres. The distance was 0.129 in. determined in the following manner:

½ dia. of small cutter (3/32 in.)	= 0.047 in.
+ ½ width of tooth to be formed (0.164 in.)	= 0.082 ,,
	+ 0.129 in.

The position of work relative to the cutter is shown in Fig. 6. It was then a straightforward job to index every second tooth as before, taking two cuts to the required depth.

When this had been completed, double packing (0.258 in.) was put under the angleplate. This brought the work 0.129 in. above the cutter centre. A further sequence of cuts as in Fig. 7 removed the extra metal

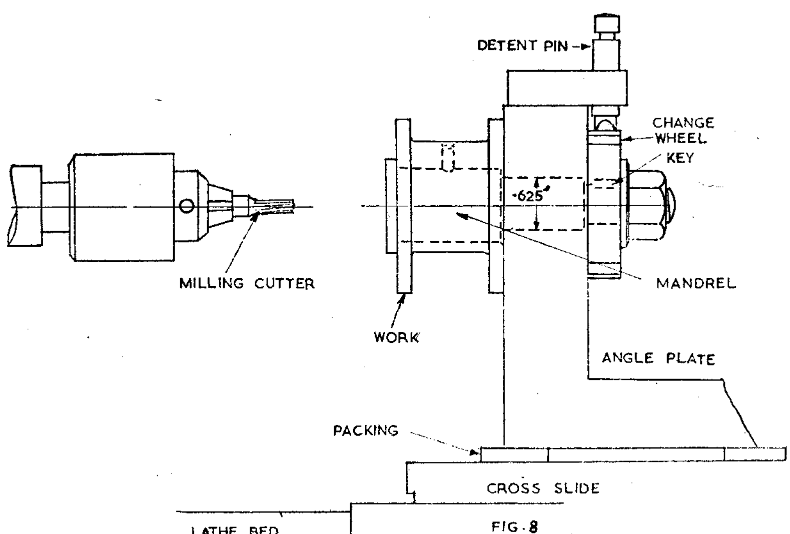


***Fig. 8**: The milling set-up*

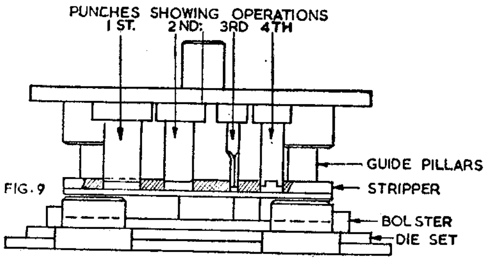


Fig. 9: Front elevation of tools with the stripper in part section showing the punches. Front pillars taken away

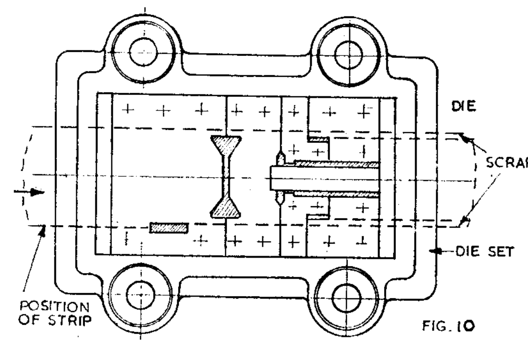


Fig. 10: Plan view of die with stripper removed showing the die construction, apertures shaded

and so finished the tapered slots.

Note that the shaded area marked as first in Fig. 5 was removed in each slot without packing under the angleplate. The lower or second shaded area was removed by the second operation with packing 0.258 in. thick under the angleplate.

By using a standard endmill of 3/32 in. dia. the cutter, being a trifle large in diameter, nipped the corners off the teeth. This, of course, was not detrimental to the work.

Before milling these teeth, the sequence of operations was put on paper and checked and all mandrels, gauges and the indexing fixture were made preparatory to milling the slots.

The model was now fixed on a base and a ¼ h.p. electric motor coupled up with a belt of ¾ in. × ⅛ in. flat p.v.c. passed round the motor pulley and one of the balance flywheels on the countershaft. The clutch mechanism of the sliding key type was next made and fitted. A similar clutch was described in MODEL ENGINEER on 17 March 1955.

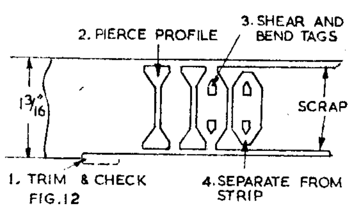


Fig. 12: Layout of strip showing the sequence of operations

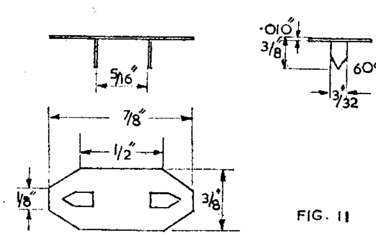


Fig. 11: Paper clip

The pedal and operating linkage was built up from ⅛ in. mild steel plate and for the coupling rod I used 3/32 in. dia. silver steel. At the back of the press can be seen a bell crank lever transmitting the action from the pedal to the clutch rod.

Mounted on a staging built on the back of the frame is a lubricating oil tank which contains a tiny geared oil-pump driven from the countershaft. The oil from this tank is pumped up to a sight feed gallery mounted on the highest point of the frame. It then falls by gravity to the eight bearing points through 3/32 in. o.d. copper tube.

Transparent feed tubes

The eight transparent tubes in the sight feed were made by drilling 1/16 in. holes in a piece of Perspex ⅜ in. thick cut out to a rough tube. Each was mounted on a small mandrel (16 s.w.g. steel knitting needle) and carefully turned and polished to a push fit in the brass body of the sight feed. The unions holding these tubes and the eight oil-pipes in position were tapered down so that when screwed home, the Perspex tube expanded slightly to form an oil seal.

Mounted at the top of the model is a dummy motor complete with adjusting rails. This was built up from odds and ends and has a shaft and pulley connected to the countershaft flywheel with four ⅛ in. dia. p.v.c. belts. Both the belt drive and the gearing are enclosed in sheet metal guards split across their centres for easy removal.

At this point I gave the press a good "run in," bedding in the slides and bearings and lapping in the gears. Meanwhile I designed a set of tools to use in the model. I wanted to produce a pressing that could be appreciated by the "uninitiated." I had a rough idea of the effort I could get out of the press, so the paper clip shown in Figs 11 and 12 was finally decided on. This was to be made from 0.010 in. tinned steel strip, each stroke of the press stamping a complete article.

A layout of the die, which is of split construction, can be seen in Figs 9 and 10. This method is easy because each section can be machined to the "mike," so giving accurate positioning of the various apertures in the die. Four operations take place. First, a punch trims the stock to a predetermined width. This provides a check in the strip which acts as a feed stop. Second, the punch blanks out the scrap area between two components. The third operation shears and bends down the two tags at right angles to the strip, and the fourth separates the completed clip from the strip. The operations take place simultaneously and the clips are pushed from the tools by the advancing strip.

A slide feed mechanism can be fitted to the left of the tools for the automatic feeding of the strip. Basically this consists of a carriage which slides on two guide bars, and two gripper blades, one mounted on the carriage and the other on the base, which is stationary.

In operation, when the tools descend on the power stroke, an angular shaped block presses on a roller positioned on the front of the carriage, and so forces it to the left against the direction of strip. On the return stroke the gripper blade on the carriage grips the strip and, by the action of two compression springs, feeds the strip the correct distance through the tools. The other blade prevents the strip from moving backwards when the carriage moves in that direction ready to feed in more strip.

I estimate there is about ½-ton pressure available at the business end of the tools.

The model is enamelled in a light grey. It took about 600 hours spread over a period of 2½ years to build. Complete with electric motor it weighs approximately 1 cwt. ■

LOCOMOTIVES I HAV

A S

William Adams' T

ALTHOUGH William Adams adopted the 4-4-2 type for his initial design of suburban tank engines for the London and South Western Railway, he abandoned the type in 1888 when new engines were needed for suburban work, and adopted the 0-4-4 type instead; it gave him a much more compact design with greater capacity for water and coal.

Adams designed two classes of 0-4-4 tank engines. The first was the T1 class which was intended for suburban passenger work, and the second the O2 class, a much smaller design for working on light branch lines.

The T1 class comprised 50 fine engines built between June 1888 and August 1896, the last ten being completed under Dugald Drummond, who introduced a few alterations to minor details. The boilers, cylinders and valve gear were interchangeable with those of the 0-4-2 tender engines of class A12 [ME, 16 May 1957], but the boiler height was lower, due to the smaller diameter of the coupled wheels.

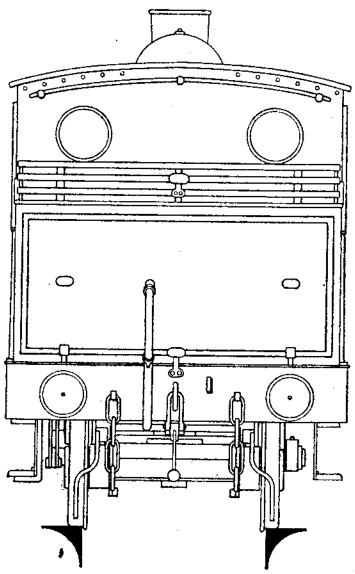
I first saw the T1s about 1900, when many were engaged on suburban work in the London area. I admired them for their simplicity, neatness and compactness. By that time, I think, they had been repainted in the Drummond style, as I do not recall ever seeing one in the original Adams livery. This seems a little odd, as I can clearly remember seeing some of the earlier Adams 4-4-2 radial tank engines in their original colours. However, I have depicted No 1 as she was when painted according to the ideas of Dugald Drummond, as that is how I remember her.

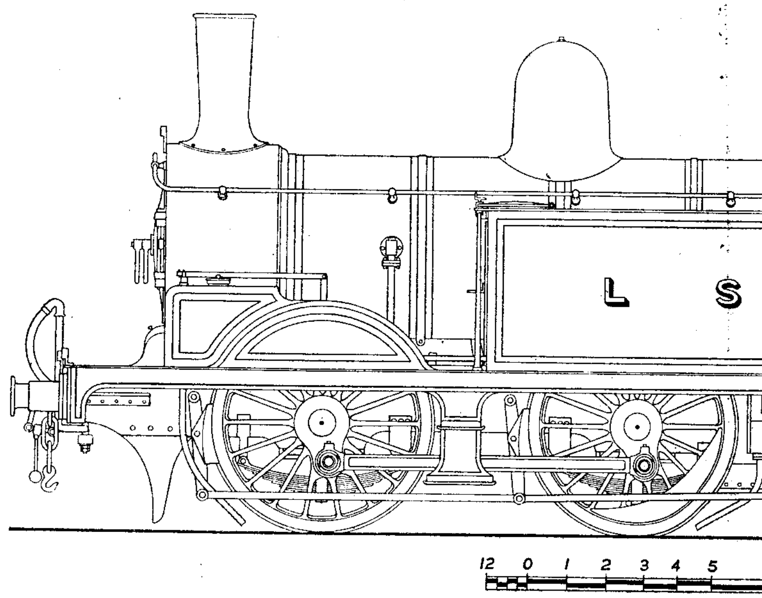
No 1 was a familiar engine in the London area when I was a small boy; but she disappeared after a few years, and I did not see her again until 1919, at Eastleigh. Surprisingly, she was still in her original condition, Adams chimney and all, a distinction she shared with at least two others, Nos 8 and 19.

The 50 engines of this fine class were built in the following order: Nos 61 to 67 in 1888; 68 to 75 in 1889; 76 to 80 in 1890; 1 to 10 in 1894; 11 to 20 in. 1895, and 358 to 367 in 1896. They were excellent workers, and I would place them among the finest 0-4-4 tank engines ever built. On those turned out in 1896, the brass beading on the splashers was omitted, and plain brass numberplates with sunk, black lettering and numerals replaced the Adams handsome cast plates. In the same group the safety valves were at first left uncased, but later they were enclosed in the normal casings.

The stationing of the T1 class was widely spread over the LSWR system, including Plymouth, Salisbury, Andover, Eastleigh, Bournemouth and Portsmouth, as well as the London area. When the electrification of the London suburban district was completed in the 1920s, the London contingent of the T1 class was transferred to provincial depots and continued to do useful work for about another 20 years.

Coal rails on the bunkers first appeared on the engines built in 1896. They were added to the earlier engines as they passed through the works for overhaul. The coal capacity was thereby increased by about 10 cwt.





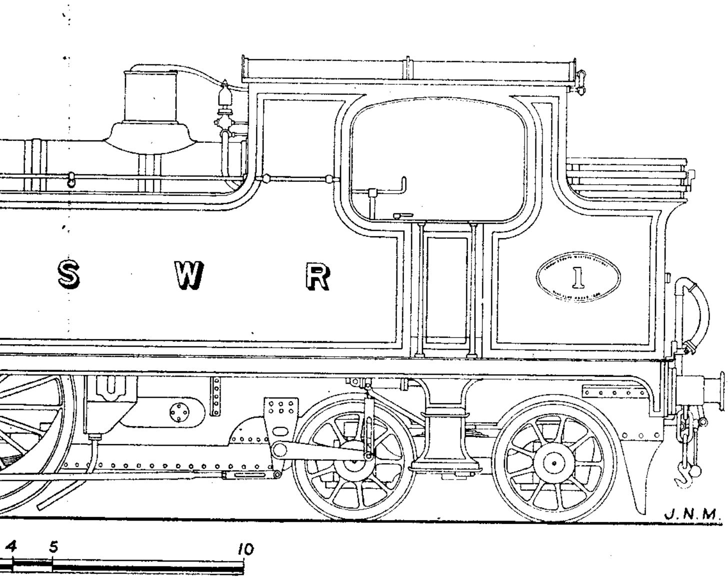
Throughout the whole of their existence, these engines remained virtually in their original condition, apart from the substitution of Drummond chimneys for the Adams stovepipes. But four of the class, at different times, were rebuilt with the Drummond boiler; these were Nos 63, 11, 15 and 361, and since never more than one engine in service was treated like this at any time, the inference is that only one Drummond boiler was used for all four engines. It seems to have made little difference to the capabilities of the engines, or

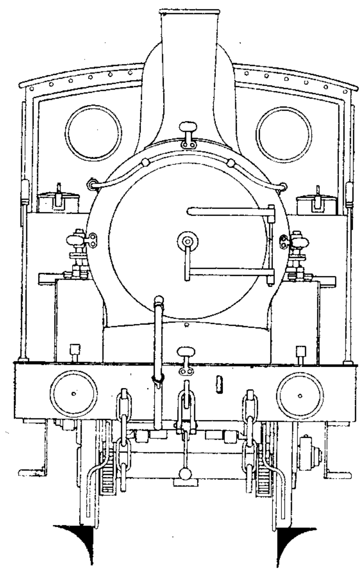
AVE KNOWN

A SECOND SERIES By J. N. MASKELYNE

more would probably have been rebuilt in this way. In any case, there may have been enough Adams boilers in stock for replacements when the older boilers wore out.

The dimensions of these engines were thoroughly up-to-date, if not actually in advance of their time. The four coupled wheels were 5 ft 7 in. dia., the bogie wheels 3 ft. The wheelbase was 23 ft divided into 8 ft plus 10 ft plus 5 ft, with overhangs of 6 ft 1½ in. in front and 2 ft 7½ in. at the back, while the total length over the buffer heads was 35 ft 1½ in.





s' T1 class LSWR

Two different arrangements of cylinders were used; the first group of engines, Nos 61 to 80, which were class T1 proper, had cylinders with the steam chest underneath, and all the others, which were originally class F6, had the steam chest between the cylinders. In both classes the cylinder diameter was 18 in. and the stroke 26 in.; the slide valves were operated by Stephenson link motion. In later years, both classes were amalgamated under the classification T1, though the difference in the cylinders was never altered.

The boiler barrel was 4 ft 4 in. dia. and 11 ft long; it was pitched with its centre line 7 ft 3½ in. above rail level. There were 216 tubes of 1¾ in. dia., with a heating surface of 1,121 sq. ft; the firebox, 6 ft long outside, added 110 sq. ft, making the total heating surface 1,231 sq. ft. The working pressure was 160 p.s.i. and the grate area 17 sq. ft.

When writing about Drummond M7 0-4-4 tank engines, I mentioned a curious difference that occurred in the weights of two batches of those engines. An even more curious difference was to be noted in the weights of the Adams T1 and F6 classes. The official particulars give the following: class T1, on the leading axle, 17 tons 3 cwt; on the driving axle, 18 tons; on the bogie 17 tons 17 cwt; total 53 tons. Class F6, on the leading axle, 16 tons 6 cwt; on the driving axle, 18 tons 6 cwt; on the bogie, 20 tons 10 cwt; total 55 tons 2 cwt.

These figures show that the adhesion weight of the T1 class was 35 tons 3 cwt, and for the F6 class it was 34 tons 12 cwt; yet the latter engines were 2 tons 2 cwt *heavier* than the former. How did this come about ? The only known difference between the two classes is that the F6s had the steam chest between instead of underneath the cylinders; but a possible explanation would be that the F6 class had a heavier drag-plate and drawgear arrangement than that of the T1 at the rear end. Examinations of the engines failed to reveal any differences in the drawgear. It is all somewhat mysterious !

The estimated tractive effort of these fine engines was 17,100 lb., which made them eminently suitable for their job, and was especially useful for working heavy trains that stopped at every station on a journey. On short distance semi-fast trains, these engines were equally satisfactory and were frequently employed on such work, at which there was little to choose between them and the Drummond M7 class.

Nos 1, 4, 5, 8, 18, 359 and 361, about 1910-14, were fitted for push-pull autotrain working, on which they were employed chiefly in Hampshire. During the war, the apparatus was removed and the engines reverted to normal duties.

Withdrawal of the 50 engines of this class began in 1931, but was not completed until 1951 when the class became extinct. They had a long and useful career amounting, on the average, to more than 50 years per engine, which does not appear to lend much support to the Board of Trade's censure of the 0-4-4 tank type of locomotive. ▣

PANSY 5in. gauge pannier tank engine

Continued from 11 December 1958, pages 748 to 750

Instructions for making the brake column and other details are given below by LBSC

At 1/8 in. from the end of the top piece, drill a No 43 cross-hole, and squeeze a piece of 3/32 in. round silver steel into it, turning up one end as shown in the drawing, to form the brake handle. Round off the ends. Push the spindle through the casing and secure it by a collar at the screwed end.

For the collar, chuck a piece of 5/16 in. brass rod, face, centre, drill No 14 to 1/4 in. depth and part off a 3/16 in. slice. Press this on to the spindle until it just touches the screwed end of the casing, allowing the spindle to turn freely but without any appreciable end-play. Drill a No 53 hole through collar and spindle and squeeze in a pin made from 16-gauge silver steel.

Tips on cock making

The bracket is made from a 3/4 in. length of 7/8 in. × 1/8 in. brass or steel angle. At 7/16 in. from the edge, drill a 3/8 in. hole, then round off the drilled part of the angle as in the inset sketch. Drill four No 34 holes in the frame as shown in the drawing in the last instalment, and countersink them. Temporarily clamp the bracket to the frame, level with the top and with the centre of the hole at 13/16 in. from the step.

Run the 34 drill through the holes, making countersinks on the bracket, follow through with No 44 drill, and tap 6 BA. Remove the bracket, put the screwed end of the column through the hole, secure it with the nut, then erect the lot by screwing the spindle through the brake nut and attaching the bracket to the frame by four 6 BA countersunk screws as in the drawing.

On the Stroudley *Gladstone* engines of the LBSCR the steamchest was underneath the cylinders, and a single cock in the cover was found sufficient to get rid of all condensate water when starting from cold. I am specifying the same arrangement for *Pansy*.

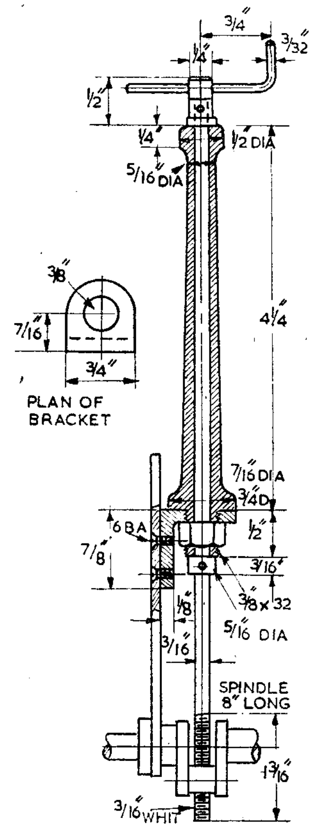
Instead of a complicated arrangement of jointed rods for operating the cock from the footplate, we can follow the late Sir Nigel Gresley's practice and use a Bowden wire. This can be run through a piece of ordinary brass tube, as the usual Bowden casing would be rather clumsy for the job in hand.

I strongly advise making the cock, as commercially-made cocks are usually of soft metal, and prone to stick, leak, or both. Good quality bronze or gunmetal should be used. A taper reamer will be needed, and here is a useful tip for beginners. Most folk find some difficulty in turning a taper plug to fit exactly into a taper hole. Chuck a piece of 3/16 in. round silver steel with about 1 1/4 in. projecting from the chuck jaws. Set a roundnose tool in the slide rest toolholder exactly at centre-height. Set the slide rest to turn 6 deg. included taper. If the top slide has a graduated base, set it over three divisions. If it hasn't, set it by eye as near as you can judge, as the exact angle of taper doesn't matter. What *does* matter is that the turned plug fits the reamed hole.

Now carefully turn the silver steel until the outer end is approximately 3/32 in. across. Take fine cuts, use plenty of cutting oil and aim for an absolutely smooth finish. Now take say half-a-dozen 1 1/2 in. pieces of 3/16 in. drawn bronze rod. Chuck each, and without altering the setting of the tool, or the angle of the top slide, turn a taper on each end of each piece, until the end is about 1/16 in. across. You then have a dozen cock-plug blanks, *each of which will exactly fit a tapered hole formed by the reamer*. The latter can then be finished off in the same way as I have described for injector reamers, by filing away half the diameter of the tapered part, hardening and tempering to dark yellow, and giving the final touch on an oilstone.

Making the cock body

To make the cock body, chuck a piece of 3/8 in. round bronze or gunmetal rod in the three-jaw, face the end, turn 3/16 in. length to 3/16 in. dia. and screw 3/16 in. × 40. Part off at a full 11/16 in. from the shoulder. Rechuck in a tapped bush, centre, drill through with No 43 drill, and counterbore to about 3/32 in. depth with No 32 drill. Turn the outside to the contour



BRAKE COLUMN

shown. The centre of the globular part should be 3/8 in. from the shoulder, but a shade more or less won't affect the working of the cock.

Be careful about the next job, which is to make a centre pop on the globular part and drill a No 34 hole right through it. This hole must cut exactly across the longitudinal hole which forms the waterway. My method is to rest the bulge in a shallow countersink made in a small block of metal on the drilling-machine table, and sight drill across the end of the hole.

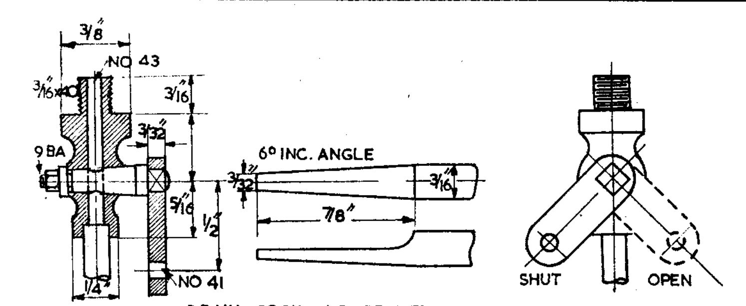
Beginners can make absolutely certain of it by putting a small piece of 3/8 in. square rod in a machine vice, setting it vertically, and making a deep countersink in the end with a 1/4 in. drill in the chuck of the machine. Then *without altering the position of the machine vice*, put a No 34 drill in the chuck, screw the cock body into the end of a piece of 3/8 in. rod which will serve as a handle, rest it in the countersink, and go ahead with the drilling. If the machine vice hasn't been shifted, the drill will go slap through the exact centre of the bulge.

Incidentally it saves time if several pieces of round rod are drilled and tapped at one end, and turned down and screwed with a corresponding thread at the other, to serve as handles for holding small fittings for drilling, filing, cleaning up after silver soldering and various other operations.

Fitting the taper plug

Put a tapwrench on the shank of the taper reamer and ream the cross-hole to its full depth, then put the reamer in the other end and carefully ream to about 1/16 in. depth. The object of this is to allow clearance for the plug when it needs grinding in after long usage. Now chuck one of the cock-plug blanks, and turn the end of the tapered part to 5/64 in. dia. The exact length is a matter of trial-and-error. Without removing the blank from the chuck, try the cock body on it. The right length is when the shoulder is about 1/16 in. inside the body, as shown in the section. Screw the turned part 9 BA. Part off at 9/16 in. from the shoulder.

A 1/8 in. square 1/8 in. long has next to be filed on the handle end of the plug. To hold the plug while doing this, put a short piece of rod in the three-jaw (any size over 3/16 in. dia.) face the end, centre, drill No 34 and ream the hole with the taper reamer. Push the embryo cock plug tightly into this, and it will "stay put" while the square is filed by the method I have often described for filing squares on screwdown valve pins, using one of the chuck jaws as a guide.



DRAIN COCK AND REAMER

The plug can now be lightly ground in. For a grinding medium, a slight scraping off an oilstone is excellent, or a smear of very fine pumice powder and water. As the plug exactly fits the taper hole, little grinding is necessary. Wash off every trace of grinding medium, smear the plug with cylinder oil, then secure it with a 9 BA nut and thin washer.

The handle is filed up from a 3/4 in. length of 1/4 in. × 3/32 in. steel, with a 1/8 in. square hole in one end to fit the square on the plug, and a No 41 hole at the other end. To avoid damaging the plug by riveting over the projecting bit of the square, the handle may be soldered.

The final job is to drill the hole through the plug in the right position in relation to the handle. Put the handle in the position marked "open" in the drawing, then put a No 43 drill down the hole in the cock body, and drill through the plug. Take it out after drilling, and if there are any signs of burring around the hole, remove them with a scraper. Solder a short bend made from thin-walled 1/8 in. copper tube into the counterbore, and screw the cock into the hole in the steamchest cover as shown. If it doesn't come right, don't force it and risk stripping the thread. Just put a copper washer between the shoulder and steam chest.

Operating lever

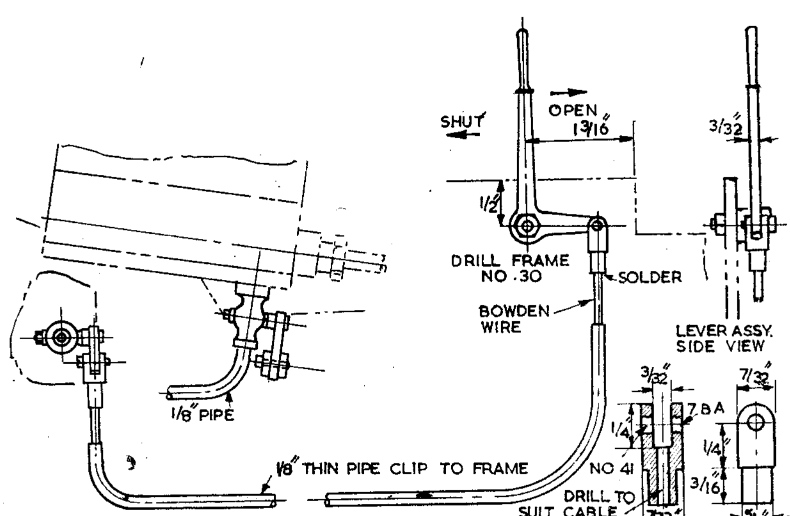
The easiest way to make the lever is to mark out the flat part on a piece of 3/32 in. sheet steel, and saw and file to outline. The handle or grip can be turned from 3/16 in. round mild steel held in the chuck, and brazed on to the flat part. My usual trick to prevent the grip from shifting during the brazing operation, is to drill a 3/32 in. hole in the end. When filing up the flat part a little pip is formed at the top to fit the hole in the grip tightly. This also ensures that the grip is located centrally on the lever.

The stud is turned from a piece of 3/8 in. round mild steel held in the chuck, and needs no detailing. Drill a No 30 hole in the frame at the point indicated in the drawing, put the 1/8 in. end of the stud through it from inside the frame and secure with a commercial nut. The hole in the lever should be a nice fit on the plain part, and is kept in place by a 6 BA nut and washer. The two forks for the Bowden wire are made as described for valve forks, the size being given on the drawing.

Tube for Bowden wire

The length and shape of the thin-walled 1/8 in. pipe which forms the casing for the Bowden wire is easily obtained from the actual engine. It should start at a point about 1 1/4 in. below the horizontal arm of the lever, proceed in a wide curve to the bottom of the frame, and run straight along to a point almost opposite the drain cock, where it is curved inwards to line up with the cock handle, finishing about 1 1/4 in. from it.

The clips can be made from 1/4 in. × 1/16 in. brass strip, and attached to the frame at convenient points by 3/32 in. screws. The kind of cable I



ARRT. OF STEAMCHEST DRAIN COCK FORK

use is that sold by cycle shops for operating brakes on push-bikes, and it will pass easily through a 1/8 in. tube. To get the length needed, solder one of the forks to the end of the cable, grease it, push the other end through the tube, and connect the fork to the horizontal arm of the lever with a 3/32 in. screw, which should have a plain part under the head, like those in the valve gear.

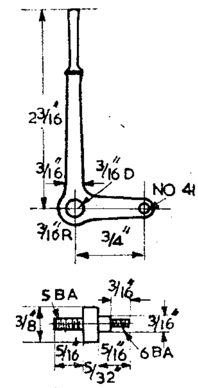
Buffers

Put the lever in the position shown, with the handle vertical, and the handle of the cock in mid-position, hanging straight down. Attach the fork to it temporarily, and cut the cable so that it enters the round part of the fork full depth. It can then be soldered. Work the lever back and forth, and if the cock operates properly, as it should, the fork can be permanently attached to the cock handle by a similar screw to that at the other end of the cable.

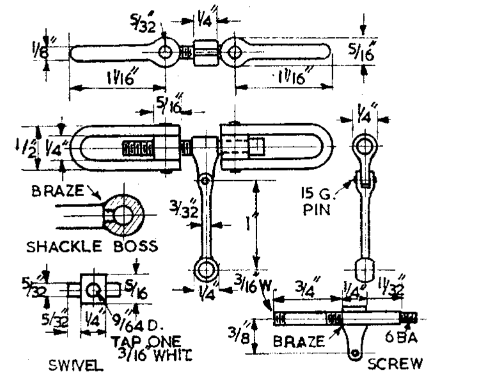
The buffer sockets should be cast without the step, or they cannot be turned. Chuck with the shank outwards, face, centre and drill through with No 12 drill. Turn the shank to 1/2 in. dia. and screw 1/2 in. × 26. Rechuck in a tapped bush, turn the outside, face the end, and open out the hole to 5/8 in. dia. for 1 in. depth. The steps are 3/8 in. squares of 1/8 in. brass or steel brazed or silver soldered on. Smooth off the square flange with a file, and drill the four small holes as shown.

The sockets could also be made from 1 in. round steel. Chuck, face, centre, drill No 12 to 2 in. depth, turn 3/4 in. length to 1/2 in. dia. and screw 1/2 in. × 26. Part off at 1 1/16 in. from the shoulder, rechuck in a tapped bush, turn the outside and open the hole as above. The flange is a piece of 1/8 in. steel 1 1/4 in. square with a 1/2 in. hole in the middle, placed over the shank and brazed to the shoulder of the turned part.

The heads can be cast, or turned from 1 1/2 in. round steel held in the chuck. The shank should be an easy sliding fit in the socket. The spindle is made from a 2 1/4 in. length of 3/16 in. silver steel screwed at both ends, and the spring is wound up from 16-gauge



LEVER & STUD



SCREW COUPLING

steel wire. The springs need to be strong for an engine of this size and weight. The buffer shanks are pushed through the holes in the beams and secured by 1/2 in. × 26 nuts. Four 3/32 in. hexagon or roundhead screws are put through the holes in each flange into tapped holes in the buffer beams.

The drawhooks are sawn and filed from 1 in. × 3/16 in. mild steel. Be sure to round off all the sharp edges, as in full size, so that there is no chance of damage to any shackle or link placed over the hook. The shackles of the screw couplings are made from 1/8 in. mild steel rod with bosses screwed and brazed on, as shown. The bosses are 1/8 in. slices of 5/16 in. round steel rod drilled 5/32 in. for the swivels. These are turned from 5/16 in. rod. Two of them are drilled 9/64 in. and tapped 3/16 in. Whitworth. The other two are drilled but not tapped.

Screw couplings

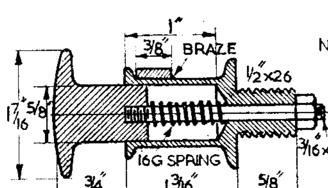
The easiest way to make the screw is to chuck a piece of 3/16 in. round steel 1 5/8 in. long and screw 3/4 in. length 3/16 in. Whitworth. Reverse it in the chuck and grip by the thread, which won't be damaged if the chuck isn't excessively tightened. Turn a bare 7/8 in. length to an easy fit in the hole in the swivel, then reduce 1/8 in. of the end to 7/64 in. dia. and screw 6 BA.

The centre part to which the weighted spindle is attached can be filed to shape from a piece of 1/4 in. square rod, drilled to fit over the plain part of the screw and brazed on. The weighted spindle by which the screw is turned can be made from a piece of 3/32 in. steel 7/8 in. long. Screw a 1/4 in. ball on to one end; turn up the ball from a bit of 1/4 in. steel rod, and file a flat on opposite sides. On the other end, braze a little block of 3/16 in. square steel, and form it into a fork, which is pinned to the tongue of the middle part of the screw. Leave it free to swing.

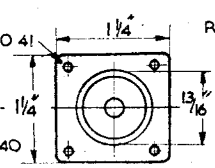
To assemble, push one of the shackle bosses through the slot in the drawhook and spring the ends over the swivel with the plain hole. This is easily done if the edges of the swivel trunnions are slightly chamfered. Put the plain end of the screw through the hole in the swivel and secure it with a round nut, which may either be pinned to prevent it accidentally slacking off, or the end of the thread burred over slightly. Screw on the other swivel and shackle, put the shank of the drawhook through the square hole in the beam, and put a 16-gauge spring over the shank, securing with a nut and washer.

★ *To be continued*

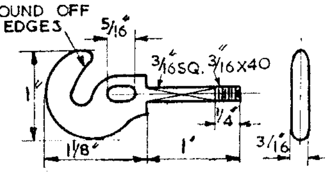
LBSC writes every week



BUFFER



SECTION THRO SOCKET



DRAWHOOK

Even a novice can have a bright idea—that is why industrial firms hold . . .

TRIGGER SESSIONS

Says
FREDERICK MASSEY

WHY not have a "trigger session" at your next club meeting? Many large and reputable industrial firms regularly hold "trigger sessions" and the number of truly brilliant ideas that come to light is surprising.

It has been found that these flashes of brilliance occur in the most unlikely people, and history is full of examples of this. For instance, who first had the idea of using an electric spark in a spark-plug instead of the porcelain tube that used to fire the charge in an i.c. engine? Who first thought of the wheel? We can be almost certain that these flashes of inspiration are not always the product of highly trained technical minds.

A typical "trigger session" in industry usually includes a wide cross-section of people. It is common to invite the office boy, someone from the warehouse, a street cleaner, and often women with no technical knowledge at all. The idea is explained and everyone asked to say the first thing that comes to mind, no matter how ridiculous it may seem.

A most trivial remark may "trigger" an idea in another mind, and then a kind of chain reaction sets in. Suddenly someone makes a remark that catches on, often in two or three places at once. That is the spark, and without the session it might have lain dormant for ever.

Sample session

In industry these meetings are almost invariably recorded on tape, but that is not really necessary. It must be made clear that no one is to be criticised for anything said, and nothing is ever regarded as irrelevant.

Let's see what could happen at a typical "trigger session." The subject is steam cars. It occurs to someone present that the motor-car engine is a great waster of heat. In fact they waste more heat energy than they deliver in usable power energy. The unbalance (ignoring friction for simplicity) is considerable and entirely in favour of the heat output.

"Running hot was once a terrible state of affairs," says someone. "But now we know more about lubricants and also more about heat-resistant materials, particularly metals. Why not start thinking of the i.c. engine as an efficient producer of heat instead? If it makes a little motive power, we could use it."

"Is the i.c. engine really an efficient producer of heat, compared with a blowlamp set-up?" asks another member. (Don't laugh—remember everything goes in this sort of session.)

Communal comments

Before anyone can reply, a voice from another corner of the room comments that a steam cylinder likes to run reasonably hot, and we desperately try to keep an i.c. engine cool. Where would we be without efficient pumps and radiators? So let's try for a heat transfer and run a sort of combined engine. "The i.c. cylinder could warm the steam cylinder," comes a suggestion.

"The heat starts in an i.c. engine in the upper cylinder region. Why not use it for a superheater for the steam? Heaven knows there's enough of it!" says another party. "Some will get away through the cylinder walls and into the cooling water. Why not let it run hot and take out the heat as a feed water heater? Why, we could almost boil the water before it gets to the boiler!"

"What about the exhaust gas?" asks the original voice. (Didn't we hear somewhere that hot gas at high velocity was just the ticket for rapid heat transfer?) "We want to be able to control our blowlamp under the boiler," another modeller points out. "Haven't we learned to make i.c. engines beautifully controllable." "Maybe there won't be enough heat here," chip in two others.

Then we recall the Kitson Still locomotive in which they got a heat transfer through the piston crown by running the engine as a steam engine on one side and a diesel on the other side. We don't remember if the diesel was on top of the piston or below, nor any other details; but why not put a gland in the middle of the cylinder cover and let a piston rod stick out? Then fix a piston on the end of the rod and make the i.c. engine piston with a central hole in it to form a cylinder? Could we work the inner cylinder as an i.c. engine and the surrounding space on steam? That would soak up a lot of heat to help the steam.

How about a four-cylinder-in-line engine with two cylinders working on steam and the other two on i.c.? That would give us high starting torque. "Oh no it wouldn't—we couldn't get steam until the i.c. part got going," comes the retort. "But would it take long? How long?"

"Then we'd have slow speed power from the steam end and we could bolster this a bit when we reached high speed from our 'power detuned' i.c. engine. Why not put the cylinders in a square like an Ariel motor-cycle square four?"

"Oh no, a better idea—let's put in six cylinders—three on each side and make a V-six. Then we can keep the middle steam cylinders nice and warm. Perhaps we could connect the two middle ones to a separate crankshaft and make them double-acting. Perhaps connect the crankshafts together with a two-to-one reduction?"

"Then why not take an i.c. engine and let the charge fire, and then inject water into the burning mass? It would be boiler, superheater and everything all at once."

Hot ideas

"I heard of water injection on wartime aircraft. I wonder if that's how it worked? We'd have to squirt the water in at a carefully determined delay period or else we'd put the fire out!" "Well, if we run that risk, why not shoot the water into a pocket off the cylinder head?" exclaims another member.

"We can preheat the water first from the exhaust, then from the cylinder head. We might even get it under high pressure." "Yes—that's the idea! It will burst into steam if the pressure is high enough. Perhaps a modified diesel injector would do the injecting. That would be a kind of diesel running on hot water."

So on and so on. Going to try it? ■

'Silver Ghost' was a champion —and a challenge

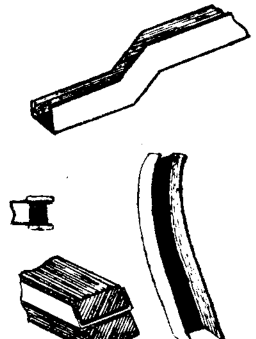


Fig. 1: The chassis channels

How Leonard Tuck made the model of a 1907 Rolls-Royce car, seen at the ME Exhibition

MY model of the world famous 1907 Rolls-Royce car *Silver Ghost* started with a challenge from my young son. " You could never do that," he remarked disparagingly. He had just seen a description of the model built by Rolls-Royce at a cost of £300 and secretly I then agreed with him.

I had built a 1913 bull-nosed Morris with some success and after a visit to the Brooklands golden jubilee celebrations where the car was on view, I decided to accept the challenge. I made a mental note of the salient features and took a number of pictures. This information was supplemented by an outline print from Rolls-Royce who also sent me three large photographs.

The chassis was made from 22-gauge brass sheet after I had made rough jigs from hardwood to bend the channel sections, as in Fig. 1. The scale was decided by the availability of suitable 3 in. dia. Meccano tyres.

Wheels were turned out of tufnol sheet plus a lot of hard work cutting the individual spokes, 14 in the rear, 10 in the front. Small ballraces were pressed into the wheels and tufnol " washers " riveted either side to reproduce the hub-plate effect, as in Fig. 6. The radiator top was cut from solid brass, the sides and bottom of 22-gauge with brass gauze to give a honeycomb. Springs were made of 20-gauge mild steel tempered and quenched.

The back axle comprises a pair of bevel gears fitted in a white-metal housing to which is sweated a flared end of tungum tube (phosphoric acid used for soldering), a mild steel half-shaft running through the tube

Fig. 2: Back axle, bevel gear and universal

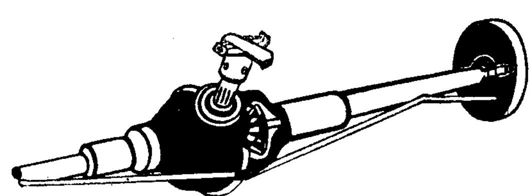


Fig. 3: Front axle and king pins

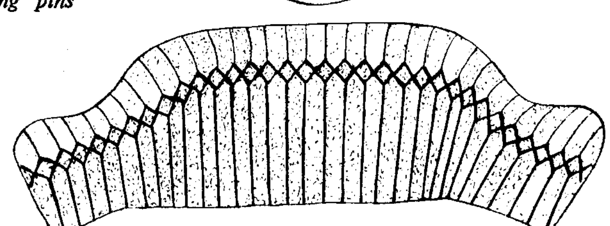


Fig. 4: Seat squab pattern

driving the offside rear wheel, see Fig. 2.

The front axle is dural cut from $\frac{1}{4}$ in. thick plate, the wheel axles are brass bar turned, and for king-pins a couple of broken off drill shafts, as shown in Fig. 3, were used.

The bodywork is in two halves split vertically down the centre of the back seat squab. They are made from my sheet of 22-gauge brass, the odd pieces providing the doors. The bonnet is of copper with lots of $\frac{1}{16}$ in. rivets for decor.

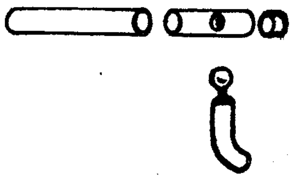


Fig. 5: *Steering ball joints*

Headlamps and sidelamps were turned from brass bar and a visit to Woolworths for a couple of glass buttons (domed with facets) provided sidelamps.

One of the secrets of model building of this nature is to prefit everything, then dismantle, clean-up, polish, paint or plate and wrap in tissue, ready for final assembly.

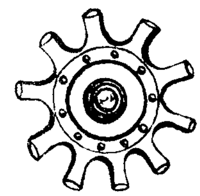
The upholstery gave me quite a problem, but here again the domestic sphere played its part. Having been told by my wife to clear off the kitchen table so that she could do some ironing, I noticed a pink sponge cover over the board; experimenting with a snippet I found it could be cut into patterns with a razor blade quite cleanly. That was it and the result was as shown in Fig. 4.

Purchasing the same material in blue after having cut templates of cardboard, a patient snicking with the razor produced quite a pleasing effect of "ribbing." This was duly stuck into place, and together with small pieces of vynide and carpet, the task was finished.

The steering comprises a wheel made from $\frac{1}{8}$ in. brazing wire annealed and wound round a mandrel with cross-bracing soldered to it. The control column is of tungum tube with a mild steel shaft pinned to a worm driving a bevel gear to which is screwed a short rod and ball end. The track-rod and drag link were made of $\frac{1}{8}$ in. wire with $\frac{3}{16}$ in. tube ends and ball joints, as shown in Fig. 5.

Mudguards are of copper with side flanges on the front guards sweated into position and mudguard supports

Fig. 6: *Wheel hub*



are $\frac{1}{8}$ in. brazing wire with flat plates sweated to take the bolts holding the guards. The prop shaft is dummy from the engine to the gearbox which consists of a small electric motor with an 11 : 1 ratio drive to the back axle. The universal is made of clock-spring cut in the form of a cross, with drives from the tips secured to the shafts of the axle and gearbox as illustrated.

The engine and accessories such as oil and temperature gauges and speedometer, which are also dummy, were made mostly from brass. The acetylene generator is turned from brass bar, and the running boxes of tufnol sheet $\frac{1}{4}$ in. thick.

At this stage, after 280 hours of work, the parts were finally assembled. The model, which is 2 ft long, weighs 8 lb. and I hope soon to fit batteries and radio control gear beneath the runningboards. ▣

★ ★ MUSEUM MODELS ★ ★

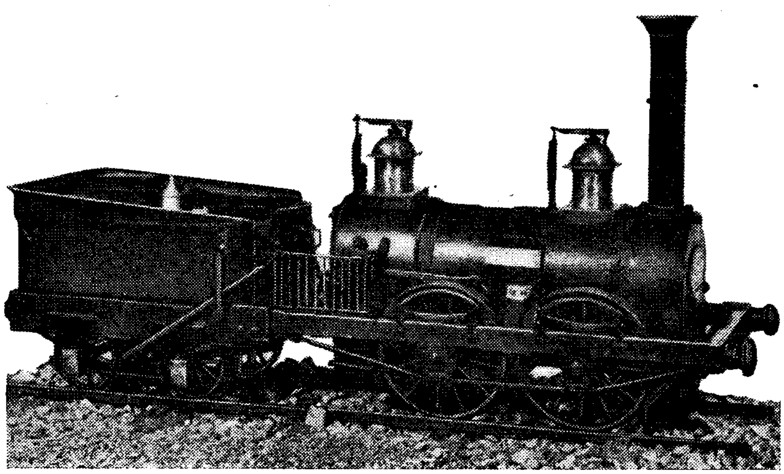
Stephenson's COMET

The first locomotive acquired by the Leicester and Swannington Railway was the *Comet*, purchased from Robert Stephenson and Co., and delivered at Leciester on 5 May 1832. It was the first steam railway engine to be seen in the Midlands and worked on the line until 1838 when it was sold to the Birmingham and Gloucester Railway where it was used on construction work.

The model shown in the accompanying photograph was made in 1845 by John Richardson, a brassworker, who had premises in Bridge Street close to the railway's Leicester terminus and who had no doubt often seen the *Comet* at work.

The total length of the model engine and tender is 2 ft 4 in. over buffers and the scale is approximately 1 in : 1 ft. As the model was intended to steam the boiler mountings are not to scale and differ considerably from those of the original locomotive as shown in surviving blueprints.

It is painted in dark green and black, and for many years was displayed in the local Mechanics' Institute. It is now on loan to Leicester Museums from F. and W. H. Richardson, and is a popular exhibit in the Newarke Houses Museum. ▣



IN THE ME WORKSHOP

Principles of INDEXING

Last of a series on this subject by EXACTUS in which he suggests some alternative ways

THE use of worm gearing makes it possible to carry out reasonably accurate indexing with much less accurate "master" plates or wheels—a fact which disproves the popular contention that "you can't do precision work without precision tools." If it happens—as it sometimes does—that an unusual number of divisions is called for and no available combination of gears or plates will provide the correct multiple, it is quite practicable to make something by hand or by reversion to first principles which will serve the purpose.

Methods of "generating" division plates have been described in ME on several occasions; the most common is the perforated strip method (Fig. 1) of which there are several variants, including the use of cinematrograph film, and balls or rollers clamped in contact around a grooved track. Many years ago George Gentry described the use of cardboard division plates, marked out in Indian ink on the drawing board with the aid of a protractor or dividers.

Examples of unusual numbers of divisions occur in many kinds of instrument and horological work, such as clocks with calendar motion, where a wheel of 365 teeth may be required. The prime factors or submultiples in this case are 5 × 73, and it may, therefore, be necessary to make a plate with that number of divisions.

In some cases the range of divisions possible with available gear can be increased by shifting the index pin or detent in a definite order of progression, in conjunction with movement of the division plate. This is described in Holtzapffel's classic work, and some of the highly elaborate lathes made by him and his contemporaries were fitted with micrometer-screw adjustment of the detent for this purpose. It involves tangential measurement, as previously referred to, and is subject to the same risk of error; in cases where a large number of divisions is called for, it may become a tedious operation.

Vernier indexing

A somewhat more facile method of compound dividing is by vernier adjustment, in which two plates with different numbers of holes at the same radius, are employed. One plate is mounted on the wormshaft, or direct on the indexing mandrel, the other is held stationary, but in contact with it. An indexing pin is then passed through holes in both plates to align them, and by working round the fixed plate, an increased number of divisions can be obtained. If two plates with 20 and 21 holes respectively are employed, the difference between the alignments of adjacent holes will be 1/20 — 1/21 = 1/420 of a circle; 24 and 25 holes will give 1/600, and so on. Gearwheels can, of course, be used instead of division plates, by locking adjacent teeth in alignment.

In the production of worm gears for power transmission, such factors as accurate tooth form, pitch, meshing adjustment and the end clearance of teeth, are highly important. But for indexing purposes, when using either spur or worm gears, the only really essential requirement is that the teeth should be equally spaced. Other considerations can largely be disregarded. This does not mean that when making the gearing, deliberately incorrect tooth forms, etc., should be encouraged, but simply that in improvisation, a much wider range of available material can be pressed into service than would otherwise be possible.

For instance, change wheels or other spur gears, although obviously not designed as worm gears, and not really well suited to power transmission in this capacity, can be applied to indexing worm gearings. As the teeth are square across the face, instead of set at an angle, as in correct worm gears, the wormshaft needs to be displaced at the pitch angle of the worm to produce a good contact of the latter with the teeth of the wheel. But even this is not an *essential* requirement for indexing purposes, as quite good results can be obtained with the shafts at right angles, even though the teeth make only limited contact at two points; not recommended, but "needs must when the devil drives."

All kinds of gearing for smooth and efficient running, require a slight meshing clearance between the teeth,

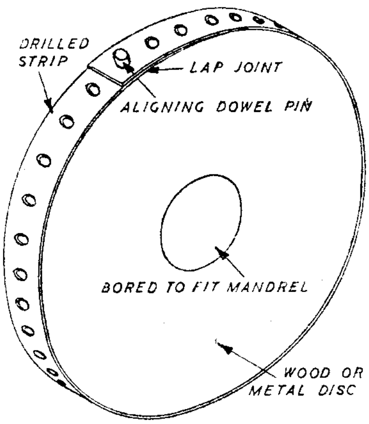
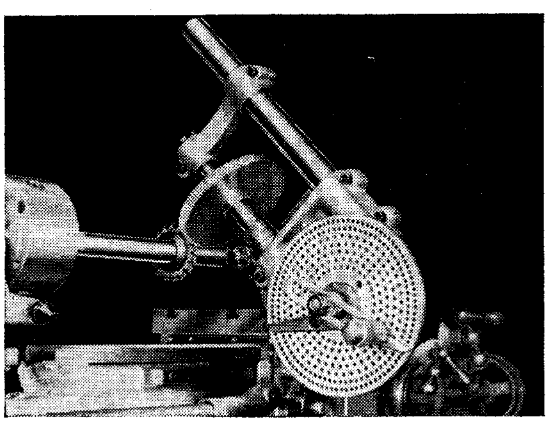


Fig. 1: A division plate can be made by wrapping perforated strip round a disc with an appropriately adjusted diameter



Myford dividing attachment with division plate and sector arms

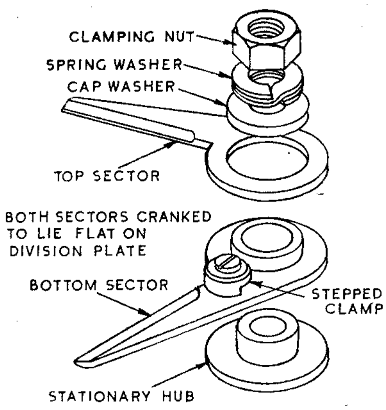
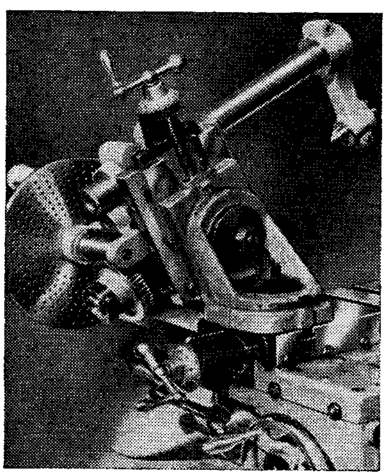


Fig. 2: Details of sector arms used with division plates to simplify the counting of holes

but this is neither necessary nor desirable for indexing worm gears. End clearance over the tips of the teeth is essential, but the flanks should be in tight contact to eliminate backlash, and of course no end play is permissible in the wormshaft bearings. If the gear works somewhat stiffly, so much the better, as this will reduce the risk of inadvertent movement. Worm indexing gear requires no locking between shifts, as the drive is quite irreversible when using a fine-angle single-start worm.

Many readers who wish to fit up indexing gear are deterred from using worm gearing by the *apparent* difficulty of producing either a complete worm and wheel, or a worm to mesh with a standard involute spur wheel. In neither case, however, is the job as difficult as it may appear, despite the fact that spur gearing is normally



Another view of the attachment showing the worm and worm wheel

based on diametral measurements, which do not work out conveniently for making worms to pitches which can be cut in the lathe by screwcutting methods.

The change wheels fitted to Myford and several other popular makes of small lathes are of 20 diametral pitch; in other words they have 20 teeth per inch diameter, measured on the pitch circle (not over the teeth). The circumferential distance between the teeth, therefore, is $(1\pi \div 20) = 0.157$ in. (approx.).

This exact pitch would admittedly be difficult to cut with normal screwcutting trains, so the next best thing is to cut the nearest convenient pitch, which is 6½ t.p.i., equivalent to 0.154 in. (approx.). On a lathe with an 8 t.p.i. leadscrew, this can be cut by using a 65 t. wheel on the mandrel and a 40 t. wheel on the leadscrew, with any intermediate wheels as idlers (i.e., no compounding). The tooth-form should be Acme (29 deg. included angle) and tooth width and mesh can be checked against the teeth of the wheel itself.

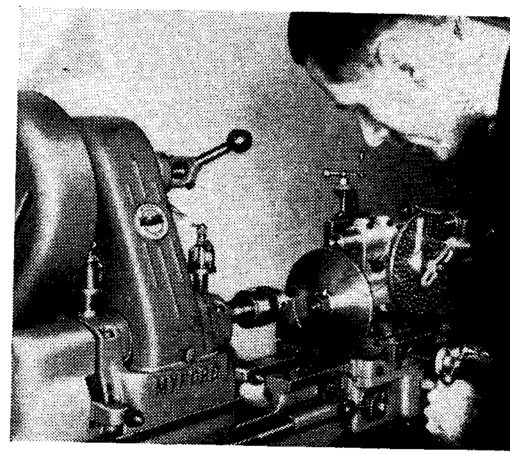
Permissible errors

If a correctly generated worm wheel is to be used, a hob of the same size and pitch as the worm can be used for finishing, after gashing in with a 20 d.p. involute cutter to about 2/3 depth, at the correct pitch angle. Extreme care is necessary to get the highest accuracy for a master worm and worm wheel, but it is not beyond the resources of the amateur workshop if correct methods are adopted.

The idea of using a worm gear with a small pitch error, as mentioned above, may worry some readers, as it may be compared to the principles employed in tangential dividing, where even the smallest error in the linear measurement becomes serious in its cumulative effect over a large number of divisions. On the face of it, a worm which produces a tangential progression of 0.154 in., when the correct circumferential pitch is 0.157 in. *must* have a minus error of 0.003 in. per tooth. If the inference is carried further, the error over, say, 60 teeth of the worm wheel would *appear* to be 0.180 in. This contention has been put to me by several people who consider that pitch errors of even a few tenths of a thou would be fatal to accurate indexing.

The fact is, however, that discrepancies of this nature do not produce cumulative errors, nor necessarily any errors at all. The apparent paradox is quite easily explained when one considers that the " pitch circle " of a gearwheel is, like the equator, an *imaginary* line. When a single-start worm with a small pitch error meshes with the teeth of a wheel, it automatically finds its own pitch circle (assuming that mesh adjustment is possible) and can only advance the gear wheel exactly one tooth per revolution. Errors of pitch that affect regular progression (i.e., " drunken " threads) are, however, a different matter, and should be avoided.

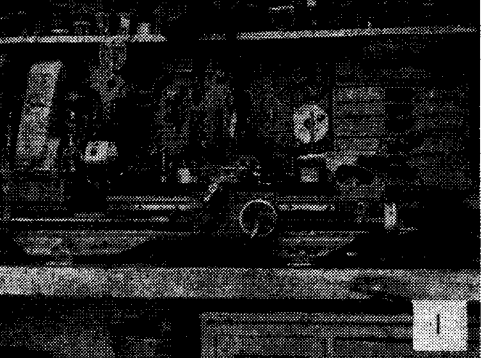
I hope I have made it clear that there are no formidable difficulties in producing indexing gear which will serve all practical purposes in the home workshop. The basic forms outlined here can be elaborated and improved as required. One addition which is well worth while, is the fitting of sectors to the division plate.



Using the Myford attachment to generate the division plates

These can be locked together at any angular spacing, while still capable of frictional rotation, to simplify and avoid errors in the counting of holes (Fig. 10). They are employed on all recognised types of machine-shop dividing heads.

Whether the attachments employed are simple or elaborate, there are few model engineers who would not find them invaluable on many occasions, provided that they operate on correct principles and are as accurately made as possible. ▣



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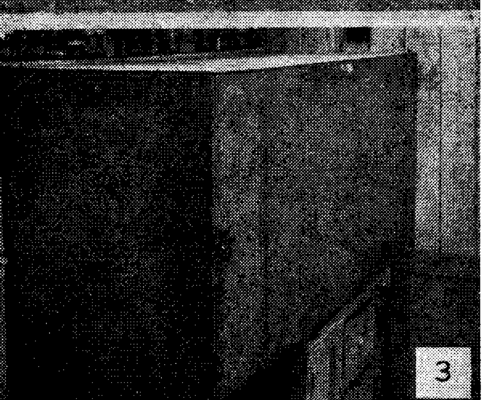

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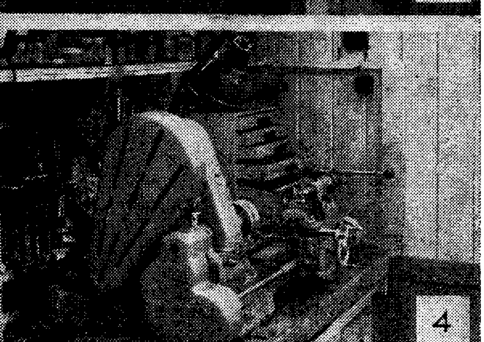

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5

A 'heating chamber' can keep rust at bay

Keeping a workshop warm need not be expensive as H. Milner found out when he devised this simple safeguard

Before being converted, my workshop had been a lean-to coldhouse. The front, top and one side are glass—a considerable amount indeed. The advantages are felt in summer when there is plenty of light for working and warmth for safety. In winter and all damp weather the advantages turn against me, and heavy condensation gives rise to the problem of rust.

To heat the whole building all the time was out of the question, and I eventually overcame the problem with a "heating chamber" as a device which concentrates the heating and the tools.

The first photograph shows how I engineered the scheme. The lathe was placed at one end of my long bench and the confined space around it houses all my tools, accessories, drills, mills, marking instruments and other instruments used in connection with lathe work. This makes (*a*) a smaller space to be heated and (*b*) easier working since I can put my hand on anything I require without having to move from the bench.

Being at the end of the bench and the end of the workshop too, the end wall and back wall combine with the bench-top to form three adequate sides of a "heating chamber." The front, top and remaining side of the box about to be described are made of hardboard on frames; fastened to the inside, the front piece has a 100 w. tubular heater, a thermostat, the necessary wiring and a plug which connects to the socket which is also on the inside of the enclosure.

Photograph No 2 shows a view of these three pieces of hardboard seen from the inside with the heating apparatus in position. The end fastens to a fillet on the back by a thumbscrew, the front bolts to the end of the workshop, and the top rests on both pieces and on a fillet at the back. All this makes an enclosure measuring 5 ft × 2 ft × 2 ft 3 in. It takes me 40 seconds to erect and 20 seconds to dismantle.

The enclosure in relation to the end and back of the workshop, and top of the bench is shown in the third photograph.

Taken from the same position, the fourth photograph gives a different view of the equipment and the last picture shows the workbench. This is a continuation of the lathe bench and the heating enclosure can just be seen on the right.

The thermostat is set for 65 deg. It has been in use for two years and has worked satisfactorily. There is no trace of rust on anything in the enclosure.

What does it cost to run? I installed a meter in the workshop as the power is from the domestic supply; and over the past two years the average cost is 8½d. a week. This figure includes all the light and power used in the workshop as well as the heating system outlined above as my anti-rust campaign. I have used 850 units at 1d. per unit: I consider this a practical and economical method of preserving the vulnerable tools we cherish against the ravages of our common enemy. ▣

POSTBAG

The Editor welcomes letters for these columns. A PM Book Voucher for 10s. 6d. will be paid for each picture printed. Letters may be condensed or edited

RAISING STEAM

SIR,—I was interested in the query by H.C.H. [ME November 6] on raising steam for model engines by using an immersion heater picking up current from a conductor rail. Surely the current needed would not be so high as that suggested in the reply?

Assuming that a boiler was fitted with an immersion heater taking 1,500 w., this represents nearly 2 h.p. of current and allowing an overall efficiency of only 50 per cent we should have 1 h.p. available at the wheels of the locomotive-enough to propel a well loaded 7¼ in. gauge miniature train!

I should be inclined to view the query from a different angle: how many watts of heat does a spirit-lamp represent? And as an answer to this query, I should say, for a gauge 1 steam engine, about 100 at the most. Now a safe maximum voltage for a model railway would be 50 (with alternating current this voltage can just be felt with the hands) and the current needed for 100 watts load at 50 v. is only 2 amps.

Suppose we had a miniature low voltage *direct* current electric motor fitted in the tender of our steam locomotive, and a voltage relay to prevent its being fed with the 50 v. heating current. On disconnecting the heating current and applying direct current to the conductor rail the small direct current motor could be made to rotate forward or backward (permanent magnet type) according to the polarity given to the conductor rail. Therefore, by coupling the motor to the engine reversing gear, the engine could be reversed or notched-up from a fixed control panel. In fact the engine could be throttled and entirely controlled by the reversing motor. Steam condensing in the cylinders? Construct the thin walled type and give 'em a few turns of resistance wire fed with a few more watts to keep 'em hot!

As to using the system for full sized locomotives, although the conductor rail is capable of supplying up to 6,000 amps at 660 v., it would be hardly worth while converting full sized locomotives to immersion heating when an electric motor is so much more simple and multiple unit electric trains are so easily reversed at terminal stations.

St Leonards-on-Sea. MARTIN CLEEVE.

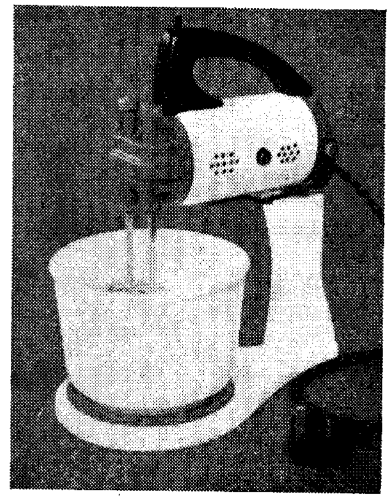
FOOD MIXER

SIR,—I am enclosing a photograph of a food mixer which was made as a Christmas present for my wife.

It was built from a motor supplied with geared twin drives and can be used on the stand or removed from the stand and used in the hand. This was necessary recently when a large amount had to be mixed for Christmas cakes.

I know that some readers frown on time being spent on making household gadgets and that they do not consider them suitable subjects for inclusion in your magazine. But as a reader of four or five years standing, I welcome them occasionally.

Halifax. V. L. KELLETT.



This food-mixer, made by Mr Kellett for his wife, came in useful for Christmas cooking

STEAM v. DIESEL

SIR,—While I still adhere to my views upon the function and scope of ME, I am concerned even more that information given to your readers should be correct; and it is for this reason that I wish to reply to LBSC's latest collection of mis-information on the subject of diesel traction on railways.

The capital cost of a diesel-electric locomotive compared with a steam locomotive of equivalent horse-power is three and not four times. Exaggeration only weakens a poor case and the misuse of quotation marks is merely a form of cheap sneer and does not alter unpalatable facts. Diesel locomotives work continuously without attention for long periods so that generally three steam locomotives are replaced by only two diesels.

Steam has, of course, been employed for 130 years and development has taken place throughout that time with such effect that we now have a modern steam locomotive attaining a thermal efficiency of 6 per cent. Diesel locomotives with electric torque conversion have an efficiency of 19 per cent. Hydraulic torque conversion lowers the capital cost materially and probably increases the thermal efficiency; but I have no authentic quantitive information on this matter and in its absence I do not express opinions.

LBSC states that the diesel locomotive has done nothing that steam could not do cheaper. Shunting duties in marshalling yards have been carried out by diesels for many years and when shunting is continuous the locomotives work round the clock and visit the parent depot for only a few hours each week. No firemen, steam raisers, coal men, ash men or boiler washers are required. The same remarks apply to the multiple unit trains, and consequently it is not surprising to learn that in respect of these two types of traffic, total motive power costs vary between 50 per cent and 65 per cent of steam costs for equivalent services.

Main line operation is not yet on a large scale, but one or two facts have already emerged. It is here that the availability of diesels will be seen to great effect. A year or two ago the "Southern" experimental diesel-electric locomotive worked two return trips per day between Waterloo and Exeter six days a week, for many months—4,300 miles per week. Where is the steam locomotive that can equal this?

What steam locomotive can produce a starting tractive effort of 54,000 lb. for a total weight of 117 tons to equal that of the North British diesel-hydraulic 600 type?

Trains have recently been worked from Paddington to Plymouth by diesel-hydraulic locomotive at high speeds without assistance west of

Newton Abbot and within a short time of arriving at North Road, the locomotive is able to repeat the operation in the reverse direction. The cost of fuel on this service is less that 10½d. per mile for the diesel and not less than 1s. 8d. per mile for the steam locomotive.

LBSC's electrician is completely off the mark. The limiting factor in regard to electrification is not the cost of generating electrical energy, but the high cost of the fixed equipment necessary to conduct the energy from the power station to the trains. If electrical energy cost nothing, it would not result in a great increase in the mileage of lines over which electrical operation would be economical.

There are several other factors affecting the eclipse of steam, but I have some regard for your space. If, however, LBSC wishes to add to his post-script, may I ask him to call things by their proper names. There must be many readers who, like myself, object to pidgin English.

Christow, Devon. A. H. MATSON.

SIR,—The correspondence on railway diesels suggests a widespread belief that considerations other than purely technical were involved in the decision.

I feel sure it would interest readers who live in Great Britain—and in other coal producing countries too—if American and Canadian readers would give their views as to what the attitude of their administrations to railroad "dieselisation" would be if the necessary oil had to be imported from some thousands of miles overseas—(as, of course, ours has to be).

Penrith. H. A. ILLINGWORTH.

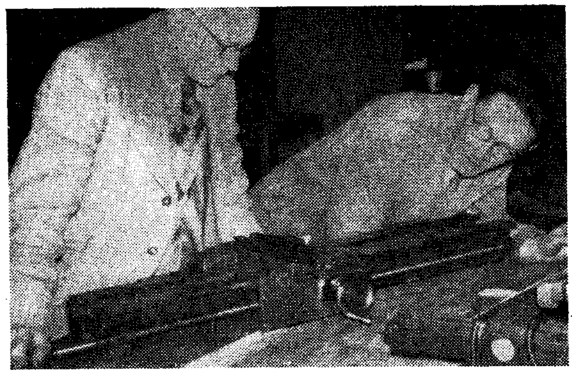
LBSC's LOCOS

SIR,—May I, as a newcomer to model engineering, second the suggestion made by METHANIDES and published by Vulcan [ME, November 27].

I, too, think that printing the instructions for LBSC's locomotives in pamphlet form—preferably with a wide margin and possibly perforated for loose-leaf binding—would be better than a full book that would cost pounds.

The economics of modelling must weigh quite a bit with most beginners, particularly the younger ones, and even LBSC himself hasn't built them all.

Solihull. F. A. REYNOLDS.



Keighley Technical College has a class in model engineering, described below in a letter from Mr Maude of Skipton. Left: Examining a lathe. Right: Workshop

MODELLERS' CLASS

SIR,—The enclosed photographs were taken in the engineering workshops of the Keighley Technical College, which is running a class for model engineers. Anything can be made in metal, but no woodwork is allowed. Engines, tools, machines and even hedge and lawn trimmers have been made there in the last few years. My shaper was also largely made there at a cost of £12 10s. including the motor.

The pictures show the instructor, Mr G. Bass, examining a 5 in. lathe being made by Mr L. Berry. It also gives a view of one half of the workshops, with an ML7 lathe in the foreground. Also to be seen are a 12 in. shaper, surface grinder, Mitchel 8 in. centre lathe and Dean Smith and Grace 8 in. centre lathe, bench drills, radial drill, tool grinders, two vertical millers, and two horizontal millers.

At the time of writing I am employed on building a locomotive-type boiler for a traction engine, the Marshall 7 n.h.p. general purpose engine described by Mr Hughes in MODEL ENGINEER.

It occurred to me some time ago, that it would be a good idea if other education authorities followed suit. There is no doubt about model engineering being educational and a great help to people who have no tools or machinery at home. It is also a great help to people like myself who want to add to their workshop and get the experience of making and using machine tools under first-class supervision.

Skipton. C. MAUDE.

YACHT BUILDER

SIR,—I should be grateful if you would correct an error as to the builder of the motor yacht at the top of page 612 of ME for November 13. This was stated to have been built by myself, whereas I was only responsible for the present "internals."

The craft itself was the work of the late Mr A. T. Trotter of Alsager, Staffs, and I believe it gained an award at a Model Engineer Exhibition a few years ago.

Stoke-on-Trent. F. G. BUCK.

BAKER UNIFLOW ENGINE

SIR,—Can you assist me to obtain the necessary measurements and other details to model the Baker special uniflow engine 23-90 h.p. *circa* 1927. I would like to model it in a showman's version if the engine was made as such. As an agricultural engine she is quite attractive. But as a showman's engine I think she would be a beauty, to say nothing of being unusual.

Grimsby. A. PIKE.

OPEN-DECK TRAMS

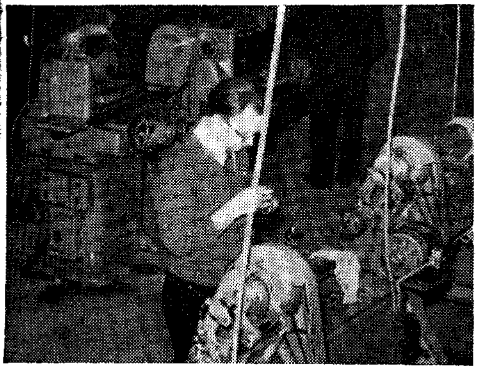
SIR,—I am afraid Vulcan is a little out in his dating of the photograph of the trams in Priory Road, Hornsey (Smoke Rings, November 20]. The left-hand car (No 169) is of type D. These cars were open-top four-wheelers, built by the Brush Electrical Engineering Co., of Loughborough, and at a much later date were fitted with plough carriers for operation over the LCC system.

The other car, No 106, is one of the 60 cars of type A which were placed in service at the opening of the first MET routes in 1904. They were originally open top bogie cars, and most of them survived to be fitted with covered tops in 1927 and lasted in their rebuilt state until 1936 or 1937. No 106 was, however, withdrawn from service prior to 1927 and was never fitted with a top cover.

I am particularly interested to see this photograph, as this is the first evidence that I have obtained of the operation of type D cars on the eastern side of the system prior to 1918.

London N20. TONY A. GIBBS.

SIR,—Vulcan's paragraph about trams has set a problem, as the



western section of the MET was isolated from the northern area and it had always been thought that the type D four-wheel cars had been on the western section until they were retracked for working into central London on the LCC conduit system about 1920. I have never seen this picture before though I have nearly 200 photographs of the MET.
Harlesden, NW10. V. WHITBREAD.

WATER WHEELS

SIR,—Can anyone supply me with a publication dealing with the construction of waterwheels, either relating to models or full scale building ?
Dunfermline. J. G. YOUNG.

BORING CUTTER

Continued from page 798

If the original direction of d be above centre, as in Fig. 5, increase the packing thickness—if below centre reduce the packing thickness the calculated amount.

5. Change in C due to top or face grinding an amount s equally from both ends of the cutter.

$C = 1.500$ $t = \frac{3}{16}$ in. $s = 0.010$ change in $C = 0.005$.

Refer to table 3, $C/t = 1.500/0.1875 = 8$.

Constant in table 3 for $C/t = 8 = 0.50$.

Hence approximate change in $C = 0.50s = 0.005$.

The above gives a fair notion of the peculiarities of floating cutters and their habits. Size produced by them is not very sensitive to their centring on the axis of the hole being bored, provided they be symmetrical. Asymmetry of leading chamfers is not good, leading to oversize holes including an internal ridge at the end of the hole. Without becoming too involved, we have been able to express some of the phenomena numerically. ■

TITFIELD THUNDERBOLT

SIR,—A group of boys here are building a 5 in. gauge *Titfield Thunderbolt*. It would help us greatly if we could contact another *Titfield Thunderbolt* builder, preferably fairly near to us; one who has either completed one or nearly so.

This would enable our boys to have some idea of what the finished job will look like.
Ackworth School, nr. Pontefract, Yorkshire. K. ROSEWARNE. (Senior Craft Master)

CRAFTSMANSHIP

SIR,—Mr D. W. E. Kyle [Postbag, November 13] appears to be annoyed because I mentioned an opinion that model engineers show a skill comparable with skilled engineers working at the trade, and says I am wrong. Well, I have worked as long, if not longer, at the tools as he. To a qualified, unbiased person the quality of the exhibits reveals a very high degree of skill; particularly so when it is remembered that much of the work (which in the case of the full sized article is done by another tradesman, perhaps on a special machine) has to be done by hand, or by interrupting work on a model to make an attachment for the lathe

I did not say that the LGOC were responsible for the bad workmanship; I said it was one of the first to lower the standard of engineering. The *B* type chassis was produced by its subsidiary, the Associated Equipment Co. Ltd, at Blackhorse Road, Walthamstow, and Mr Frank Pick was responsible for the design.

In an article in *Motor Transport* dealing with production of the new model Mr Pick said that machining and fitting limits were more " flexible " (I believe that is the word he used) in order to facilitate maintenance, and on some components up to 0.005 in. was allowed.

As these vehicles were produced entirely for their own use and not for resale, there could be no complaints at the slackening of engineering standards, except from the workers who were expected to produce more for a day's work.

I cannot agree with Mr Kyle that the motor manufacturers almost brought ruin to the LGOC. The fact was that the directors aimed at a monopoly and absorbed other concerns, notably the Vanguard, Great Eastern, Union Jack (London Road Car Co.) and some smaller ones, and obtained operating agreements with others.

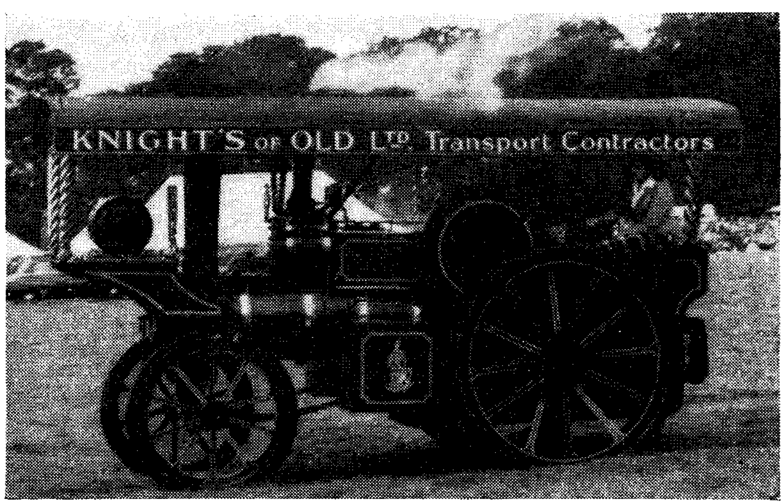
The LGOC had such a miscellaneous collection of vehicles (of which, said Mr Pick, " the De Dion Bouton, despite its multiplicity of parts was the most reliable "), that economical operation was almost impossible, and followed the lead given by Tillings (petrol-electric) and National (steamers), with their own design.

May I end by wishing model engineers everywhere the compliments of the season ?
London, E12. WM. J. TURNER.

PURCHASE TAX

SIR,—That purchase tax is levied upon sets of castings and other unfabricated model components, when it is not levied on unassembled kits in other commodities, is just one more bureaucratic absurdity.

The derived revenue must be piffling; the obstruction to national skilled potential, serious; but it is



Foster showman's 4 *n.h.p. tractor No* 14066 *built in* 1916 useless to expect either politicians or civil servants to help us, because of all classes they are undoubtedly the most creatively inept.

However, either within our fraternity or in sympathy with it, there are certain very eminent gentlemen who could and would plead our cause in high places, if we so implored.

Also we could muster a large petition if we got together, and democracy is without value if we fail to use its facilities of collective representation.

Bedford. J. D. BROWNSON.

ROAD ROLLER

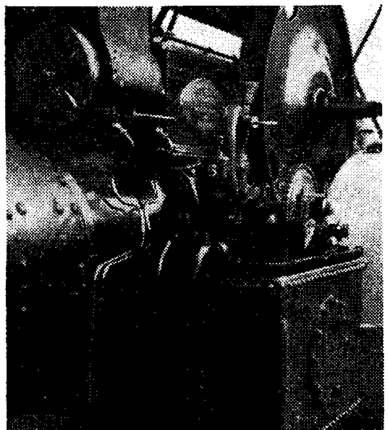
SIR,—These photographs of a Fowler road roller with a compound engine were taken in Reading and I have tried to include as much detail as possible. I understand this engine is 32 years old and has been in the hands of the one driver nearly all the time. It is in fine condition with no leaky glands and all paintwork and piping bright and shiny.

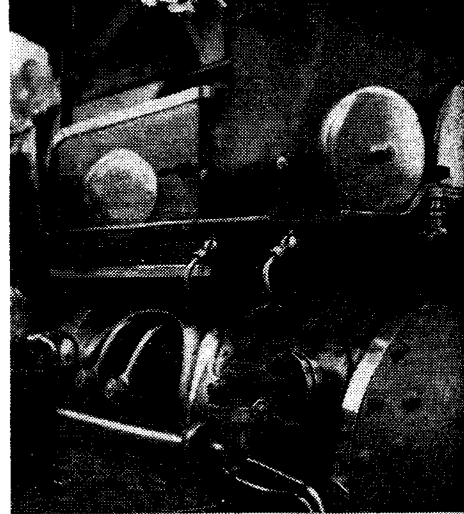
The sizes of the cylinders are 5 in. h.p. and 9 in. l.p. but I cannot give the length of stroke. I expect some readers of ME may be interested in these engines. I have enough with a 3½ in. gauge *Netta* at present.

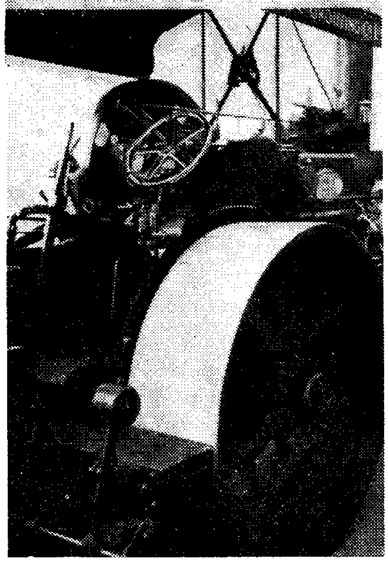
Do you know of anyone who could supply photographs of a North Eastern T class 0-8-0 as I would like to have a few more external details ?

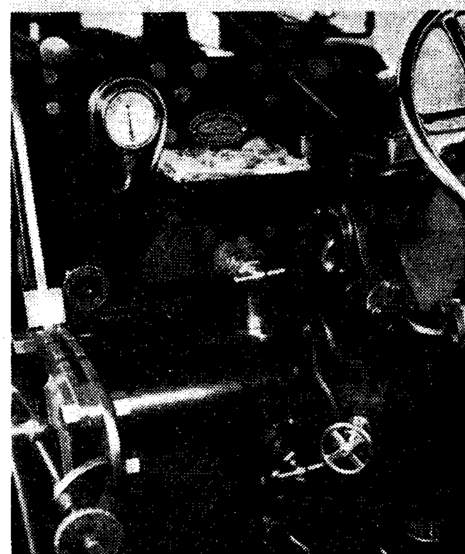
Bovey Tracey. D. R. LUMMIS.

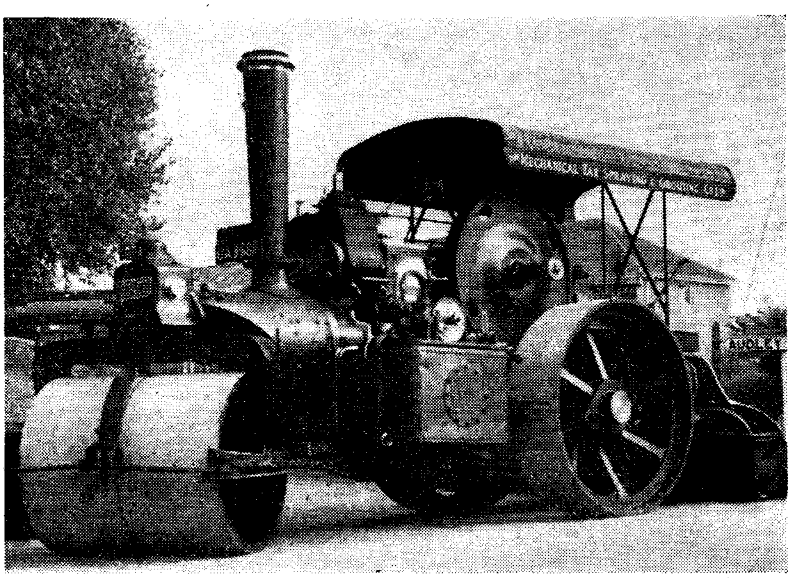
* *If any reader can help, we will forward letters.*—EDITOR.

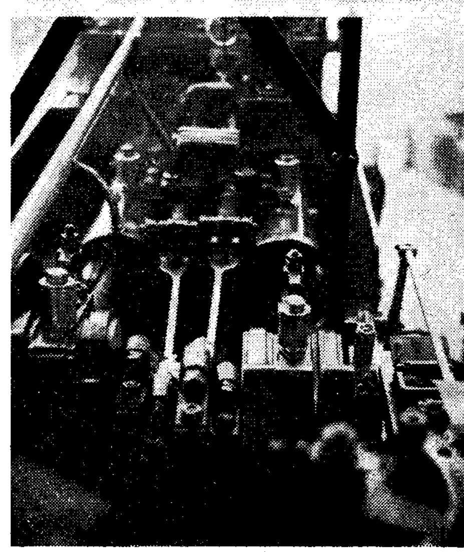












This free advice service is open to all readers. Queries must be of a practical nature on subjects within the scope of this journal. The replies published are extracts from fuller replies sent through the post: queries must not be sent with any other communications: valuations of models, or advice on selling, cannot be given: stamped addressed envelope with each query. Mark envelope clearly "Query," Model Engineer, 19-20 Noel Street, London, W.1.

READERS' QUERIES

DO NOT FORGET THE QUERY COUPON ON THE LAST PAGE OF THIS ISSUE

Boiler working pressure

I am constructing an 0-4-4T locomotive (LO.58) and I should be grateful if you could tell me the recommended boiler working pressure? I am considering fitting a small axle-driven feed water pump. Bearing in mind that the boiler is only spirit-fired, do you think the steaming rate will be very much affected by the fitting of such a pump?—D.T.L., Stroud.

▲ *A suitable boiler working pressure for the* 0-4-4T *locomotive (LO.*58) *would be* 70 *p.s.i.*

A small axle-driven feed pump would be a great improvement, but to ensure that the supply of water is not too great for the spirit-fired boiler, we would advise fitting a bypass pipe, with adjusting valve, returning any excess water to the sidetanks or bunkers.

We would suggest that the pump be 7/32 *in. bore* × $\frac{5}{16}$ *in. stroke, and pipes* 5/32 *in. outside diameter and thin walled.*

There is ample room for the eccentric between the crank and the valve gear eccentric. Alternatively, a crosshead pump of about $\frac{1}{8}$ *in. bore could be used.*

Diesel-electric

Having built a 3½ in. gauge Shay geared locomotive I am toying with the idea of constructing a 5 in. or 3½ in. gauge diesel-electric, but just don't know where to start as my knowledge of electricity is nil.

I visualise having a four-cylinder petrol engine direct coupled to a d.c. dynamo to provide current for two motors mounted on four-wheel bogies, complete with the necessary control gear.

If built to 1 in. scale, I imagine that the chassis would be about 9 in. wide and 3 ft 6 in. long. The wheelbase of each bogie would be about 9 in. and the bogies about 30 in. between centres.

I imagine I should require an engine giving 1 b.h.p. coupled to a dynamo with an output of 30 v. and 20 amps and two ¼ h.p. motors running on 24 v.

Can you help me to evolve such a scheme?—E.C., Hitchin.

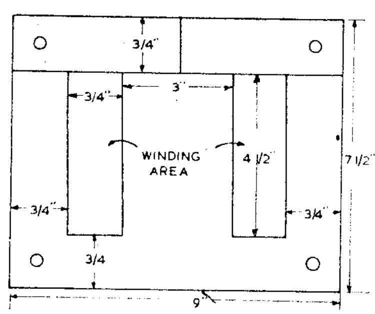
▲ *We have always been very keen on the possibilities of locomotives driven by internal combustion engines, and as far back as* 1941 *a design for a* 3½ *in. gauge* 0-6-0 *locomotive driven by a* 30 *c.c. o.h.v. twin petrol engine was published in ME. This had a friction drive transmission and produced very satisfactory results, but it has never been very popular, though the engine has been built by a good many readers and put into large size power boats.*

While it is by no means impracticable to use either electric or hydraulic transmission, the disadvantage is that in both cases the conversion losses are relatively high. Mechanical transmission makes better use of the available power.

There have been several petrol driven locomotives made in 3½ *in. and* 5 *in. gauge, which have performed very successfully, though they have been generally what would be described as a "lash-up," built entirely for utility.*

Transformer winding

I would appreciate information on winding a transformer, the core section of which will measure 5¼ in. × 3 in. as in the enclosed sketch. The input voltage will be 240 at 50 cycles. I would like a secondary output of 75 v. for light welding.



Can you please tell me the number of turns and gauges for both windings and the maximum rating when used, air cooled, as a welding transformer? (Control of output by tapped primary seems easiest.) Is any other ancillary control gear needed for limiting current as when striking an arc to start welding?—W.C.W., Jersey, C.I.

▲ *Transformers used for welding function in a manner different from an ordinary transformer. They require what is known as a "drooping characteristic." This is obtained by the arrangement of the coils on the core. Instead of winding both coils on the centre limb, the coils are wound one on each limb, leaving the centre without any winding. This arrangement will give the necessary magnetic leakage required. Welding voltages lie between* 80 *and* 100 *v. These values enable the arc to be struck and maintained. Afterwards the transformer automatically adjusts the voltage for easy handling.*

A winding to suit your transformer could be as follows: the primary will need 120 *turns of* 8 *or* 10 *s.w.g. double cotton covered copper wire. The secondary will need* 80 *turns of* 4 *s.w.g. A tap should be brought out at* 64 *turns. As the secondary gauge size may be difficult to handle, a number of smaller wires may be wound on in parallel, but of the same cross-section as the size given. If a parallel winding is carried out, there must be the same number of reels as wires used: sections must not be wound over each other.*

A regulating choke coil that will match with this transformer can be made from a stack of laminations, measuring 5 *in.* × 5 *in. and* 1 *ft* 6 *in. long. This assembly is riveted together along its length, and a form of handle should be provided at one end. A clamping device is necessary to hold the core in place after an adjustment has been made. The bobbin is best made in metal and it should be slit through its length or it will act as a short-circuited turn. The winding for this choke can be to* 150 *turns of the same size wire as used for the secondary. Taps should be brought out at* 60 *and* 90 *turns, this arrangement will give a wide range of regulation.*

The transformer should be assembled in a stout metal casing, with free ventilation. Air cooling can be used for long periods. The better way is to arrange for the transformer to be in an oil-filled tank. This should be of ample area, and only transformer oil must be used. If the transformer is oil-cooled, the windings will not need to be varnished. In the ordinary way, the windings should be varnished as winding proceeds, and finally baked out. Any type of armature varnish can be used, but shellac must not be used as a varnish.