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CONTENTS

COVER PICTURE

Aveling & Porter 6 n.h.p. traction engine of 1903 now owned by Mr C. J. Lee of Sandy Bay Holiday Park Devon Ltd., Exmouth. The driver seen is Mr Gordon Wenn, who carried out most of the restoration work on the engine. Colour photograph by Adrian C. Muttitt.

NEXT ISSUE

A ⅜ in. scale model traction engine: Workshop hints and tips.

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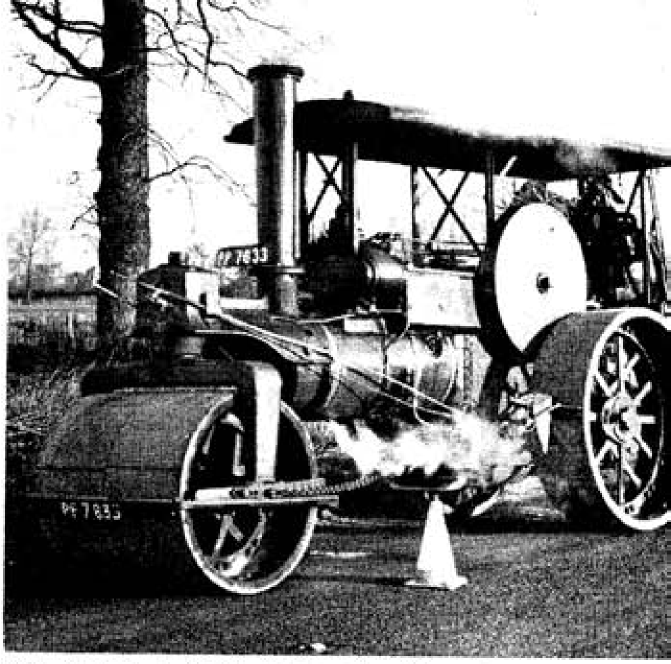
The Editor is pleased to consider contributions for publication in *Model Engineer*. Manuscripts should be accompanied if possible by illustrations and should also have a stamped addressed envelope for their return if unsuitable.

SMOKE RINGS

A commentary by the Editor



This Aveling & Porter steam roller, No. 11804, is believed to be the only one now working in Buckinghamshire. It is owned by the Bucks County Council. Photograph by Mr J. Cousins.

Exhibition afterthoughts

I am often asked whether enthusiasts who visit the Model Engineer Exhibition and see models of such exceptionally fine workmanship and beautiful finish are not discouraged, realising perhaps that they themselves will never be capable of similar work. It is true that this thought has sometimes occurred to me, and perhaps there are readers who become "afflicted" in this way. However, I think that most model engineers react the opposite way—they go home resolving to do better next time!

There is no truer saying than that we never know what we can do until we have tried, and this applies in full force to model engineering. I know that when I take a look at a model, or part of a model, that I made years ago, I am surprised to see how badly it compares with my present day work, though I hasten to add that even today, my work falls far below some of that seen at the M.E. Exhibition.

As a class, model engineers are not jealous people, they can always give genuine admiration and praise to the work of others more gifted than themselves. The M.E. Exhibition has been criticised at times for introducing the competitive element; but I see no harm in this, so long as no feelings of jealousy are aroused. Perhaps model engineers are like musicians in this respect. I am reminded of some remarks by the great composer Wagner; on hearing one of Liszt's later sonatas, he wrote to the distinguished Hungarian composer and pianist "your latest work I find beyond all conception beautiful; great, lovely, deep and noble—sublime, even as yourself!"

Model engineers may not use such lofty language, but when looking at the work of Bradbury-Winter, Barker, Carter, Hinds and others, perhaps their feelings are not so very different.

Model boiler designs

Turning to a less pleasant subject, I was surprised to read the following passage in the latest number of the Journal of the Steam Locomotive Society of Victoria (Australia): "Experience has disclosed some very obvious weaknesses in published designs which would have been patently obvious if the designer had attempted to construct to his own design."

The writer of this paragraph, a Mr Bill Stokes, was referring to model locomotive boilers, and I think that most readers will take his remarks as being directed to boiler designs which have been published in *Model Engineer*.

The great majority of model locomotive boiler designs which have been published in *Model Engineer* over the past 30 years or so have been by the late LBSC, the late J. N. Maskelyne, the late C. M. Keiller, Mr Austen-Walton, Mr C. R. S. Simpson and myself. I think that I am correct in saying that in nearly all these cases, the designers have built the boilers before publishing the design.

While *every* boiler described may not have been built personally by the designer concerned, whenever any new feature has been introduced, the designer has always tried it out before drawings were prepared. In the case of the late J. N. Maskelyne, it is possible that he did not build any of his own designs of boiler, but they were in all cases built by a highly competent boiler-maker before being offered to the general reader.

It is of course possible, indeed probable, that many of our M.E. boiler designs can be improved, either in the direction of greater safety, or in ease of building. Speaking for myself, I have always welcomed *constructive* criticisms of my own boiler

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Realism
in
model steam plants

by Edgar T. Westbury

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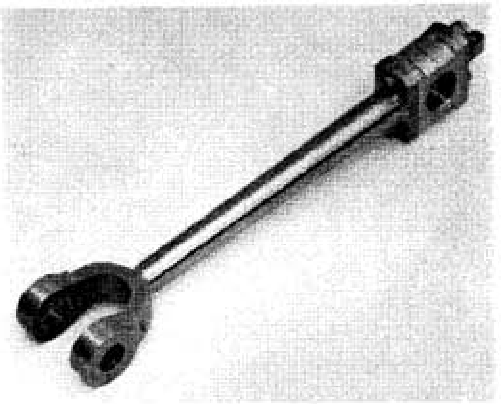


A connecting rod for the " Unicorn " engine.

SPLIT CRANKHEAD brasses may be made from castings, if the detail accuracy of them can be assured, but it is often more satisfactory to make them from rectangular pieces of bronze or gunmetal, bolted or sweated together temporarily for machining. They are sometimes left square on the end faces, or partly rounded by filing, but it is better to machine them over these faces, not only to improve accuracy, but also to reduce weight to some extent. The pair of brasses shown in the sketch page 327 is easy to machine and its shape is generally tolerated; but in full-size practice, it is common to reduce weight as much as possible, not only to simplify balancing, but also to minimise the amount of relatively expensive metal necessary. Though the pair of brasses on the right are a little more difficult to make from the solid, they can be fabricated by first machining as before, then opening out the bolt holes, filing away at the sides, and then brazing in short tubes or bushes. For these operations, it is best to make the pair in one piece, with allowance for splitting, and carry out final boring after separating them.

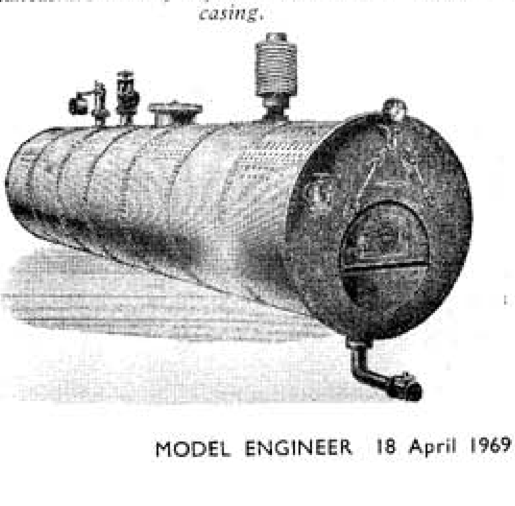
Brasses are often made wider than necessary; the bolts should only be sufficiently widely spaced to clear the bearing. In full-size, it is common to reduce or " waist " the bolts in the middle, and to make the heads small and circular so that they can be fitted as closely as possible to the sides of the rod. All such details may be considered tedious and troublesome, but they make all the difference between models which just pass muster, and those which are convincingly authentic and true to prototype.

Many non-working models of boilers, some of them part-sectioned to show internal construction, have been built for display in trade exhibitions and industrial museums. But very few of the working model boilers built by amateurs have any pretensions to scale accuracy, and the only important consideration in the majority of cases is to make them perform their function as steam generators more or less efficiently. There is no reason, however, why this should not be combined with general fidelity to well-established types of boiler used in full-size practice, and there are indications that many constructors of model steam plants would find it worth while to study this aspect of design. Several queries have been received on how to equip prototype stationary or marine engines with appropriate " period " boilers, capable of functioning at least well enough to run the engines for demonstration purposes. Though compressed air serves effectively, and is sometimes the only permissible means of displaying engines in motion, there is obviously an enhanced attraction in the facility to run them under live steam when required.

Cylindrical boilers

A wide variety of boilers have been used for full size steam plants, but in general practice, a few well-known types have been predominant. Apart from the very early boilers used to produce steam at very low or even sub-atmospheric pressure, such as the externally fired " cauldron," or the " haystack " with

A Lancashire boiler, before installation in brickwork casing.



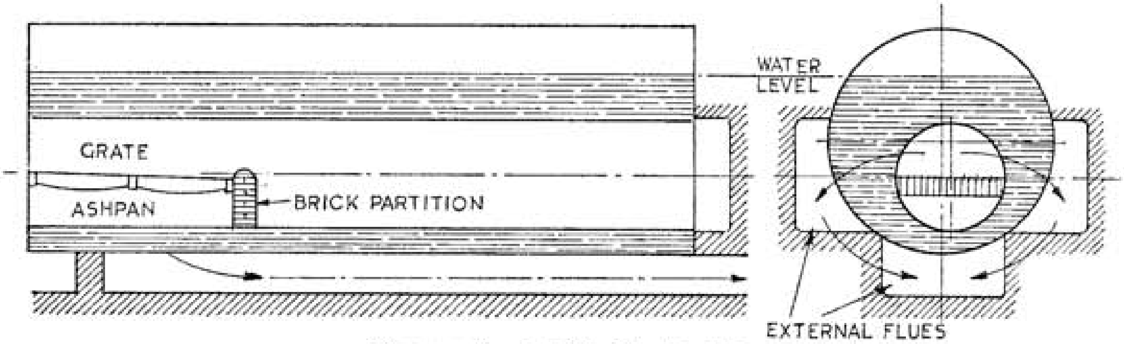


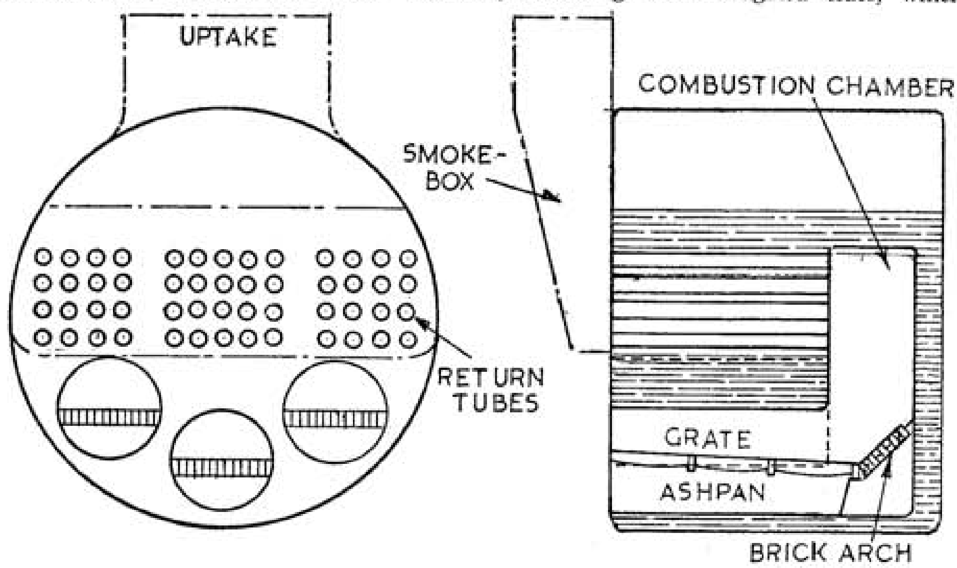
Diagram of a single-flue Cornish boiler.

internal furnace, boilers were mostly of the cylindrical type with internal flues, with or without the addition of banks of fire tubes. At a later date, when the demand for greater steam power and efficiency became urgent, the water-tube boiler, in various forms, established its superiority, though it did not completely supersede the older types for moderate duties.

The best known examples of cylindrical boilers are the Cornish and Lancashire types, which are similar in basic design, but vary in minor details. As originally constructed at the beginning of the 19th century, the Cornish boiler had a single internal flue, the front end of which was fitted with a fire grate, and the remaining length formed a combustion chamber. Up to the height of the water level, or nearly so, the shell of the boiler was encased in a firebrick structure, with channels at the bottom and sides. After passing through the main flue, the combustion gases were directed through the side passages in the casing, which traversed the full length of the shell, and then through the underside channel, and into the base of the chimney or uptake flue. In this way the diminishing heat of the gases was used to the best possible effect, so that they were finally discharged at the lowest practicable temperature.

In the single-flue Cornish boiler, it was usual to offset the flue slightly to one side of the centre line, with the aim of improving the rather poor water circulation inherent in this type. The length of the shell was not more than about three times its diameter; sometimes it had two or more furnace flues, and occasionally these were fitted with cross water tubes. But the increased demand for steam power in cotton mills led to the development of the Lancashire boiler, which was larger in diameter, and greater in proportionate length. Some of these boilers were 9 ft. dia. × 30 ft. long, and worked at pressures of 120 to 160 p.s.i. Galloways of Manchester were the best-known manufacturers of these boilers, from the middle of the 19th century and are credited with the introduction of several features, including the corrugated flues, which

Diagram of Scotch return-tube marine boiler.



increased their heating surface and provided elasticity to cope with differential expansion; also the tapered cross tubes, in the form of flange-ended forgings which were fitted across the main flues (or combustion chambers adjacent to them) in a vertical or oblique position. They also patented the "high pressure-low water" safety valve, which became a standard fitting on nearly all cylindrical boilers.

The fittings on both Cornish and Lancashire boilers included one or more safety valves of the dead-weight and lever type respectively, a stop valve, a non-return feed check valve, two gauge glasses, a pressure gauge and a blow-down valve. At the front of the furnace, a hinged fire door with a ventilating shutter, and a flap, which could be adjusted to control the entry of air to the underside of the grate, were usually provided. In Lancashire boilers of the two furnace type, the flue gases were directed through the underside external flue, and then through the side flues, before passing into the uptake, as this was found to give a better distribution of temperature. Both Cornish and Lancashire boilers looked much the same when installed, as the only parts visible were the front end and less than one-fourth of the circumference along the top of the shell.

Scotch Marine boiler

In the application of steam to marine engines, the restricted space available aboard ships made it necessary to develop more compact boilers. Apart from the early low-pressure "tank" boilers, which were often tailored to fit the holds, the most successful type was the Scotch return-tube boiler, which held its own for over 50 years and is not completely obsolete for merchant ships even at the present day. In common with the types already described, it was cylindrical with internal furnaces, but considerably shorter, and was provided with a vertical combustion chamber, from which the combustion gases passed through banks of fire tubes, back to the front end, and into a sheet steel smokebox leading to the uptake. The diagram shows the general scheme of this type of boiler, whose design varied widely in detail, however, as it was built by several firms (mostly on the Clyde and in the North-east of England) all of which introduced their own features.

While most Scotch boilers had the combustion chamber completely enclosed in the water space, a few of the smaller ones, known as "dry backs," had the chamber open at the back, and blanked off by a firebrick wall. Others were of the double-ended type, with furnaces at each end and combustion chambers in the centre. Three furnaces were usually provided, and sometimes four; I have heard of boilers with five furnaces, but they must have presented stoking problems, owing to the height of the outer furnaces. No external flues were provided for these boilers, and they were not enclosed in brickwork, but supported on girder underframes bolted to the floor of the hold.

Davy-Paxman boilers

A boiler which had much in common with the Scotch type, though mainly built for land use, was the Davey-Paxman "Economic" type. In its original form, this was not provided with a combustion chamber, but the back and sides were enclosed in a brickwork casing, which served the same purpose. Return tubes were fitted to convey the flue gases to a smokebox at the front end, and thence to external side flues in the casing before passing to the uptake. In many of these boilers, feed water heaters were fitted in the smokebox, and sometimes superheaters, either in the same place or at the dry back. These boilers are still manufactured, but, unfortunately, not to drive steam engines; their use is mostly confined to producing heating or process steam in factories.

Towards the end of the 19th century, the need for still greater steam power in both land and marine installations became so urgent that the limitations of cylindrical fire-tube boilers were a bar to progress. These boilers were inherently unsuitable for plants of improved power-weight ratio, as they were difficult to build strong enough to stand increased steam pressure, and if "forced" to generate steam more rapidly by intense firing and forced draught, they were liable to serious priming, or failure to segregate the water from the steam. This led to the development of water-tube boilers, in which tubular constructions could be more effectively employed, nearly all the structure of the boiler being useful heating surface; less metal was required to withstand high pressure, and circulation of water and steam was organised to avoid ebullition at rapid rates of steam generation. These virtues had been demonstrated by pioneers such as Perkins and Goldsworthy Gurney in the early days, but had not been followed up in general steam engine practice to any substantial extent until much later.

Yarrow boiler

Water-tube boilers found their first important application in naval vessels, in the last decade of the century, when the need for fast, light craft became imperative. In the Royal Navy, comparative tests of various boilers under seagoing conditions were carried out, and produced convincing results. According to available records, the water-tube boilers employed were of French Belleville design, and though they suffered from leakage of the tube elements, not to mention other teething troubles,

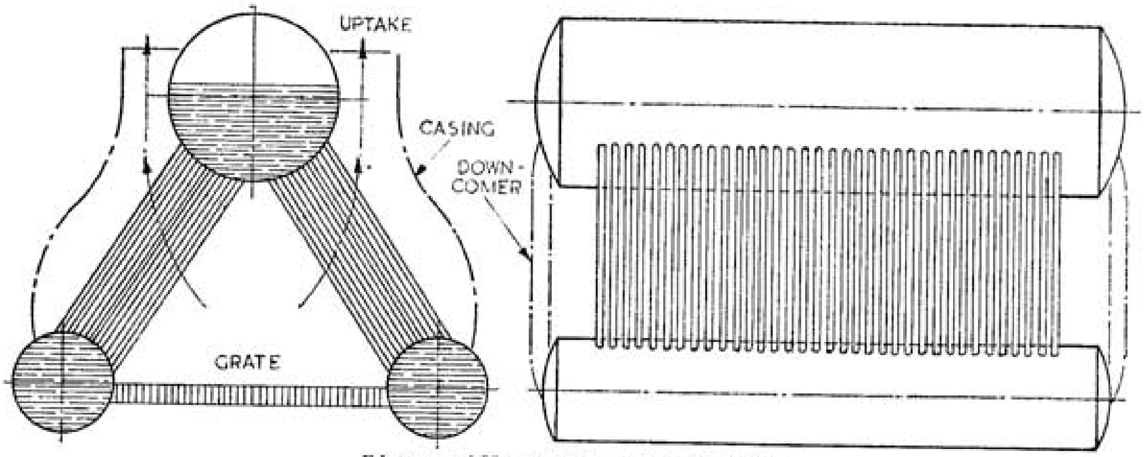


Diagram of Yarrow type water-tube boiler.

they established beyond all doubt the superiority of water tubes for rapid steam raising and overall performance. In the battle cruisers and destroyers of the early 20th century, two types of water-tube boiler became firmly established. The first of these was the Yarrow boiler, in which the salient features were the three cylindrical drums, connected by banks of straight tubes in the configuration of a capital A. Though the upper and larger of the drums contained water up to a certain level, it was generally defined as the steam drum; the two smaller drums were intended to contain water only, but as they tended to collect a certain amount of scale and sludge in the course of working, they were often referred to as mud drums. They were not always of circular section, as some flattening of the upper sides made it easier to fit the tubes.

The water circulation in the Yarrow boiler was

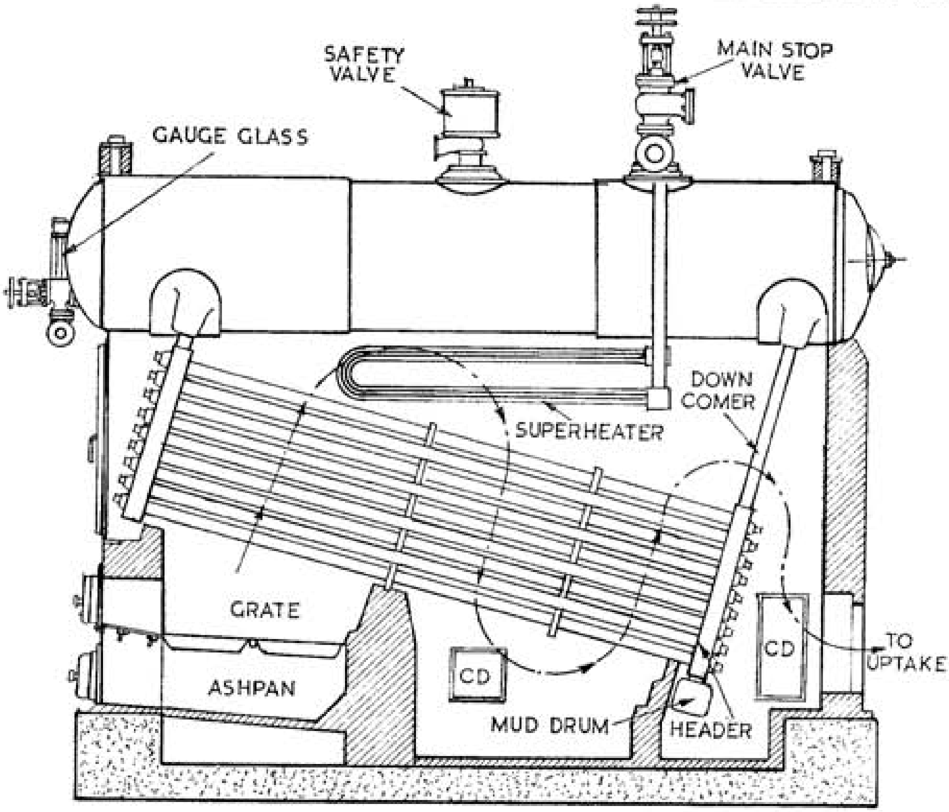


Diagram of land type Babcock and Wilcox water-tube boiler, circa 1900.

very good, and in its original form, it was considered sufficient to rely on difference of temperature between the hotter and cooler zones of the combustion chamber to maintain convection flow; the water rose in the hottest tubes and descended in those which were somewhat cooler. This action was sometimes assisted by fitting baffles in the combustion space to direct the flow of combustion gases. But it was found better to fit downcomers to the ends of the drums, in the form of large pipes, external to the actual furnace space. These are indicated in the diagram by broken lines. Baffles were fitted inside the steam drum in many cases, together with perforated internal steam pipes leading to the main stop valve, to reduce the risk of water passing over with the steam. The grate area of such boilers was very large compared to that of internal furnaces, providing for a rapid rate of combustion, usually assisted by forced draught on the "closed stokehold" system. A continuous flat grate with four fire doors was provided. Sheet metal casings, protected in the hot zones by refractory linings, led the combustion gases to the uptake. When superheaters were fitted, they were located, flanking the tube banks, on one or both sides, and the contour of the casing was adjusted to accommodate them.

Babcock and Wilcox boiler

The other famous water tube boiler was the Babcock and Wilcox type, originally developed for use in power stations and other land installations. An early and relatively small version of the design is shown in the drawing, in which the steam drum is disposed from front to back of the furnace. Later and larger designs had the drum at right angles to this position, enabling a large number of headers carrying banks of tubes to be accommodated along its length. The inclination of the tubes was also reversed, being lower at the fire door end, but the principle was the same in all cases. Because of the difference in level at the two ends of the tubes, uni-directional convection currents were set up by heating, so that the water rose to the drum at one end, and descended by way of down-comer tubes at the other. Baffle partitions across the tube banks directed the gases through them three times, as shown by the arrows, and also served to support the tubes against sagging.

In the wide grate forms of this boiler, four fire doors were provided, giving ample space for combustion. The outer structure of the boiler comprised four vertical steel columns at the corners, with cross girders and saddle brackets to locate the drum at both ends. Brick walls formed the two sides, and were provided with inspection or cleaning doors (C.D.), with large panels at the front to give access to the headers. These were provided with hand holes in line with each tube, to give facility for cleaning and these had individual closure plates with studs and gaskets. The rows of tubes were staggered so that each encountered the flow of combustion gases. It will be understood that the tubes in these diagrams are not drawn to scale, either in size or number, as they are intended only for explanatory purposes. In small scale working models, very small tubes are impracticable, as they may restrict circulation instead of promoting it. Babcock and Wilcox boilers employ longer tubes than most other water-tube boilers of comparable size; the multiplicity of joints, which have to be broken and remade for internal cleaning, however, is a disadvantage, compared to Yarrow boilers, which only need manholes in the main drums.

It may perhaps be thought superfluous to explain the inside details of boilers, since they are not visible under normal conditions, and in prototype models, it is the outside appearance with which constructors are mainly concerned. But to those who wish to build working model steam plants without departing from prototype design of all important parts, it is important to know something about their internal design and arrangement; there is no reason at all why they should be mere caricatures of the objects they are intended to represent. Realism, to my mind, should apply not only to appearance but also to function, wherever it is possible to make models work at all. Another reason for showing diagrams of the various boilers is that I have received many queries on the subject of boiler design. In most cases I have referred querists to Mr K. N. Harris's book *Model Boilers and Boiler Making*, which contains a wealth of practical information on this subject; my object here is to emphasise the importance of correct design in various forms of prototype boilers and their relation to periods of steam engine development.

Methods of firing

Admittedly, it is not always easy to make scale models of boilers work properly in the same manner as their prototypes. Many constructors of Cornish or Lancashire boilers would like to fire them with solid fuel, and some of them have tried to do so, but the results have not usually been very successful. In the first place, the size of internal flues in small boilers is not really adequate either for fitting grates of sufficient area, or for proper combustion space. The full-size boilers worked on natural draught, provided by convection air currents in very tall chimneys. Even if it were practicable to model these in true scale, the draught would only be in *scale* proportion to the height, which is not sufficient to maintain combustion in horizontal flues.

To be continued.

The New Model Engineer
TRACTION ENGINE

PART VIII

A one-inch scale model built and described by L. C. Mason

Continued from page 331

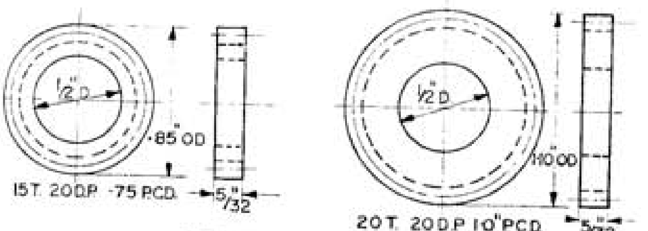
ALL THE GEARS coming on the crank and second shafts involve keys and keyways. All the keys are the same size—3/32 in. square, so we need a 3/32 in. slot drill or end mill and a keyway cutter 3/32 in. wide.

Making small end cutting slot drills has been described so many times that it would be unnecessary to detail the procedure here. If you have to make one up especially for this job, there are just a couple of points worth noting; turn the sized cutting end on the end of a stub of ¼ in. dia. silver steel, keeping the small diameter end as short as possible. This makes for a stiff cutter which will cut truer to size than one which can spring a bit. The other thing: when you make it, do the turning in the three-jaw and mark the No. 1 jaw position. The reason for this is that if your chuck doesn't turn dead true (and few do at all diameters!) by doing it this way you can always replace it in the three-jaw so that it runs true again.

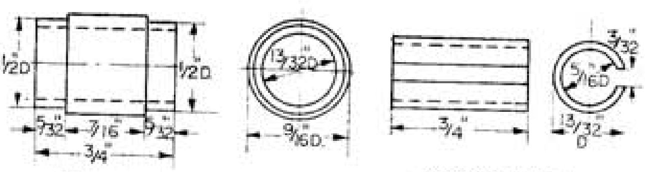
You can also get it to run true in the four-jaw. Should you get the blank to run dead true in the four-jaw in the first place, you will probably never be able to get it to run really true in the three-jaw, and it is much quicker to use it subsequently in the three-jaw than setting it up true in the four-jaw.

The keyways are planed through the bore while the job is still held in the chuck from machining. The set-up is similar to a toolpost boring bar, with the cutting tool held by a set-screw just like a boring cutter. However, the cutter itself is shaped like a parting tool point at the business end and is held with its cutting edge vertical, so that it cuts as the bar is thrust through the bore by movement of the saddle or top-slide. The obvious way to traverse the bar is by winding the saddle along the bed by the handwheel, but this is not the best way to do it. The effort required is more than the apron gears should be called upon to withstand. If you have a lever feed tailstock barrel, the saddle can be propelled by a stub of rod held in the tailstock chuck and butting against the boring bar end, judiciously aided by the saddle handwheel.

Much the best way of producing the movement is by a separate lever attachment to move the top-slide only. I hooked up a gadget on these lines for use on the ML7 which works perfectly. A long hand lever pivots on a stout peg riveted in a plate bolted firmly down to the back of the cross-slide, and a short swing link connects the lever to the top-slide via a simple bar fitting made to take the place of the top-slide endplate. In use, the endplate carrying the feedscrew is removed and the lever fitting substituted, using the endplate's own Allen screws to attach it. An incidental advantage of this arrangement is that, by slewing the top-slide slightly, it will plane keyways through tapered bores. However, no panic called for—there are no tapered bores at all!



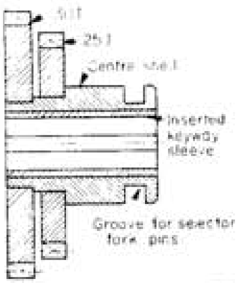
CRANKSHAFT GEARS



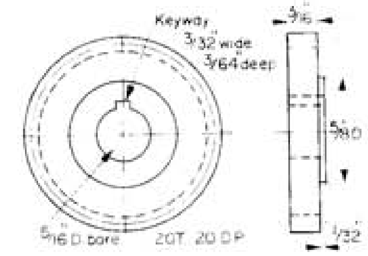
CRANKSHAFT GEAR CENTRE

KEYWAY SLEEVE

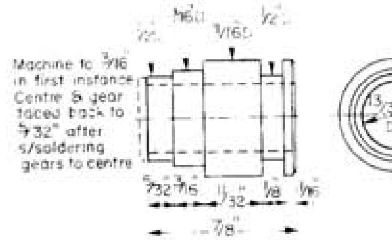
The smallest bore in which a keyway is required is 7/16 in., so the bar holding the cutter can't be any bigger than 5/16 in. dia., or we've no spare movement across the bore with which to deepen the cut. If you have to make up a bar for this job, the 5/16 in.



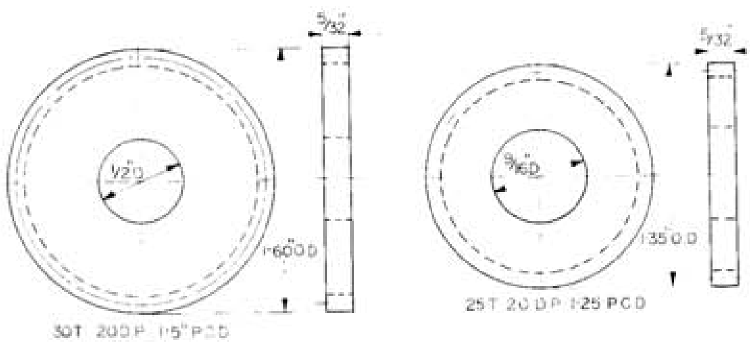
BUILT UP SECOND SHAFT GEAR CLUSTER SECTION

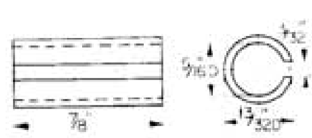


SECOND SHAFT DRIVER GEAR M.S



SECOND SHAFT GEAR CENTRE





KEYWAY SLEEVE

SECOND SHAFT GEARS M.S

portion need be no longer than 1 in. behind the cutter edge—again making for stiffness.

So let us start with the simplest gear requiring a keyway—the 20 tooth gear on the outer end of the second shaft. This, as supplied, has a collar " in one " with the wheel bored ¼ in. Spin the wheel on the shank of a ¼ in. drill and check that the bore is true with the outside diameter and with the collar. If so, you can use a drill in the bore to check the true running of the wheel when held in the chuck by the collar. Get it running true, either by packing one or more jaws of the three-jaw with slips of paper if necessary or by adjusting the jaws of the four-jaw. Open up the bore with a 19/64 in. drill held in the tailstock chuck and follow up with a 5/16 in. reamer or D-bit.

Mount up the cutter bar with the keyway cutter and ensure that the centre of the cutter is exactly at centre height. Set the cutter point only just proud of the bar for the first cut or two. Turn the chuck, so that the keyway will miss the set-screw hole in the wheel boss, and lock the mandrel. It doesn't matter if the keyway does plough across the screw hole, but having to do so can make the job more difficult and might perhaps deflect the small diameter bar. Press the bar through the bore, taking off an only just perceptible scrape along the keyway. Make two or three passes at each setting of the cutter. As the keyway begins to take shape, advance the cutter into the slot, by only a thou or two at a time, by the cross-slide index until the keyway is deep enough for the side of the bar to be rubbing in the hole. At this point slacken off the cutter set-screw, withdraw the cutter a few thou further out of the bar and carry on again until the bar is once more rubbing in the bore. It does require considerable patience, but it does produce a nice true keyway, carefully carried out. The keyway needs to be 3/64 in. deep, i.e. about 0.047 in. on the cross-slide index.

When the keyway is complete, remove the wheel from the chuck and saw off the boss just behind the screw hole, leaving about 1/16 in. of the boss on the wheel. Chuck an odd stub of ⅜ in. rod for a mandrel, turning the end down to a tight wring fit in the 5/16 in. bore of the wheel. Remove any thrown up burrs along the edges of the keyway, or you may get a false fit. Mount the wheel on the mandrel with the rough remains of the boss outwards and face this back till it is only 1/32 in. thick. The wheel should then be 7/32 in. thick at the centre, and is finished.

We can now come back to the second shaft and finish off that to match the wheel just dealt with. Remount the shaft between centres and turn down the short outer end to a little over 5/16 in. When you are getting near the size of the wheel bore, take cuts of only half a thou at a time, taking each cut no more than 1/16 in. or so along before trying the fit of the wheel. The ideal to aim at is where the last cut just wouldn't let the wheel go on, but the start of the next scrape just suggests that the wheel would wring on tightly by hand. When you reach that stage—leave it: you are there.

All the shaft needs to complete it now is a couple of keyways, and these are simple end milling jobs with the shaft held in the machine vice on the vertical-slide.

Make sure the shaft is held exactly horizontal by a surface gauge stood on the bed, and square across the lathe by a rule nipped edgeways between shaft and faceplate. The end mill must be level with the shaft centre too, which you can check by lining up the centre hole in the shaft end with the tip of a small centre drill held in the chuck. Mill both keyways 3/64 in. deep, the long one positioned as shown in the drawing. The outer gearwheel can now be mounted for keeps, as it need not come off any more. Offer it up to the end of the shaft, exactly lining up both keyways, and then after making sure that all surfaces are clean, press it firmly home in the vice with a slip of copper or aluminium over the jaws to protect the job.

A large ⅜ in. washer over the wheel hub ensures that the wheel goes right home, leaving the nose of the shaft just proud of the wheel boss. A short key cut from 3/32 in. square silver steel rod tapped home completes that. Note that it is officially correct for the key to overhang the end of the shaft by just a fraction; do not make it more than 1/32 in.

The long keyway takes the drive from the pair of gears driven by the crankshaft—one at a time, of course! This key needs to be tight in its bed in the shaft, but free enough in the gears for them to slide along the shaft to select the required gear. These two gears, of 30 and 25 teeth, are silver soldered to a central hub which carries not only the long sliding keyway but also the square bottom groove engaging the selector fork pins. To deal first with the gears themselves, check, as before, that they are true, and set up the 30 wheel in the chuck, holding it by the boss. Run the ⅜ in. drill into the bore about ¼ in. deep, and then proceed to bore out the hole only that deep to ½ in. dia. with a tiny boring tool. Saw off the shell remains of the boss as before, then re-chuck the wheel lightly over the teeth, interposing little slips of soft aluminium between the chuck jaws and the teeth. Face back the remains of the boss, flush with the surface of the wheel and, at the same time, turn a tiny countersink to the central bore.

Chuck the 25 tooth wheel by the boss in the same way, checking that the face runs true. This wheel is faced back for a start to 5/32 in. thick, then the bore opened out as before by boring to 7/16 in. dia., finally facing back flush the remains of the boss. The two wheels seat on the matching diameters of the centre, as shown in the drawing. The seat for the 25 tooth wheel is shown as 3/16 in. wide, while the wheel has been reduced to 5/32 in. thick. This gives a 1/32 in. space between the two wheels. The outer 30 tooth wheel, now still 3/16 in. thick, will be faced back to a similar 5/32 in. thick after silver soldering in position, which nicely cleans up any roughness on the face from the silver soldering.

There are two ways of making the centre. It can be turned all at the same setting and a keyway planed in the bore at the same time, as for the second shaft wheel, or it can be turned as a large bore shell and a slit sleeve silver soldered in at the same time as fixing the gearwheels. The "inserted keyway" method may seem unorthodox, but it seemed to me a good way of obtaining a nicely-fitting, true keyway in a comparatively long bore. This was the method used in the gears on the engine shown—which confirms that the method works. For planing the keyway, the procedure is just as detailed for the gearwheel, making the keyway the same depth and width.

For the insertion method, the centre is turned from a piece of ¾ in. rod, wheel steps outwards, and the selector groove turned in with a parting tool. Turn the wheel seats with nicely square corners and a free fit in the wheels. Ream or bore it 11/32 in. Do not forget that the ½ in. dia. portion for the outer wheel should be 3/16 in. wide at this stage. The key sleeve is a plain turning job about 11/16 in. long, drilled and reamed to 7/32 in. bore, and turned a close but free fit for the 11/32 in. bore of the centre. When shaped up, treat the sleeve exactly as for cutting a shaft keyway: only grip it by its ends in the machine vice and take the milling cut right through to form a true 3/32 in. wide slot.

Clean all the surfaces free of chips or grease and slide the fluxed inner sleeve into the centre. Silver solder will faithfully cover any fluxed surface, so it is essential to make sure there is no trace of flux in the keyway. It may pay to do as I did and occupy the keyway with a 3/16 in. wide strip of dural 3/32 in. thick, wedged into the bore during brazing up. Lightly flux the seat for the 25 tooth wheel and position the wheel. Spring a ring of 40 thou silver solder wire over the nose of the seat so that it rests on the face of the wheel. Treat the outer 30 tooth wheel the same, putting a horseshoe of silver solder wire round the countersink in the face of the wheel and another small one round the end of the sleeve. Allow a fair gap between the ends of the two horseshoes, centrally about the keyway.

Warm things up gently for a start, so as not to "fizz" the flux into places where it should not go, and when it has dried out press on and run the silver solder well in.

To be continued.

THE STRONG and BREMME VALVE GEARS

by J. N. Liversage

Continued from page 353

FOR MY EXAMPLE of the Bremme valve gear, the measurement "x" (CB) will now be 2.17 in. and BD 6.83 in.

Drawing the gear Fig 8, the distances AG and AM have been increased to 1⅜ in. as against the 1⅛ in. in order to increase the valve travel due to the reduction in the eccentric diameter. The lengths of the swing link and hanger link remain the same at 4⅛ in., the latter link incidentally affecting the valve only in so far as it dictates the path of the top pivot of the swing link on the arc GH in the same way as the slotted link in Fig. 6.

Plotting the paths of the end of the eccentric rod in the way already described and using a modified strip of celluloid as a template with the points C, B and D the correct distances apart, the shape finally developed will more nearly approach a perfect ellipse, owing to the reduced angularity of the eccentric rod. It will be a little pointed at one end and again inclined at an angle to the centre line of the motion.

In this diagram the forward gear position of the top of the swing link AC is shown at G and the backward at H. Which position is used is immaterial and depends solely on the type of reverse operation adopted. With the forward position at G, the reach rod can be coupled directly to the trunnion of the reverse screw nut, so that this is at the front of the screw in forward gear, the normally accepted position. Should the reach rod be at about or below the footplate level, a centre pivoted lever, connected at the top of the nut and at the bottom to the reach rod, will reverse the movement and so bring the forward gear position of the link eye at H. Similar considerations apply to the lever reverse, depending on whether the lever is pivoted above or below the connection of the reach rod.

Having settled the reverse point of the swing link, this will determine which of the two elliptical paths of the eccentric rod will be used for forward gear, and this is the path which must be used to proportion the arms of the bell crank to give the valve travel required.

Taking the maximum travel points on the ellipse at points between 11 and 12 and at 2, and marking off arcs on the vertical CJ, it will be found that the movement is 0.70 in. As this is insufficient, we can adopt one of two methods of correction: either move the full gear positions of G and H further from the centre line AC (that is increase the range of the reverse screw) or, should it be thought that this is as much as can be accommodated in the cab, make the two arms of the bell crank unequal, steeping up the travel of the arm OK in relation to the arm OJ by making it a little longer.

As we had a total movement in the Strong gear of 0.84 in. this figure can be used again and by proportion the length of the arm OK will be $1.25 \times 0.84/0.70 = 1.5$ in. Some slight movement is always lost in setting the final angle of the vertical arm of the bell crank OK in the correct position to give equal movement either side of the mid position, and from the drawing the total valve travel finally arrived at is 0.82 in. and the angle between the two arms is such as to give a distance between of 2.07 in.

In using the alternative position of the swing link and the opposite elliptical path of the eccentric rod, it will be seen that the point J of the bell crank moves rather more below the mid point than above, 0.36 in. against 0.34 in. This is different from the gear in Fig. 8, where the excess movement was above the mid point, owing to the slight difference in the two paths, forward and back, so, in order to adjust the travel to be equal both sides (in this case) the angle between the two arms must be increased and so lose the 0.02 in. excess. Again this can be found by trial and error, and the total valve travel of 0.82 in. adjusted to ¾ in. when the valve gear has been completed and assembled, by reducing the arc of movement of the hanger link G to H.

The two arms of the bell crank need not be in the same plane: one arm can be directly above the eccentric rod and the other in line with the valve spindle to make direct connections with no offset links. Any horizontal difference between the eccentric rod and the valve can be taken care of in this way.

Having now completed the drawing of the gear and being satisfied that all the movements are correct, the position of the eccentric or return crank can be related to the position of the main crank,

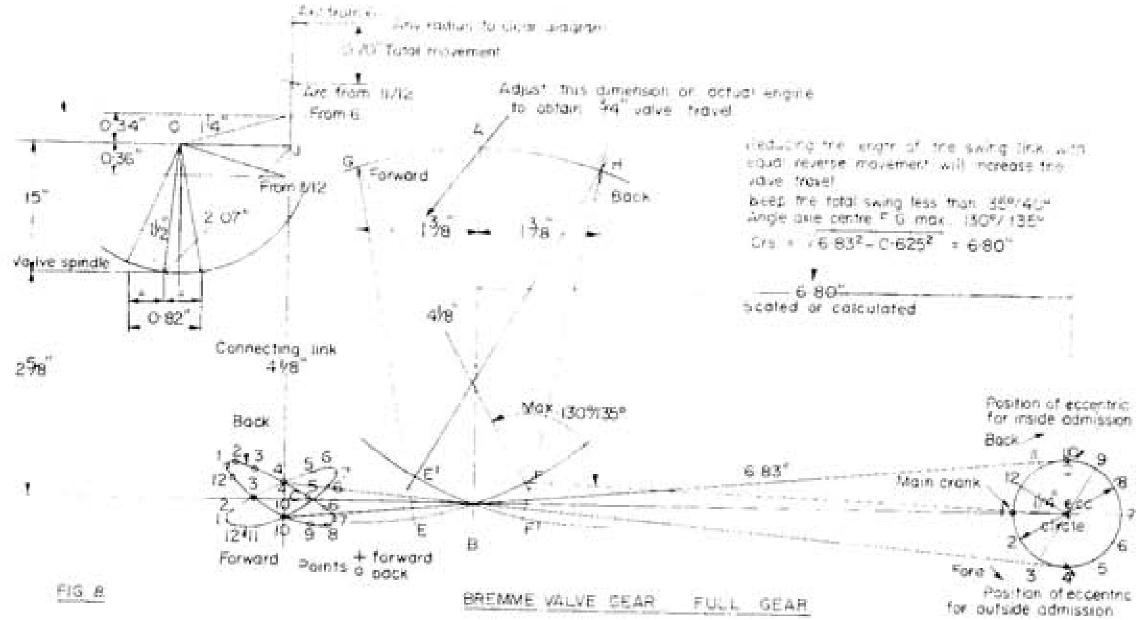


FIG. 8

BREMME VALVE GEAR FULL GEAR

whether 90 deg. in front of or behind, depending on the use of either inside or outside admission.

It is quite easy to confuse things here as it is not always obvious which way the connecting link will move and also the variation in direction caused by the bell crank. Using the celluloid template again will show quite clearly what happens when the eccentric rotates through the numbered stations on the eccentric circle, noting that the main crank is always at right angles to these at any time. With the crank on either the inner or outer dead centres, the eccentric is at either point 4 or 10, and bearing in mind that with inside admission the valve moves in the opposite direction to the piston and in the same direction with outside admission at this particular instant and checking with the template, no difficulty will be experienced.

In the two examples given, one of the Strong and the other of the Bremme gears, the gear is arranged on the centre line of the motion but if for any reason it is desired to lift the links at the cylinder end to clear say an intermediate axle, this can be arranged simply by rotating the whole of the gear about the centre of the axle, but keeping the main crank in the same position. This will throw the angle between the eccentric and crank either slightly more than, or slightly less than the right angle depending on the amount of inclination adopted.

Both gears are practical propositions and taking the Bremme gear, it is simple, requires only one eccentric, the links are straightforward to make and take up very little room between the frames, an important consideration. Ample pin and bearing sizes can be allowed and from experience covering the Hackworth, Hackworth modified, Joy, Stephenson, Baker and of course Walschaerts valve gears, mainly with 7¼ in. gauge engines, I think that I can say without doubt that this gear properly arranged is as good as, if not better than some of the more common gears, to a great extent because of its simplicity.

The weakest point in the whole arrangement is the pin joint of the eccentric rod connected to the swing link at B, so at this point deepen and thicken up the rod to take what will be the highest stress in the whole gear.

I adopted the Bremme gear for my 2 in. scale "King" locomotive more in the way of necessity than anything else, but for any future miniature locomotive which I may make with inside valve gear, my choice would most certainly be the Bremme gear in preference to either Joy or Stephenson. ■

DRAWINGS FOR *SIMPLEX* L.O. 935

Sheet 1. General arrangement, frames, etc.
" 2. Feed pump, wheels, cylinders.
" 3. Walschaerts valve gear.
" 4. The boiler.
" 5. Superheater, regulator, grate.
" 6. Running boards, cab, side tanks.

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BRITISH COMPOUND LOCOMOTIVES

by K. N. Harris

Part II

Continued from page 295

In 1893 Webb produced a three-cylinder compound 0-8-0 goods engine, of which between 1893 and 1900, no less than 111 were built.

Unlike the passenger engines, all three cylinders drove on to a single (the second) axle, so the advantages of the divided drive disappeared. All three cylinders, which of course were in line, were steeply inclined at 1 in 8½ to allow the inside running gear to clear the leading axle, and this in conjunction with very short 5 ft. 8 in. centre connecting rods did not tend to produce a sweet running engine. Cylinders were 15 in. and 30 in. by 24 in. The H.P. valves, in chests inside the frames, were direct driven by Stephenson gear, and unlike the "Greater Britain" and "John Hick" classes the valves were not balanced. The L.P. valve arrangement was as before, with the slide valve overhead and driven by slip eccentric via a rocking shaft. Naturally, as all cylinders drove the same axle, the fault of one engine turning in one direction and the other in the opposite, already referred to, could not arise.

The boiler had no combustion chamber, the front tubeplate was set well back and the length between tubeplates was 13 ft. 4 in. with 210 1¾ in. dia. tubes. The firebox was of normal type with still only 20.5 sq. ft. grate area, and the working pressure was 175 p.s.i.

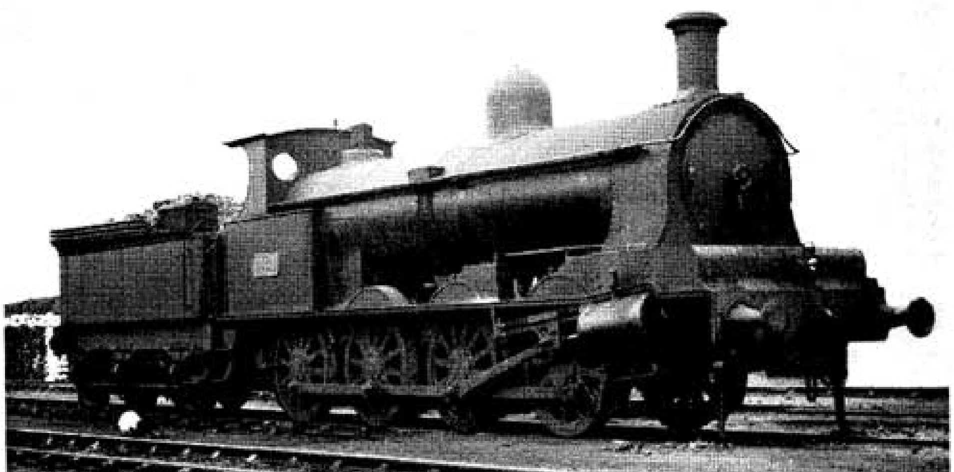
Later all these engines were converted to simple, at first with 18½ in. × 24 in. inside cylinders, and later with 20½ in. × 24 in. cylinders and larger boilers. Mr Whale very evidently had no use for the three-cylinder brigade.

Before dealing with Webb's four-cylinder compounds, reference must be made to compound tank engines; all of them had the usual three-cylinder arrangement. As anyone familiar with Webb's methods might well expect, all four were different, one from another. Period 1884-7.

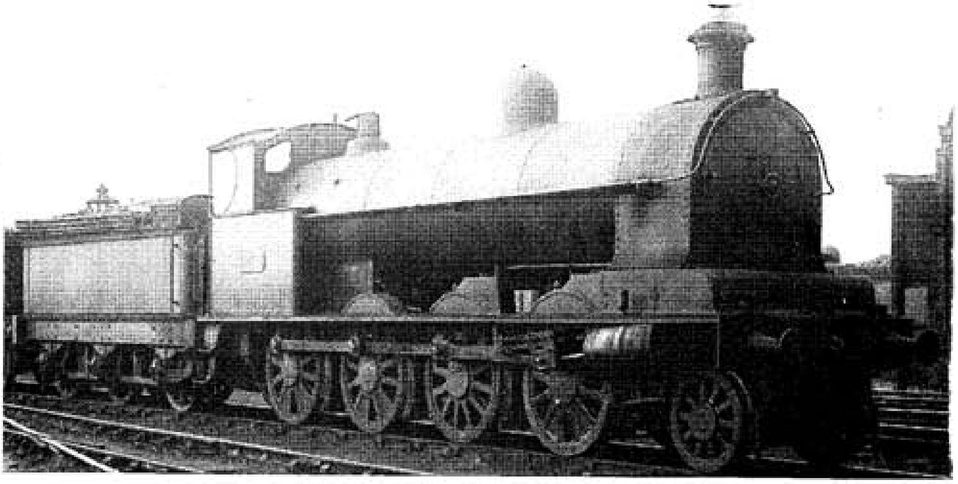
For his first one Webb took one of the 4-4-0 Beyer Peacock "Metropolitan" tank engines and reconstructed it very much along the lines of his first "Experiment" of 1882. The cylinder layout and valve gear arrangements were just as in that locomotive, including the return crank arrangement for controlling the correcting link. The cylinders were 13 in. and 26 in. by the usual 24 in. stroke and the driving wheels, which were 5 ft. 9 in. dia., were not coupled. The boiler had a total heating surface of 1,028 sq. ft. and a grate area of 16 sq. ft. with a working pressure of 150 p.s.i.

The condensing arrangements were retained. The next two engines were of the 2-4-2 type, but of course with uncoupled wheels. The first of these was more or less the equivalent of the small standard 2-4-2 tank engines with inside cylinders.

The new engine had the usual outside cylinders 14 in. × 18 in., set in the usual position, driving



Webb's 4-cylinder compound 0-8-0, of which 170 were built between 1901 and 1904.



When converted to 2-8-0, some locomotives were given large boilers of the "Experiment" type.

the rear driving axle. In this case the valves were *above* the cylinders and were operated by the normal type of Joy gear, with anchor link. The low pressure cylinder driving the leading driving axle was 26 in. bore by 24 in. stroke (note the difference in stroke between H.P. and L.P.) the ratio of H.P. to L.P. was 1 to 2.3, as in the "Dreadnoughts." The boiler had a total heating surface of 994 sq. ft., a grate area of 14.2 sq. ft. and a working pressure of 160 p.s.i.

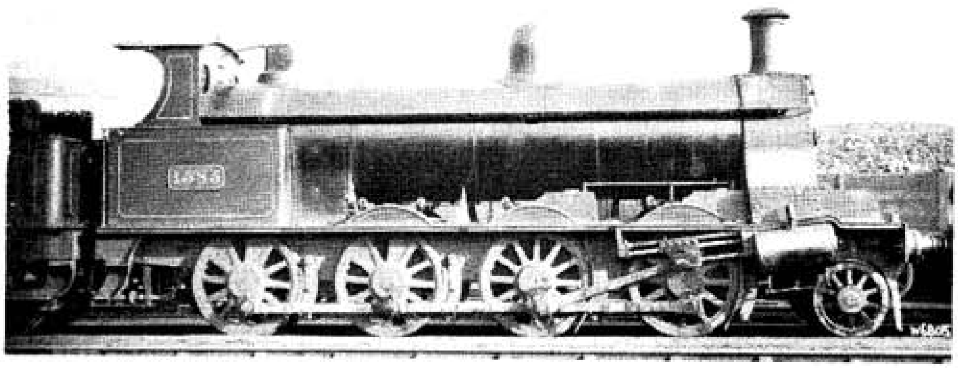
This particular engine was one of the worst culprits in producing a really vicious surging movement at starting and as it was used on the Broad Street-Mansion House line with constant starting, it can well be imagined that it was not particularly popular!

The third engine, in presumably an endeavour to overcome this trouble, had much larger driving wheels 5 ft. 9½ in. dia., but the same general layout. In this engine the cylinders were H.P. 14 in. × 20 in., L.P. 26 in. × 24 in. giving an H.P.-L.P. ratio of 1 to 2.07. The boiler was similar to that of the engine just described.

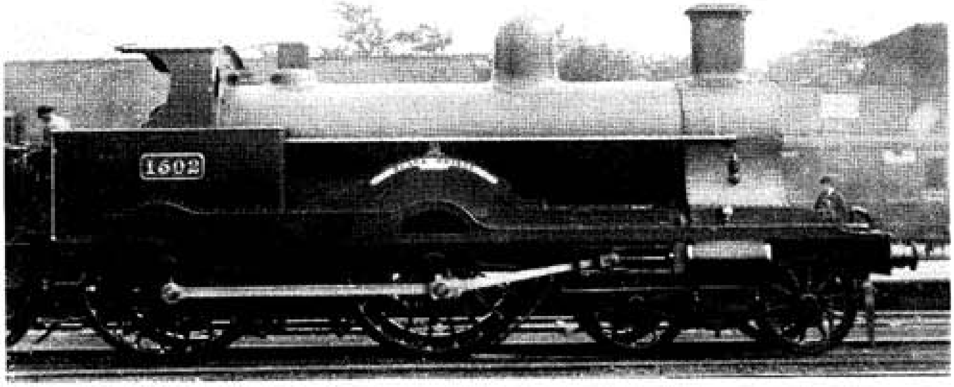
The last engine again had the same cylinder arrangement and was built as a goods tank engine. The wheel arrangement does not fit into the White notation, as there were a pair of leading wheels in a radial axlebox, a leading pair of driving wheels, driven by the L.P. cylinder and not coupled and finally four *coupled* wheels, the leading pair of which were driven by the outside H.P. cylinders: a real hybrid. The H.P. cylinders were 14 in. × 24 in. and the L.P. 30 in. × 24 in. Ratio H.P. to L.P. 1 to 2.3.

This engine was exhibited at the Manchester Exhibition of 1887. It was very soon transferred from goods work to the Manchester-Buxton passenger service, where it worked for a few years. When I was living in the Buxton area in the 1920's, I knew an old retired L.N.W.R. driver who was familiar with this engine, and he said that it was a love-child, though that was not the word he used! None of these engines had a long life and Webb himself scrapped them between 1897 and 1901 as their boilers wore out.

In 1897 Webb finally abandoned the three-cylinder compound and turned his attention to the four-cylinder variety. Two series of express



Four-cylinder compound as converted from 0-8-0 to 2-8-0 to relieve excessive over-hanging weight at front end.



Webb's 4-cylinder compound No. 1502 "Black Prince," built at Crewe in 1897. Seen here fitted with a double chimney. Later re-numbered 1902.

engines were built, the first of the first series being named *Black Prince*. This was a 4-4-0 with the L.P. cylinders inside the frames and the H.P. outside, all four in line and driving the leading axle; the axles were of course coupled. The outside H.P. cylinders were 15 in. × 24 in. with piston valves above, the inside L.P. cylinders were 19½ in. × 24 in. with balanced slide valves above. The H.P.-L.P. ratio was 1.69 an exceptionally low figure, and the L.P. cylinders had to be altered to 20½ in. bore, which became standard for all the subsequent engines, giving a ratio of 1 to 1.87; even this seems very low compared with generally accepted practice.

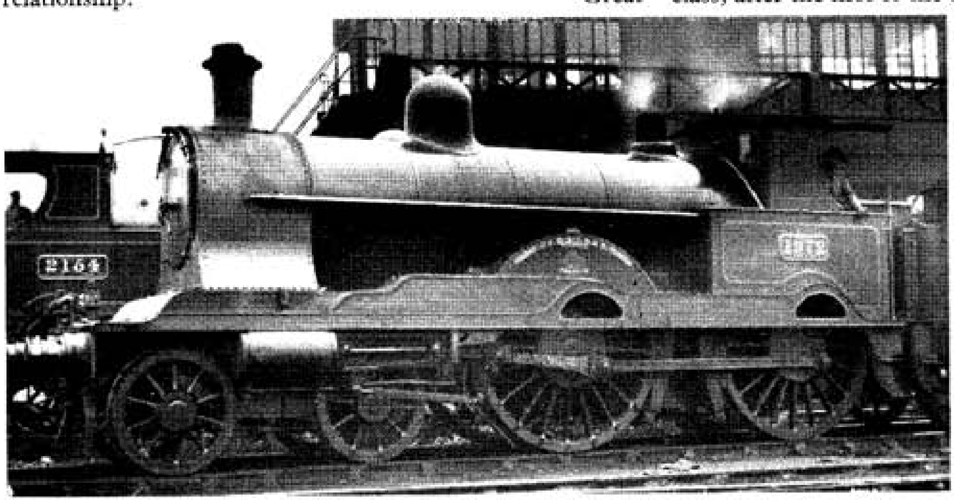
The inside valves were operated directly by a standard type of Joy's valve gear, and the valve spindles were extended through the fronts of the steam chests and by means of rocking levers of the first order, worked the H.P. piston valves. According to a drawing I have before me as I write, the arms of these rockers were of different length, giving an increased travel to the H.P. valves. Of course the valve events were inter-related and there was no means of varying this relationship.

The boilers were similar to those used on the "Dreadnought" and "Teutonic" classes and curiously, at this late stage, the water bottom to the firebox reappeared!

Originally the pressure was 175 p.s.i., but in subsequent engines this was raised to 200 p.s.i. The coupled wheels were 7 ft. 1 in. dia., and the truck wheels 3 ft. 9 in., dia. The leading wheels were carried in "Webb's Patent Radial Truck" which, so far as I can make out, was nothing more or less than an Adams bogie with a curved instead of a straight slot. The coupled wheelbase was 9 ft. 8 in., then the longest in Great Britain. Inside and outside cranks were set at 180 deg. and thus the reciprocating masses were approximately self-balancing.

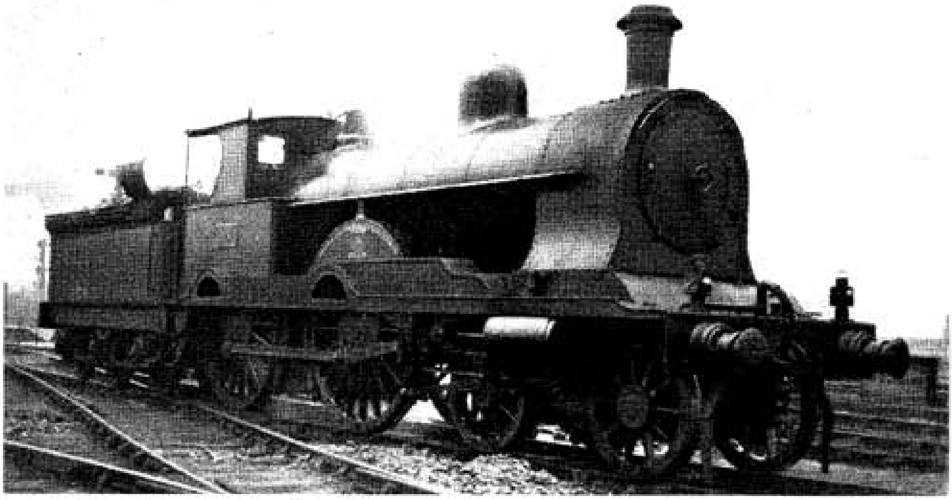
The crank-axle was built up, with balanced webs, and like so many L.N.W.R. engines, had a centre bearing carried on a centre sub-frame. In all, 40 of these engines were built by the end of 1900.

Between 1901 and 1903 another 40 were built with larger boilers, known as the "Alfred the Great" class, after the first of the series. The H.P.



"Alfred the Great" class No. 1972 "Hindustan," built at Crewe in 1903.

Another engine of the "Alfred the Great" class, No. 1960 "Francis Stevenson." All photographs by courtesy of Real Photographs Co.



cylinders were increased to 16 in. × 24 in. the L.P. remaining as before at 21½ in. × 24 in. The new boilers had a tube heating surface of 1,329 sq. ft., and the firebox added 179 sq. ft., including the precious water bottom (40 sq. ft.). The general arrangements were the same in the two classes.

Once again the cylinder ratio, H.P. to L.P., was found to be too low, and the outside cylinders had to be lined to reduce this bore to 15 in. as in the "Black Prince" class.

When George Whale succeeded Webb, he decided that the inability to vary valve events between H.P. and L.P. engines was not a feature conducive to efficiency, and he fitted separate sets of outside Joy gear to the H.P. cylinders.

A single reversing control was provided which could be used to operate the two sets of valve gear together or independently. The layout of the outside valve gear and of the reversing gear was very well carried out and reflected great credit on the Crewe drawing office.

From 1908 onwards, most of these 80 engines were rebuilt as simple engines, with inside cylinders 18½ in. × 24 in.

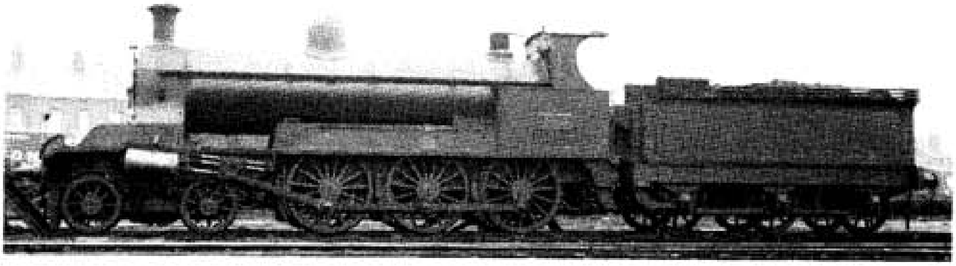
The "Black Prince" and "Alfred the Great" classes were the last express engines built by Webb.

Before we consider Webb's four-cylinder goods classes there remains one more experiment to be recorded. In 1895, he altered his original little two-cylinder compound (the old Allan 2-2-2) to a triple expansion engine, which was named *Trifler*.

In its new guise, there was a 9¼ in. bore HP cylinder on the right-hand side, a 13 in. bore cylinder on the left-hand side and a 19½ in. bore low pressure cylinder between the frames, all 20 in. stroke. The outside cylinder valves were operated by Stephenson gear as originally, and the LP valve was operated by a slip eccentric. A by-pass valve was arranged for the intermediate (left hand) cylinder so that boiler steam could be admitted for starting. Working pressure was 200 p.s.i. This prodigy had considerable difficulty in starting, even with one coach behind it. I do not think there is any record that it ever did any useful work, and it was broken up in 1903.

Lastly we come to Webb's four-cylinder compound goods and mixed traffic engines. In 1901 Webb produced a four-cylinder 0-8-0 engine for mineral traffic, with two outside HP cylinders 16 in. × 24 in. and two inside LP cylinders

One of the notorious "Bill Baileys."



$20\frac{1}{2}$ in. × 24 in. between the frames, all driving the second axle. The driving wheels were 4 ft. $5\frac{1}{2}$ in. dia. The total heating surface was 1,753 sq. ft. working pressure 200 p.s.i. Once again it will be noted that the HP-LP ratio was only 1 to 1.64. The valve gear was generally similar to that employed on the four-cylinder compound Express engines.

Naturally there was a considerable concentration of weight at the front end and Whale modified some three dozen of these engines by adding a leading pony truck. However, as compounds their performance was, to put it mildly, not brilliant, and in 1908 Whale converted a number to simple engines by removing the HP cylinders, retaining the LP cylinders and feeding them with boiler steam at the reduced pressure of 165 p.s.i. It was stated that in this condition they could haul an additional five loaded coal wagons with the coal consumption increased by only 1.2 lb. per mile.

In common with the earlier 0-8-0 three-cylinder compounds, these engines had their axles so arranged that each adjacent pair of wheels were at the same centres and the coupling rods were arranged in three separate sections of equal lengths, a simple and efticient arrangement, originated I believe by J. F. Stephenson of the N.E.R. Both series had, so far as I can trace, cast iron wheel centres, which in the comparatively small diameters involved were apparently quite satisfactory.

Webb's last compound engines, produced 1903-5, were thirty 4-6-0 express goods engines, these were the famous (or perhaps "infamous") "Bill Baileys" and were probably the worst of all the compounds.

Generally they were similar mechanically to the four-cylinder mineral engines, but the leading coupled axle of the latter was substituted by Webb's patent four-wheel radial truck. All the four cylinders were in line and steeply inclined, driving on to the leading coupled axle. The coupled wheels were 5 ft. 3 in. dia. They were a most unsatisfactory lot and were all (there were 30 of them) broken up by Bowen-Cooke after no more than 15 years' service at the most.

All this long series of compounds, extending in time from 1879 to 1904, were heavy on repairs and maintenance, and those that Whale rebuilt as simple engines were in every way better than the originals.

In the foregoing I have made no reference to port sizes, valve proportions and travels, etc., but there were many variations of these; to deal adequately with them would take up far more space than I think would be justified. For those who are interested in the deeper technicalities, I would refer them to the copious information to be found in the late E. L. Ahrons' great work "The British Steam Railway Locomotive, 1825-1925" to which I take this opportunity of making my own acknowledgements for much of the foregoing.

Ahrons was a Swindon man, and I do not think he had any very high opinion of the L.N.W.R. or its locomotives, but he was scrupulously fair in his comments and analysis of the Compounds and their work.

Looking back, one does not know whether to admire or deplore Webb's persistence with compounding. Of all the many engines he built on the compound system, the only ones which could be called even reasonably satisfactory were the ten engines of the "Teutonic" class, and even these were patchy as between one and another.

The extraordinary variations in cylinder proportions and the repetition of proportions already proved unsatisfactory, are almost impossible to explain. It seems to me that Webb, who was undoubtedly a clever mechanical engineer and a wonderful organiser, was perhaps not so good as a designer of efficient steam engines, and that his knowledge of thermo-dynamics in the special case of the application of compounding to the locomotive, was decidedly limited. I can see no other explanation of his vagaries in this regard. Unfortunately by all accounts Webb was a man of supreme self-confidence who simply would not listen to criticism or advice, and he was of such an overpowering personality and arbitrary temperament that none of his subordinates at Crewe ever dared to voice either, and it seems highly probable that many of the failings and weak points of his various compound designs were never brought to his attention at all, and that he was largely ignorant of them. The real mystery is that he was able for so long to get away with it with the Board of Directors of the L.N.W.R., but he was very much persona grata with Sir Richard Moon, the Chairman of the Board, reputedly an even more arbitrary character than Webb himself, who treated the Directors like a lot of schoolboys.

The saga of Webb and locomotive compounding is a long and most interesting one, more for its persistance and perseverance with the principle of compounding than from any noticeable success achieved. No railway, other than the L.N.W.R., ever produced so many varieties of compounds.

While the L.N.W.R. rejoiced in variety, the Midland, through the genius of Walter Smith and the sound judgment of S. W. Johnson found a satisfactory type of engine at the outset, stuck to it (with the L.M.S.) almost unchanged (with the exception of applying superheating later) for the better part of half a century. Two greater contrasts it would be hard to find.

To be continued.

Stability in model power boats

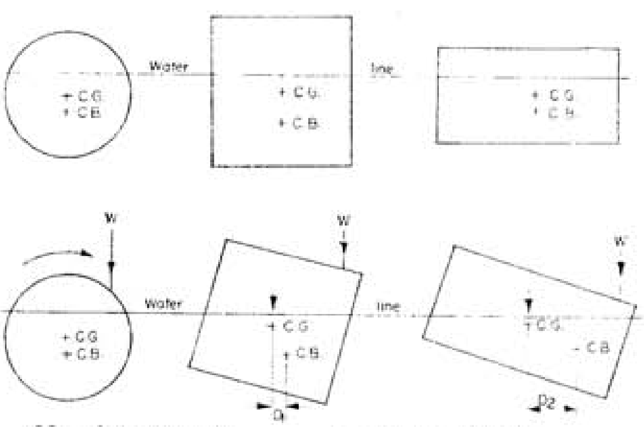
by T. B. Rose

IN A RECENT letter to M.E. a reader said that he had a problem with his model power boat which had a tendency to turn on its side under the influence of torque from the propeller. While it may be rash to try to diagnose the cause of his troubles without seeing the boat, it is more than likely that the main cause is lack of inherent stability in his hull.

To many people, stability in a boat means only one thing—plenty of ballast. But ballast is a poor substitute for a properly designed hull. The best way to understand this problem is to consider the stability of three pieces of wood floating in water, one cylindrical in section, one square in section, and one oblong in section.

Since the wood is solid, the centre of gravity of each piece will be at the centre of cross-sectional area. The upthrust of the water can be considered to act at a centre of buoyancy, which in this case would be at the centre of the submerged cross-section. From this it will be seen that since part of the cross-section is above the surface of the water, the centre of gravity must be higher than the centre of buoyancy in each case.

From this it might appear that the three pieces of wood are unstable, but this is not so, except in the case of the cylindrical section. If a load is applied on one side of the cylinder it will rotate as there is no force to oppose it. In the case of the square piece, a load on one side would cause it to tilt, but then another force begins to operate because the centre of buoyancy has moved to that side. This produces a turning movement which tries to push the wood back on to an even keel. This then, is the secret of inherent stability.



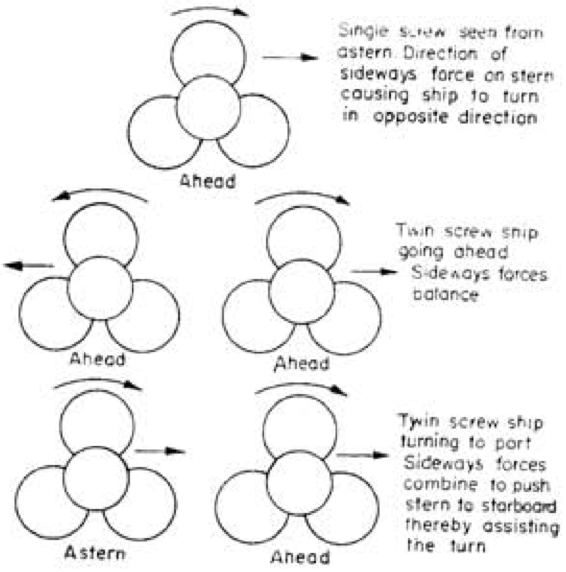
C.G. = Centre of Gravity   C.B. = Centre of Buoyancy
D1 & D2 = Sideways displacement of Centre of Buoyancy

In the case of the oblong piece of wood, there is a similar state of affairs, but a study of the diagram will indicate that in this case the centre of buoyancy has moved further (see D1 and D2 in the diagram) than it did in the case of the square section. From this it will be seen that a circular cross section has no inherent stability, and that a wide rectangular cross section of shallow draught has more stability than a square one. Of course this does not mean that the cross section of a hull should be a rectangle with square corners, but it does mean that there should be enough buoyancy in the bilges to produce a sideways shift of the centre of buoyancy when tilted, and circular cross sections should be avoided.

A single screw does have a tendency to make a hull steer to port or starboard, according to the direction of rotation, but I am not sure that this is due to torque. The usual explanation is that the water near the surface is not as "solid" as deeper water, and so the lower half of the screw gets a better grip on the water than the upper half. This causes a tendency for the screw to "walk" sideways in the direction of motion of the upper half. Thus a screw which rotates clockwise when viewed from astern will cause the boat to turn to port, as the stern will be pulled to starboard.

This can be prevented by means of an application of rudder in the opposite direction, or by offsetting the thrust line of the screw by an amount sufficient to produce a slight side thrust in the opposite direction, according to whether the screw is right or left hand.

This is important in the case of a ship with twin screws. The screws are of course of opposite pitch and therefore when both go ahead, the forces due to the tendency to "walk" sideways balance each other, so that the ship will steer a straight course. A twin screw ship can turn in a very small space by going ahead on one screw and astern on the other. If the screws are arranged to turn outwards at the top when going ahead, it will be seen that when one goes ahead and the other astern, the "walking" forces will combine to help the ship to turn in the required direction. If they rotated inwards at the top when going ahead, the reverse would apply, i.e. when going ahead and astern, the "walking" forces would combine to oppose the turning couple caused by the ahead and astern thrust of the screws, so that the ship would turn very slowly. It is therefore important that the



maximum manoeuvrability is required.

Another factor affecting straight running which may not be appreciated is the fact that a boat will turn if the centre of pressure of the wind on the superstructure does not coincide with the centre of lateral resistance of the underwater parts. This depends on the type of ship, but it will be seen that a ship with most of its upper works forward, like a destroyer, will tend to turn away from a side wind. One would expect that a ship which was anchored in a tide way would ride in a straight line with the anchor cable, but this is not necessarily so. I have often seen a destroyer making a considerable angle between her fore and aft line and the anchor cable, due to the turning couple of wind above and tide below. I believe that the small sail which is often seen at the stern of a trawler is for the purpose of balancing the centre of pressure so that a side wind does not blow them off course when they have not sufficient leeway for the rudder to have full effect. In order to secure straight running therefore, when there is any side wind, it is important to have a boat in which the side pressure on the superstructure coincides as nearly as possible with the centre of lateral resistance. This can be found by pushing the hull sideways in the water with a stick until the balancing point is found. ■

SMOKE RINGS

Continued from page 371

designs, and in fact I have been most grateful in the past for help from some of our leading experts in this field.

Bill Stokes should come out into the open with his criticisms, which are certainly not constructive. If he feels that some of our designs are unsafe, or capable of improvement, he should supply details, when someone competent to do so will go into the matter and make any alterations that appear to be desirable. But Mr Stokes' comments, as they stand, are somewhat offensive, and could easily do considerable harm to our hobby.

7¼ in. gauge "Highlander"

Our reader R. G. Sparrow, of Landford, Wilts., is building the 7¼ in. gauge L.M.S. 4-6-0 locomotive *Highlander*. He is very anxious to contact others who are building this engine, so that he can compare notes, etc. Letters will be forwarded.

The late C. M. Keiller

SIR,—May I say how sorry I was to read of the passing of Mr C. M. Keiller, one of the most pleasant and intellectual of your contributors. It is not given to many to be able to investigate and solve difficult subjects in the cool, clear manner that was his. I believe he was a Swindon Works man (in his early days, at least), if that means anything.

Do readers remember his discussion and summing up of the bad performances of the Webb Compounds (M.E. September 5, 1957)? I thought this revelation was masterly indeed, especially in view of all the arguments that have raged over the decades in various journals; none of which were ever as convincing and as satisfying as Mr Keiller's explanation of the lack of success.

I have just read the article mentioned above over again; commenting on the 7 ft. Teutonics, he concludes: "The L.P. cut-off should not have been later than 60 per cent. In passing I would mention that LBSC's *Jeannie Deans* has a L.P. cut-off of about this figure." Mr Keiller could say things like that, since he had a sincere appreciation of the achievement of others.

I had hoped that we should have been favoured with more news of the "Jubilee" compound he had under way. I have often wondered if it was ever completed; now I shall miss the pleasure of his writing and the reviewing of his handiwork.

Nr. Bingley, Yorks. F. WILSON.

The late H. Greenly

SIR,—Your remarks concerning the late Henry Greenly in "Smoke Rings" (January 17, 1969) were both timely and welcome. Henry Greenly was a sound, capable engineer and his only fault as far as I can see, was that he was somewhat inflexible in his ideas as far as small locomotives were concerned. While he can certainly be regarded as the Father of the Miniature Steam Locomotive, it was LBSC who brought the hobby within the reach of the man in the street. I have always regretted that there was so much antipathy between them. How much happier everything would have been had they worked together for the common good.

Johannesburg. D. F. HOLLAND.

MODEL STEAM PLOUGHING ENGINES

AND THEIR IMPLEMENTS

by Colin R. Tyler

OVER THE PAST few years, a collection of models of steam ploughing engines and apparatus has been gathered and it was thought that a description of the items so far would be of interest.

As yet, the items are not representative of the whole subject from a historical point of view, as the models have been made and collected as and when they occur, but from the model engineering point of view, they show what can be done with a subject which hitherto has not received a great deal of attention from model engineers, particularly those who prefer making "original" models; that is models which have probably not been constructed before.

It is hoped that the small number so far in the collection will increase as time passes. One of the problems of making one's own models is the time it takes. So far, an estimated 11,000 hours have been devoted to the construction of the models, not to mention a considerable sum of money from very limited resources. However, on reflection, it all seems worthwhile, considering the enjoyment obtained as engineers in building up—literally—the collection, and the friends made throughout the world.

About six years ago, I became interested in steam ploughing. It seemed then, as now, the ultimate in hobbies, combining as it does the many features a hobby should have.

As many readers know, John Haining and I decided to team up in the design and making of the Fowler Class BB ploughing engine in 2 in. scale which was featured in these pages between July 1966 and April 1967 (inclusive).

Mr. Haining, having spent his apprentice days among Fowler ploughing engines and being, therefore, an expert on their technical and historical details, designed the model class BB using his knowledge and referring to still extant full-size engines. Therefore little research was required to produce the finished model, and after a period of three years or so, our models were in steam and working well.

The Fowler BB was probably one of the most attractive yet functional ploughing engines ever made. Introduced in 1913 in both 14 and 16 n.h.p. versions, it was designed to replace the popular AA types of 18 n.h.p. produced in large numbers up to 1912. Sometimes with two-speed (but usually with single-speed) winding drums, they are still frequently seen parading at rallies up and down the country and occasionally a pair of engines at

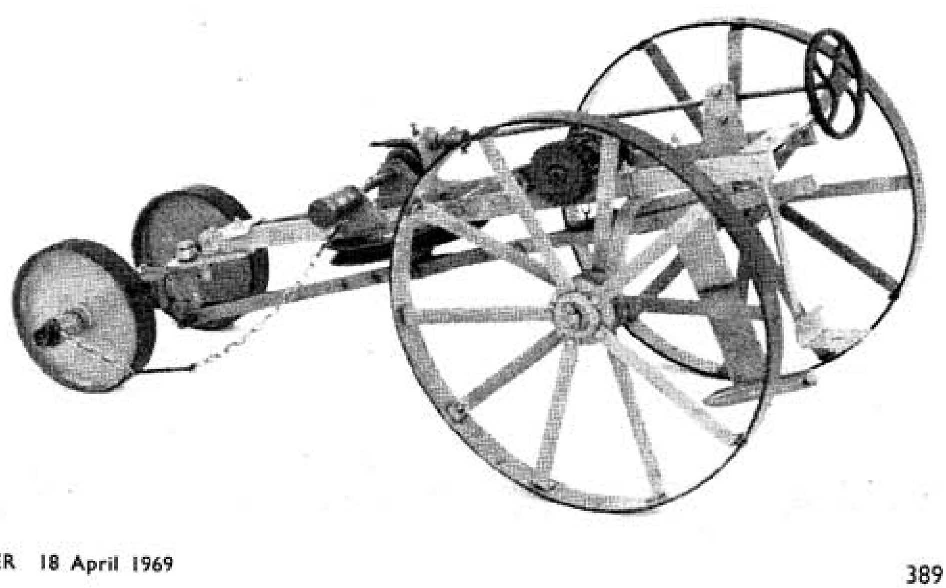


Fig. 1. The model mole drainer made by John Haining.

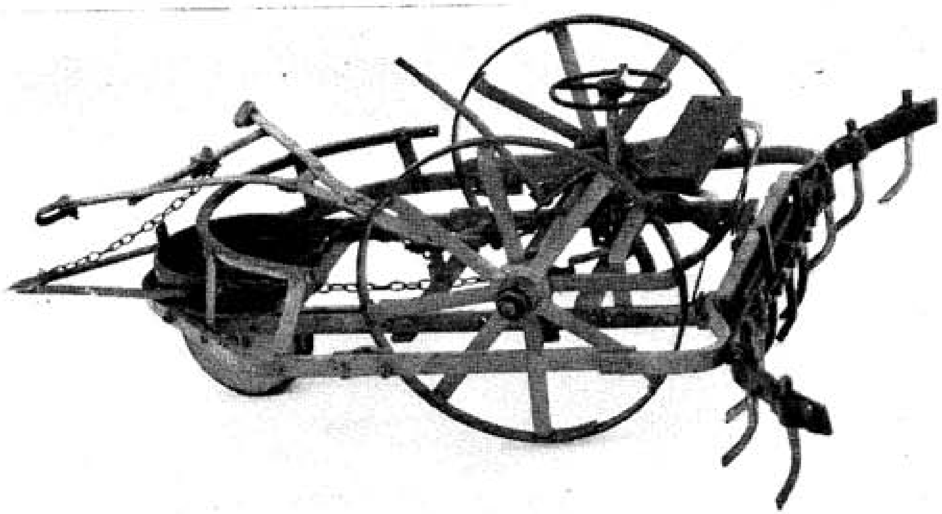


Fig. 2. The model turnabout cultivator built by John Haining.

commercial work. It is a pleasure to see these great hearted engines performing their original tasks some 50 years after their construction.

We then decided that it was essential to have the associated implements, as a pair of ploughing engines by themselves are not much more useful than traction engines, albeit there are winding drums under the boilers. It followed therefore that the implements should be drawn and made to complement the engines, which were already being shown at various rallies, demonstrating how well my daughter could be hauled along by the cable—in her pram!

The model drainer and cultivator were drawn and made by John Haining, while I treated the six-furrow anti-balance plough similarly.

The mole drainer or mole plough, Fig. 1, was used to drain land, using a bullet or mole which was attached to an arm which could be lowered or raised to the required depth. The mole was hauled through the soil leaving a tunnel in the ground through which the land could drain. The effort required for this, particularly at the maximum depth of 2 ft. 3 in., necessitated the cable to be passed round a pulley on the mole drainer and taken back to the engine, where it was attached to one of the rear wheel spokes, thus gaining a two-to-one advantage. So much power was available that more than one spoke was pulled bodily from the wheel. Unlike the cultivator and plough, the mole operated in one direction only.

The turnabout cultivator, Fig. 2, chosen for the set of model tackle was the nine-tine type. This implement which was available with up to 13 tines was used for breaking up stubble and heavy top soil, the land generally being worked in two directions both down and across.

A heavy channel frame has the tines bolted to it, and is mounted on a cranked axle to the rear of the frame, with a smaller solid wheel at the front. The machine was hauled towards one engine and when the pull was completed the previously idle cable took up the slack and pulled on a yoke which automatically raised the tines out of the ground and turned the cultivator round. When lined up for the next pull the ploughman moved a lever and dropped the tines into the ground.

The six-furrow English topsoil anti-balance plough, Fig. 4, completed our set of implements, making an imposing model several inches longer than the engine. Like the cultivator it leaves something to be desired when used with the engine for two reasons, one being lack of weight and the other that a scale soil is required and while this can be made up, using damp sand mixed with small grit stones, it normally had to be guided by hand. BBC Television provided two tons of garden peat for a demonstration of steam ploughing with our models in the studio and we found that this was far too soft and spongy to be satisfactory.

However, this anti-balance plough is the prime implement used with the engines and is a most interesting model to construct. Pulled by cable to and from the pair of engines on the headland, many thousands of acres were ploughed in this way.

Shaped like a shallow "V," the framework carried the mould boards along each leg of the frame with two main wheels on a carriage independent of the frame. As the machine reached the end of a pull the slack cable pulled the wheel carriage over centre and the upper end of the frame was pulled groundwards to bite another series of furrows.

While making the Fowler BB and implements, I

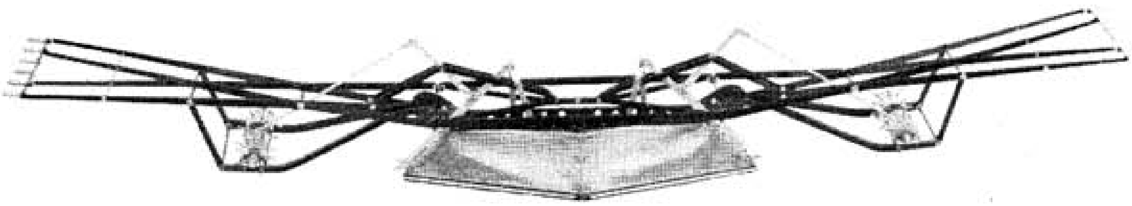


Fig. 3. A model of John Heathcote's plough. Circa 1837.

had become interested in the historical aspects of steam ploughing and started delving back into the 1800's to find out how the whole business started.

A whole range of most intriguing machines came to light, each asking to be made in scale model form. Here we find a very good reason for reproducing machines such as these, as there are comparatively few *types* of full-size ploughing engines left and the only way to see them in three dimensions now is to construct reproductions as accurately as possible.

The selection of 2 in. scale allows as many details as required to be incorporated, while keeping the larger parts within the scope of the average home workshop.

Having made a start on learning about the subject at its beginning, it was logical to make a model from this early period. The result is the curious plough shown in Fig. 3. John Heathcote's plough of 1837 is believed to be the first steam drawn plough to be used with any degree of success.

The only records left for model building purposes are some non-scale sketches of the plough, published in a handbook written about the trials in Lochar Moss, Dumfriesshire by Ambrose Blacklock. Fortunately in the text he includes some overall sizes and by interpolating these with the sketches, a reasonable working drawing was obtained.

The reconstruction suggests some interesting theories for the reasons for the failure of the machine to come up to its ingenious inventor's expectations. It is probable that the rather complex series of levers and joints in the knife system would not work as efficiently in practice as in theory, bearing in mind the technological means at the disposal of engineers at that time.

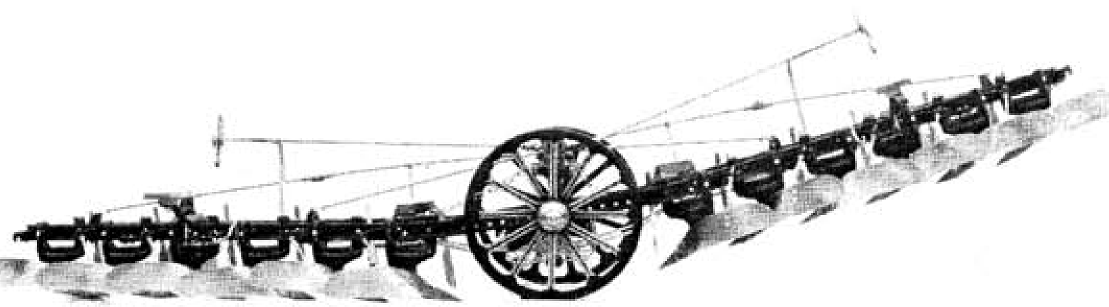
Three knives, situated each end of the twin mould boards, were designed to chop a way through the thick roots of heather to allow the plough to turn a furrow. The bogland which Heathcote was hoping to reclaim, afforded no help to a plough, and it was reported that the two or three unfortunate ploughmen worked waist deep in the mire.

The engine which hauled the plough was the first caterpillar tracked vehicle made, the idea being to spread the load over the soft ground. Two ploughs were hauled, one to and one from the engine which was situated centrally in the field, with moveable anchors on the headlands.

Unfortunately, the trials were abruptly terminated when one night the engine and ploughs sank out of sight, never to be seen again! Perhaps one day the engine can be found and raised—a historic vehicle indeed. Some, however, doubt that it is there but think that it sank too far to be recoverable, yet not out of sight, and that the local population made good use of the wood and scarce metal.

About this time, the first addition to the collection was made which was of some historical interest. This is a model made by the late Mr Albert Whatley of Bucklebury in Berkshire, who worked in conjunction with Hosier Inventions, and it is shown in Fig. 5. It is his development of the balance plough and the main improvement claimed was the incorporation of the power unit on the plough itself. Made about 1930, it is quite possible

Fig. 4. Fowler anti-balance plough. Circa 1917.



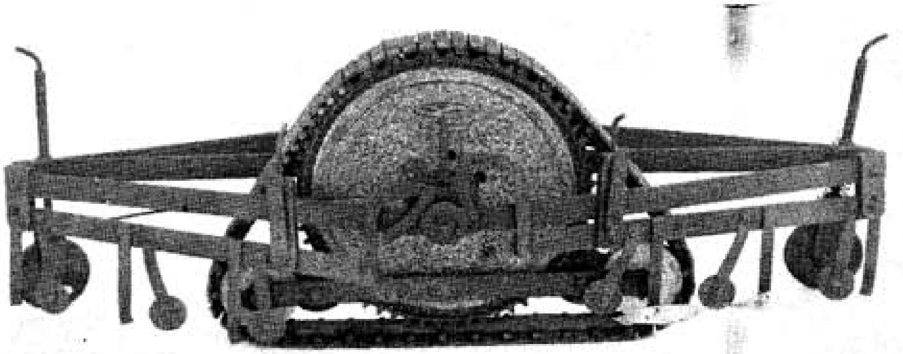


Fig. 5. Albert Whatley's plough, built about 1930.

that it was not intended for steam power but an internal combustion engine. However, it is thought by Mr Whatley's family that steam was the originally intended power, and indeed the general arrangement of gearing and layout suggests this, but later on an oil or diesel engine was envisaged.

Built to approximately 2 in. scale, it is based on a diamond shaped frame which carries in the centre a single large wheel with two smaller wheels one at each end. Around the periphery of the wheels passed a caterpillar track, affording a good grip to the ground. Internally cut gear teeth on the large wheel mesh with a gear on a cranked handle to demonstrate the movement of the model. Along two sides of the main frame are mould boards which are pivoted at one end and a quadrant on the other. A gear on the same centre shaft as the main wheel meshes with the two quadrants and by an ingenious trip mechanism, raise or lower each mould board arm, according to the direction in which the machine is travelling. Thus the problem of anti-balance was solved.

This project did not proceed beyond the model stage, but it is believed that some of the ideas, particularly incorporating the caterpillar track, were later used on converted farm tractors during World War II. The "Timesaver" motor plough of 1920 bears strong resemblance to the Whatley model and it is possible that some inspiration was derived from this machine.

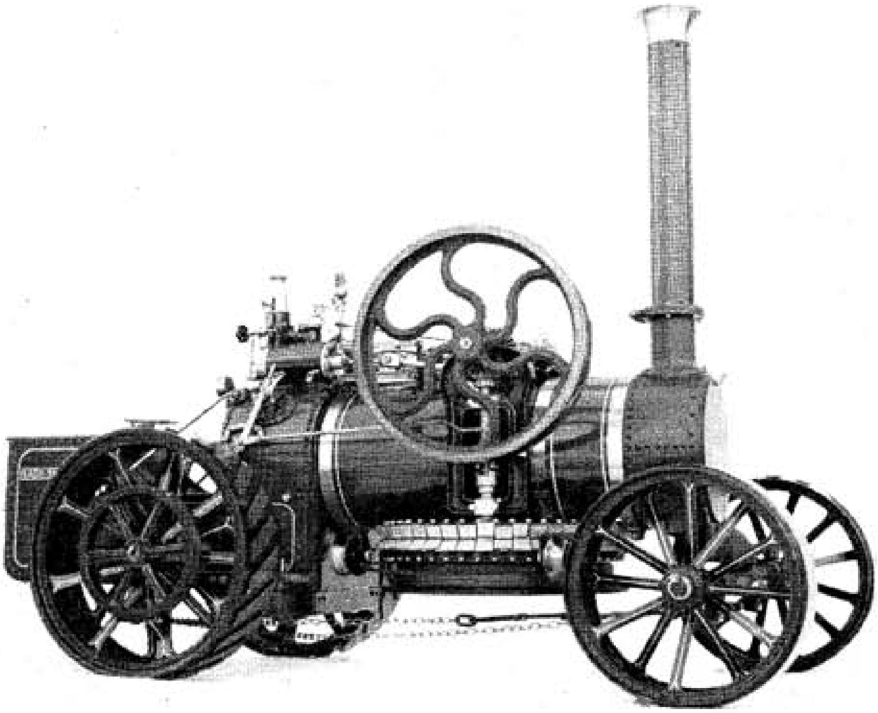


Fig. 6. Mr. C. R. Tyler's 2 in. scale Kitson & Hewitson ploughing engine of circa 1862. This model was awarded a Silver Medal at the recent Model Engineer Exhibition.

A number of nameplates are the only full-size items in the collection, all of them connected with steam ploughing and including Fowlers' smokebox plates and oval boiler number plate, Burrell cylinder plate, John Allen of Oxford, Savages of Kings Lynn—this one is from an engine of 1872—Aveling and Porter, and Ransome Sims and Jeffries boiler number plates; also ploughing engine contractors' and owners' plates of Lord Rayleigh of Essex, James Penfold of Arundel, Sussex and John Patten of Hall Farm, Little Hadham, Herts. A reproduction is included of Fowler's early coat of arms which was used by Fowler until Leeds Corporation obtained a court order to prevent its use on Fowler's engines, as it was almost identical to the City of Leeds coat of arms.

The Kitson and Hewitson ploughing engine of 1862 is shown in Fig. 6. This fine looking engine was the first produced by the well-known locomotive manufacturers to Fowler's design, under contract. The "portable" influence on design can clearly be seen and the handsome lines make an attractive model. In 2 in. scale it complements the later Fowler BB model and represents the first and the last in the long range of engines in the firm's history.

Drive to the rear road wheels was made through what in later years was to become the famous slanting shaft. This made a direct drive through bevels to the wheels. A simple in or out of mesh of the tender end of the slanting shaft bevels provided the "clutch."

Less complicated and smaller than the Fowler BB, she is a period model, pleasant to make and typical of the many types which have yet to be modelled. As none of the full-size engines are left, a model is the only way to see these old engines in three dimensions.

As with the Fowler BB, John Haining produced the design from details and drawings taken from the last known engine during the last war, which had been converted into a coal pithead winding engine in South Wales. The wheels and winding drum had been removed and the engine placed on a concrete plinth, but it was otherwise complete. Fortunately details and measurements were taken before it was cut up for the war effort. It is hoped that the Kitson and Hewitson will soon be featured as a constructional series in these pages.

Increasing collection

An ever-increasing collection of photographs, books and documents complete the collection so far, while plans are afoot to make either or both a Darby Walking Digger and a Burrell-Boydell direct-traction ploughing engine of 1855.

I would be glad to hear from anyone who is similarly interested, or who may know of any ploughing engine information of any type, be it photographs, drawings, etc., which are needed to fill the gaps in the steam ploughing story.

MODEL LOCOMOTIVE LUBRICATION

Continued from page 406

running-in process and prevents scoring.

A steam locomotive needs more running-in than a new car, because the parts are hand fitted, no continuous oil supply circulating under pressure is provided and because the motion is part of the chassis of the vehicle and subject to the strains thereof. Internal combustion engines, whether in cars or locomotives, are separate from the chassis of the vehicle and can be partly run-in prior to installation.

On the first run it pays to allow the locomotive to move up and down for at least one hour and preferably two, without any load. The owner's job is to walk (or run) beside it watching for any signs of stiffness and taking appropriate action. No attempt to tackle a full load should be made until about 10 hours satisfactory running with progressively increased loads have been completed. Plenty of oil all the time is essential. Care at this time will produce working surfaces which will last and which can be obtained by no other means.

Running on compressed air

A final word about running on compressed air for demonstration purposes may not be out of place. Compressed air is cold and it gets colder as it expands in a cylinder. Compressed air always contains moisture, and therefore risk of corrosion exists, as the moisture condenses. What is needed is a thin oil of very good lubricating qualities which will take up this moisture. For this purpose, household oils (like the popular 3-in-1 oil) and cycle lubricants are not recommended. From personal experience, Singer Sewing Machine oil gives very good results.

Passenger cars

Since in 5 in. gauge a single bogie may be carrying about 30 stone in human freight, ball or roller bearing axleboxes are called for. Unless completely sealed, oil is not a suitable lubricant for such bearings due to risk of dust and grit being worked in. These bearings are best packed with a good quality chassis or ball and roller bearing grease, of light or medium consistency. A water-pump grease is unsuitable. ■

COUNTY CARLOW

A 3½ in. gauge G.W.R. 4-4-0 locomotive

by Don Young

Part II

Continued from page 323

BEFORE CONTINUING with the description, acknowledgement must be made for the photographs provided by the C.M.E.'s office at Swindon. These are of *County of Radnor*, No. 3818, and were taken in December, 1906, when the engine was new. They were obtained because the "official" photograph, from Clapham, was of extremely poor quality and did not do the engine justice. Perhaps the Editor will publish the latter print, as it is of historical interest; readers will also appreciate the difference in quality. Incidentally, No. 3818 is fitted with yet another pattern chimney, the tall, small bore pattern, in cast iron. Swindon certainly played some variations on a Standard theme !

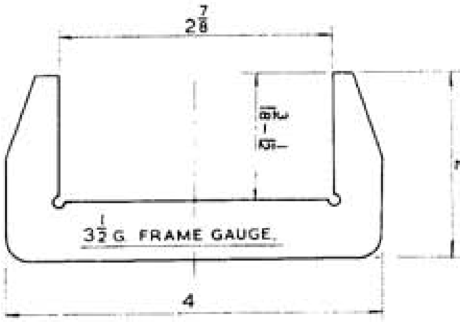
The frame gauge as illustrated is one of my pet aids. Actually it is a bit of a misnomer as it is used to check widths of frame stays, etc., to which the frames are attached. It is best made from ground flat stock, when it will last a lifetime's locomotive building. If access can be gained to a toolroom gauge profiling machine so much the better; if not, mill the two faces carefully. Finish with swiss files, checking with an internal "mike." The 2⅞ in. dimension does not matter to a few thou either way, but the faces must finish parallel.

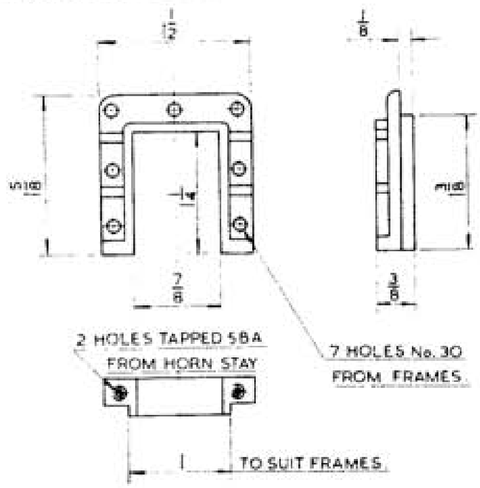
Due to the peculiarity of G.W.R. practice (to me that is) the best method of assembly will be to erect the main frames first, then add the front extension pieces and buffer beam. To copy big *County Carlow* faithfully, the main frames would terminate at the back of the cylinder casting, the latter including half of the smokebox saddle. This huge casting would be difficult to machine so the more orthodox English layout was substituted. Yes, I know Sir Nigel cast all three cylinders and the saddle at one go for the V.2.'s, but think of the expense of a "scrapper" !

We are rather jumping ahead and must return to the horns. As these are rather flimsy, the axlebox slots will have to be machined after erection, to avoid distortion. Chuck in the four-jaw and machine the front and back faces to an overall thickness of ⅝ in. Clean up the casting around the ribs, removing also the ragged edges produced by machining, then tidy up the outer profile.

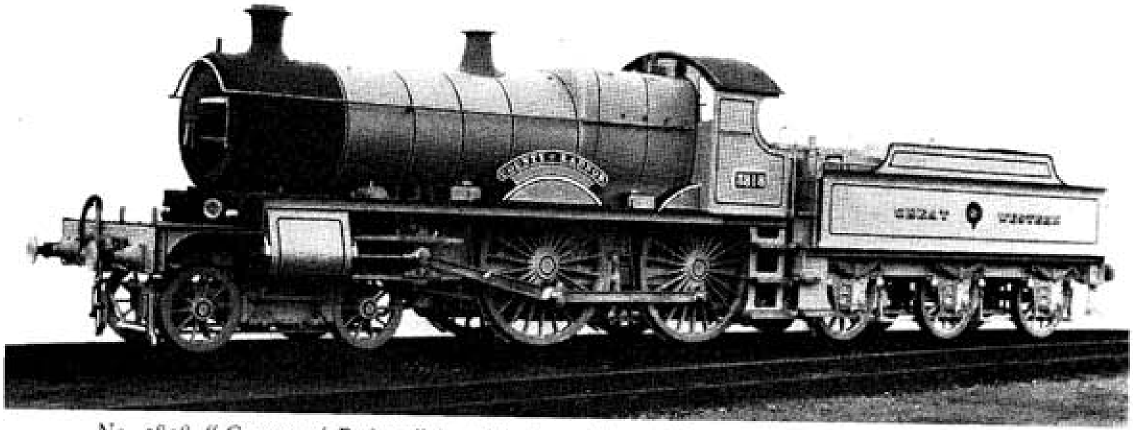
Chuck carefully in the four-jaw and face off the bottom, hornstay seatings. Cut a 15/16 in. length from ¾ in. × ½ in. bright steel flat and drill a 9/32 in. dia. hole in the centre of the larger face. Use this bar as a clamp to bolt the horn to the vertical slide. Check that the hornstay seatings are parallel to the lathe bed, then with say a 5/16 in. end mill, profile the back of each horn to a tight fit in its frame slot.

Clamp the horns into the frames, drill through the top centre fixing hole and fit with 3/32 in. dia. snaphead soft iron rivets. Take a ¼ in. dia. bolt ¾ in. long, complete with nut and fit at the bottom of the axlebox slot in one horn. Unwind the nut





HORNS - 4 OFF



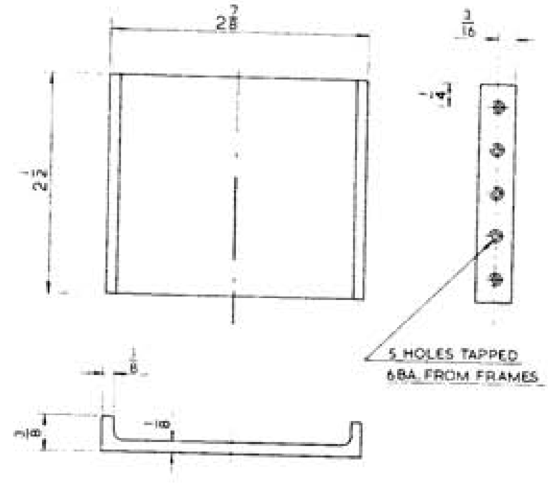
No. 3818, "County of Radnor" in original condition. Photograph courtesy British Railways.

so that the legs of the horn are pressed tightly against the frames, then drill for and fit the remaining rivets. This will ensure that the horns never work loose in the frames, one of the troubles experienced in full size. File flush any projection of the horns through the frames, then bolt them back to back.

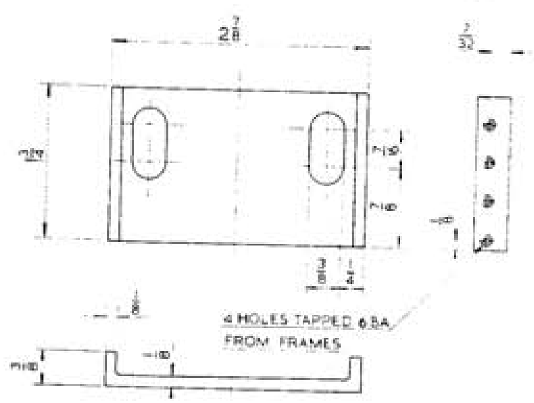
Fit the machine vice to the vertical-slide and grip the frames, with one pair of horns directly in front of the vice jaws. Chuck an end mill of at least $\frac{5}{8}$ in. dia. in the three-jaw and carefully machine the axlebox slides to give a $\frac{7}{8}$ in. gap. Finish the bottom of the slot at the same setting. This set-up is rather flimsy so take fine cuts to avoid "dig-ins." Repeat for the other pair of horns separate the frames and remove any burrs. Oh, one important point missed earlier is that when the frames were parted initially, after profiling, all sharp edges should have been removed. I hope that no-one required first aid treatment because of this omission!

One of the features of most tender engines is a rather massive dragbox at the rear end. This is very useful for a 4-4-0 design, adding adhesive weight where it is most wanted, hence its adoption. Being a lover of fabrications, after seeing some of the beauties on the B.R. "Standards," this settled the method of construction. Shudders from the casting suppliers ! A cast box would prove intricate and expensive.

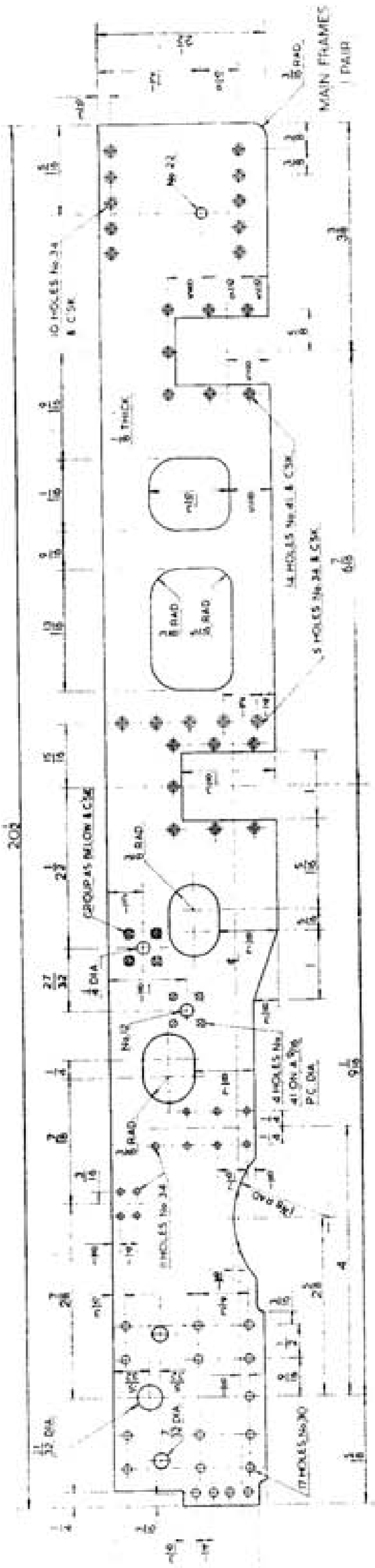
Start with the two side plates, which are $2\frac{1}{4}$ in. square and $\frac{1}{8}$ in. thick. The back is from the same thickness plate, as are all the rest of the pieces and the size is $2\frac{1}{4}$ in. × a full $2\frac{7}{8}$ in. Clamp the pieces



REAR FRAME STRETCHER - OF



MOTION PLATE STRETCHER - 1 OFF



DETAILS OF THE MAIN FRAMES FOR "COUNTY CARLOW"

together and drill from the side plates No. 44 into the edges of the back member. This operation is a little tricky at first, but is soon mastered. Drill into the back member, from the spotted holes, No. 50 to $\frac{3}{16}$ in. depth. Tap 8 BA and assemble with round or cheesehead screws, three per side will be sufficient. Slot the back for the drawbar before fixing. Next cut the top and bottom plates, sizing in place. Drill the drawbar pin hole, profile the cut-outs, then screw to the side plates, same as the back. To complete the box, cut and fit the front plate, which need only be a push fit between the top and bottom plates.

Mix some flux into a thick creamy consistency and apply liberally around all the joints. Light the blowlamp or torch and heat the whole as rapidly as possible. Run spelter into the joints. Speed is the essence of success with steel fabrications, together with plenty of flux, to prevent oxidation.

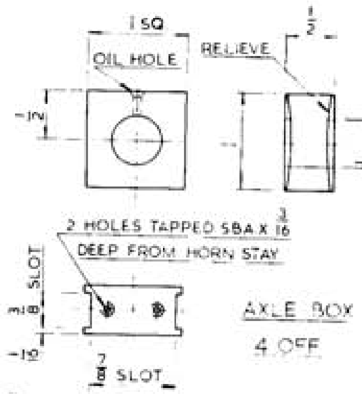
Wash off in warm water, scrubbing off excess flux with an old tooth-brush, then dry. Either file or machine the sides to fit the frame gauge. Clean up the other surfaces with files and emery cloth, then paint all but the machined faces, red is the final colour.

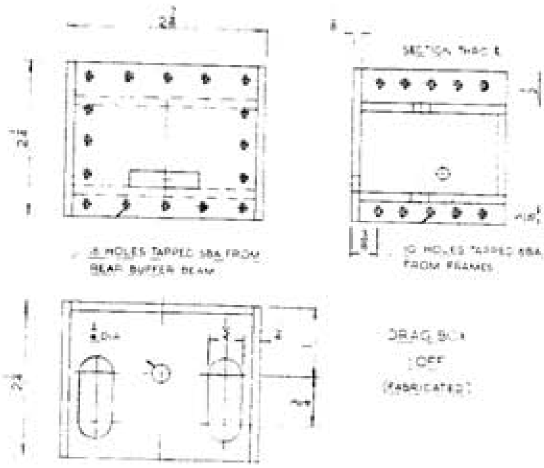
The dragbox comes level with the top edge of the frames. By way of variation in assembly, bolt it to one frame only. This will allow us to adjust the other frame, when the axles are tried in place, before bolting finally together.

Stretchers

The rear frame and motion plate stretchers can be made from identical castings, 2½ in. deep. File, or machine the outside faces to fit the frame gauge, then saw the latter stretcher to 1¾ in. depth, as shown. Clean up the sawn edge and produce the cut-outs for the intermediate valve rods. The odd piece of stretcher remaining will come in very useful as a temporary fixture. Locate it at the front of the mainframes. Drill and tap 5 BA, from two of the No. 30 frame extension holes, at one frame only. Fit the other stretchers in their respective positions, again to one frame only, and clamp the other frame to them. By the way, if anyone is at all hazy as to the correct positioning of any item, the valve gear layout is virtually a cross sectional arrangement and will provide the answers. In the meantime the various "bits and pieces" can be made, so let us proceed to the axleboxes.

The *Ivy Hall* pattern will be suitable, in fact there are many 3½ in. gauge engines with very similar boxes. Cut the gunmetal stick in halves, chuck in the four-jaw and machine width and thickness to finish dimensions, then just square off the ends. Grip in the machine vice, on the vertical-slide and with a ¼ in. or $\frac{5}{16}$ in. end mill, machine

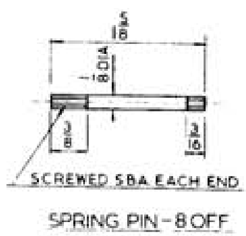


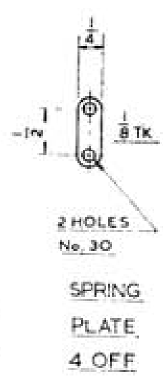


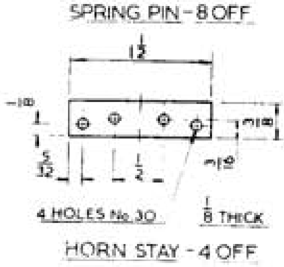
a $\frac{7}{8}$ in. wide slot to $\frac{1}{16}$ in. depth. Note the readings on the vertical-slide micrometer collar, where the final top and bottom edge cuts were taken.

Turn the casting, horizontally, through 180 deg., and produce an identical slot on the opposite face. Take very fine cuts, until the axlebox just enters the horns. Saw the casting again, into individual boxes. Chuck them as a pair in the four-jaw, and face off the sawn, outer ends. Find the centre of one of the 1 in. square faces for the axle centre, and "pop" deeply. Hold the boxes together with the slots machined at each setting adjacent. There will be either a slight physical difference, or a tell-tale machining mark, to distinguish them. Fit pieces of packing into each of the slots, say, $\frac{3}{4}$ in. long by $\frac{5}{16}$ in. wide and $\frac{1}{8}$ in. thick. These packing pieces stand proud of the slots; the pair of axleboxes are next chucked in the four-jaw.

Adjust the chuck jaws until the tailstock centre aligns with the "pop" mark. Centre drill No. 5 and drill through to $\frac{7}{16}$ in. dia. Select a 12 in. length of $\frac{1}{2}$ in. mild steel bar for the axle material. Now, with a boring tool in the toolpost, open out the axleboxes until the axle steel passes through freely, with just a hint of slop. Possessors of $\frac{1}{2}$ in. precision ground steel bar may ream the boxes in lieu of boring. Remove the boxes; stamp or centre pop them on their bottom faces for identification. Try each box in its allotted horn; if it can be pushed to the top of its slot, all is well. Do not force a box in or the frame will distort, just ease the axleboxes slightly. When both boxes are fitted, try the axle steel, but do not carry out any frame adjustment until the second set of boxes are fitted, it would be just a waste of time.







Incidentally, with operations such as above, milling and turning alternatively, instead of breaking down each time and changing from vertical to top-slide, the turning tools are gripped in the machine vice. Providing a little common sense is used on the size of cut applied, this set-up is perfectly sound. The main point to remember is to keep the gib strips properly adjusted, as well as the feed-screws. This is good lathe practice anyhow, to produce reasonable work.

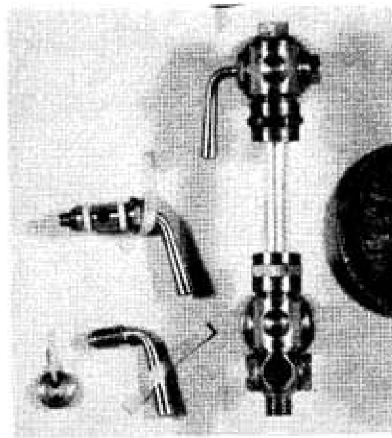
Wind the lathe carriage and tailstock to the end of the lathe bed. Wipe the ways clean, or oil will spread on to clothing and hands, then lay the frames, top edge, on the bed. Adjust until there is no rocking motion, then further adjust until each axle passes through its pair of boxes and turns freely. Clamp firmly, spot through the second frame holes, drill and tap the stretchers and drag-box before securing with screws.

The hornstays come next, they are $1\frac{1}{2}$ in. lengths of $\frac{3}{8}$ in. × $\frac{1}{8}$ in. steel flat. Drill the holes as shown, spot through the outer pair into the horns, drill, tap and fit with 5 BA hexagon head screws. Pack each axlebox up to its hornstay, spot through, drill and tap 5 BA for the spring pins. Thread each end of the pins as shown and screw the shorter portion

Continued on page 412

A Three - Cock Water Gauge

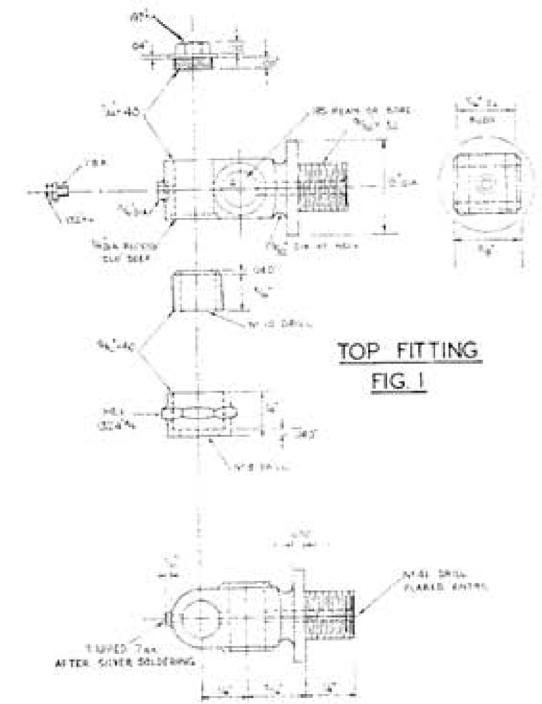
by W. A. Carter



WHEN I WAS building L.N.E.R. No. 3285, I was very conscious of the fact that although I might be able to keep to scale very closely for the majority of the work, the footplate fittings would be a more difficult proposition and that in any case they would certainly be overscale.

Careful consideration was given to the problem and the outcome was that most of the fittings could be made of acceptable size, yet reliable in operation. They were, in outward appearance, representative of those on the prototype and were placed in the correct relative position together with correctly positioned pipework.

Now, the Atlantics had two water gauges of the usual three cock pattern and they were fitted with protectors. A lay-out of the backhead revealed that there was only room for one, because of the generally overscale fittings, but it was decided that the one that remained should follow prototype practice and have three cocks.



TOP FITTING
FIG. 1

I must explain that when I made the original with ordinary taper plugs I knew I was asking for trouble; I had had enough experience of cocks on boilers, but decided to try using modern lubricants and hoped I should " get away with it "—which, of course, I didn't, they ran true to form and stuck fast after a while.

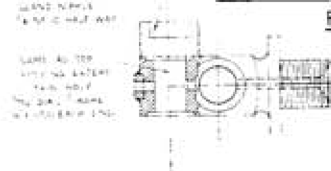
I looked into the possibility of asbestos packed plugs as on full-size cocks, but it seemed pretty hopeless in such small fittings.

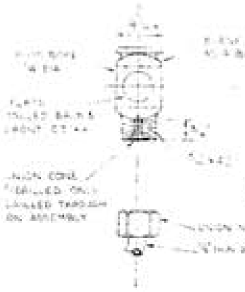
I felt that there must be an answer and it came in the form of O rings. I read Mr Throp's excellent articles in September and October 1964 and designed a ring-sealed plug which is used for the top and bottom cocks. The blow-down cock defied the use of O rings and I adopted the screw-down idea used by the late T. Rowland years ago, except that, by making the thread two-start, a quick opening was obtained by lifting the handle.

The drawings show the actual dimensions of my own gauge and they would be suitable for the majority of 5 in. gauge engines.

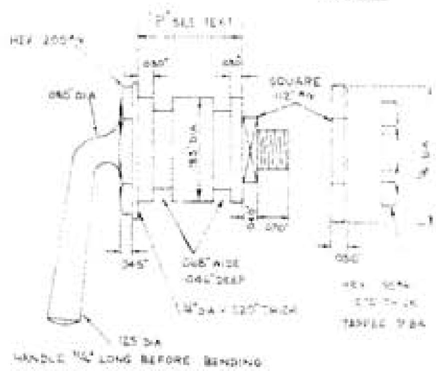
The O ring chosen was of the silicone-rubber variety by Dore Engineering and is the size which is for a $\frac{3}{32}$ in. spindle and with a ring section .050 in. I would suggest drawn gunmental for such steam fittings; leaded brass may be all right for radio terminals, but to my way of thinking it is not suitable for steam. The actual machining calls for

BOTTOM FITTING
FIG 2





DRAIN COCK BODY
FIG 3



PLUG FOR TOP AND BOTTOM
FIG 4

care and accurate working, but I am sure that it will make the job all the more interesting.

Let us consider the top and bottom fittings, Figs. 1 and 2. From $\frac{1}{2}$ in. bar turn and thread the $\frac{3}{16}$ in. × 32 spigots for attachment to the boiler and cut them off the stock, leaving enough for the body length. Prepare a screw chuck and mount each in turn by the thread and with a round nosed tool form the neck and flange. Still locating by means of the screw chuck, mill the remainder of the body $\frac{3}{8}$ in. × $\frac{7}{16}$ in.

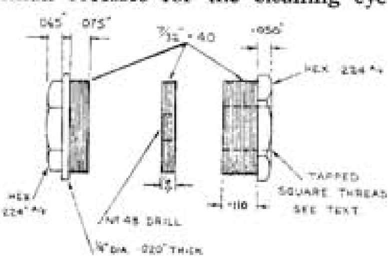
On the $\frac{7}{16}$ in. face, carefully mark the position for the bore of the cocks "A" and on the $\frac{3}{8}$ in. face, the position for the gauge glass fittings. These are best bored using a small boring tool (the .185 in. is an odd size anyway, dictated by the O rings) and I would suggest that for each of these operations, the job be mounted on a solder chuck located by a small spigot: it means making a fresh chuck for each bore, but one can be made in a few minutes and repays the trouble by ensuring that the hole is square to the face of the job.

The top fitting should be tapped $\frac{7}{32}$ in. × 40 and the lower fitting recessed on one side whilst on the chuck. The next move is to make an expanding stub mandrel .185 in. dia. and this is used to chuck the fittings, each side in turn, to machine the $\frac{3}{8}$ in. width back to $\frac{7}{16}$ in., thus forming a $\frac{1}{32}$ in. facing at each end of the bores "A." Now make a $\frac{5}{32}$ in. screw chuck and a $\frac{3}{32}$ in. expanding chuck to hold the fittings for the recess on the top fitting, the other recess on the lower fitting and for holding both fittings for milling the rounded ends. The small recesses for the cleaning eye bosses can be machined by using the $\frac{5}{32}$ in. screw chuck. The gland nipples and the cleaning eye bosses are made next, ready for silver soldering into their respective recesses.

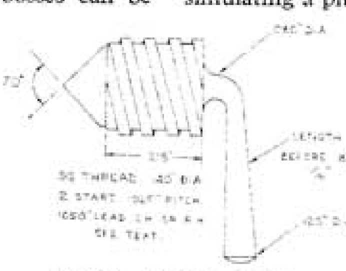
Blow-down "cock"

This is really a screw-down valve! The body, Fig. 3, is turned as a sphere with a $\frac{7}{16}$ in. × 40 male union connection and a $\frac{1}{4}$ in. dia. spigot to match the lower recess of the bottom fitting. Two flats are milled on the sides of the sphere to give a width of $\frac{1}{4}$ in., and this is bored through $\frac{1}{8}$ in. dia. into which is fitted the little bush "B," which is tapped $\frac{7}{32}$ in. × 40. When tapping this bush, use a taper tap and stop cutting before the thread has been brought to size—reason for this later. The bush is silver soldered in when the time comes, so that it projects an equal amount each end; the purpose of this bush is to add a little to the much needed space to house the parts of the valve rather than making the ball profile larger. The two small flats, back and front, are for appearance only—the prototype had them so why not the model?

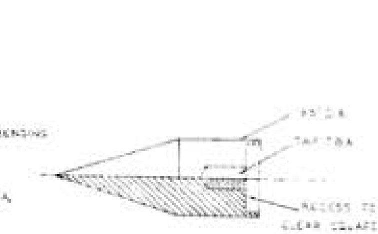
The next stage involves some really interesting work. The thread on the blow-down valve, Fig. 6, must have a large pitch in order that a quarter-turn opening will be sufficient to clear the glass (thus simulating a plug cock). This will mean a two-start



END CAPS AND SEAT
FIG. 5



BLOW-DOWN PLUG
FIG. 6

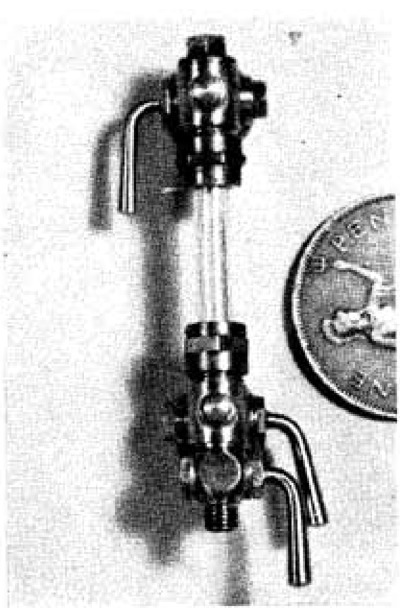


'O' RING ASSEMBLY JIG
FIG. 7

thread, which will have to be screw cut and whilst we are about it, it may as well be a square thread. At this point we shall have to consider which "hand" the blow-down handle is to be; if it is on the R.H.S. of the gauge the thread will be left-hand and vice versa—I said it would be interesting! Prepare a little tool, .013 in. wide, taking particular care to get the helix angle right. A tap will be required so we can cut that while we are all set up for 20 t.p.i. Do not bend the handle yet.

Having made the valve and the tap, make the caps and seat shown in Fig. 5 and follow with another interesting job: the two plugs shown in Fig. 4, with their nuts and washers. Two important points to observe: (a) the square in the washer must be a tight fit in the mating square; the slightest movement would inch the nuts loose in no time, (b) all sharp corners on the .183 in. dia. must be removed, a touch with a watchmaker's pivot file would be just right. The dimension "P" should be made .002 in. greater than the width of the top and bottom fittings over the facings, taken from the actual job. The dimensions of the slots are very important and you should take care to obtain the greatest accuracy possible, as the success of O ring sealing depends on this. The handles of these two plugs may be bent at this stage. The top cap, cleaning plugs and gland nuts are simple jobs and complete the bits and pieces.

Another view of Mr Carter's three-cock water gauge.



Assembly

Easy-flo No. 2 silver solder .025 in. wire is just right for little jobs like this (Whiston stocks it), the very minimum makes a neat job. Start by soldering bush "B" centrally into the drain cock body, which in turn is soldered into the bottom fitting, at the same time as its gland nipple (the bottom one is different from the top nipple) and the cleaning-eye boss. The top fitting can have its nipple and its cleaning eye soldered in, which completes the hard soldering.

After cleaning off the flux and generally tidying up, finish tapping the bush "B," which will leave the threads bright and clean and ready for the next operation. Screw in the seat, Fig. 5, so that it is exactly equidistant from each end. Apply Baker's Fluid to the periphery of the seat, by means of a piece of wire, and drop in three pieces of soft solder about 1/32 in. cube (hammer out some solder and cut it up with scissors—handy stuff). Space the solder to the outer edge, well away from the hole, and heat the fitting gently over a bunsen flame and watch the solder flow round and seal the thread. We now have two chambers separated by the valve seat.

Now comes a tricky bit of drilling to connect the chambers to their respective points. For a right-hand handle blow-down, the left-hand chamber will be the pressure side and a No. 48 drill must be passed down through the nipple at such an angle that it will just break through on the left-hand side of the valve seat. The "way out" from the right-hand side of the seat is made by drilling up through the centre drill mark at an angle to break through into the right-hand chamber: it sounds more complicated than it really is. For a left-hand handle blow-down, the drillings will be to the opposite sides of the valve seats.

Screw the square threaded cap into its appropriate side, tighten it up and screw in the square threaded valve stem tightly and mark the handle as a reference for bending so that in the bent state the handle will be pointing downwards when the valve is tightly closed. Take it out and carefully bend the handle.

Now we come to the O ring plugs. Assemble from whichever side is correct for the prototype with a stout paper washer under their heads so that they are gripped tightly for drilling, with their handles pointing down (for open) and drill through with a No. 41 drill. Take out the plugs, discard the paper washers, clean off any burrs and the job is finished.

A word about the O rings: they are wonderfully efficient but their efficiency depends upon the accuracy of the allowances arranged for them and also their freedom from damage caused by sharp edges, so their assembly on the plugs calls for a little jig as shown in Fig. 7. Made from brass, it enables the rings (greased) to be slid over into their grooves with the utmost ease. Make sure everything is finished before the rings are put on because it will be difficult to remove them without damage.

Careful and accurate workmanship is called for in the making of this water gauge, but the result, in the form of an absolutely leak and stick-proof three-cock gauge, is a joy worth the trouble. As a demonstration I closed one of the cocks after months of standing idle by using nothing stronger than a blade of grass looped over the handle. Some may doubt the wisdom of using waterways less than the bore of the glass but so far I have had reliable and "freely live" readings during the two years the gauge has been in use. ▣

INTERNATIONAL MODEL LOCOMOTIVE EFFICIENCY COMPETITION

THE FIRST COMPETITION WILL BE HELD ON THE ILLSHAW HEATH TRACK OF THE BIRMINGHAM SOCIETY OF MODEL ENGINEERS

ON SUNDAY, JULY 20th

(by kind permission of the Committee of this Society)

20 LOCOMOTIVES OF 3½ in. OR 5 in. GAUGE WILL COMPETE FOR THE MARTIN EVANS LOCOMOTIVE CHALLENGE CUP AND £25. SECOND PRIZE £10.

THIRD PRIZE TWO YEARS' SUBSCRIPTION TO M.E.

The Competition is open to any type of 3½ in. or 5 in. gauge coal-fired steam locomotive. 16 entries are invited from recognised model engineering societies, (one from each club) home or abroad, and 3 from individuals. Entries from societies should be made by the Secretary or Chairman.

CLOSING DATE FOR ENTRIES — JUNE 1st

No entry form is being issued—send your entry direct to the Editor

A FEW YEARS AGO there were some 1/8 h.p. 24-volt electric motors on the market. Although I did not have any use for these at the time, I bought a couple and put them on one side until I could find a use for them. I should point out that they were ex-W.D. and represented very good value for money. I regret to say that as far as I can tell these motors are no longer available. They were about 5 in. long × 2½ in. dia. The output shaft was of 5/16 in. dia. and 3/4 in. long with a key way. Three terminals were located under a dust-proof end cover making it possible to reverse the motors.

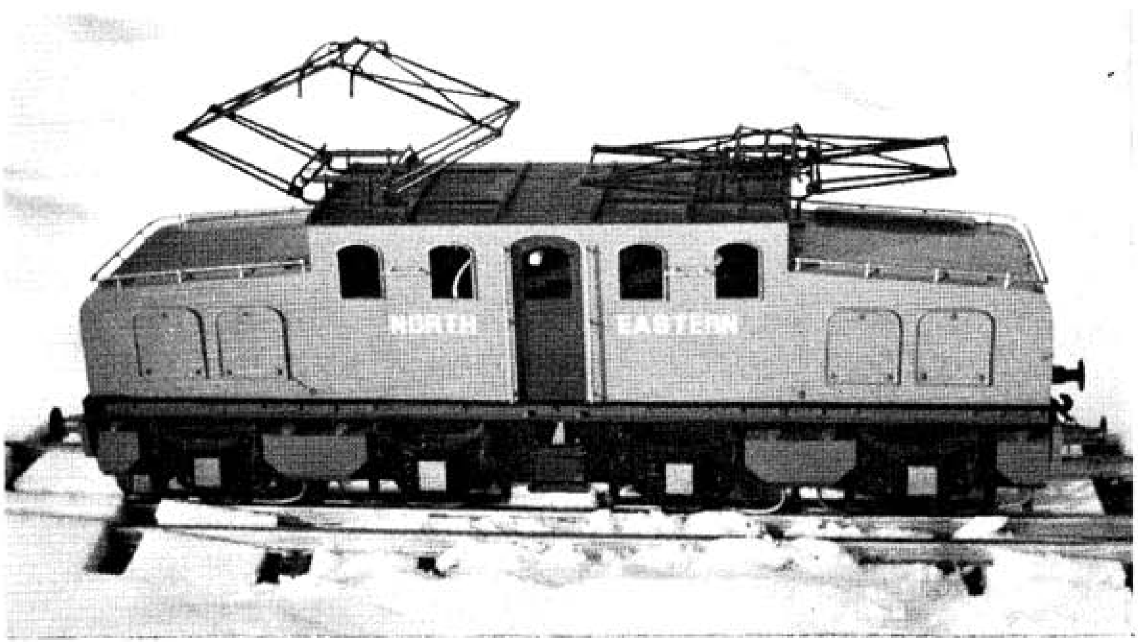
S. R. SPALDING

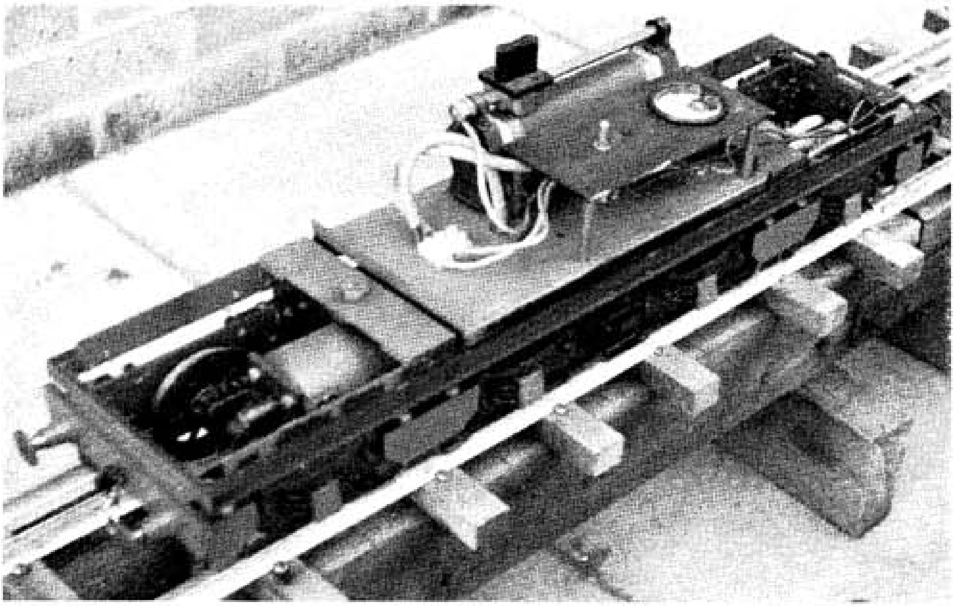
describes the construction of

3½ IN. GAUGE ELECTRIC LOCOMOTIVE

I suppose in some ways it is a mistake to buy parts that *may* some day prove useful: most model engineers must have boxes full of assorted equipment that may prove useful some day, the difficulty being to find a suitable model in which to use the parts. The correct method is to design the model and then make or buy the necessary parts. However, last year when I rediscovered the two motors, I was looking round for a new project, having just completed a steam engine, and I thought that the motors would be suitable for a model passenger-hauling electric locomotive.

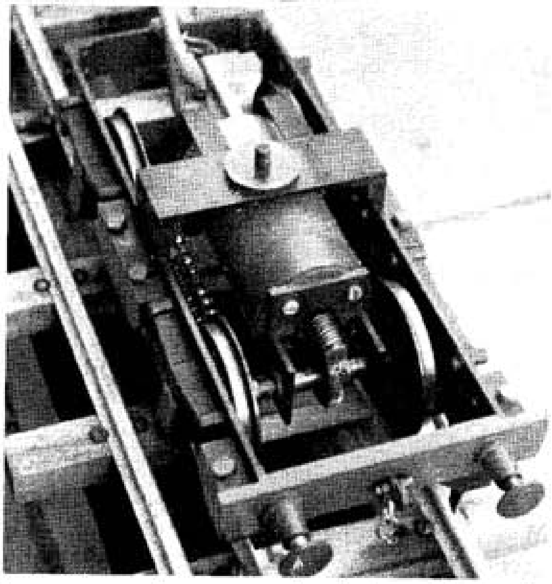
As the size of the motors was fixed, the scale of the model would have no effect on the power output, so I decided on 3/4 in. to the foot as a suitable scale that would give a model that could be handled with ease, but would be large enough to accommodate the two motors. I really wanted to carry the batteries also in the locomotive but after working out the size of battery required for live passenger hauling, I decided to have a driving truck with batteries. As to the prototype, I must admit I had thought of electric and diesel locomotives as tin boxes on wheels, but after looking through a number of books about electric locomotives, I changed my mine—some of the earlier Swiss locomotives would make excellent models. I





Left: Body removed to show details of electrical control mechanism.

Below: One of the motor bogies showing details of mounting the electric motor.



wanted a locomotive from a British railway, however, and so decided on the North Eastern 0-4-4-0 electric, class EB1 mineral locomotive. This class was designed by Vincent Raven and was built at the Darlington Works in 1914. The locomotives worked mineral trains on the Shildon-Newport line from 1915 until 1935. After a run-down of traffic they went to Darlington for storage and were withdrawn and sold for scrap in 1950.

Blueprints for this engine were obtained and a start made on the detailed design work. From the outset it was apparent that the choice of prototype was a good one. I found that there is no more work in a model of this type than in a tender for a steam locomotive. The two bogies are large enough to accommodate a motor each. I do not propose to go through all the details of making the various parts, as this has been frequently described. However, it may be of interest to point out some of the features of the bogie design.

All the wheels are driven and sprung and to do this was a little difficult. The motors are supported on the driving axles and the drive is by a worm and wheel giving a 40-1 reduction. The rear of each motor is attached to a couple of strips of bronze, enabling the wheels and motor assembly to move in the axlebox guides. This is a simplification of the nose suspension system used on the full-size engines. Using this system, part of the weight of the motors is unsprung, but it has not given any trouble on the track. The two axles on each bogie are coupled using 8 mm. chain and sprockets and, although not yet fitted, there is room for a chain tensioning device. The details of the bogie will be apparent from a study of the photograph. Although the design may look a little weak, I can assure the reader that it has given no trouble after 100 miles running. Both bogies are the same and when fitted to the body the worm drive is on the two outer axles. The springing is by small coil springs between the top of the axlebox and the frames.

The two motors are permanently wired up in parallel and a three-way switch gives forward off and reverse. The motor speed control has proved to be the most difficult part of the job. It was found that on 24 volts the current consumption is high under starting conditions. With a really heavy load and plenty of adhesion, as much as 30 amps could be drawn from the batteries. It was obvious that the motors must not be allowed to draw so much current if they were to last. A suitable rheostat of about 20 ohms resistance 240 volts was bought from a Government surplus store and has proved fairly satisfactory, in addition a circuit breaker which trips at 20 amps was bought.

Rheostat control is not ideal as too much battery energy is dissipated as heat from the rheostat coil. The present driving technique is to accelerate to top speed and get the controller out of the circuit. Then most of the energy is being used for traction. I feel that a thyristor control circuit could well be used in this model. However, the high price of components has stopped any experiments on these lines. A 2 in. ammeter with a red line at 15 amps. is fitted and drivers told not to exceed this current consumption.

After the model was completed lead weights were added to increase adhesion. However, these have proved unnecessary and the model has been lightened to such a point that the wheels will slip on a dry rail as soon as the current reaches 20 amps.

Initial trials of the model were encouraging. Two 12 volt batteries connected to give 24 volts were used and carried on the driving truck. The engine could haul three adults at the fairly high speed of 10 miles per hour. Once the engine had reached this speed the current consumption was about 12 amps. on level track. One thing which has baffled me is that on a rainy day with a wet rail, the current consumption went down with the same load and speed. Before making the model the battery life had worried me. However, the battery will last for about 2½ hours running; this must not be continuous as the battery should be given time to recover between runs of 15 min. or so. I feel that for normal running the battery has proved quite satisfactory.

One problem which has not been solved is the overheating on one motor. This is caused by one motor taking over more of the load than the other. In full-size this is overcome by cross connecting the field of one motor to the armature of the other. This causes the loading of one motor to adjust the speed of the other to the balancing point, the process being called concatination. However, the two motors would have to be in series if this method were used.

Information on building passenger-hauling model electric locomotives is fairly scarce, but to any person thinking about making one I would say, "Have a go." The performance may well be a surprise to them and it has the advantage of instant availability. It certainly hasn't the charm of a steam locomotive, but on the other hand it can be built very quickly and for a fraction of the cost.

THE LUBRICATION OF MINIATURE STEAM LOCOMOTIVES

by Group Captain J. N. C. Law, F.I.Mech.E.

THERE ARE SO MANY differences between the operation of miniature, passenger-hauling locomotives and full-scale practice, that a fresh approach to lubrication problems is required, if disappointment and the ruination of the hard-earned fruits of labour are to be avoided.

To consider some of the differences, the most important is the pattern of usage. Miniature engines are expected to haul loads a good deal heavier than are strictly fair, interspersed with long periods out of use. The boilers are pressed to give a tractive effort some four or five times the scale equivalent with proportionately increased bearing loads. Operations are often of a shunting nature with severe gradients thrown in and seldom much opportunity of steady running round a continuous track.

Different materials are used in small scales: up to 5 in. gauge, bronze or gunmetal cylinders predominate, whereas these materials are never found in full-scale practice for cylinders, for which purpose only cast-iron or ferrous alloys are accepted engineering practice.

Common Materials for Model Steam Cylinders, Pistons and Valves

	Copper	*Zinc*	*Tin*
Bronze (gunmetal)	90	—	10
Best Brass	80	20	—
Common Brass	70/75	25/30	—
Machining Bronze	80/90	2/10	5/18
Phosphor Bronze	85/95	5/10 with up to 2½ per cent Phosphorus.	

All these materials contain a large proportion of the same metal, copper, and they are all relatively soft. To obtain good wearing qualities between two rubbing surfaces, it is desirable that these should be metallurgically dissimilar and that at least one of the materials should be as hard as practicable. The usual choice of materials for cylinders, valves and pistons for miniature locomotives satisfies neither of these requirements, and to obtain reasonable wearing qualities in $3\frac{1}{2}$ in. and 5 in. gauge special measures are necessary.

High speed and light load are the easiest conditions. For engines that normally run round and round an oval track, "Hornby-wise," and are not running very frequently, high rates of wear with scoring of cylinder bores and valve faces are not likely to be a problem. But shunting activities, especially with heavy loads, are an entirely different thing and the problem then becomes one of getting the right lubricant, in the right place, at the right time, in the right quantities. And for this pattern of use the conventional type of oscillating pump has severe limitations. A hand pump to supplement the oil feed may become a necessity.

Lubricants

For steam cylinders in cast-iron, good cylinder oils are available. These are either straight mineral oils or are compounded with animal or vegetable oils such as lard and rape oil. The straight minerals are normally intended for saturated steam and slide valves, the compounded oils for superheated steam and piston valves. These oils may be dark or light in colour depending upon whether they are made from unfiltered or filtered stock. The light coloured filtered oils are usually the more expensive. Valvoline was the traditional example.

Neither straight mineral nor compound cylinder oils are designed for anything except cast-iron because no other material is ever used in normal practice for cylinders. It is therefore not to be wondered at, if results are disappointing with bronze cylinders and heavy scoring is encountered. A compounded oil has a better prospect of success, owing to the chemical nature of the compounding fatty oil.

However, this is skating round the problem. If a decision is taken to use bronze for the cylinders of any locomotive in order to avoid the corrosion associated with cast-iron, then the best way to obtain satisfactory lubrication with little wear is to use a heavy SAE 140 grade of *mild* extreme pressure lubricant, and plenty of it. Several of these are readily available from garages for automobile use. In addition there are colloidal graphite and molybdenum disulphide which have useful qualities, but chiefly for ferrous working surfaces. For cast-iron the former is particularly good, especially during running-in. Iron castings contain some 4 per cent of occluded graphite, which is an important factor in the good wearing qualities of this material.

Types of lubricants

The main types available from the motor trade and from Halfords are:

a. *Mild extreme pressure oils.* Mostly for gear boxes etc., in SAE, 80, 90 and 140 viscosities.
b. *Full extreme pressure oils.* For hypoid rear axles. Usually SAE 90 viscosity. This is of similar viscosity range to SAE 50 engine oil, but with additives.
c. *Engine oils.* Viscosity range SAE 10, 20, 30, 40 and 50, including several Multi-Grade varieties. The latter have now superseded the former to a large extent.

Generally speaking there are three lubrication categories to be considered for miniature steam locomotives. These are:

a. *The cylinders.* Normally fed by mechanical or displacement lubricator. At 100 p.s.i. the temperature of saturated steam is 330 deg. F. Superheat is additional and in full-scale, 600 deg. F may be reached or exceeded. With the dart-type superheater in miniature scales, temperatures may be comparable.
b. *The motion work.* By and large, all the motion work carries heavy loads and much of it runs more or less hot by conduction of heat from the cylinders. Normally lubricated by oil-can. Ordinary motor engine oils run off too quickly.
c. *General chassis lubrication.* This includes axleboxes, eccentrics and miscellaneous gear, not subject to conducted heat (axleboxes adjacent to fireboxes excepted).

Recommended Lubrication Table

Material	*Cylinders*	*Motion*	*Chassis*
Bronze	SAE 140 E.P.	SAE 140 E.P.	SAE 90 E.P. or Heavy grade engine oil
Cast-iron	Superheated Steam Cyl. Oil	Cyl. Oil or SAE 140 E.P.	SAE 90 E.P. or Heavy grade engine oil

Suitable lubricants which have been satisfactorily used over a period of years are:

SAE 140 E.P.—Shell Spirex 140.
Castrol Hipress (but this is lighter viscosity).

SAE 90 Hypoid—Shell Spirex 90 E.P.
Castrol Hypoy.

Steam Cylinder Oils—Shell Fiona Oils. (These are lighter grades.) Compounded and non-compounded.

Steam Cylinder Oils (continued) Shell Nassa J 85 (compounded; specially recommended for superheated steam).
Valvoline.

Note 1—It is most important that hypoid lubricants should not be used in steam cylinders because of the risk of chemical decomposition and resulting corrosion.

Note 2—The Shell Nassa range of lubricants appear to have some anti-corrosive qualities and are ideal for cast-iron cylinders.

Note 3—The use of Shell Spirex 140 for steam cylinder lubrication is unlikely to be supported by the makers, but since no special lubricant is made for the purpose it is suggested as the best so far available for bronze cylinders.

Rates of oil feed

Many locomotives run better, with less friction and wear, with a higher rate of oil feed to the cylinders. The presence of oil round the chimney is a good guide and it should always be possible to see oil there. With bronze cylinders the amount of oil passing should be copious, necessitating wiping off at intervals. If there is plenty of oil, piston packings will remain in good condition. With too little oil, packings shrink and harden, becoming ineffective and inviting scoring of cylinders.

The amount of oil required depends upon the load and running conditions. Since there must be sufficient oil under the worst conditions, it is inevitable that excess will be supplied at other times, until some ingenious model engineer develops a lubricator which will feed oil in direct proportion to the steam flow (as is the case with a two-stroke i.c. engine running on petroil lubrication).

Ratchet wheels in use on LBSC lubricators usually have about 36 teeth. With these one complete delivery stroke of the pump is made every 36 revolutions of the driving wheels, but all the oil is delivered in less than 18 revolutions; none is fed during the remaining revolutions. Engines with small wheels can do with less oil than those with larger wheels, and the normal oil feed is usually sufficient for such engines as *Ajax, Juliet, Butch,* etc. This is because in a given distance run, few revolutions are made by larger wheels and less oil is fed. The work done in each revolution by an engine with large wheels is more than by a similar engine with smaller wheels.

For engines with larger wheels, such as mixed traffic and express types, this oil feed may not be sufficient. The linkage to the lubricator can be adjusted to give two clicks per stroke, so that the pump makes one complete revolution to every 18 of the driving wheels. For heavy pulling, especially with large wheels such as *Maid of Kent* ($6\frac{3}{4}$ in. in 5 in. gauge), the lubricator can well be adjusted to give one stroke every 12 revolutions of the driving wheels. Even so, this is only one stroke of the pump for every 22 ft. travelled by the engine.

It is not good practice to run the oil too low in the lubricator because air bubbles may enter the pump and reduce the oil feed. Sticky steam cylinder oils do not feed too well especially when cold. The nearer a lubricator is to the smokebox where there is plenty of warmth, the better it should feed. After 30 to 45 minutes running a normal size lubricator should require replenishment. When it has taken years to build a good engine, economy in oil does not make sense.

Assembly

Pistons may be of bronze, brass or aluminium alloy. A bronze piston with bronze cylinders seems wrong in principle and a change to brass will bring in zinc as the alloying metal, in contrast to the tin in the cylinder block. Brass is sometimes selected for cast-iron cylinders if a packed piston is used, but 1 thou clearance per inch of bore will be needed to avoid seizure due to differential thermal expansion. Light alloy pistons will run well in cast-iron bores, but may be subject to corrosion owing to condensation of water. There is little evidence to show that light alloy pistons are a good proposition in steam cylinders, however good they may be for i.c. engines.

The following procedure with brass pistons in bronze cylinders will be found effective, whether new or requiring attention. Firstly, tin the piston. This is easily done by mounting the piston rod in the chuck and running the lathe at low speed, applying gentle heat by bunsen burner or similar means. After applying solder to the working face of the piston, but not to each end face or in the packing groove, the excess solder is "wiped" off by means of a damp cloth held against the piston as it rotates. A smooth and silky finish should be obtained. The surface may then be polished with graphite powder. Messrs. Hall and Hall (the "Hallite" people) used to produce a very fine grade filtered through silk, in 1 lb. tins to order.

A really good braided, graphited, square section packing is needed. "Supeta" brand made by Walkers of Woking is excellent. It is important that the packing should be compressed into the grooves. "O" rings are coming into fashion and a point to watch is that the material of these is compatible with the lubricant selected.

It is also good practice to tin the working face of slide valves before assembly, as this assists the

Continued on page 393

JEYNES' CORNER

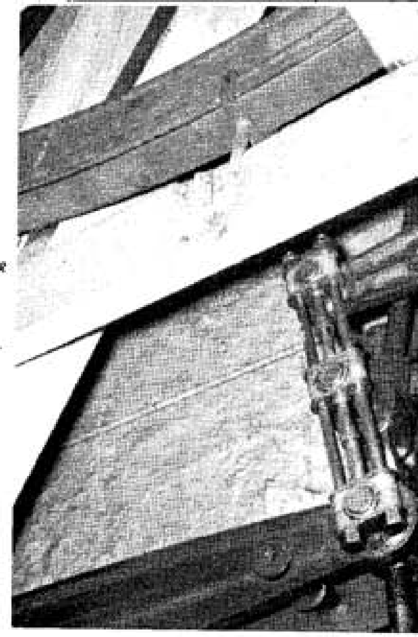
E. H. Jeynes on Winding Engines

I WAS VERY pleased to see the excellent drawings made under Mr J. Harrison's supervision, by the Eston Grammar School boys, of the Crowther type winding engine at Beamish No. 2 Pit; in passing, I would say that these are not the first drawings I have been able to examine, coming from the same source, covering archaeological subjects.

There are, however, several points which disagree with my own notes on this particular engine, and on which, if I am wrong, I should be glad of the opportunity to correct them. The excellent drawing on page 192 rather perplexes me, as it is underwritten, "Beamish Mary Pit Winding Engine." Now the Mary Pit engine I have noted as No. 380 of 1887, a much later type by Joicey, which I believe, incorporated a substantial proportion of cast-iron in its structure, compared with the subject of the article, Joicey's No. 20 which had a wood A frame to support the inboard end of the crankshaft.

I imagine the difference in the stonework under the outboard crankshaft bearing might have been caused when the other winding drum was removed; this was geared to the crankshaft, and operated from outside the engine house, and used for bringing timber from the yard to bank; this could only be used when winding however, and may have been superseded by the horizontal engine noted by Mr Harrison.

I must take exception to Mr Harrison's remark that the "Under and Over" (universally used with single winding drum) system of ropes gives a balancing of cages and ropes: cages and ropes in suspension are only in approximate balance near the point of passing, which is midway in the wind (unless a system of head and tail rope working is used, and this is most unusual). The weight of rope between cage at Bank, and point of suspension on head-gear pulley, would only weigh hundredweights: but the weight of rope between point of suspension and cage at Bottom would run into tons; the deeper the pit, the greater the difference. It was for this reason, and to assist single cylinder engines, that the counterweight system was evolved; I mentioned this in my article of November 3, 1967, and Mr Watkins dealt very fully with the subject, also giving illustrations in *Model Engineer* for July 1968.



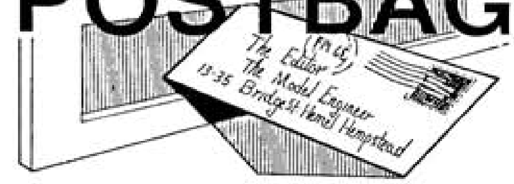
A view of the bottom of the fly-wheel showing brake stirrup supporting brake band: Beamish No. 2 Engine.

When the engine ceased work, after 107 years winding, one of the four Lancashire boilers had semi-circular surrounds to the furnace doors carrying Joicey's name, presumably having been supplied by the builders of the engine at some later date.

The isolating steam-valve mentioned by Mr Harrison, was I think connected to the overspeed winding governor. This was on the ground level, driven by roller-chains from the crankshaft, via a countershaft. I have never examined the brake closely on this engine, so I was greatly surprised to learn that oak blocks were bolted to the periphery of the flywheel rim: imagine the very large number of holes which would require to be drilled and tapped, radially into the rim of the flywheel! I would have thought the frictional material would be bolted, or riveted, to the brake-band itself, which could be removed, and worked on in the comfort of the fitting-shop. Even a spare band could be kept in case of emergency; to renew blocks bolted to the rim would be a major operation (unless done while ropes were changed, otherwise, the whole weight in suspension would have to be barred round, and the rim is over 60 ft. in cirmumference). Another thing which occurs to me, is that as the blocks wore down, the diameter would be reduced, thus the braking power would be reduced. It is only reasonable to suppose that when a new set of oak blocks were fitted, they would require turning. In a photograph I have, the braking material appears to be fitted to the brake-band.

I have recently noticed a growing opposition to the re-erection of this engine, and other large exhibits which can only be accommodated out-of-doors, both from Beauty Spot lovers, and resident farmers who begrudge the use of land for this purpose.

POSTBAG



The Editor welcomes letters for these columns. He will give a Book Voucher for thirty shillings for the letter which, in his opinion, is the most interesting published in each issue. Pictures, especially of models, are also welcomed. Letters may be condensed or edited.

Bench tests and boiler design

SIR,—In "Smoke Rings," March 7, you mention the S.M.E.E. Test Bench. There is an article in M.E. September 21, 1950 (Vol. 103), page 439 by Mr Wildy describing the tests you refer to. Another article appears in the Journal of the S.M.E.E. for May, 1950, page 73-75, which perhaps contain further details than Mr Greenly's book. One of the difficulties was tendency to slip, which may have caused premature dropping-off of pull at speed; another may have been difficulty in keeping the firing rate up.

From the charts, the 0-6-0 seems to have developed maximum d.b.p., or, strictly, railhead pull of 11.8 lb. at 2½ m.p.h. Rated tractive force of this engine at 85 per cent boiler pressure is 60 lb. adhesive weight not stated. The "Gladstone" maximum 19.1 lb. at 4.3 m.p.h., rated t.f. being 32 lb., again no a.w. stated. I am inclined to suspect slipping at speed, unless pressure drop between boiler and steam chest became appreciable, and no measurements of this are included in the data.

I wonder whether the S.M.E.E. can supply results of any subsequent tests, in which the difficulties of 1950 may have been overcome? I was shown the Test Bed when I visited the Wanless Road headquarters in 1958, and Mr Wildy said something about trouble with slipping.

The fact that overall thermal efficiency is low in models need cause no despondency; it is bound to be so in any steam engine, and to become worse as cylinder dimensions and piston speed in ft. per min. become smaller, but, at the same time, a given increase in steam temperature makes a bigger improvement in a small than in a large cylinder, hence the desirability of superheating in models.

When I see contributors advocating large ports and passages in model cylinders, I sometimes wonder if they are not overdoing it—in effect, designing for track speed that cannot safely be attained in actual running.

Referring now to boiler design, do you not agree with me that plate joints in steam boilers held with soft solder instead of brazing, are a positive menace unless soundly riveted? Mr Westbury, in his series "Boilers for Beginners," fails, it seems to me, to draw any attention to this important matter. Soft solders, being tin-lead alloys, weaken rapidly as temperature rises above 200 deg. F, and they all begin to melt at 361 deg. F, hence Mr P. F. Janes' report in April 5, 1968, page 335, in which a soft-soldered boiler head blew out at 110 p.s.i. only (341 deg. F).

In your *Simplex* article April 5, 1968, page 337, the contributor quoted as saying that crown-wrapper staying is essential, was wrong in thinking that its purpose is to relieve the foundation ring. In the *Simplex* boiler, the stress in p.s.i. on the plates at the foundation ring is practically the same as that at the endplate and backhead joints, and these are half of the circumferential stress in the barrel at the same pressure. Why, then the need for shell stays, since the wrapper is circular? The girder stays on the crown sheet are good, since this is a case of external pressure upon a "tube" rather than internal.

Windsor, Ont. H. S. GOWAN.

Traction engine practice

SIR,—With reference to my article on hornplate construction (August 2, 1968) and the letter of Messrs. Digby A. Wrangham and W. J. Hughes of January 3 and February 21, 1969 respectively; perhaps I should make clear that I did not mention in detail the method of using a single length of boiler tube to include the outer firebox wrapper in one piece with the barrel, as this was fully described and illustrated in the article of August 5, 1966 covering the construction of the 2 in. scale Fowler BB ploughing engine boiler. After slitting to the centre-line and longitudinally, the opened-out ends of the tube are extended each side by the addition of a dovetailed strip, bringing the outer wrapper to the required depth, a method which I think is to be preferred for the long ploughing engine boiler.

Regarding the other points raised; the outer ends of the hollow stays should be machined back to allow the hornplates to sit close to the wrapper plate, on assembly, making a barely perceptible increase in the scale width over the plates, but a good sound mounting. With the exception of engines fitted with a cylinder casting having a flat flanged base sitting on a flat machined upstand riveted to the outside of the boiler shell, it was not common practice to use an *external* stiffening pad; if it is desired to use this method on a small scale engine, the dimension from cylinder centre-line to machined radius of the curved base flange should be reduced proportionally, thus keeping the distance from cylinder centre-line to boiler centre-line correct to scale.

An external pad does have the advantage of being easy to machine to suit the cylinder radius, despite not being quite typical of general full-size engine construction. Luckily, most machining and constructional problems encountered in model engineering seem to be capable of solution in more than one way, and I am sure that both the above correspondents will agree that this is a very good thing, bearing in mind the wide variation in equipment and skill encountered in the home workshop, and the appalling price of raw material these days.

Usk, Mon. JOHN HAINING.

P V. Baker

SIR,—I am currently building LBSC's *P.V. Baker* and am experiencing many difficulties due to inadequate detailed drawings and drawing errors. Perhaps some of your readers who have succeeded in completing *P.V. Baker* could give some advice ?

1. The dimensions of the Baker valve gear give a total valve movement of ⅜ in. whereas the piston valve requires $\frac{5}{16}$ in. for full port opening. My cylinder ports cannot now be altered but how should the valve gear be modified ?

2. The method shown on the drawing for linking the two valve gears is too flimsy to work.

3. What is the large flange on the top of the boiler for ? Obviously not for the regulator which is a disc type.

4. With the boiler the same size as the smokebox, how is the lagging fitted?

5. Does the engine need a snifting valve?

6. How many more stretchers are needed in addition to the one shown on the drawing?

I am amazed that, despite the fact that the errors on the drawings must have been noted before now, no corrections have been made.

Redditch. P. A. FRAWLEY.

LBSC did not usually specify lagging on his boilers. Regarding the valve gear, the total movement obtained (⅜ in.) is almost certainly correct.—EDITOR.

Steam turbines

SIR,—*Re:* Mr J. A. Radford's letter on steam turbines (M.E., February 7), I would like to ask if he wants to design a steam car or a milk float; 100 volt lead acid batteries indeed! As far as I can see small steam turbines are not yet a viable proposition at present for motor cars. To compete with the internal combustion engine the design has to be simpler and cheaper. This will not be achieved by the use of expensive and difficult to construct turbines. Mr Radford's idea though interesting is far too complicated.

The following may be of interest to Mr Radford. From experiments taking place the best working pressure seems to be from 1,000-2,000 p.s.i. Mr Radford's "Pancake type motors" are, I presume, to drive the car from starting position until steam pressure is raised. This is not necessary as the time lag now is very small. The Smith and Petersen experiments in U.S.A. have reduced the time from starting from cold to moving off to 8-15 secs. As you can see this is no reason to employ a secondary power system and they believe that this can be cut still further. The fuel most used in the majority of experiments is paraffin; as an example the Williams Brothers' cars cruising at 70 m.p.h. use 1 gallon per 25 miles. These new steamers are said to be easier to drive than an auto-transmission internal combustion engine car.

If it is any consolation to Mr Radford, a millionaire called William Lear is entering two steam cars for the Indianapolis 500 in May. One is a reciprocating type, the other a turbine; so it can be done.

I do not think that steam turbines are for model engineers Mr Radford, we have not the facilities or the finance.

Haywards Heath. M. J. CRUTTENDEN.

2½ in. gauge

SIR,—I have followed with some interest the correspondence in the last few numbers of *Model Engineer* on the deadness or otherwise of the 2½ in. gauge. In my view it is far from dead. I myself have built two locomotives, and have four more in the shops, and I am fortunate in having the facilities to run them when completed; so I am to that extent biased. Nevertheless I may perhaps ask for some of your valuable space in order to present the matter in somewhat broader perspective than has so far been apparent.

First, may I sum up as briefly as I can the advantages and disadvantages of the 2½ in. gauge?

Advantages:

1. Lower first cost in raw materials, though nowadays not necessarily in castings or machine-tools.

2. Portability and saving of space. This consideration operates more especially for those of riper years, or those who would rather have a "little big 'un" than a "big little 'un." Here again the availability of aid in man-handling as well as ease of transport and stowage may well play a large role.

3. In the light of these considerations, and for those who wish to run outdoors, 2½ in. gauge is about the smallest size on which more than the driver can conveniently be hauled. It is also about the smallest practicable size for the making of "live steam" coal-fired small editions of inside—or multi-cylindered real or imaginary prototypes. In this connection I would respectfully venture to discount Brigadier Richards' strictures on the smallness of the clearances which occur in such types as *Mary Ann*. These clearances can be made perfectly adequate for working purposes. Few of us, of course, can claim Mr Keiller's skill and patience, but his example is there for all to strive at, if not to emulate.

Disadvantages: These have already been so heavily enlarged on that they can be more briefly summarised. I would list them as follows:

1. Inability to haul more than four adults.

2. Need for greater skill in management (mainly firing) and for greater frequency of stops for replenishment.

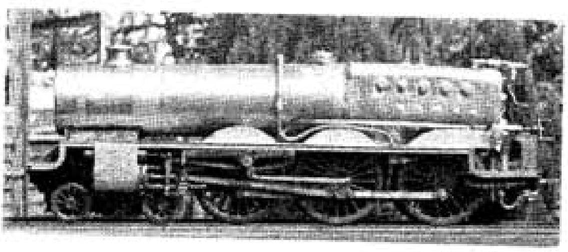
3. The need to work to closer limits in manufacture, with awkwardness in such items as sizes of firedoors and backhead fittings, coupling-up (in the case of a tender engine) and the need to break up the coal smaller, with consequent losses in dust and slack.

How far one is prepared to discount these drawbacks must clearly depend on one's general approach.

Now to turn to the somewhat vexed question of Club Tracks and Passenger Hauling. Had I been writing Mr Williams' letter, I would have said rather that "Practical passenger hauling is not the be-all and end-all of many model locomotive builders and operators." So much for individuals: for Clubs the position may well be different, and their line of effort may be dictated by their need for "viability," which may in turn depend on revenue from passenger-hauling, owing to the difficulty nowadays of finding a ground of their own. But it should not be forgotten that Clubs so placed, though they may be in a majority, do not constitute a totality. Other clubs (of which my own is an example) are more happily situated, and in such cases—again *pace* Brigadier Richards—where even one or two members only are prepared to stand up for their own views and back their convictions if need be with cash and work, the extra rail needed on a 5 in./3½ in. track to accommodate the smaller size can be laid in without insuperable difficulty (except in the case of all-welded tracks). In this way the line may become accessible, not only to some more of their own members who would otherwise be debarred from running, but also to more members of visiting clubs.

Too much has been made, Sir, of your apparent reluctance to cater for the 2½ in. gauge. You justify this by opinion-poll statistics (on which I am inclined to share the late Sir Sam Fay's views on statistics in general) and no doubt your own early experience with *Mary Ann* have reinforced this view. But for the benefit of others I would suggest that this raises no unsurmountable obstacle, if anyone wishes to build to your excellent designs in other gauges. It is indeed laborious, but not impossible, to scale up or down from a given outline design. LBSC and Mr Maskelyne have shown the way, and, unless intended for exhibition in their own right, drawings so prepared need only be finished enough to guide the builder. Standard dimensions (such as back-to-back distances between wheels, the separation of main frames, and suchlike) are readily available in published works: scantlings can be likewise determined by studying the work of LBSC and others; so that laying out the chassis should present few difficulties. If I wanted to build *Nigel Gresley* in either 3½ in. or 2½ in. gauge, I should start on these lines: but in addition, at an early stage, take care to provide myself with at least one view lengthwise following Greenly's example). This would be, for preference, a cross-section through the firebox, to enable me to determine boiler and other clearances in the frames for future reference.

It is a commonplace that boiler redesign for a given size presents the crucial problem, and needs separate treatment. Given the outside dimensions, and the plate-thicknesses required to stand a given working-pressure, how are we to arrive at the most effective layout of the "innards"? Here again a great deal of information is available from our existing authorities and researchers (of the former I am thinking more especially of Mr Keiller, whose findings on firetube length/diameter ratios were published in the M.E. in 1939; of the latter, Mr Ewins' name immediately springs to mind). If this information be intelligently studied and applied, design should present few difficulties; manufacture must of course depend on the builder's skill, diligence and resources. But, in our calculations, we could use as a starting-point LBSC's observation that, for a coal-fired boiler, the firetube bore should not be less than 5/16 in. if undue blockage is to be avoided, and this is valid throughout the range from 2½ in. gauge or less and 5 in. gauge. As regards superheater flues, plenty of information has also been published; in addition, Mr Cox's remarks on full-size practice (see the relevant pages in "Chronicles of Seeam") regarding the relation between firetube heating surface can be studied with advantage, though the execution of his precepts in the smaller gauges may be difficult, and Mr Ewins' or Mr L. J. Green's findings may provide a surer guide.



May I end this long screed with some small experience from my *Olympiade*—still, after 28 years, in process of completion? Her boiler is a first-class steamer: to judge by earlier performances on compressed air, her chassis should furnish her with power enough to haul myself and three 11 stone adults; but her pistons now need repacking if not renewing. I shall try O-rings. Lubrication in this engine may be rather a problem, and, as for dismantling, her smokebox offers a "plumber's nightmare." Nevertheless, I hope to have her running successfully next season.

She now has her tender, and her outside "plumbing." The boiler is now lagged with fibreglass, and cleaded with nickel silver sheet, 28 gauge, which seems to take the paint reasonably well. I have fitted sliding firedoors, as I have had nothing but trouble with "oven doors," which, with their baffles, always get in the way of the shovel at crucial moments. For this I have won space by fitting a "banjo"-mounted adaptation of Mr Cottam's design of water gauge, which is fitted with O-rings and has given no trouble either in fitting or steam. The "top-dressing"—i.e. platework—is ready for fitting when she has run successful trials round the furlong of our Society's track.

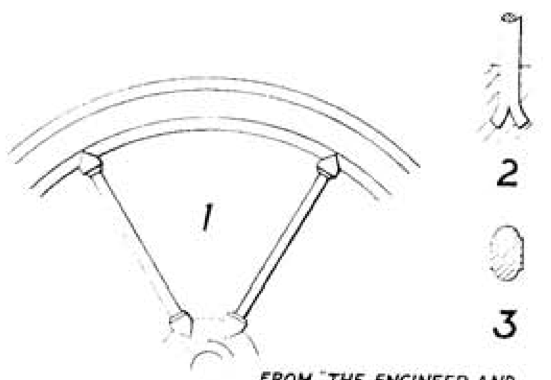
Cheltenham. R. GREIFFENHAGEN.

SIR,—May I briefly reply to Mr B. K. Bibby's letter (February 7). It was not my intention to discourage the builders of 2½ in. gauge engines. The point which I missed in suggesting a small 3½ in. gauge engine in preference to one of 2½ in. gauge has come out in subsequent letters. The 2½ in. gauge builder is aiming at one of the larger prototypes—such as a "Britannia" or a "Duchess," and this explains the choice of the smaller scale. Perhaps this point was not made clear at the outset.

From his wide knowledge of society tracks, our Editor might give us an idea of how many clubs run 2½ in. gauge tracks. Apart from my own, I have only heard of one such track, condition deteriorated. The larger the prototype, the larger the track radius required for satisfactory running. Of course one can erect a straight up-and-down track, but an express engine cannot show at its best on a stop-and-start road.

As regards detail, a certain degree of robustness is required from a live steam engine which is not needed in a 4 mm scale job. They get quite different handling.

Abergele. D. J. R. RICHARDS
(Brigadier)



FROM "THE ENGINEER AND MACHINISTS ASSISTANT," 1846.

Table engine flywheels

SIR,—When I saw the photograph of a table engine with the wrong kind of flywheel, on page 171 of M.E., February 21, I remembered I have an engraving of a table engine as built by Murdoch, Aitken & Co. at Glasgow.

This is in "The Engineer and Machinist's Assistant" published by Blackie & Co. in 1846.

The diameter of the wheel, of which Fig. 1 shows two spokes and part of the rim, was 10 ft.

The rim and the boss were iron castings, the spokes were wrought iron; it was common until quite recent years for rope pulleys, and flywheels, including some very small ones, on hand-worked mangles and pumps, to be made in this way, and the spoke ends would be split as in Fig. 2, no steel spokes before about 1885. At Fig. 3 is a section of the rim of the flywheel in Fig. 1, drawn to the same scale.

The book I refer to is an instance of the rewards to be obtained by keeping an eagle eye open everywhere; a stationer in a seaside town was selling off the contents of an underground store-room, and this splendid two-volume work on early Victorian engine builders and millwrights' work was among the rubbish.

Seeing the fine picture on the cover, February 7, of the model from Crewe, recalls to my mind another splendid model I saw when a boy at Alexandra Palace, one of the " Brighton ' steamers on the Newhaven to Dieppe run, and I believe designed by Stroudley in the " eighties " of the last century.

This model was about six feet in length, and when I saw it, was getting into a ripe state. Was it taken in hand by anyone and reconditioned, or has it vanished, along with so many other precious relics ?

That model from Crewe also suggests something else. Did Thomas Aveling copy the colouring and lining of Allan's engines for his traction engines and rollers. There used to be an Aveling roller at Hackney, new just after the first war, which had almost the identical colour of this Crewe model, and the lining very similar; it seemed to be traditional. Note the " real vermilion " colour on the frames of the Crewe engine. No doubt this wonderful colour is unobtainable now. I believe it was made from mercury; I think you will find it was imported from Canton, or " Chinese Red," and deadly to absorb through the skin.

London, N.W.7. H. H. NICHOLLS.

The late Dr Hallows

SIR,—*Re:* Postbag, February 20 and the late Dr Norman Hallows. As a reader of *Model Engineer* for only a short time of some six years, I would say that the passing of Dr Hallows was a very great loss indeed to the world of model engineering.

On visiting the last Model Engineer Exhibition, one thought kept going through my mind: What is the possibility of having a Dr Norman Hallows Trophy at a future exhibition for a workshop tool or workshop appliance ?

I do feel very strongly about this. I would like to know how other *Model Engineer* readers feel.

Seaford. J. A. CORNWELL.

COUNTY CARLOW

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hard into the axlebox. Remove each box in turn and relieve the flanks of the slots as illustrated. The box can then tilt without side play. At the same time drill the oil supply hole in the top of the box, countersinking deeply, as a reservoir. Re-assemble and elongate the spring pin holes in the stay so that axlebox tilt is not restricted.

Check with the axle material again that one box can be lifited approximately 1/16 in. above its partner, this movement being free. Any tendency towards stickiness and sooner or later the engine will part company with the track. Cut eight 1 in. lengths from a 3/16 in. O.D. " Terry " compression spring, make up the little spring plates and assemble with 5 BA nuts. Final adjustment of the springs will be done with the engine in working order.