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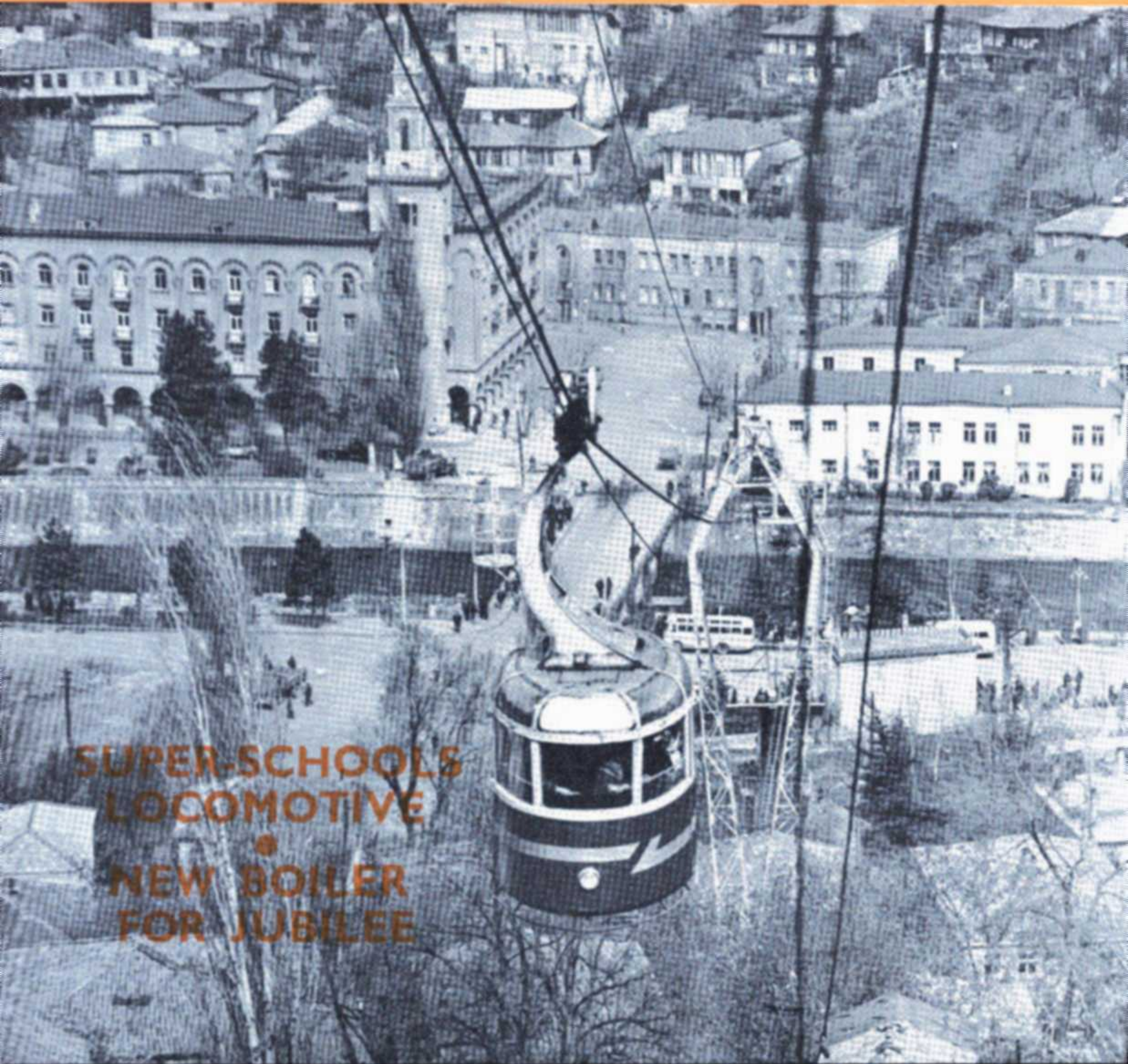

SUPER-SCHOOLS LOCOMOTIVE

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Model Engineer

Founded 1898

Incorporating Mechanics and English Mechanics and Ships and Ship Models

17 June 1966 Volume 132 Number 3299

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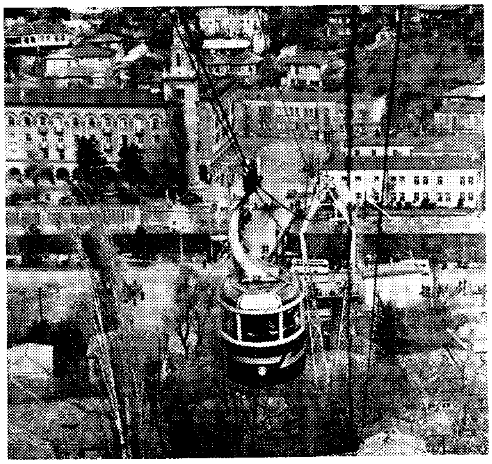

Cover picture

The new passenger cableway in Georgia, USSR. Some details are given on page 530. Photographs by courtesy of Novosti Press Agency.

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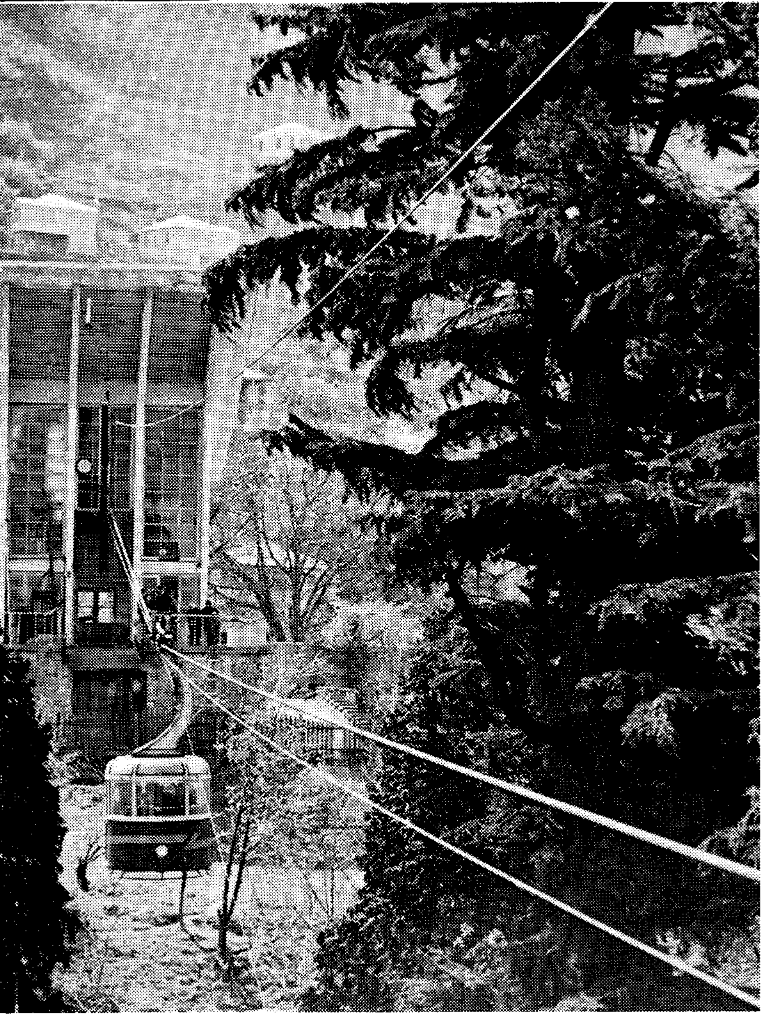


SMOKE RINGS

A commentary by the Editor

Soviet Cableway

OUR cover picture and the photograph reproduced above show a new 2000 metre overhead passenger cableway which was recently opened for service in the town of Chiatura, Georgia, U.S.S.R., a town noted for its manganese deposits. The cableway connects three miners' settlements with the centre of the town and consists of three independent radii with a single station.

The cableway was designed by Georgi Pantsulaya, who has assisted in the design of no less than 300 cableways in industrial centres in Georgia, the Urals, the Ukraine, Armenia and Latvia. With a difference in altitude in the Chiatura district of 200 metres, cableways are found extremely useful for conveying the manganese ore, some 15 million tons of which is handled every year.

Model Locomotive Design

IN his letter to Postbag in this issue, Mr. K. N. Harris defends his argument that model locomotives should be designed from first principles, and should not be slavishly scaled down from their respective prototypes. No doubt Mr. Harris has a very good argument here, but he spoils it by taking as an example the Johnson *Princess of Wales* class single-wheelers.

These engines were never so good as some of Johnson's earlier examples, and most observers agreed that they were somewhat over-cylindered.

If Mr. Harris refers to some of my earlier remarks on this subject, he will find that I claimed that the practice of scaling down cylinder size and boiler external dimensions was only applicable to highly successful full-size designs. Also I never intended this to mean that cylinder bores should be *exactly* scaled down. My own practice is generally to reduce the cylinder bore very slightly from the exact scale dimension.

Another point is that I have never said that my argument applied to single-wheelers. It is equally true that I never said that such engines were exempt, but most locomotive men would agree that single-wheelers are so prone to wheel-spin that they must be considered separately.

I think if Mr. Harris takes a more representative class of full-size locomotive, one that has been thoroughly successful in service, he will find that my contention is not so very far out after all. Take my *Springbok* design for instance. Although I have received one or two very minor complaints, those who have built the engine seem very pleased with it, and I have not had one single complaint (so far!) that the engine is over-cylindered. Yet it has cylinders almost to scale dimensions plus a working pressure of 100 lb.

While I agree that it is a mistake to design a model locomotive that is likely to turn out really over-cylindered, if I was faced with the choice of one that was over-cylindered or one that was under-cylindered, I would prefer the former any time! After all, we can very easily lower the working pressure.

In his argument about connecting rod proportions, K. N. Harris is on a better wicket, though I might well ask him why, if he agrees that connecting rods may be made to scale, he invariably shows very heavy connecting rods on his model designs!

LBSC versus K. N. Harris

Already, many letters have been received regarding the possibility of a locomotive efficiency contest between LBSC and Mr. K. N. Harris. The idea appears to have aroused tremendous interest, and it is only natural that many readers tend to "take sides". A selection of these letters will be published as soon as space allows.

More than one reader seems to think that it is unfair to put up a "standard" *Maid of Kent* against an engine that Mr. Harris can now design purely with the winning of the contest in mind. But those who take this point of view seem to be losing sight of how the original challenge was made and accepted. I think it is important that the facts about how this matter started should be kept clearly in mind, otherwise we shall all be constantly be-devilled by "red herrings"!

This friendly "battle" was undoubtedly started by the appearance of two "re-designs" of well known locomotives by LBSC (*Maid of Kent* and *Speedy*) from the drawing board of K. N. Harris. LBSC's reply to this was the following statement (Postbag March 4):— "When K. N. Harris can design AND BUILD a $3\frac{1}{2}$ in. gauge locomotive with a boiler not more than $3\frac{1}{2}$ in. dia. which will pull a 12 stone load for $2\frac{1}{4}$ actual miles *without touching the fire*, as I have done, then—and only then—will his criticisms be worth attention".

To this challenge, Mr. Harris replied (Postbag May 6) that he was quite prepared to design and partially to build a 5 in. gauge 4–4–2 tank engine of about equal nominal power to *Maid of Kent*. LBSC's challenger to be built strictly to his own specifications as published in M.E. and fitted with his version of Stephenson gear. . . .the trials to be arranged, observed, recorded and reported upon by an independent committee of experts. . . .etc. etc.

To my mind, this is all quite straightforward, and if LBSC was to design a completely new engine with the sole intention of beating Mr. Harris, it would be very interesting, but could not possibly have any bearing on the subject under dispute.

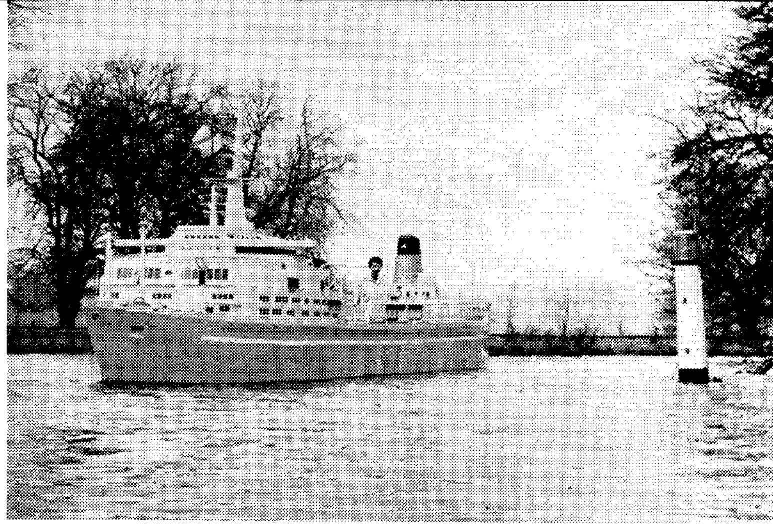
Incidentally, my first reaction was that LBSC's original challenge was quite a reasonable proposition, but on reflection, the fact that a $3\frac{1}{2}$ in. gauge locomotive with a $3\frac{1}{2}$ in. dia. boiler will pull a 12 stone load for $2\frac{1}{4}$ miles without the fire being touched means nothing in itself. Firstly, it would be considered very bad driving to pile up the firebox as high as possible and see how far the engine would go before the fire went low; it could not possibly have any connection with efficiency, or even normal good performance. Such a performance could always be achieved by the use of a very deep firebox and a very free-running engine!

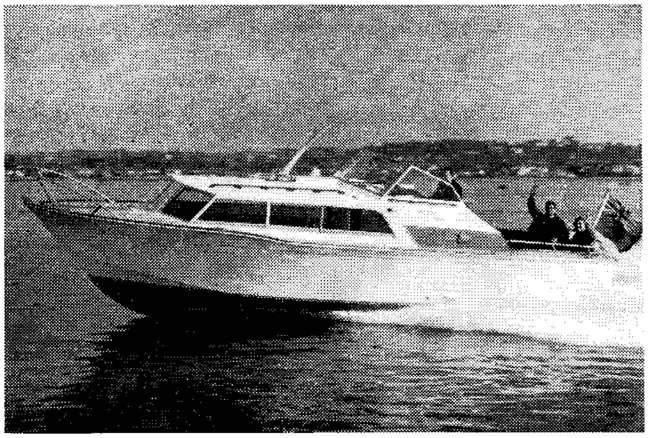
Another correspondent appears to think that the argument really revolves around the question of the size of the steam passages in the cylinders, as LBSC has always kept these on the small side, while K. N. Harris has opted for large passages. He suggests that a model fitted with LBSC type cylinders should be tested, and then, after the passages have been opened out to the "Harris" dimensions, tested again! But of course this could prove nothing. The engine would probably be worse with the larger passages!

It has been stressed by Mr. C. M. Keiller, and by many other writers since, that it is useless specifying large passages, *unless the rest of the steam line is designed for them.* To use large passages successfully we must have the minimum practical piston/cover clearance volume in order to keep the total clearance volume to the minimum, we must also have reasonably large steam chest volume, and the passages themselves should be as short and direct as possible. Added to this, the cross-sectional area of regulator port, main steam pipe, superheater elements, branch pipes to cylinders, branch pipes to exhaust, blast pipe and nozzle must ALL be adequate, otherwise the whole conception falls to the ground. This of course has been proved in full-size work without a shadow of doubt; whether it applies equally in small scales has not been definitely proved, though the evidence that it is so, is I think fairly good.

Mini-Liner

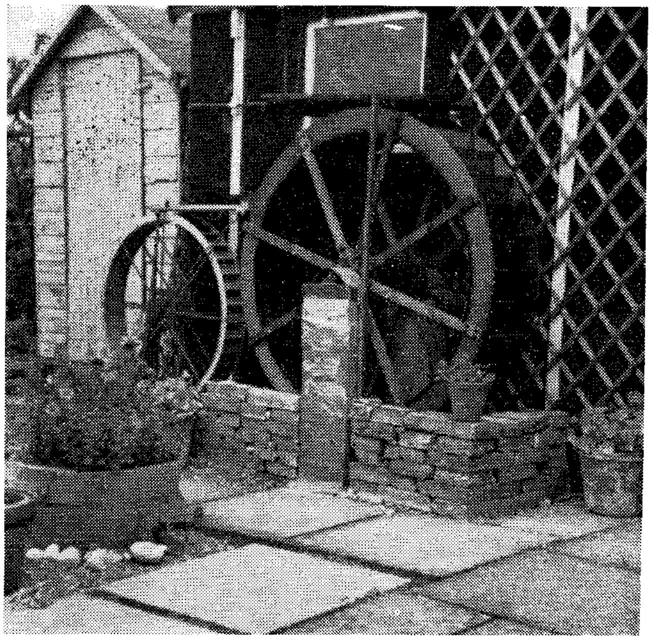
THE picture reproduced, above right, shows the mini-liner *Northern Star* on trials on Stapleford Park Lake, Leicestershire. This miniature liner carries 36 passengers, displaces between 2 and 3 tons, and is capable of 5 knots. Stapleford Park, the home of Lord and Lady Gretton, is now again open to the Public, each Sunday and Thursday afternoon, and on Bank Holidays.





THE picture above is of a new 31 ft. motor cruiser powered by twin Perkins diesel engines, and is one of the range designed by Cox & Haswell of Poole, and built by the Christchurch Yacht Co. She has a speed of 30 knots.

The photograph below shows a model water wheel, made by John Young of Dunfermline. The larger wheel is made of red wood and the smaller of zinc. They revolve on ball-bearings and rain water from the roof is the motive power.



WORKSHOP WAYS AND MEANS

Banjo Unions *By Artificer*

THE type of pipe joint known as a banjo union is often used as an alternative to other forms of pipe joints when neat and compact assembly is called for. Whereas the usual form of union joint, fitted to a flush face or boss of a major component, must necessarily project perpendicular to it for a distance at least equal to the union body and connector nut assembly, plus the minimum radius of the pipe bend, the banjo union assembly requires less than half this axial length, and the pipe can be laid parallel to the major component, at the minimum distance from it.

For these reasons, the banjo union, typical examples of which are shown in the assemblies A, B and C, is specially suited for lubrication or other limited-flow services where tidiness is a cardinal virtue. On the other hand, the passageways through this type of union are less direct, involving abrupt change of direction, and often some restriction of flow, compared with the usual form of union. It should not, therefore, be used where the maximum rate of flow, and streamlining of passages, are required. A further disadvantage of the banjo union is that it involves joints on two flat or bevelled faces, which thus need to be very accurately machined to make a metal-to-metal seal, or the insertion of two fibre washers.

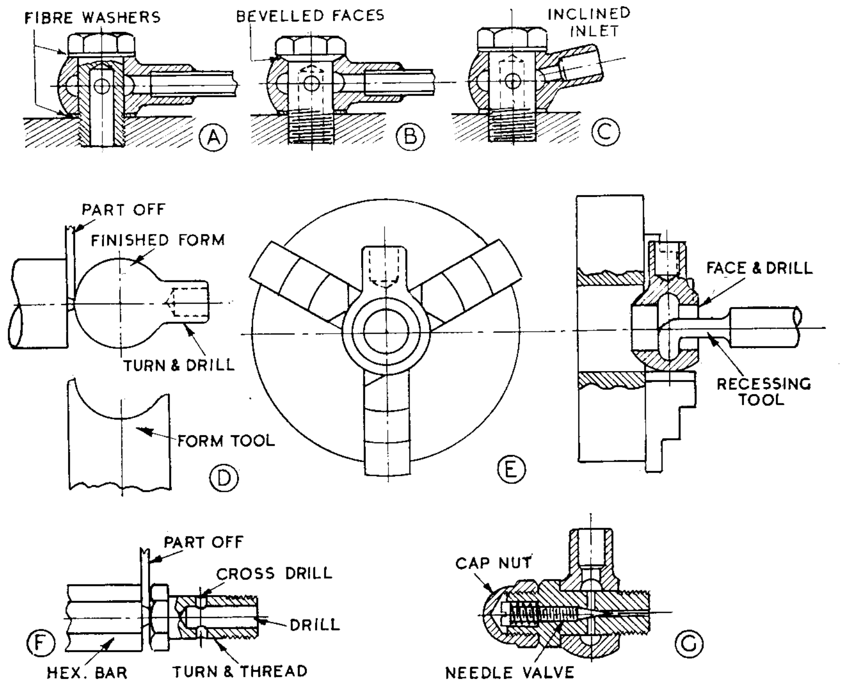
The body of the banjo is the only part which presents anything in the way of a machining problem. Sometimes it is built up by brazing a short sleeve into the side of a larger bush, and this may be most convenient for unions of large size on the grounds of metal economy. But for small unions it is quicker to machine the body from solid metal, at a single set-up so far as the turning is concerned. This involves the need for a spherical contour on the banjo, which can be produced with simple forming tools, or by hand turning. There is no need for special accuracy of form so long as the shape of the body looks about right (D).

The stock (brass or gunmetal round bar) is held in the chuck and the end is turned down parallel for a short distance to form the sleeve which fits the pipe. It is then centre-drilled and drilled to fit neatly on the pipe (No. 31 drill for $\frac{1}{8}$ in. pipe) but not deep enough to penetrate the body at this stage. To form the body contour, a form tool may be made by drilling a hole obliquely in a piece of gauge plate or other tool steel which can be mounted in the tool post in any convenient manner. The unwanted metal is cut away at the hole, and any filing required done before hardening and tempering the cutting edge. It is possible to machine the full contour of the body and part off (or down to a mere pip) with one tool, but many operators prefer to leave more metal on the back, and after parting off, finish the contour with a hand tool while chucked in the reverse position.

The body may now be held crosswise in the 3-jaw chuck, provided that the end projection is small enough to fit between two of the jaws without fouling them (E). If not, some form of chucking jig may be required, and this is recommended in any case if a number of banjos have to be made. To set the projection parallel with the chuck jaws, before fully tightening them, a close-fitting rod may be inserted in the sleeve. Sometimes it may be more convenient to set the projection at an angle, as at C, for better clearance between the pipe and the major component when fitted.

The body may now be machined flat on the front surface, to produce the width of joint face required, and drilled through to the size of the connector bolt. At the same setting, an internal groove is machined with a small recessing tool, which will probably have to be made specially for this operation. The body may then be removed from the chuck and wrung on to a stub mandrel for facing the other side of the hole. Then, and not before, the cross hole may be drilled into the groove of the body.

Machining of the retaining bolt from hexagon stock is a straight-forward operation, which can be carried out at one setting, prior to parting off. Sometimes a groove is turned in the shank of the bolt to match that in the banjo, and thereby increase the area of the passageway, but as the bolt has also to be cross-drilled, the groove may weaken it unduly, and is best avoided. After facing, turning to size and threading, the bolt is centre-drilled, and drilled axially to the diameter and depth required.



A WEIGHT-DRIVEN

REGULATOR TIMEPIECE

Part four

by

Claude B. Reeve

(continued from page 498)

THE motion wheels are seen in Fig. 15. No. 1 and 1A represent the hour wheel which is cut with a .6/W cutter and has 72 teeth. It is mounted on a brass tube which revolves on the minute wheel tube seen in No. 4.

No. 3 shows the reversed minute wheel and six leaved pinion; the pinion is drilled centrally and rotates on a stud screwed to the front motion plate, positioned in line below the front centre wheel pivot (Fig. 11). The dimensions of the stud are shown in Fig. 15 No. 6. The diameter of the stud is approximately .045 in., the free end is screwed 14 BA and has a small round knurled brass retaining nut. No. 4 shows the minute wheel attached to a tube which is friction fitted by a spring to the front centre wheel pivot.

The contacting surfaces of the hour and minute tubes need to be well polished. These components need no oil. The outside diameter of the minute tube is approximately .165 in.; the wheel is soft-soldered to its seating at the rear end of the tube, this also applies to the fixing of the hour wheel to the flange of the tube. The meshing of the hour wheel with the pinion attached to the reversed minute wheel, and the meshing of the two minute wheels requires care. Proceed as follows: Find the right depth between the hour wheel and the pinion, remembering that the pinion in this case is a driver; (a lantern pinion cannot be used here) having ascertained that the centres of the pinion and hour wheel are satisfactory, the two minute wheels can be turned to size to suit them. It will probably be necessary to make the diameters of the minute wheels very slightly larger or smaller than their nominal diameter; this will, however, make no difference to performance.

The reversed minute wheel is attached to the pinion and one end of the pinion is turned down to form a seating for the wheel and is a light press fit; the ends of the leaves are lightly riveted over. Before attaching the wheel, the pinion should be carefully drilled a running fit on the stud (No. 6). At the outer end of the minute wheel tube, a slot is filed and a pin fitted to the minute hand collet; this pin protrudes inwardly for the thickness of the tube to the collet and engages with the slot thus formed. Fig. 15 No. 7 is the small friction spring made of brass. It is placed on the front pivot of the centre wheel and is retained in position by the shoulder formed on the pivot; this shoulder must be just proud of the jewel bearing. When the minute wheel is placed on the pivot, the back of the wheel presses against the spring, making a friction fit; it will be seen that the outer end of the front pivot to the centre wheel is threaded 8 BA (Fig. 6 No. 1). After the minute hand had

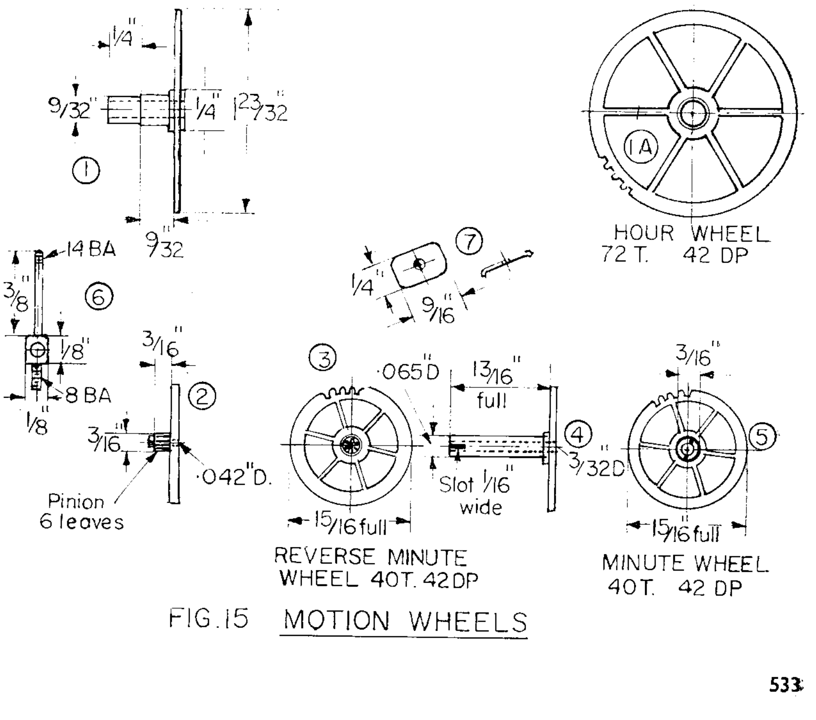


FIG. 15 MOTION WHEELS

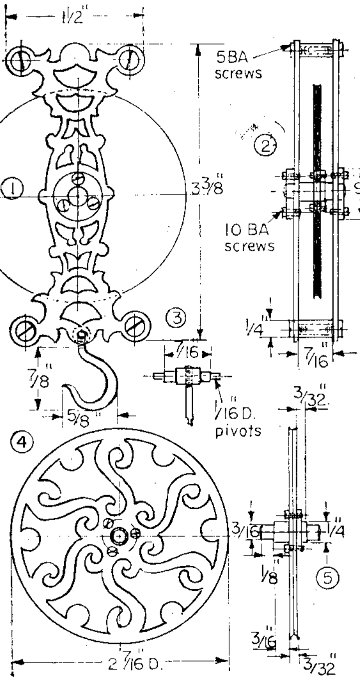
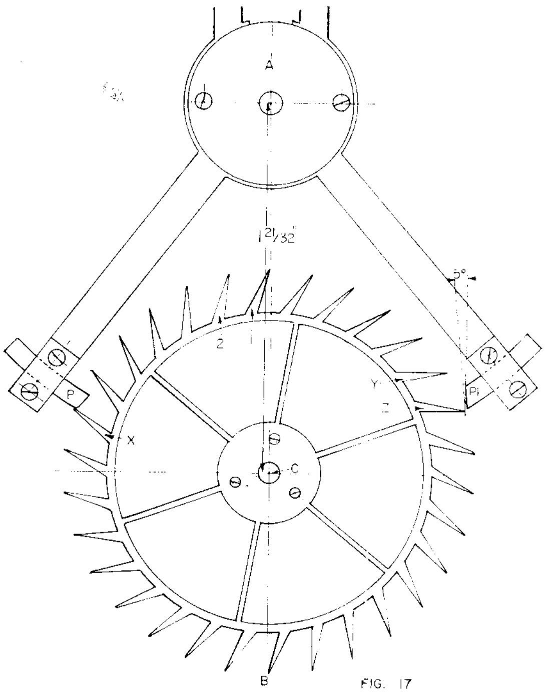


FIG.16. PULLEY



been placed on its wheel tube, a collet is screwed on to the threaded end of the front pivot, this will produce the friction fit required. Fig. 13 items 5, 5a, and 5b show the collet to the front pivot, which should be made of German Silver. No. 5 is the front view, No. 5a is the side view and 5b the back view; when finally screwed into position a cross pin retains it. The hour hand is a friction fit on the hour wheel tube and a shallow step is turned on the hour tube to fit the collet of the hour hand (Fig. 15 No. 1).

The Pulley and Shackle

Fig. 16 gives all the dimensions for constructing these items. The sides of the shackle are cut from $\frac{1}{16}$ in. brass plate; the two sides should be temporarily pinned together and cut and filed in one operation. Inserted bearings made of phosphor-bronze are screwed to the shackle sides with 10 BA screws. The pulley wheel is cut from $\frac{3}{32}$ in. brass plate and its groove should be a half-round section to fit the driving line. No. 1 shows the design of the shackle and the diameter of the pulley wheel is also given.

Note the hook at the bottom for the driving weight; this is made of steel and is fitted centrally to a cross-member of the shackle. The wheel should revolve in the bearings of the shackle without end-shake.

The Escapement

A great deal has been written about the theory of the dead-beat escapement and about the rather complicated methods of setting out the escapement. It is, however, proposed to give details on how to do this from quite a different angle which it is hoped will be easier to accomplish and understand. Fig. 17 represents the escapement and the escape wheel as seen from the front; the escape wheel is rotating to the right, a tooth of the escape wheel has arrived at the pallet pad marked P and the tip of the tooth of the escape wheel is resting on the corner of the circular part of the pallet pad.

This is known as the entrance pallet pad; as the pendulum swings to the left the tooth of the escape wheel will travel a little way along the pallet pad giving no impulse to the pendulum rod and the escape wheel will remain stationary. When the pendulum swings the reverse way the tooth of the escape wheel will travel along the short flat part of the pallet pad; this is at a slight incline to the tip of the escape wheel tooth, which when travelling along this part of the pallet pad will give a very slight impulse to the pendulum; when the tooth of the escape wheel marked X has reached the end of pallet pad, another escape wheel tooth Y will contact the inner circular part of pallet pad P.1, this is known as the exit pallet pad.

The action of the escapement is exactly the same as before, the flat part of the pallet pad P.1 is also an inclined plane, this constitutes the action of the dead-beat escapement.

To lay out the escapement, proceed as follow: Take a smooth piece of brass plate and on it scribe a vertical line AB to serve as a datum line at point C. Describe a circle $1\frac{3}{4}$ in. dia., which is equal to the diameter of the escape wheel, at a distance of approximately $1\frac{21}{32}$ in. above C, this will be the centre distance of the escapement. Now position the escape wheel centre over C so that a tooth touches line AB above centre C and a tooth also touches line AB below centre C, now count back seven teeth inclusive from tooth one to tooth X with dividers from pallet centre, scribe the circular locking surface of pallet pad P and the unlocking corner of pallet pad P.1.

To arrive at the thickness of the pallet pads it is necessary to measure the space between two adjacent escape wheel teeth, and half this amount plus a little extra for clearance, and for the thickness of the tips of the escape wheel teeth, with this measurement another arc is described from the pallet centre, which will give the unlocking corner of pallet pad P and the locking corner of pallet pad P.1. To obtain the impulse plane on pallet pad P draw a line passing through tip of tooth X and passing through tip of tooth two. To obtain impulse plane on pallet pad P.1, draw a line passing through tip of tooth Z and parallel to the line AB. Now from the tip of tooth Z draw another line making an inclusive angle of 5 deg. with the previously-drawn line from the tip of tooth Z; this will give the angle of the impulse plane or pallet pad P. 1. An easy way to make the pallet pads is to scribe out on a piece of smooth zinc, two circular lines representing the thickness of the resting surfaces of the pallet pads, then anneal a piece of say $\frac{1}{8}$ in. thick square silver steel; reduce the steel to the thickness required for the pallet pads and bend the steel to conform to the previously described arc; short pieces can then be cut off for making the pallet pads.

Making the Yoke of the Escapement

As a rule, escapements are made in one piece from a forging, this allows of no chance of adjustment of the pallet pads. In this escapement, the pallet pads are individually adjustable and also adjustable together.

Figs. 18 and 19 show several views of the yoke and various parts of the crutch. In Fig. 18 Nos. 1, 2 and 3, show the yoke assembled and dismantled and also the circular joint, similar to that of a carpenter's rule.

The half sunk circular part of the joint can be turned on the lathe by strapping the arms of the yoke to a piece of wood fixed to the faceplate and taking care to get it centred correctly. It is important that the pallet pads should fit easily in the grooves, otherwise adjustment is very difficult. To make the circular window arcs near the centre joint of the arms, drill two holes at each end of the arcs, cut out with a piercing saw and finish with a thin needle file.

The half round fitting outer edges of the joints can be formed by filing. Steel retention plates are fitted to the arms for locking the pallet pads in position when adjusted. It will be seen that by adopting this method of holding the pallet pads, there is plenty of scope for adjustment. Fig. 19 No. 1, shows the front view of the Yoke assembled, but not yet fixed to the collet on the escapement arbor. The purpose of the different diameter screw seen at the top of the arms of the yoke is for fine adjustment of both pallet pads together (*see* Fig. 19 No. 2) with the escape wheel teeth.

The circular parts of the hub to the yoke are elongated upwards to form two short square-section pillars; inserted in each pillar are two short lengths of steel rod, a movable fit. These rods are drilled through to take a 14 BA thread and the other rod 10 BA thread; the pallet pads and the arms are adjusted nearly correct to the escape wheel teeth and the double-threaded screw is inserted. Its purpose is to make the pallet pad arms open and close evenly with each other; but previously an equal amount of lock of the escape wheel teeth on the pallet pads must be made before any adjustment can be done with the double threaded screw.

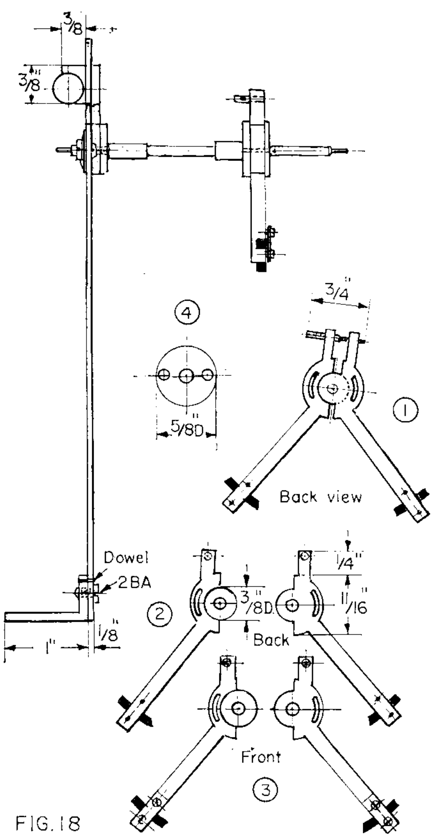


FIG. 18

Briefly, the setting of the escapement is as follows: tooth X must be resting on the circular part of pallet pad P, but only just beyond the corner; at the same time tooth Z must have cleared the impulse corner of pallet pad P.1. As one tooth of the escape wheel leaves a pallet pad there will be a little free run of the escape wheel before the other tooth of the escape wheel contacts that of the opposite pallet pad; there must be this free run, but the shorter it is the better the escapement. The escapement arbor should now be made from hardened and tempered steel and the collet made for attachment. The collet may be a press fit or it can be soft soldered to the arbor. Two 10 BA screws pass through a polished steel washer and then through the slotted arcs and into the flange of the collet.

To adjust the escapement, these two screws must be loosened and tightened again afterwards. The steel washer is shown in Fig. 18 No. 4 and again in Fig. 19 No. 1. Fig. 19 No. 3 is a plan view of the escapement arbor with the various dimensions shown. Note that the adjustable crutch is not shown in position on the arbor. Before drilling the pivot holes for the escapement arbor, make a simple jig; on a small piece of brass plate scribe a vertical line and centre pop for two holes the approximate distance apart of the escape wheel pivot hole and the pallet centre hole. Fit short studs on, after drilling suitable size holes: one of these studs to fit the hole in the yoke of the escapement and the other to fit the hole in the escape wheel. This stud hole should be elongated into a short slot and a small nut fitted to the protruding end of the stud so that it can be adjusted lengthways.

Fine centre dots should be made on the front ends for measuring purposes; with this jig the correct centres of the escapement and the pallet wheel are transferred to the motion plates for drilling the holes.

Fig. 19 No. 4 shows the adjustable crutch as viewed from the back whilst in Fig. 18 is seen its side view. No. 4

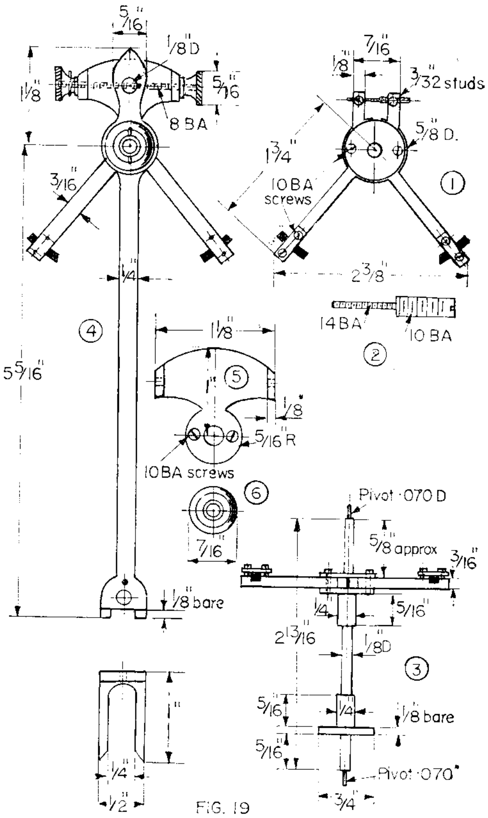


FIG. 19

shows the main flat section rod; provision is made for slight rotation of its axis, which is in line with the axis of the pallet arbor. The upper end of the rod is made spear-shape and has a small rotatable stud whose centre is positioned ¾ in. from the pallet centre. At the bottom of the arm a fork is screwed at right angles embracing the pendulum rod; this fork is attached to the arm with a 2 BA screw and also with a locating dowel. The stud attached to the spear-shaped part of the arm is cross-tapped to fit a No. 8 BA screwed traverse rod.

To be continued.

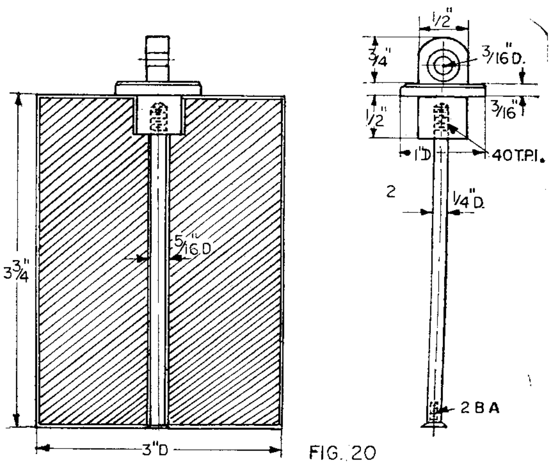
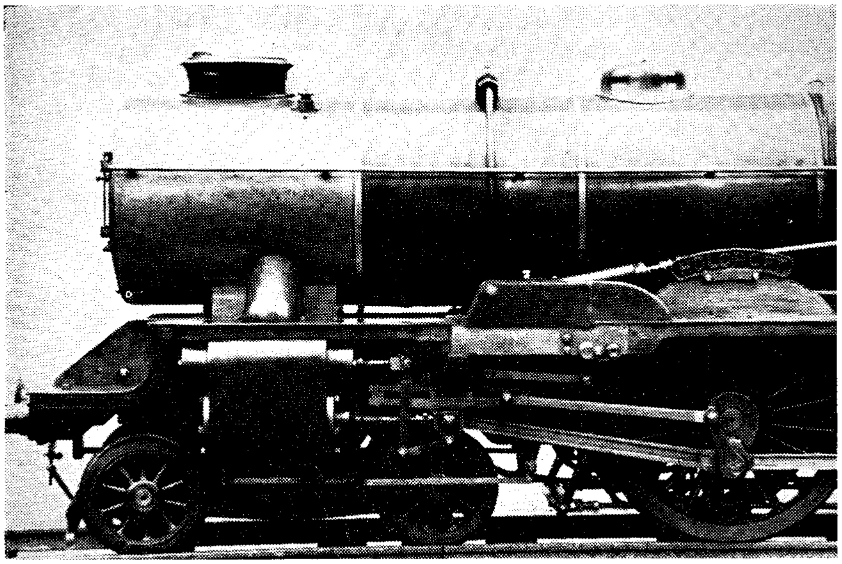


FIG. 20



As a break from *Mabel*

LBSC

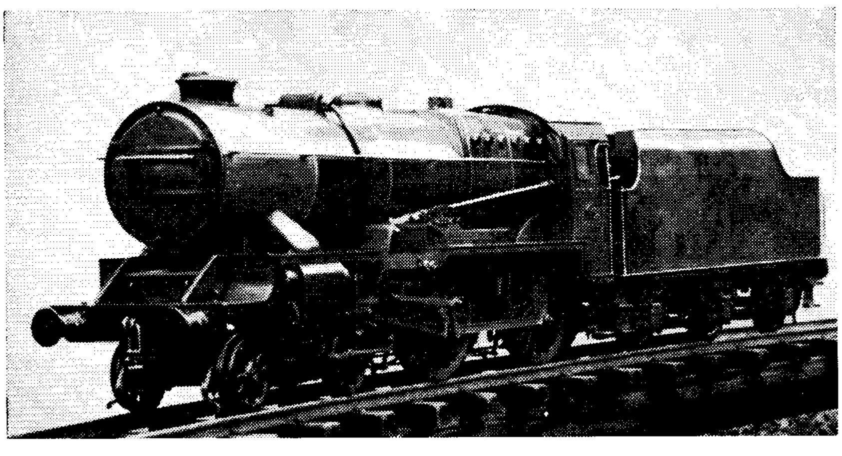
describes

a $3\frac{1}{2}$ in. gauge

"SUPER-SCHOOLS"

NEW readers may be interested to learn that for 25 years (1930/1955) I wrote weekly articles on locomotive construction for *English Mechanics* as well as this journal, and blueprints of the engines I described how to build, are still available from A. J. Reeves of Birmingham. Among them was a Southern "Schools" class engine in $3\frac{1}{2}$ in. gauge which I called *Roedean*—did I feel an earthquake tremor from the direction of Rustington, way down in Sussex, or was it caused by four "milly-amp" trains passing at the same time?—because I didn't think it fair that they should all be named after boys' schools. Now the design of the full-size jobs had to be somewhat cramped by the necessity of clearing the narrow tunnels between Tunbridge Wells and Hastings, and naturally, I made my little one conform to full-size practice. Mr. H. Holcroft was very interested in her, as he had a lot to do with the design of her big sisters, and conceived the idea of showing what might have been done, had the loading gauge permitted it. He got out the drawings for a $3\frac{1}{2}$ in. gauge *Super-Schools*, my good friend Roy Donaldson brought her to life, and the result you can see in the accompanying pictures.

You can bet your sweet life that when a full-size locomotive engineer of Mr. Holcroft's experience gets down to $3\frac{1}{2}$ in. gauge, the result is going to be startling, to say the least, and it is certainly so in this instance. The valve gear, for example, is unique. If there is one thing more than another, in which Mr. Holcroft is a specialist, it is conjugated valve gears. The arrangement that he designed for the inside cylinders of my *Tugboat Annie*, which has four cylinders and 135 deg. cranks, is a real masterpiece; no trouble at all to make and erect, and works perfectly. In the present instance, the three sets of Walschaerts gear, as fitted to the full-sized engines, are replaced by two sets of radial gear, and the motion from these is transmitted by a cross-shaft and short levers to the radius rod of the inside valve. All three valve spindles have their own combination levers, so Mr. Holcroft calls the gear "semi-conjugated".



It is a well-known fact that the usual two-to-one arrangement, as fitted to the LNER Pacifics and other engines, does not give correct valve events on the inside cylinder. The whip in the long lever, and any slack in the joints, causes serious over-running of the inside valve at high speeds, and was the cause of most of the casualties that befell the Gresley Pacifics in the high-speed trials before the days of British Railways. The arrangement on the little engine entirely eliminates this. When the works were first tried under compressed air, the wheels turned quite evenly; and on the track under steam, the six beats per turn are all perfectly even, without any trace of syncopation. As the engine has run on my own line, I can fully confirm that; she would delight the heart of any driver.

The outside valve gear is similar in principle to the Baker gear, the radius rod being driven from a bell crank actuated by a "sickle" lever, but there is no reverse yoke. A curved link takes the place of this, and carries a die-block from which the sickle lever (gear connecting-rod) is suspended by a short link. The cylinders and valves are the same as I specified for *Roedean*.

Two-stage Boiler

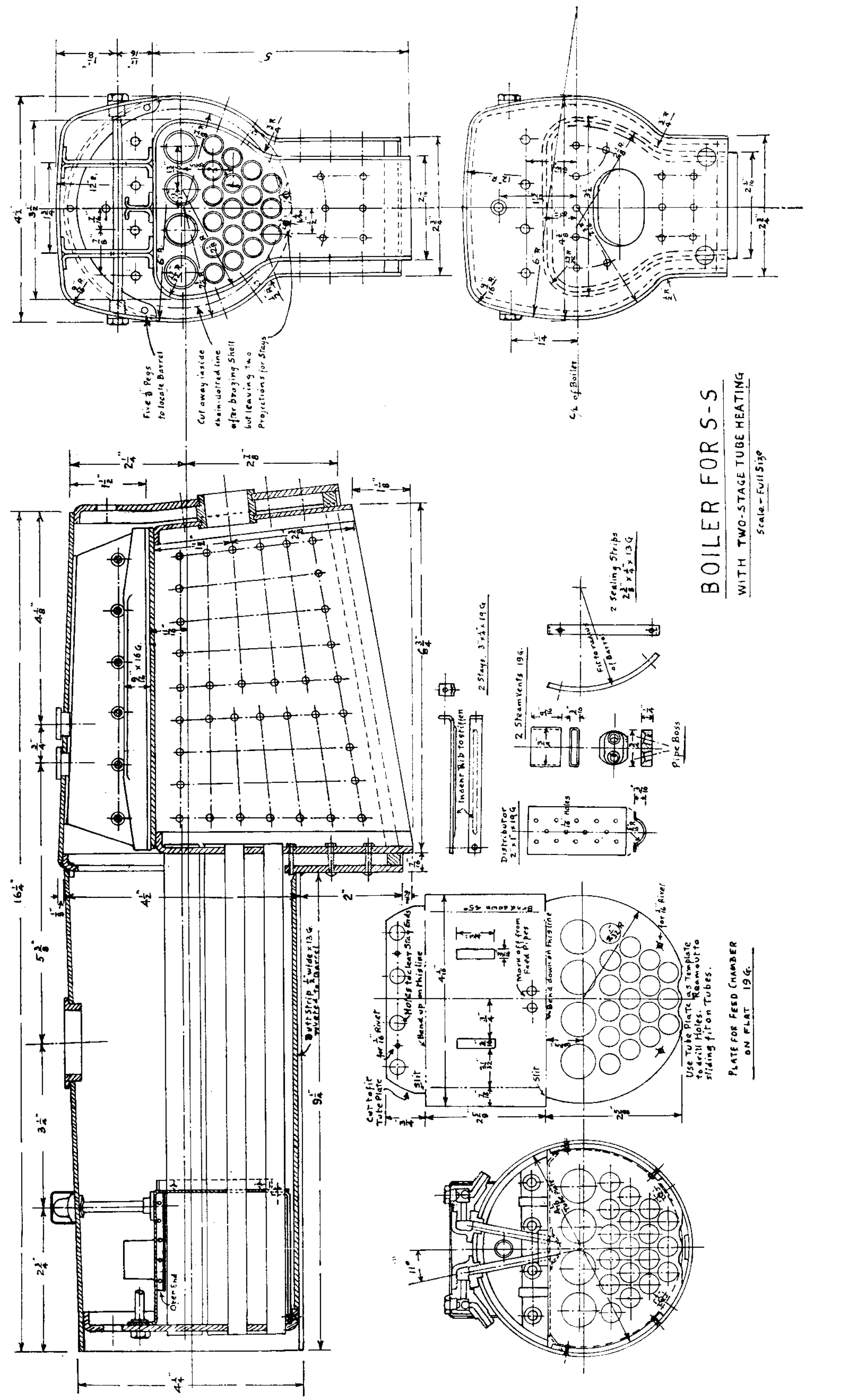
As there are no loading-gauge restrictions to bother about, Mr. Holcroft specified a different boiler to *Roedean's*. It has a Lord Nelson Belpaire firebox, and a separate chamber taking the feed-water. As will be seen from the reproduced drawings, Mr. Holcroft approves the method of boiler construction that I always specify, notably the girder staying, firehole ring, and arrangement of tubes. One very useful tip is the provision of five locating pegs in the throatplate, to prevent the boiler barrel shifting while the brazing is in progress. I just stand the barrel over the hole in the throatplate, and get cracking with the blowpipe, but some folk may not be quite so lucky, and accidentally shift the barrel!

The main point of interest in the boiler is the separate chamber which receives the feedwater. A piece of 19 s.w.g. sheet copper is cut and drilled to the dimensions shown in the detail drawing, and bent to the shape shown, then fitted to the front end of the barrel before assembling the smokebox tubeplate. It is prevented from sliding back by two sealing strips of 13 s.w.g. copper which are riveted to the inside of the barrel. Two holes are drilled at the back of the flat part to receive the ends of the feed pipes, and below these a distributor, shaped like a flanged gully, is riveted, so that the incoming water has to run along the gully and out through the $\frac{1}{16}$ in. holes. It then goes down among the tubes, where it becomes well warmed up, and then out into the boiler barrel through the aperture at the bottom of the baffle. There is no question of it doing the thermo-syphon act, as the incoming water keeps the circulation going.

The top feed clacks are made in two pieces, as shown in the detail drawing. Both clacks and elbow fittings can be made from castings, or cut from solid, the delivery pipes being screwed in, and the outside feed pipes attached by unions in the usual way. The whole lot is covered by a sheet-metal casing. One pipe takes the feed from the crosshead pump, and the other from the injector.

The Smokebox

The smokebox itself is similar to that on *Roedean*, also the steam pipes and superheater, but this engine has a double chimney and twin blast and blower nozzles to suit. A hollow flanged casting is screwed to the top of the blastpipe, and the two nozzles, in one piece, are screwed over the holes in the top of it, a blower ring fitting over each nozzle. The boiler fittings are much the same as I specified for *Roedean*, but a steam brake is provided, the driver's brake valve being similar to a plug



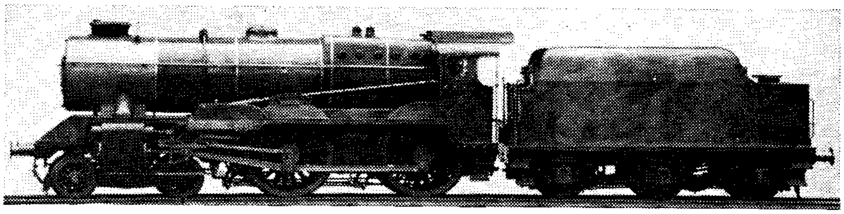
cock, the exhaust from it going into the smokebox.

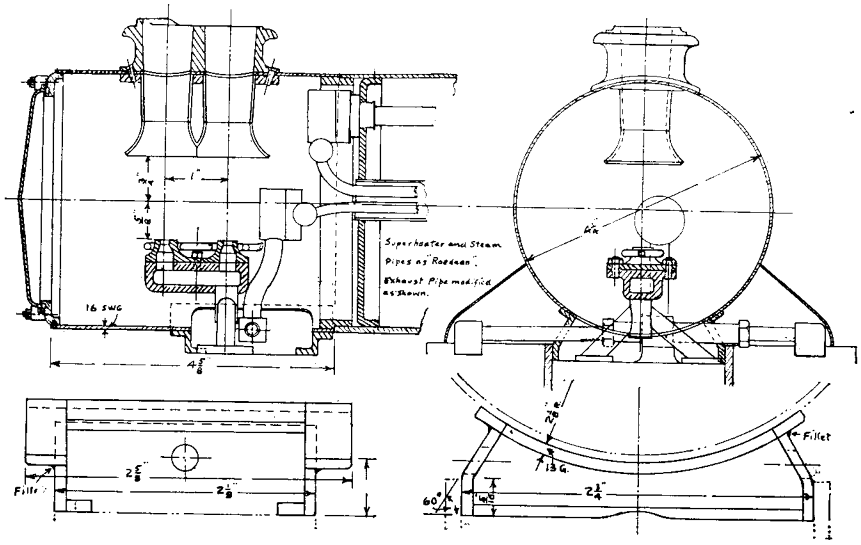
Tender

The tender is a high-sided six-wheeler, and certainly doesn't lack innovations. Inside each outside frame there is a narrow supplementary inside frame, which carries part of the brake gear, doing away with the need of over-hanging brake hanger pins. A working water scoop is fitted, all complete with the operating gear, worked by a push-down knob at the footplate end. This has an automatic return, so that the scoop can't be accidentally knocked off.

Owing to the position of the scoop, the emergency hand pump cannot be fixed in the usual position inside the tank, so it is located on the underside of the soleplate, on its side, and operated by an extension handle through one of the slots in the outside tender frame. All the usual accessories are provided, as can be seen from the reproduced photographs.

On the track, the engine performs exactly in the manner one would expect, seeing who designed it, and who built it. Roy Donaldson, who was in charge of reorganizing and modernizing Ashford Works, is a first-class locomotive builder, and among the jobs he has turned out are a North Eastern R.1, an LMS class 5, a Metropolitan 4-4-0 tank, a GWR 0-6-0 of Armstrong design, a GWR County class 4-6-0, and a small-boilered *Tich*, which, incidentally, K. N. Harris saw at work on the Beech Hurst line; and after the little thing took Roy up the gradient in fine style, had to admit that it was a good engine! The "*Super-Schools*" steams freely, can run like a deer, the acceleration is as lively as one could wish for, and *can* she pull! If anyone who reads the above is sufficiently interested to build a similar locomotive, it is quite possible that Mr. Holcroft would allow prints to be made from his own drawings. Then you really *would* have what our cousins on the other side of the big pond call "the real McCoy".





For those pressing on with *Mabel*, we can now dispose of the cylinder covers.

The front covers only need the chucking piece off, and facing to $\frac{1}{8}$ in. thickness, but after cutting off the chucking piece on the back covers, face the gland boss until combined thickness of boss and cover is $\frac{3}{8}$ in. not including the register. Open out the hole to $\frac{5}{16}$ in. depth with a letter R or $\frac{11}{32}$ in. pindrill, and tap $\frac{3}{8}$ in. × 32, using a pilot tap if available. If not, use a second tap with a tapwrench on it just above the thread, and guide it in truly by holding it loosely in the tailstock chuck. Beginners note: it is absolutely essential to have the piston rod glands true, so that the rod will be perfectly free in any position of the piston. You want all the available power at the drawbar, as in my own engines, and not mopped up in overcoming needless friction in the engine itself. Face off the covers as far as you can to $\frac{1}{8}$ in. thickness without cutting into the gland bosses. These can be cleaned up by applying a smooth flat file to them with the lathe still running—a job that gives me pins and needles in my wrist!

For the glands, chuck a piece of $\frac{1}{2}$ in. hexagon bronze or gunmetal rod in three-jaw. Face, centre, drill to $\frac{1}{2}$ in. depth with No. 3 drill, turn a full $\frac{1}{4}$ in. length to $\frac{3}{8}$ in. dia. and screw $\frac{3}{8}$ in. × 32 with die in tailstock holder. Part off at $\frac{3}{8}$ in. from the end, repeat operation, reverse in chuck (if held in a tapped bush, there is no chance of the thread being damaged) face the hexagon slightly, chamfer the corners, and put a $\frac{7}{32}$ in. reamer through.

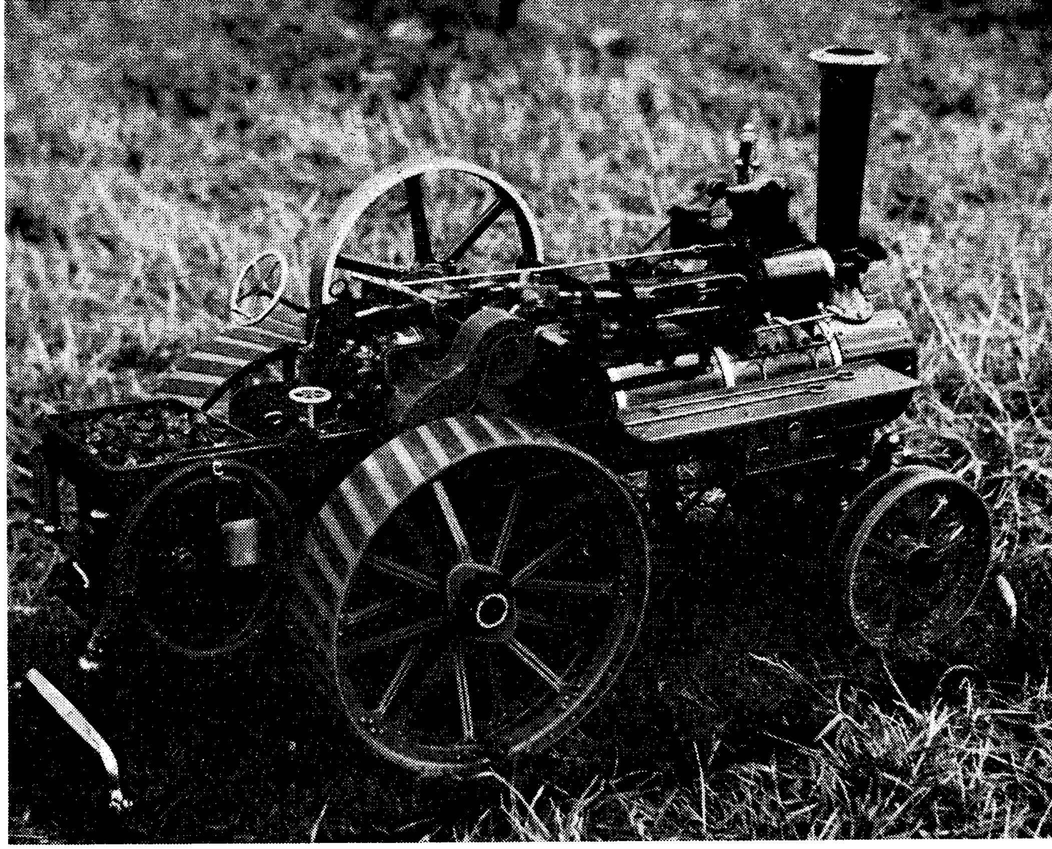
Piston and rod

The rods are 3 in. lengths of $\frac{7}{32}$ in. rustless steel, ground for preference, but ordinary rolled or drawn will do at a pinch. Chuck in three-jaw and put a full $\frac{3}{16}$ in. of $\frac{7}{32}$ in. × 40 thread on one end, with die in tailstock holder. The pistons should be a different kind of metal to the cylinder casting; I use bronze, gunmetal, rustless steel, or metal from an old motor-engine piston melted down and cast into a stick, using a bit of cardboard tube for a mould. This is grand stuff, resisting wear, working with the minimum of friction, and very easy to machine up. Anyway, chuck in three-jaw and turn down a full 1 in. to $\frac{3}{16}$ in. dia., face the end, centre, and drill down to a full 1 in. depth with $\frac{3}{16}$ in. drill. At a full $\frac{1}{8}$ in. from the end, cut a groove $\frac{3}{16}$ in. wide and same depth, with a parting tool, then part off at a full $\frac{7}{16}$ in. from the end, and repeat operation. Rechuck one of the pieces, with about $\frac{1}{16}$ in. projecting from the chuck jaws, gripping tightly. Open out the hole for $\frac{1}{4}$ in. depth with No. 3 or $5\frac{1}{2}$ mm. drill, and tap the remains $\frac{7}{32}$ in. × 40. Grip the piston rod tightly in the tailstock chuck, run it up to the piston blank by sliding tailstock along the lathe bed, enter the screwed end into the hole, and pull the belt by hand.

To be continued

TALKING ABOUT STEAM

W. J. Hughes on Portable Steam Engines



LOOKING through some negatives recently, I was suddenly reminded of the Market Bosworth rally last summer. The cause was my first two photographs herewith, which I took there of a very fine $1\frac{1}{2}$ in. scale Allchin. It has been built by Mr. M. S. Nixon of Appleby Hall, near Burton-on-Trent, and it was awarded the Cup for the best model at the rally.

There is no need for a fully detailed description of the model, except to say that as the photographs show it was a very good example of the marque. The finish was excellent, both mechanical work and paintwork. Mr. Nixon has also taken the trouble to add a full set of spuds, three oil lamps, and a full kit of tools including spanners, hammer, axe, oilcan and pliers. There is a billy-can for the driver, and a bucket for the engine. To complete the picture, Mr. Nixon told me that the performance was all that could be desired. Certainly he has "done me proud", and is to be congratulated on a first-class model.

My next photograph was given to me at the Pickering Rally three or four years ago by Mr. E. Burley of Holme-on-Spalding Moor, in the North Riding. It shows a well-made portable engine of perhaps 6 or 8 n.h.p., built by a firm of whose identity I had previously been unaware, C. T. Stephenson and Sons, Ltd., of the Mount Bridge Ironworks, Boston, Lincs.

Mr. Burley told me that Mr. A. W. Wheater, also of Holme, might perhaps be able to give me information about the firm, but actually there was little for him to tell. Charles Tooley Stephenson was Mr. Wheater's maternal grandfather, but unfortunately the works were sold up early in the century, before Mr. Wheater was born.

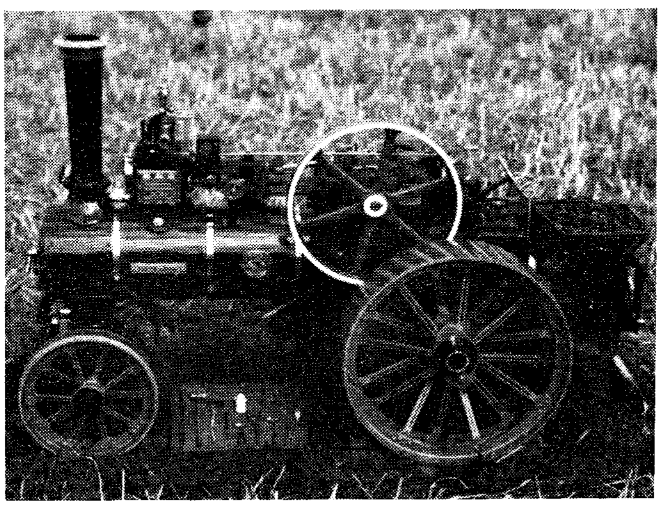
A point of considerable interest is that Mr. Wheater's mother always claimed descent from George Stephenson, but he says he has not pursued the matter. I should be very grateful to any reader who could give me any information either on this point, or on the firm, its premises, or its products.

This photograph appears to be copied from a catalogue, which quotes the firm as "Engineers and Founders", with "Improved Coal Saving PORTABLE STEAM ENGINES made in all sizes". The engine is of conventional design, but with good features not always found. For example, whilst the cylinder casting is saddled to the firebox top, the steam supply enters it by way of a separate elbow which also incorporates the regulator valve and the Salter-type safety valve.

The wheels are nice examples of the wheelwright's art, well-dished for strength and with nicely chamfered spokes embellished with lining. Motion work and bearing brackets are elegantly light in appearance, yet of sufficient strength for the job.

In the background is another portable engine either partly completed, or perhaps partially dismantled for repair. It is chocked up at the firebox end, without axle or wheels; there is no cylinder or motion, and the manhole cover is removed. Next to this engine, and leaning against the factory wall, is a

Above and Below: Two views of Mr. Nixon's model Allchin



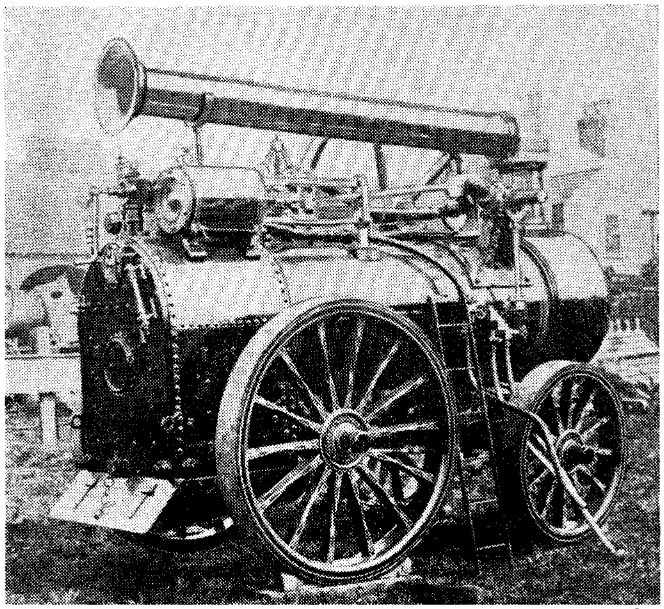


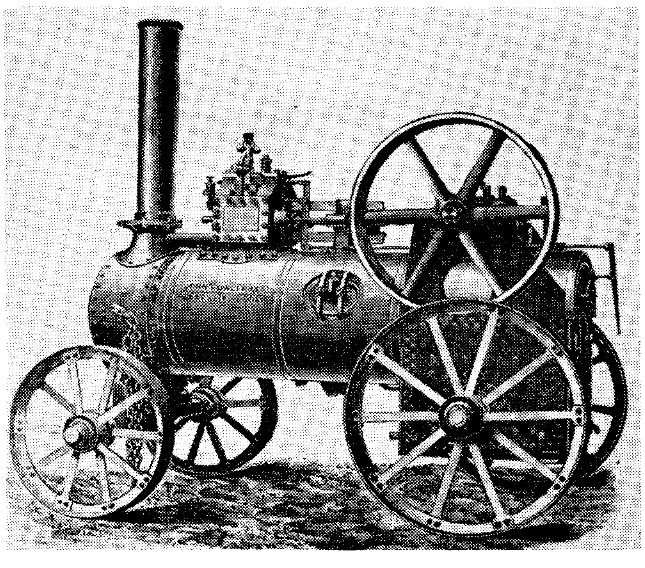
Fig. 3: Portable engine built by a descendant of Geo. Stephenson

large cruciform casting which almost certainly is the central casting to support the arms of a four-sailed windmill. It seems likely therefore that the company was in the line of general engineering and foundrywork, rather than specialising in engines: in fact, a real "country workshop" ready to tackle any job of manufacture or repair which came along.

Still on portables, I wrote in my recent article on Green's of Leeds that Fowler's also built portable engines in "traction engine" style, with the bearing brackets carried in hornplates and the cylinder at the chimney end. Fig. 4 now shows an engraving of one of these, taken from a catalogue of the mid-nineties, and for my money this style makes a more handsome engine than the conventional one.

This is probably about an eight-horse engine, though in the absence of means for dimensioning any component one cannot be assertive about this. It has the typical Fowler shape for chimney and cylinder block, and the governor and guide-bars

Fig. 4: Single-cylinder Fowler portable of late nineteenth century.



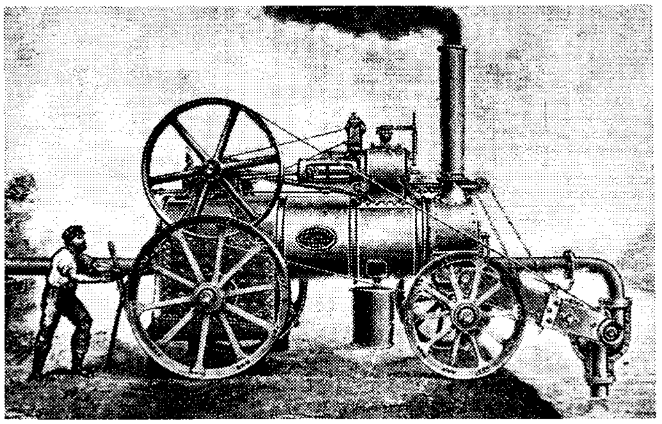


Fig. 5: Fowler portable driving a centrifugal pump on irrigation work

breathe Fowler too. But Fig. 5 also shows a Fowler with differences: notably a quite un-Fowler-like trunk guide and a governor on a horizontal spindle. The chimney is still Fowler, of course, and so is the arrangement of the Salter safety-valves which overseas buyers so often specified.

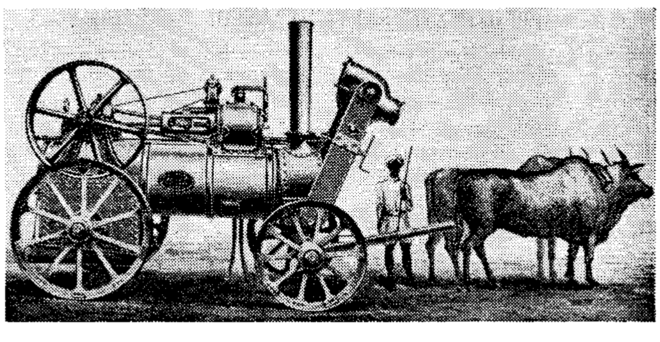
Taking proportions now from the engineman (and duly allowing for artistic licence and/or error), this is a somewhat larger engine, probably of 10 or 12 n.h.p., with a bore and stroke of 10 in. or 11 in. by 14 in. On the same proportions, the flywheel is 5 ft. diameter (with probably an 8 in. face), and the hind and front wheels 6 ft. and 4 ft. 6 in. respectively. Evidence of greater weight is in the three rivets per spoke, as against two in Fig. 4.

This irrigation work, with a centrifugal pump mounted on the engine, was typical of the sort which fell to portable engines abroad, and is an illustration of how steam power helped in bringing aid to less well-to-do peoples. A cynic might say that in those days the chief beneficiaries of such aid were those who supplied it in the first place, yet there is no gainsaying that the spread of steam power was of really lasting benefit to the recipients as well.

Fig. 6 shows the engine ready for removal: presumably the cast-iron suction and delivery pipes would be carried in a separate bullock-cart, along with the driving belt and water butt. The method of raising the pump boom was to turn the handle, when a worm and worm-wheel wound in the chain. When the handle rose too high, it could be transferred to the underside to keep on winding.

Still keeping to portable engines, Fig. 7 goes back to conventional design, but another make of which I had no knowledge until fairly recently. I *was* familiar with the name of the firm, W. B. Haigh & Co. Ltd., of Oldham, but only as builders of stationary engines and woodworking machinery.

Fig. 6: The Fowler packed up and ready to move to the next job



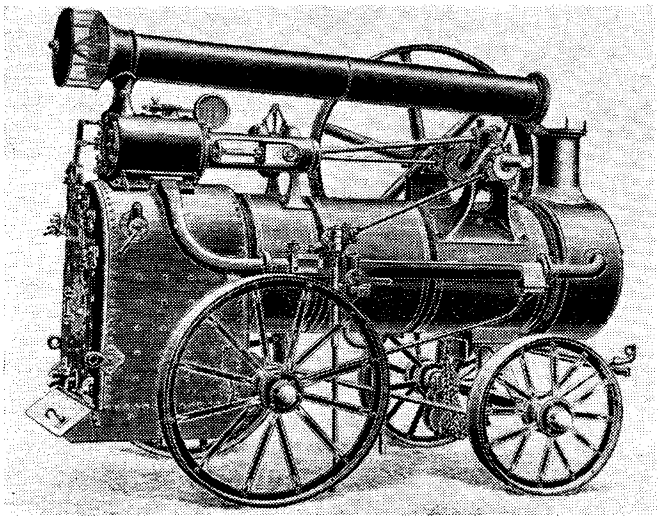


Fig. 7: Portable engine by W. B. Haigh and Co. of Oldham

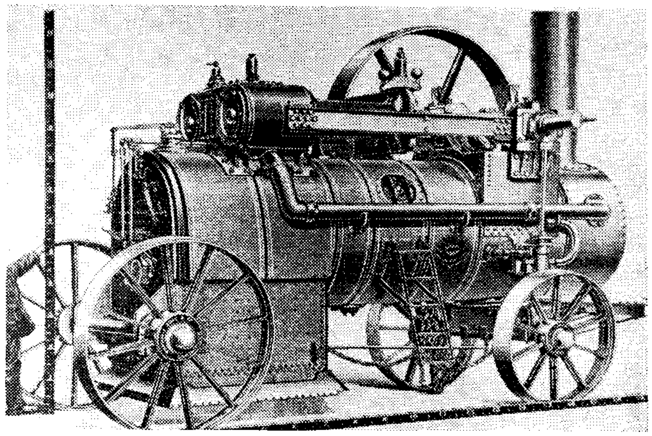


Fig. 8: Large two-cylinder portable by Marshalls

However, Stuart Fletcher of Clowne offered to lend me a Haigh catalogue which, in its 500-odd pages, carries my Fig. 7 on page 38, with a description opposite.

Apart from the more usual claims, the fittings include a grease extractor, a feed-water heater, and a steam blast tube cleaner. It will be seen that the feed-pump and feed-water heater are in one, with the exhaust steam to provide the calories. As usual, the cylinder is steam-jacketed (and in this case saddled to the boiler, with a direct steam connection), and the boiler barrel is wood-lagged with a sheet iron cleading.

As described in this catalogue, Haigh portables were made in twelve sizes, from 4 n.h.p., but a keen student will realise quickly that the Haigh "nominal horsepower" unit does not match up to the more usual one used by many makers. The commonest method of calculating nominal horsepower was to square the cylinder diameter (in inches) and divide by ten.

Thus for a cylinder of 9 in. bore, 9 times 9 equals 81, which divided by 10 give 8 horsepower. Many builders of traction engines used this formula, and applied it also to their portable engines. But Haigh's catalogue quotes a 9 in. cylinder as 7 n.h.p., and a 10 in. as only 8 n.h.p., which the more usual method would reckon as 10 n.h.p. I have noticed the same discrepancy in some other portable engine catalogues, and indeed in the first edition of Wansbrough's classic "The Portable Engine" he publishes a table of horsepower which substantially coincides with that of Haigh's.

Of course, the "squared diameter over ten" formula gave grossly inaccurate results—much too low—not taking any account of either of those two very important factors, working pressure and cylinder stroke. But Haigh's (and Wansbrough's) formula gives an even lower figure.

I have an official Foster drawing of about 1940 which shows a single cylinder portable of 10½ in. bore by 14 in. stroke, and this is titled as being of 50 *brake* horsepower. Wansbrough's table quotes a 10½ in. cylinder as 9 n.h.p.—some difference!

Finally, I include an engraving of a quite big Marshall double cylinder engine. (I seem to recall that this picture appeared in *Model Engineer* in the early thirties, but make no apology for repeating it thirty-odd years later.) This time we do have a definite scale provided, from which the size of cylinders appears, near enough, 13 in. by 16 in. On Wansbrough's table this would be 30 n.h.p., but the actual brake horsepower would be nearer 100 or 120. The flywheel is over 6 ft. dia. and would probably be 12 in. on the face, rotating at 90 r.p.m.

There are several interesting features, one being the way in which the crankbox is built up from plate and angle. Massive girder stays support an equally massive cross-casting, which in turn supports the outer ends of the guide-bars. The pump incorporates a feed-water heater, supplied by steam from the exhaust, and is carried on a downward extension of the crank bearing-plate.

It is likely that comparatively few "portable" engines of such a size were built, but mines and quarries could and did use them. Some were exported: I recall that some years ago Frank Woodall of Shipley sent me a photograph of a large derelict portable in Australia on very similar lines, even to the hind axle in brackets behind the firebox. Large *semi*-portable engines were common enough in factory usage both in Britain and abroad of course. At first the double-cylinder principle was fairly popular even in quite small portables, but the Royal Agricultural Society discouraged their manufacture because of the added complexity. However, when the demand grew for engines larger than 10 n.h.p., the double cylinder engine became popular again for all sizes of 12 n.h.p. and over.

Then in 1879, Garrett's of Leiston started to build compound portables, and from then on the use of double cylinder engines declined steadily. Eventually virtually all portable and semi-portable engines of 12 n.h.p. or more were compounds, and most makers catalogued them as small as 8 n.h.p. It is interesting to recall that Wansbrough's second edition shows a 200 I.H.P. compound portable engine of Robey's, "believed to be the largest portable engine ever constructed". Some portable!

SINGLE-ACTING STEAM ENGINES

Part Six

by Edgar T. Westbury

RETURNING now to our Corsair steam engine, further operations on the cylinder include the drilling of the oblique holes which communicate with the port belt. To start these holes, it is necessary to chamfer the top of the bore locally at about 45 deg. This can be done by filing, in which case the farther side of the cylinder wall should be protected against damage by a semi-circular strip of metal or fibre.

But if a vertical slide is available, a neater chamfer can be made by milling. The slide is set up with its table surface at 45 deg. to the lathe axis, and the cylinder mounted on it by the underside flange face. After adjusting the bore to centre height, the chamfer may be machined with a small end mill. At the same set-up, the holes may be drilled, $\frac{1}{16}$ in. above and below the centre line respectively, by adjusting the vertical slide as required. A small centre-drill should be used to start the holes, and it is worthwhile to follow this with an undersize drill, say $\frac{1}{16}$ in. dia. It would not matter if the holes broke into each other, except that the deviation would make deep drilling difficult; neither does it matter if the holes do not come out exactly on the centre of the port belt, so long as they join up in the passages without restriction.

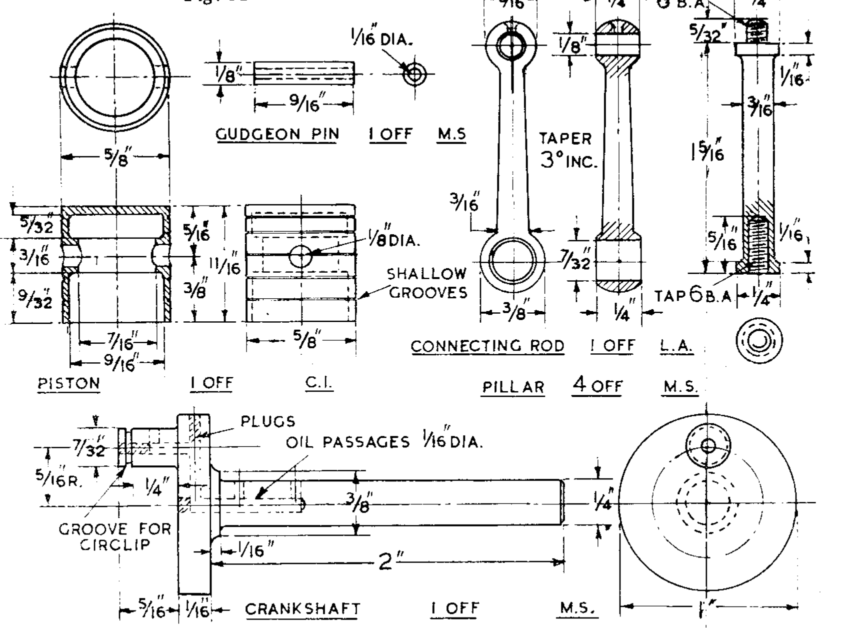
The piston valve liner should be a light press fit in its bore, and the location of the groove, with its eight holes, should be arranged to line up accurately with the port belt when inserted. There is no advantage in making it an excessively tight fit, especially as it is relatively weak in the region of the ports and might collapse under compression. A good method of fitting, after the liner has been turned on the outside to not more than $\frac{1}{2}$ thou. interference fit, is to ease the lower end with a fine Swiss file until it can be pushed in nearly half way. To assist insertion, which may be carried out in a vice, or by means of a draw bolt—not by hammering—a smear of graphite or moly grease may be used. If the fit is on the easy side, a sealing compound, such as Loctite may be applied instead. It is possible to pin the liner near the lower end to avoid risk of movement, but this should not be necessary.

Both the cylinder bore and the liner should be carefully lapped to a smooth, parallel and circular finish. A good deal has been published in *Model Engineer* on the subject of lapping and I have little to add to this, except that I prefer short laps to facilitate local control, and that relatively mild abrasives such as fine silica or aluminium oxide, are best for non-ferrous metals. On no account should the piston or piston valve be used for final lapping in to the bore, as the clearance which would be produced by the finest film of abrasive would be sufficient to cause leakage. Both these parts may, however, be lapped separately with a ring lap until they are a *tight* fit in their bores, then run in with tallow or moly grease.

The piston valve, which is also shown in the cylinder group, (Fig. 30, May 20) can be machined nearly all over at one setting. Apart from its fit in the liner, the only critical dimension is the width of the "land" or collar at the top end, as this controls the steam lap and point of cut-off. The valve is made as light as possible, as it is a substantial part of the reciprocating weight, which cannot easily be balanced. Most piston valves on small engines are far too heavy. Incidentally, for turning the valve round when adjusting the timing, a short length of $\frac{1}{4}$ in. tube with the end split, can be pushed into the counterbore at the top of the valve. When its correct position is found, an Allen key or a screwdriver can be inserted through the tube to tighten the locking screw against the screwed end of the knuckle.

The group of components shown in Fig. 31, includes the piston, which may, with advantage, be machined from cast iron stick. There is no better metal for pistons than cast iron, and this applies even when the cylinder is also of cast iron. The wall thickness is kept as small as possible, but to give adequate strength in the region of the gudgeon, a thickened belt is left in the centre; it is possible to cut away the unwanted part of this, if one is prepared to take the trouble, by milling operations. Narrow grooves (not more than five thou. deep) in the piston, assist in retaining oil and retarding steam leakage. The boring and external turning operations may be carried out at one setting, but before parting off from the stock, the cross drilling for the gudgeon pin may be carried out by mounting

Fig. 31



crosswise on a V-block on the lathe faceplate, with the centre line of the pin, 3/8 in. from piston base, set to run truly. The hole may then be centre-drilled, followed by an underside drill, and a reamer, which should not pass completely through, as a slightly tapered hole facilitates fitting the gudgeon pin to tap in lightly from one side only. A piece of stock material b.m.s. or silver steel) drilled through the centre and tapered slightly with a fine file, may be used for the pin.

The crankshaft should preferably be machined from solid 1 in. b.m.s. bar. It can be built up by brazing or pressing the crankpin and main journal into the crank disc, but this may involve some risk of inaccuracy or mechanical failure, and it saves hardly any time in making a small crankshaft. Most of the surplus metal at the crankpin end can be cut away with a hacksaw, after the throw centre has been marked out. A simple method of turning the crankpin is to mount the bar in an eccentric fixture, such as a Keats V-angle plate, but if no such fixture is available, the throw centres can be marked out and drilled both ends of the bar, with due care to ensure parallel alignment, and the crankpin then turned between lathe centres.

The main journal

The main journal can be turned by centre-drilling the end of the bar truly, and holding it in the chuck over the disc portion, with the end supported by the back centre. These methods are only practicable if the stock material is truly round and parallel—b.d.m.s. usually fulfils this condition—or has been pre-machined all over. But alternative methods call for extremely accurate marking-out and centre-drilling, and are thus more liable to error in shafts of small dimensions.

Long experience with high-speed engines has convinced me that there is only one way to oil a crankpin bearing properly—that is, from the inside. That is why I have specified drilled oil passages in the main journal, web and crankpin, with their ends plugged with short screws. It is worthwhile to provide for lubricating the eccentric sheave in the same way, but note that the hole in the shaft must be lined up with that in the sheave after it has been set to approximately correct timing. The oil is, of course, led from the inner main bearing, which will, therefore, require more frequent or copious feed than the outer one.

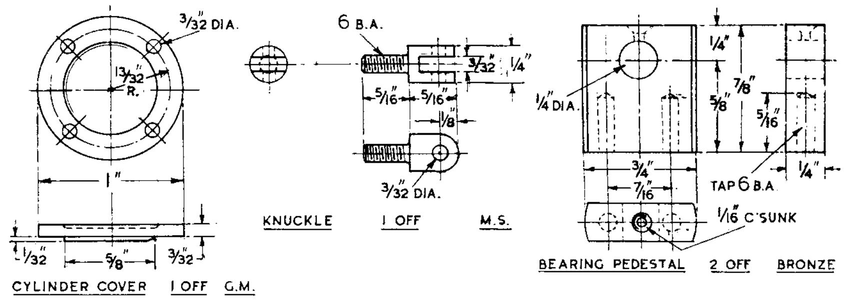


Fig. 32

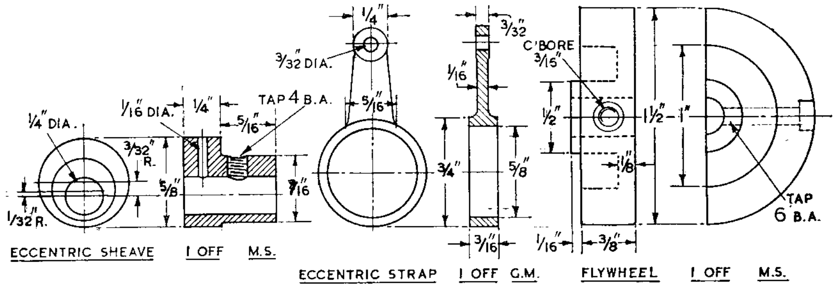
The crankpin is shown with a narrow groove to take a circlip, for preventing end play of the big end bearing. A circlip is better in this respect than a retaining nut or screw, as it is not liable to work loose while running. It need not be a special type of spring circlip; a ring bent from steel wire, or a washer with a sawcut across it, squeezed into place with pliers, will serve the purpose equally well.

Light alloy such as Duralumin or Hiduminium is favoured for the connecting rod. It is shown as turned all over from round bar stock; some constructors may consider it easier to make it from flat bar and file or mill the contours of the shank and bosses. This is largely a matter of individual preference, but it is quite easy to make it as shown by adopting correct methods of procedure. I recommend that the round bar should first be chucked truly and the spherical ends machined in turn, using either a simple ball turning tool, or hand turning tools with the aid of radius gauges for checking. The little end may be centre drilled lightly at this stage. Before turning down the shank, it may be used to mount the rod crosswise, on a V packing piece, on the faceplate. Each end may then be set to run centrally for cross drilling and facing. Finally the big end can be held in the chuck, the little end supported by the back centre, and the shank turned taper as shown.

The pillars which support the cylinders may be turned from 1/4 in. b.m.s. bar, with one end drilled and tapped and the other shouldered down to 9/64 in. dia. and screwed 4 BA. It is important that the length between the base and the top shoulder should be equal in all four pillars, also that the screwed ends should screw fully home in the base flange of the cylinder. Turning the centre part of the pillars may be done last, with a 4 BA nut held in the chuck to support one end, and a centre-drilled 4 BA stud to engage the back centre at the other end. When assembling the engine, the pillars should first be screwed loosely in the cylinder, and the countersunk screws inserted through the holes in the baseplate before screwing them in tightly with pliers, the finished surface being protected by a folded strip of copper or aluminium.

The cylinder cover shown in Fig. 32 may be made from the same material as the cylinder itself, or from brass bar if more convenient. It is machined on the rim, spigot and faces, then parted off, reversed in the chuck and skimmed on the top face, with the centre slightly relieved as indicated. A close-fitting register in the cylinder bore is not a necessity, but helps to locate the cover concentrically. The screw holes are first drilled in the cover, which is then used as a jig to spot the tapping holes in the cylinder. A local chamfer on one side of the cover spigot avoids restriction of the steam passage from the cylinder ports. To seal the joint, a thin paper or card gasket may be fitted,

Fig. 33



with a smear of shellac or joint varnish.

Bronze is specified for the bearing pedestals, but if this is not available, they may be made from rectangular brass bar, with bronze or gunmetal bushes inserted (brass of the ordinary kind is not a good bearing metal). The rounding off of the vertical edges helps to improve neatness, and it is easily carried out by holding the bar truly in the 4-jaw chuck. At the same setting, to top can be faced and a centre drill used to start the lubricating hole. After parting off the pedestals to equal length, it is advisable to sweat them together and mount them in the 4-jaw chuck for drilling and reaming the bearing holes (or oversize for fitting bushes). Before separating them, they should be checked to make certain that the bottom faces coincide exactly; if necessary they should be chucked endwise and a skim taken on the faces.

When fitting the pedestals to the baseplate, only one of the tapping holes should be drilled, as nearly as possible to the specified position. The pedestals should then be mounted on the base, each by a single screw, and lined up by inserting a piece of $\frac{1}{4}$ in. bar in the holes. This enables the other fixing holes to be jigged from the base, and thus allows for any possible error in marking out or drilling the holes which may throw the bearings out of line when fixed. Mark the pedestals for location, and while in position, a reamer may be run through the bearings to correct any minor inaccuracy.

The knuckle for the piston valve may be turned from $\frac{1}{4}$ b.m.s. bar, which is first turned down and screwed 6 BA, then parted off to length. To slot the fork, the part may be held by screwing it into the end of a bar held in the tool post, and using a slotting cutter or circular saw, making more than one cut if necessary to obtain the right width. Care is necessary to ensure that the cross hole for the pin is square with the slot. As a practical aid in such operations, a piece of flat strip metal may be fitted in the slot, and supported across a V-block, or the jaws of a small machine vice, during drilling operations. A piece of $\frac{3}{32}$ in. steel $\frac{1}{4}$ in. long may be used for the knuckle pin, and after final assembly of the eccentric strap, it may be lightly burred over to retain it in position.

The group of fittings shown in Fig. 33 includes the eccentric sheave, which is made with an extension boss for mounting it on the crankshaft journal. A piece of $\frac{5}{8}$ in. b.m.s. bar, if in good condition, may be used for this part, and need not be machined on the outer diameter. After facing the end, the offset centre of the hole should be marked out at $\frac{3}{32}$ in. from the main centre, and the bar then set up in the 4-jaw chuck, or in an eccentric turning fixture, for centre-drilling, drilling and reaming the hole. The boss is turned on the outside to reduced eccentricity, the object of which is to provide sufficient thickness of metal for the thread of the fixing screw, without making the boss unduly heavy. This entails resetting the work, but the amount of offset is not critical, and after the boss is turned, the complete sheave can be parted off. The radial holes for the fixing screw and the oil passage should be drilled at right angles to the throw, that is, through the thickest part of the sheave or its boss.

Unless a casting is available, the eccentric strap will need to be machined from solid, or fabricated by brazing the upper extension to the bush. The latter portion, in any case, should be of gunmetal or bronze, bored to a close running fit on the sheave. At the top end, the boss is drilled to fit the pivot, and machined or filed to fit closely in the fork of the knuckle. It will thus be noted that the strap is free to float endwise on the sheave, and does not exert any side thrust on the piston valve.

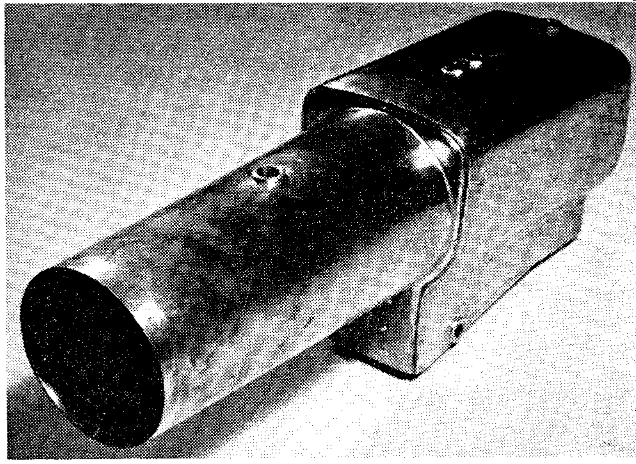
Either a mild steel blank, or a casting in iron or gunmetal, may be used for the flywheel. The object of recessing it deeply on one or both sides, is to avoid excess weight, without reducing momentum. It should first be machined on the back face, and the hole centre-drilled, followed by drilling and reaming at the same setting. To true the outer face and the outer diameter, the flywheel may be mounted on a true running mandrel. After drilling and counterboring the hole for the fixing screw, only the part which passes through the inner boss needs to be tapped, and a screw having a head which fits the counterbore should be fitted. A brass screw, which will not damage the surface of the journal, is to be preferred, unless a flat or dimple is provided as a seating for the screw point. This applies also to the screw in the sheave, which may have to be shifted a few times before its correct setting is arrived at.

The assembly of the engine is straightforward; all parts should go together easily, and work smoothly. First the bearing pedestals should be secured to the baseplate and the crankshaft, with the eccentric sheave and strap, inserted in the bearings and the flywheel fitted at the outer end. The connecting rod, with the piston and gudgeon pin in position, is fitted to the crankpin. Likewise, the piston valve is fitted to the knuckle. The cylinder is carefully lowered on to the piston and the piston valve, taking care that they do not tilt and jam in the bores, and the pillars fitted as described above. It should now be possible to turn the engine freely, and with the piston at the top of its stroke there should be sufficient clearance to enable the cover to be fitted without fouling the piston but excessive clearance is bad for steam economy, and should be avoided.

To set the piston valve, the eccentric sheave should first be secured to the shaft at about 45 deg. behind the crankpin in the direction of rotation. That is, to the *left* of the crank when at T.D.C. for clockwise rotation (looking at the crank end), and to the right for clockwise rotation. The position of the piston valve in relation to the knuckle should then be set by adjusting it up or down on the screwed end. As it is not possible to set the opening and closing points on the live steam side by inspection (unless an inspection port is provided in the cylinder) this must be done by measurement from the top of the liner. If the port belt is located as specified, with the ports just cracking open at $\frac{5}{16}$ in. from the top end, and the top *land* of the piston valve is $\frac{3}{32}$ in. wide, the top *end* of the valve will be $\frac{5}{16}$ in.-$\frac{3}{32}$ in.= $\frac{7}{32}$ in. from the top of the liner when steam admission commences; that is, at approximately 10 deg. before T.D.C. of the crankpin. These settings may be varied experimentally to obtain optimum results, remembering that the *timing* is controlled by the eccentric setting, and the steam admission and cut-off, also exhaust opening and closing, by the valve adjustment. Any form of depth gauge, or even a piece of $\frac{5}{16}$ in. rod with the depth marked may be used to check the valve position.

The *Corsair* engine is designed in a size to suit light cruising boats up to about one metre or 40 in. in length, but its size may be varied if required, keeping generally to scale working proportions. It is intended to drive the propeller directly at a speed of 3,000 r.p.m. or more; this speed would have horrified steamboat builders a few years ago, but many i.c. engine-driven boats use much higher speeds efficiently by the use of correctly designed propellers.

AN OUTSTANDING LOCOMOTIVE BOILER



Built by Alec Farmer

and described by Martin Evans

WHATEVER theories locomotive enthusiasts may have about model valve gears, no one will deny that the modern all-brazed or silver-soldered superheater boiler is reasonably efficient, and up to its job in almost all respects.

It has, therefore, become exceedingly difficult for the optimistic designer to make any appreciable improvement.

Many readers, and builders of the actual engine, have been kind enough to say that the original boiler specified for my 3½ in. gauge 2-6-4 tank locomotive *Jubilee* was an excellent steamer, and not too difficult to build. But experience gained with my own *Jubilee* convinced me that some improvement *was* possible, and the new design reproduced on the next two pages shows the result of a considerable amount of thought, experiment and practical work.

I have never been very impressed by the argument that before a person's opinions on any particular aspect of locomotive (or boiler) design should be listened to, that person must have actually built—with his own hands—literally dozens of locomotives. This is not to say that I think a successful engine can be designed and built entirely from the drawing-board; theory and practice must always go hand-in-hand—they are of equal importance.

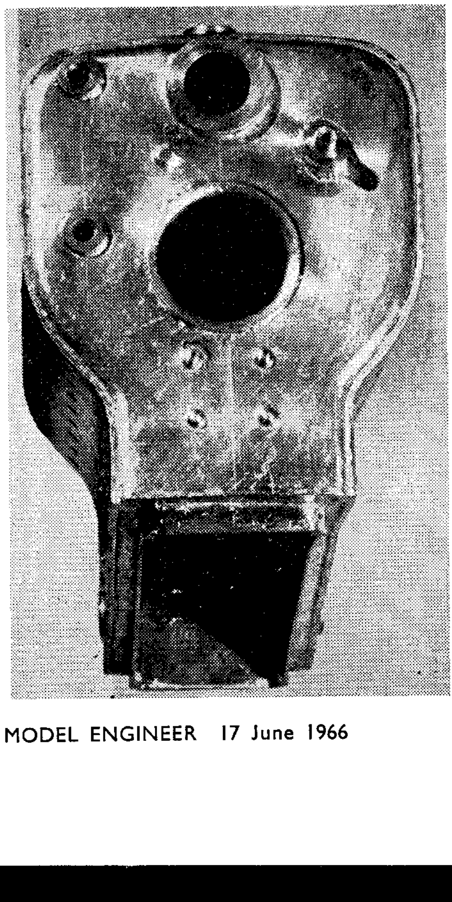
No, what I am getting at is that it is possible to learn a great deal about the subject by studying the work of others, and by adopting and adapting good ideas as they are found.

In connection with my own locomotive design work, I have, on at least one occasion, been described as a "copy-cat"; but I am sufficiently thick-skinned not to let that worry me! In fact, far from being penitent in this matter, I make no apology at all for having at times copied ideas from other model locomotive men, though I believe I have always made a due and proper acknowledgment!

After all, one of our greatest full-size locomotive men, George Jackson Churchward, "copied" many ideas from other engineers. It was his success in recognising the best features of other designers' work, and in blending them together in a single locomotive, that made Churchward's reputation and put the Great Western in the forefront of locomotive design.

But to return to the improved boiler for *Jubilee*, the alterations and new features are as follows:—

1. A slightly longer firebox, the barrel length remaining the same as before.
2. Greater water space between the throatplate and the firebox tubeplate.
3. The "cutting out" of the girder-type crownstays in order to improve water circulation and evaporation.
4. The fitting of a proper Nicholson thermic syphon.
5. The reduction of the number of superheater flues from three to one, with the object of fitting a firebox "radiant-

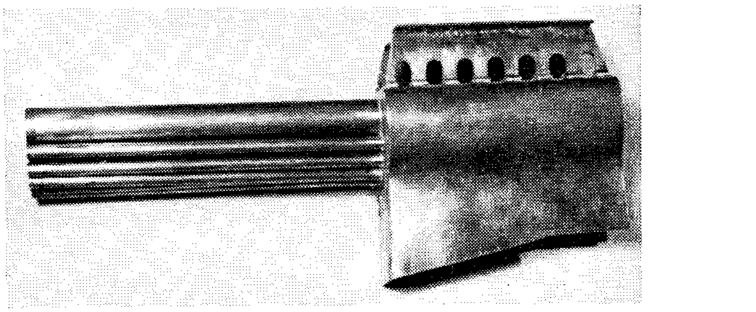


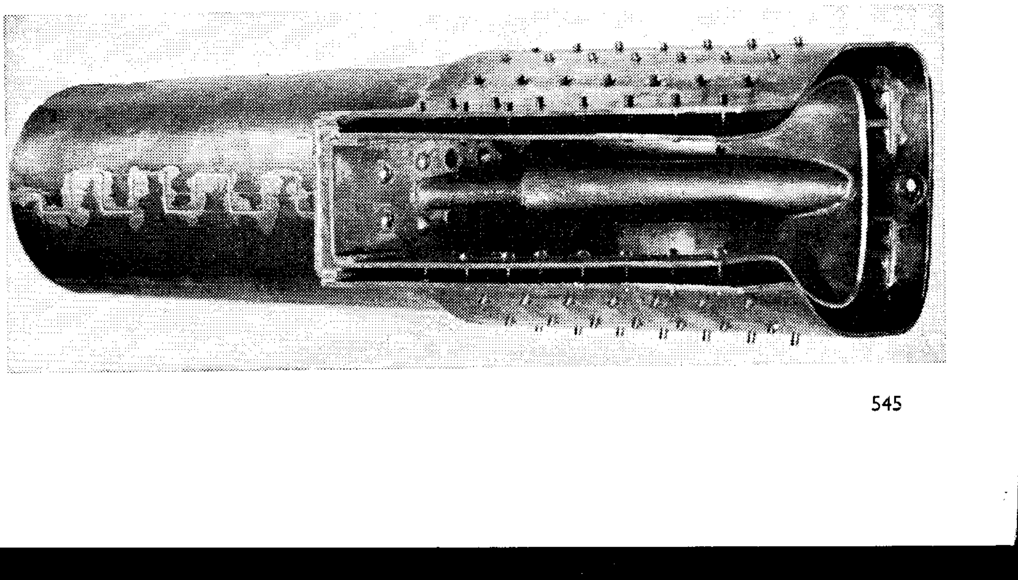
Top: The completed boiler

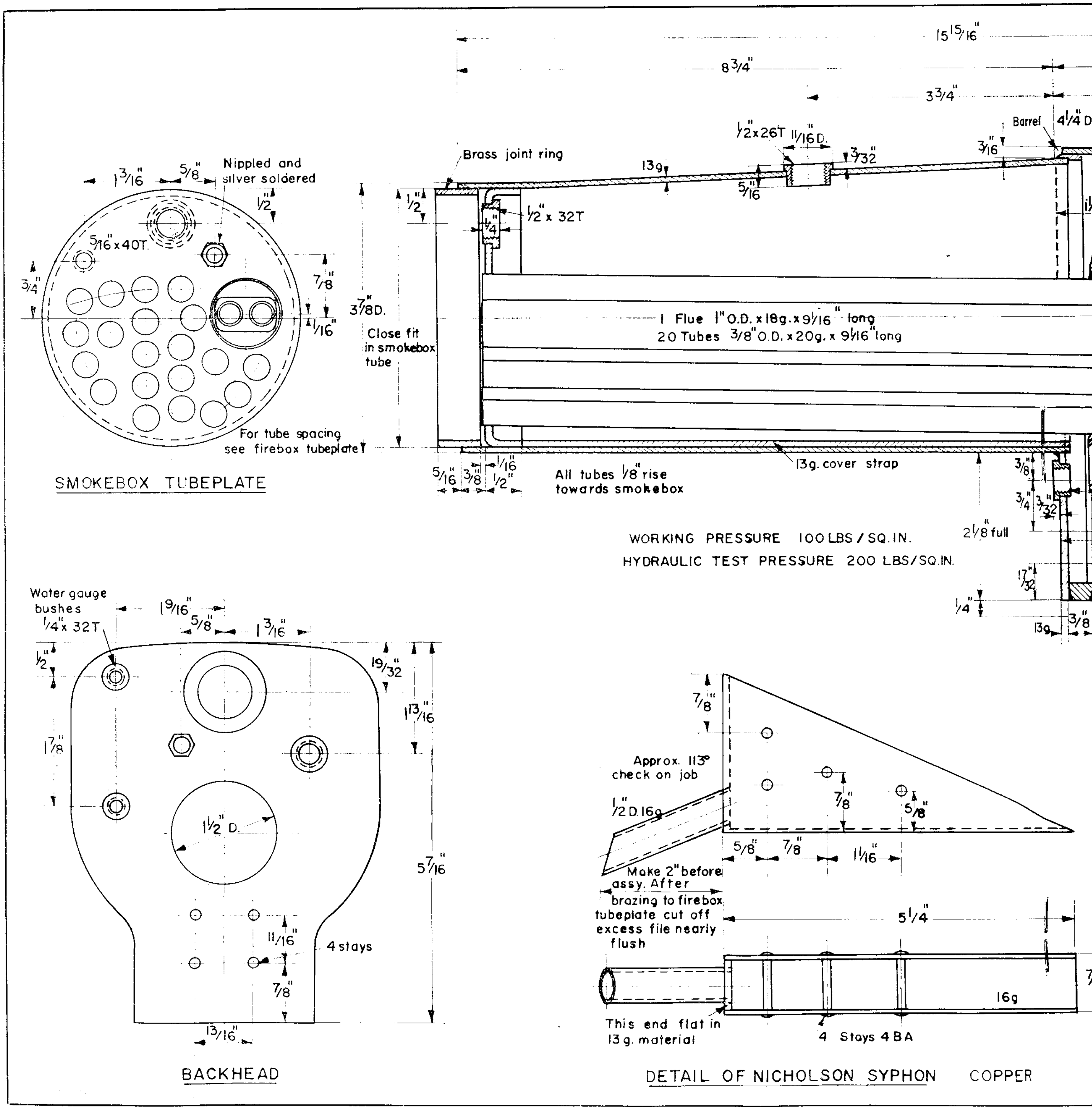
Bottom left: The backhead

Right: Inner firebox showing the crownstays

Bottom right: Underside view showing the syphon.





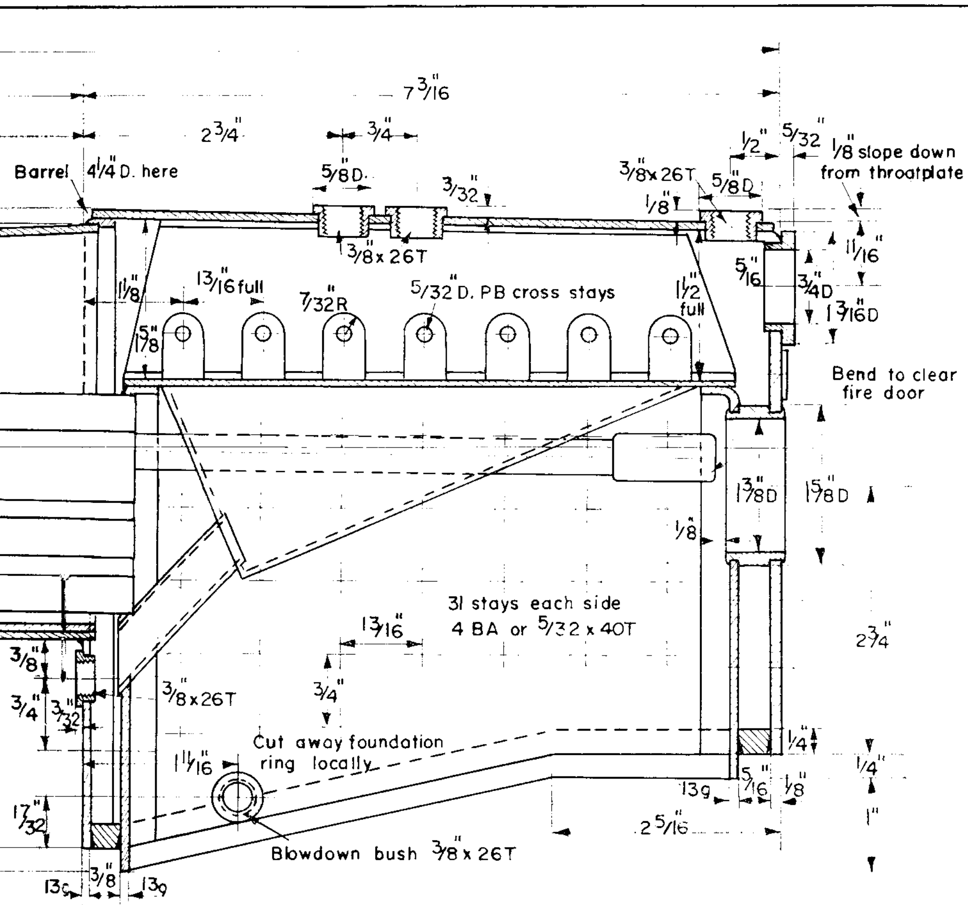


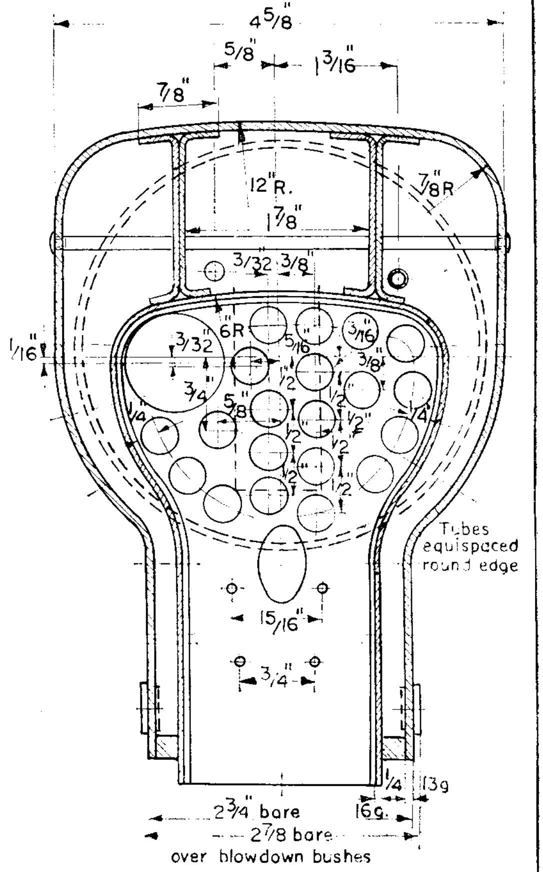
heat" superheater element, on the lines of that used by Mr. J. Ewins.

6. Re-arrangement of the firetubes to give greater tube heating surface without increasing the length of the tubes, and also to give better water circulation.
7. The specification that every stay is to be silver-soldered —no soft solder being used anywhere in the boiler.

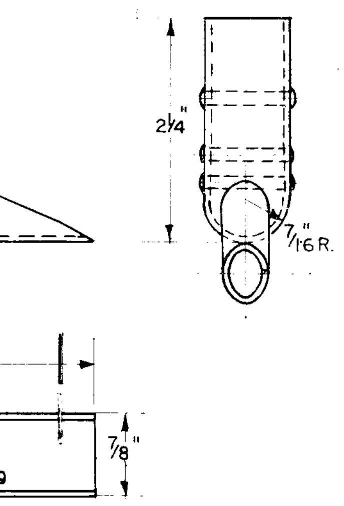
I believe that any one of the above seven alterations makes a significant improvement to the boiler as a whole, and there is no doubt in my mind that given all seven, we have here a boiler which shows a definite advance in all-round efficiency, one that should bring a gleam even to Mr. K. N. Harris's eye!

Should anyone wish to build a similar boiler, there are





PART SECTION THROUGH
FIREBOX LOOKING FORWARD



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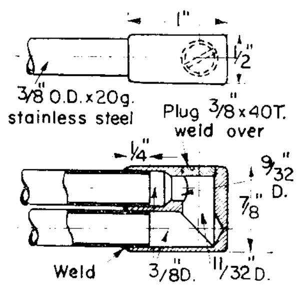
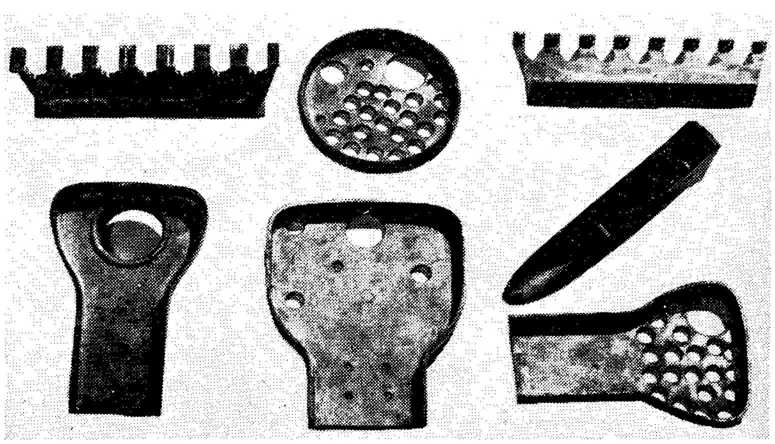


DETAIL OF SUPERHEATER
STAINLESS STEEL

THE NEW JUBILEE BOILER

designed by Martin Evans



The flanged plates, crownstays and thermic syphon before assembly.

Continued on page 556

STEAM CARS

Part two by K. N. Harris

MY STANLEY steam car water gauge was made of non-magnetic material, and the thing worked with complete reliability. Some years later Stanley's fitted an identical piece of apparatus to their own cars; it differed only from mine in being rather neater and more compact. To me, that has been an outstanding example of the way in which, given a mechanical problem, different and entirely independent people will solve it along similar (and, in this case, identical) lines. It also taught me the folly of rushing into print with loud-mouthed claims that "I done it first!".

I should regard an engine of only 2 in. bore by 3 in. stroke and working at only 180 lb. per sq. in. pressure geared 2 to 1 on the wheels as distinctly on the small side; the early *Locomobiles*, which were very lightly built indeed, had engines $2\frac{1}{2}$ in. $\times$ $3\frac{1}{2}$ in. and worked at 200 lb. per sq. in. and upwards, and nobody who had any experience of driving them would be likely to regard them as being over-powered!

I agree entirely with LBSC on the value of superheat; as I said earlier, I should regard really high superheat as an absolute "must" for any steam car which is to be of practical use.

Early Burners

LBSC says that the early burners were gauze covered, the flame burning on the top of the gauze; all I can say is that I never saw one of this kind. All the burners I ever saw, of the the burner regenerative type (as used by Locomobile, Stanley, White etc.) had cast iron or steel burner plates, or in the case of Turner-Miesse, tubes, the early varieties of which usually had small holes drilled to allow the passage of the combustible mixture; later types had the plates ridged, with narrow saw-cuts in the upper parts of the ridges and all of them, at times, suffered from "lighting back". The "white-flame" type, such as the Lune Valley (Kitchen's Patent) and the Pearson Cox, were free from this annoying habit, but were probably rather less efficient thermally under road conditions. For marine work I don't think any better burner than the Lune Valley has yet been produced.

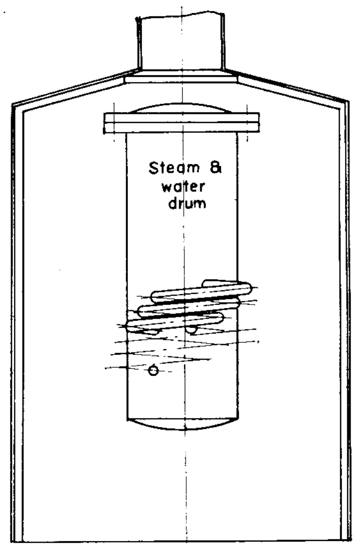
Whilst the blower type of burner is undoubtedly attractive, it is by no means perfect and it is quite a complicated piece of apparatus, more so than the ignition system of a petrol engine.

The Thorn Burner

Of all the regenerative type burners of which I have any knowledge, I think that the Thorn is easily the best. In this the burner plate has a series of steel ferrules inserted into its top side, each of which contains a perforated insert, made I believe of pumice, and generally similar to the stealite inserts used in the Meaker bunsen burner. The spaces between the ferrules are filled with Keiselghur and the whole construction prevents the plate itself ever getting hot enough to ignite the gas in the burner pan, whilst the holes in the pumice discs are of such proportions that it is almost impossible for the flames to "strike back" however much the gas supply is reduced.

From the standpoint of the amateur-produced steam car (and a commercially produced steam car is, to say the least, something highly improbable) I think that a burner of the Thorn type, using paraffin with a bottle-gas fired pilot is perhaps the best bet.

I note that LBSC refers to one of the watertube boilers that he illustrates as the "Babcock & Wilcox" type. True,



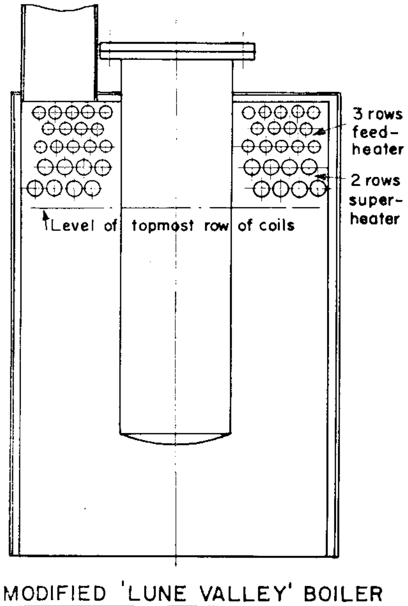
A series of helical coils of steel tube each of three turns set in spiral fashion around the drum from bottom to top. Each coil is itself off set as shown and each successive coil off set relative to the one below. Upper coils filled with steam

'LUNE VALLEY' W T BOILER

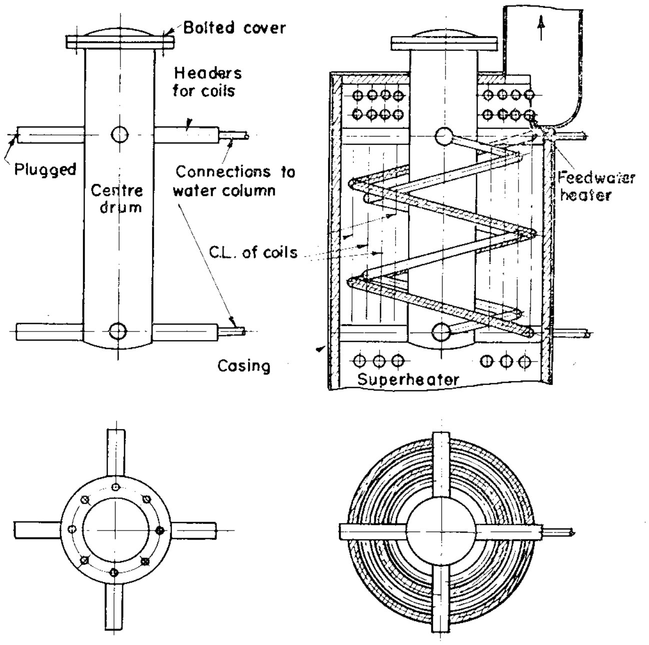
this boiler does bear a general resemblance to that famous make, but its proportions, construction and general arrangement differ very widely from the B. & W. and credit for its design goes to Mr. Durr of the U.S.A.

These boilers were applied to a number of the later Stanley steamers, and I know that Dr. Bradbury-Winter, a lifelong user of Stanley cars, had one. It has an excellent circulation, is a fast steamer and has quite a useful reserve capacity, whilst with modern welding techniques its fabrication is quite a simple proposition; finally, its shape is such as tc fit in beneath the bonnet admirably.

The diagram of the Lune Valley boiler is like no boiler of their make that I have ever seen, either in proportions or in the tube arrangement. I have seen some scores of these boilers and years ago I visited the Lune Valley Works in Lancaster (they afterwards sold out to Phillip & Co. Ltd., of Dartmouth, who also took over the famous firm of steam launch builders, Simpson, Strickland & Co. Ltd., also of Dartmouth), and they were all fitted with 3 turn coils, not



MODIFIED 'LUNE VALLEY' BOILER



BOLSOVER EXPRESS WT BOILER

loop tubes as shown, the coils being set slightly askew, or pushed sideways, so as to offer as much of their surface as possible to the hot gases from the burner. Relatively, the centre drum was less than half the size of that shown in the diagram.

There is another form of water-tube boiler eminently suited to steam car work, namely the Bolsover Express, which incidentally has been described several times in M.E. in the past. This consists of a central drum, having top and bottom four to six radial tubes with their outer ends plugged. From the lower tubes run smaller tubes, wound spirally and each row alternatively wound opposite hand, their upper ends being welded into the top radial tubes. All the spiral tubes are of approximately the same length. Here again the circulation is extremely rapid and the steam producing capacity of a very high order, whilst in comparison to the exposed heating surface, there are few joints.

High Pressures

All these three types are well adapted to working at high pressure. (the Lune Valley usually worked at 250 lb. per sq. in. but was eminently capable of using much higher pressures). All are, if properly constructed, very safe, and capable of high quantity steam production relative to their bulk and weight and all have a reasonable reserve capacity.

I have not mentioned the monotube generator, for two reasons; firstly, whilst it is an extremely efficient and rapid producer of steam, it depends, more than the watertube types, on close automatic control of feed water and burner, which is not too easy to attain combined with a very high degree of reliability; secondly, because it has practically no reserve. It is often stated that its small water capacity is compensated for by the amount of heated metal it contains. This I should regard as an argument of very dubious validity. The specific heat of steel is only .117 (water being 1) and it requires an awful lot of hot steel to evaporate one pound of water and turn it into steam at 600–800 lb. per sq. in. and 700–800 deg. F. total temperature.

Whatever type of boiler is used, I should regard two things as essential; auto-control of water level and auto-control of burner. Fortunately both these things are quite simple of accomplishment with simple and reliable apparatus; thermostatic for water level, and pressure diaphragm operating a needle valve for burner control. I had long experience with this type of apparatus as applied to steam cars, and found it almost unfailingly reliable; the only exception was the thermostat used in the later *White* models, which controlled an auxiliary water supply, admitted to the generator when steam temperature rose too high. It was, in my experience, the Achilles Heel of the system and, again in my opinion, very poorly designed; this was all the more remarkable for their original thermostat which controlled the *fuel* supply never gave any trouble at all, and in my experience never failed to do its job.

The Stanley controls, both thermostatic and pressure operated diaphragm, I always found trouble-free and 100 per cent. reliable.

It may be thought that the foregoing is unduly critical, but the criticism is not captious and I have endeavoured to give reasons and to make it constructive; furthermore it is based on years of practical experience with steam cars of several different makes, and thousands of miles of running over all sorts of country.

Finally, a comment on the appearance of the car illustrated on page 115. This (like the appearance of a hippopotamus in the lake at St. James' Park) is certainly eye-catching, but distinctly bizarre: it reminds me irresistibly of the Hot Potato engines which were such a feature of the London streets 60 or more years ago, which in turn bore a striking resemblance to Stroudley's LBSCR locomotives; which inspired which I do not know. The chimney and dome would infallibly create a blind area in the driver's view and do nothing to assist road safety!

Readers interested in steam cars may like to know that there is a design for a three-cylinder uniflow steam car engine in the current issue of the BLSPS Bulletin. (The British Light Steam Power Society, 18, Rodney Road, Saltford, Bristol.)

MOGUL

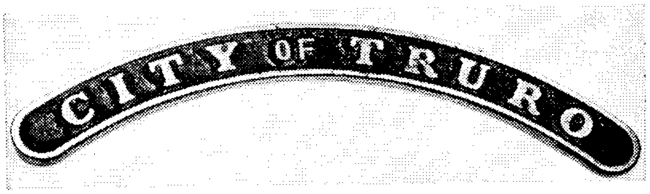
Some notes on a $7\frac{1}{4}$ in. gauge Great Western 2-6-0

Part IV continued from page 511

by K. E. Wilson

AN ARTICLE some years ago on making name and number-plates for locomotives set me thinking. It recommended the practice of plotting the plate details on graph paper, then using a small flat milling cutter (end-mill type) to mark out the letters. This of course left a negative, from which prints could be made by impressing the negative into a piece of soft material.

This method, while ingenious, made correct style lettering a bit tricky; the beautiful G.W.R. style needs to be copied exactly by any true Western fan. Two methods are described here, either can give good results as the photographs show. The numberplate 6026 was made by first enlarging a photograph of the full-size nameplate to ten times the size required for the finished 5 in. gauge locomotive; this was traced on graph paper. It was then a simple matter to allow for the radius of the dental burr, and, using the vertical and cross-slides of the Myford as a jig-borer, to slowly but surely machine away the unwanted material. This resulted in a 'master' from which castings could be made. Fig. 1 shows one of these castings actually on the King's cab side. One or two small flaws can be seen, but the effect is clearly G.W.R.



The second method was used for the nameplate in Fig. 2; this is $3\frac{1}{2}$ in. gauge size. The photograph of the full-size nameplate was studied, and a special set of figured and lettered stencils ordered from a suitable manufacturer. Actual drawings from Swindon were sent to the manufacturer, so there should be no arguments about accuracy and style. These stencils are 1 in. high; so it was easy to calculate the correct size of drawing. I prepared blanks of this size to save work in the future. The drawing was one fully completed in black Indian ink, and sent to a firm of photo-engravers. They reduced the drawing to the specified size photographically, then etched a deep specimen in brass. This was then used as a pattern for castings; the results are shown.

This method was suggested to me by the late D. G. Webster, of the Harlington Society; but he stopped short at the etching stage as he only wanted two off. He showed me the finished results for his Dean Single, even the works plate was there, beautifully done.

Headlamps

These fittings are very rarely seen on miniature locomotives possibly because of lack of published information on the subject. This is one of the rare points on which I disagree with LBSC; the lamp shown in his "Live Steam Book" bears but small resemblance to the correct article. However, as he himself would be the first to point out, it doesn't affect or improve the working of the engine! The tremendous service that he has given to us all far outweighs any such minor matter.

The drawings in Fig. 3 give the correct proportions for the G.W.R. Headlamp. I have no official drawings, but found a good photograph that turned out to be $2\frac{1}{2}$ in. gauge size. No difficulty should be found in making these; look up the appropriate letter for the dimension that you require in the table; and beside it will be found the correct dimension under the selected gauge column. The 'glasses' can be made from small glass buttons (Woolworths) or machined from perspex. This may be screwed into the lamp body. There are available certain sizes of electric bulb for the fastidious, but I did not think them worth the trouble. Lamp brackets are also shown.

One point here that is a MUST if you actually run your locomotive: that is to attach the lamps in such a way that they are not removable. Children (and many adults too) can't help having 'sticky fingers' and why should you supply them with easily-stolen fittings? The photograph Fig. 4 shows the lamps as made for the $3\frac{1}{2}$ in. gauge *City of Truro*. I made sets for the "King" and the "Mogul"; incidentally, the G.W.R. headlamps were not white but red, prior to about 1932. (I mean the colour of the body, not the lens.) On many locomotives there were a couple of spare brackets mounted just near the steampipes to the cylinders on the left-hand side; these were for spare lamps.

Screw Couplings

I have seen both good and bad examples of screw couplings. The worst was on a *Hielan' Lassie;* although the engine was a fine runner (it still holds the track record of 36 seconds for the Chipperfield track as far as I know) the maker had not taken much care with the details: the coupling links were 18 SWG wire!

From a photograph obtained from the G.W.R., I prepared the following drawings; once again they are shown by reference letters for the three gauges. Points to note are:—

a. The top of the screwed portion is not riveted over, but is threaded and a long but narrow nut is placed on it, this is split-pinned for security. The lower end, however, is riveted over after screwing through the lower shackle to prevent it falling off; just imagine the full-size one landing on a toe!

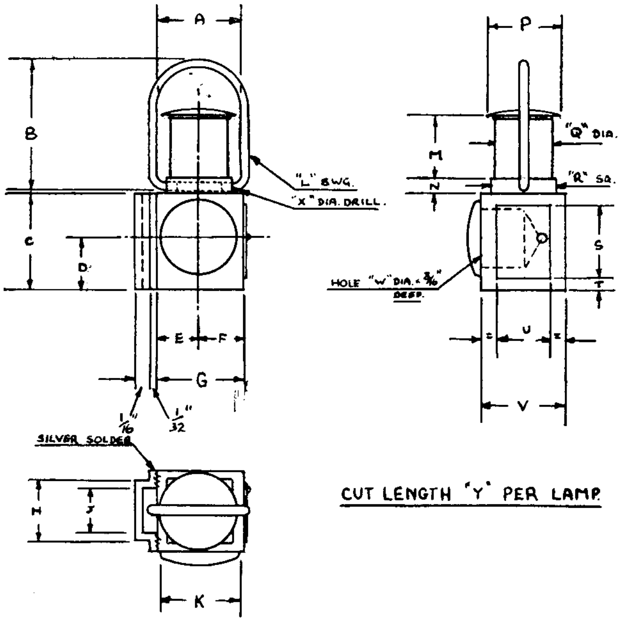


FIG. 3. HEADLAMPS

DIMS.	3½"	5"	7¼"
A	11/32"	½"	11/16"
B	9/16"	13/16"	1 1/8"
C	13/32"	19/32"	13/16"
D	7/32"	5/16"	7/16"
E	11/64"	1/4"	11/32"
F	3/16"	17/64"	3/8"
G	23/64"	33/64"	23/32"
H	1/4"	3/8"	1/2"
J	3/16"	1/4"	3/8"
K	5/16"	7/16"	5/8"
L	22	19	16
M	11/64"	1/4"	11/32"
N	5/64"	1/8	5/32"
P	5/16"	7/16"	5/8"
Q	15/64"	11/32"	15/32"
R	9/32"	13/32"	9/16"
S	5/16"	7/16"	5/8"
T	1/16"	3/32"	1/8"
U	7/32"	5/16"	7/16"
V	11/32"	1/2"	11/16"
W	1/4"	3/8"	1/2"
X	69	60	52
Y	11/16"	1 1/64"	1 3/8

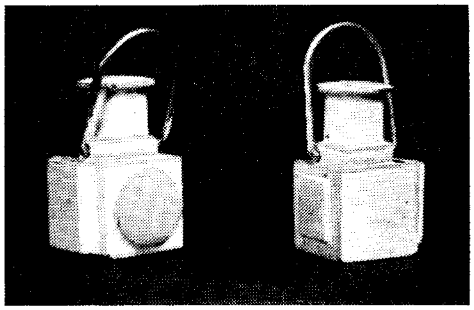


Fig. 4: Lamps for the City of Truro

b. The loops for the swivels at the end of the shackles are forged up to size and then drilled; but being lazy I myself make them in the usual way. A split pin (or split cotter, if you prefer) is put through outside each loop to stop the shackle popping off the swivel.

c. The swivel itself is made from square or rectangular bar, NOT round.

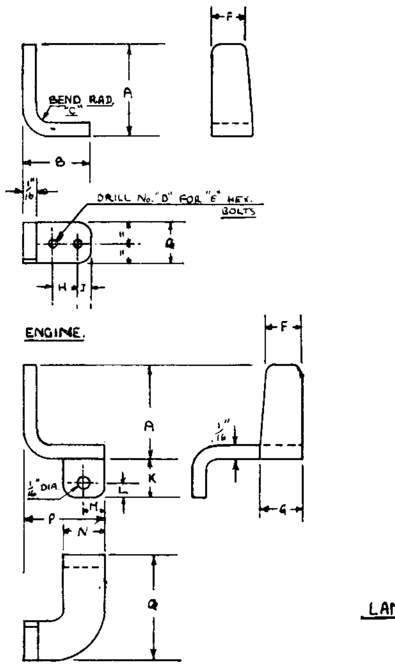
d. The lever for tightening is not just put through a hole in the screw, it has a forged fork-piece on the top which fits over a little lug on the screw, thus it folds over easily when not in use.

The hole in the coupling hook, incidentally, is not round but oval to allow the shackle to be pushed through.

To be continued

DIMS.	3½"	5"	7¼"
A	3/32"	1/8"	3/16"
B	1/4"	3/8"	1/2"
C	3/4"	1 3/32"	1 1/2"
D	3/4"	1 3/32"	1 1/2"
E	5/32"	7/32"	5/16"
F	3/16"	17/64"	3/8"
G	7/32"	5/16"	7/16"
H	5 BA	3 BA	1/4 BSF
J	No. 29.	No. 19	1/4" DIA.
K	7/32"	5/16"	7/16"
L	5/32"	7/32"	5/16"
M	5/32"	7/32"	5/16"
N	5/8"	7/8"	1 1/4"
P	1/8" DIA.	·166 DIA	1/4" DIA.
Q	13/16"	1 5/32"	1 5/8"
R	7/32"	5/16"	7/16"
S	1 3/16"	1 11/16"	2 3/8"
T	3/16"	1/4"	3/8"
U	1/16"	14 SWG	1/8"
V	1/8"	3/16"	1/4"
W	10 BA	8 BA	5 BA

DIMENSIONS FOR FIG 5



DIMS.	3½"	5"	7¼"
A	7/16"	5/8"	7/8"
B	5/16"	7/16"	5/8"
C	1/16"	1/16"	3/32"
D	55	51	43
E	12 BA.	10 BA.	8 BA
F	11/64"	15/64"	11/32"
G	3/16"	1/4"	3/8"
H	1/8"	3/16"	1/4"
J	1/16"	3/32"	1/8"
K	3/16"	1/4"	3/8"
L	1/16"	3/32"	1/8"
M	3/32"	1/8"	3/16"
N	3/16"	1/4"	3/8"
P	3/8"	1/2"	3/4"
Q	1/2"	23/32"	1"

LAMP BRACKETS.

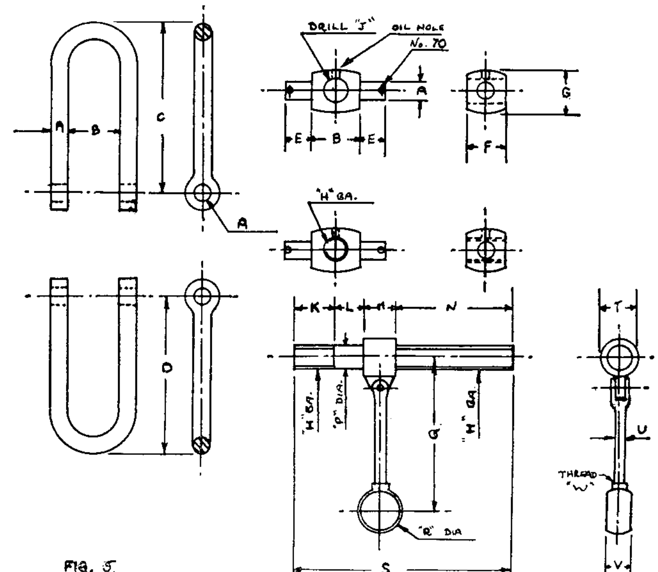
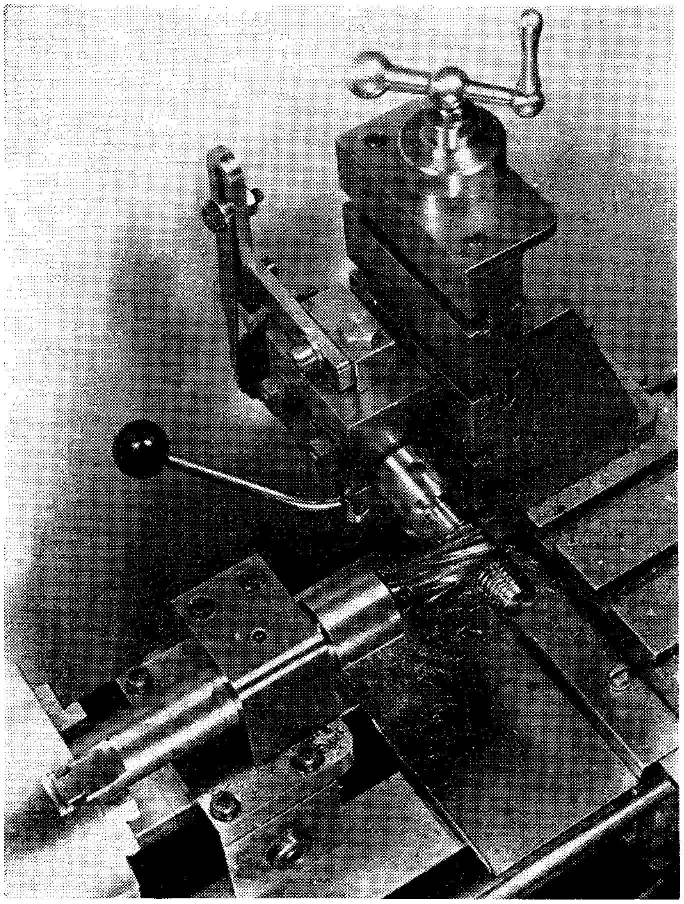


FIG. 5
GWR. LOCOMOTIVE COUPLINGS

Aids to GEAR CUTTING and INDEXING

By Martin Cleeve



Direct indexing for milling four flutes in a special tap.

CERTAIN queries have resulted from my recent series on gear cutting and indexing (M.E. February 18, March 4 and 18) and it is these that have prompted me to offer more information. For example, one reader found that his lathe change gears were of No. 14 DP and therefore had much larger teeth than the ML 7 gears: he wondered if my indexing chart would apply in his case. I was able to reassure him, and others may like to note that whenever a worm is made to mesh with a gear, it does not matter what size the gear teeth are, one complete and exact revolution of the worm will always advance the gear by exactly one tooth. If the worm is meshing with a 40 T gear, 40 revolutions of the worm will revolve the gear exactly one turn.

Indexing Indicator

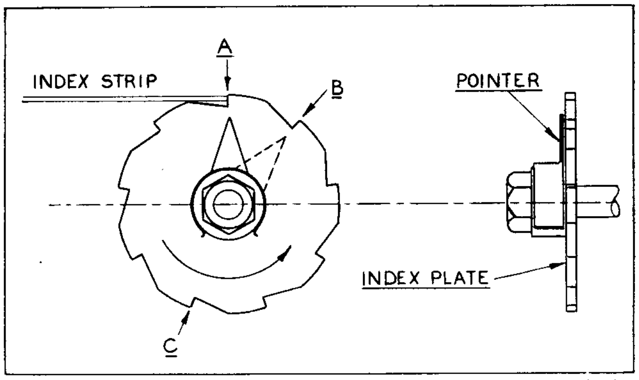
When worm indexing, and the required number of divisions is less than the number of teeth on the gear driven by the worm, the worm will always require turning through more than one revolution. A more common requirement for example, is one revolution plus a definite fraction of a turn. A circle of holes that is capable of giving these fractions of a turn is therefore nearly always necessary. In the case of my own index head which can use the "ratchet" type of plate, turns or parts of a turn may be controlled or indicated by the method shown in Fig. 1.

Let us suppose that it is desired to index 36 spaces, or teeth for a gear. My table (page 267, March 18) shows that we can obtain this number by meshing the worm with a 40 T gear and indexing $1^1/_9$ turns of the worm-shaft. Accordingly, we select a plate capable of giving nine divisions. This plate is mounted on the worm-shaft, or worm-shaft boss, and may be held by a nut with an interposed circular collar, as shown. It is then possible to mount on this collar a simple pointer made from sheet brass or even zinc, and with a portion bent to give a frictional grip to the collar, after the manner of a micrometer indicator clip, then the method is as follows:—

Assuming everything else is ready, to set for cutting the first tooth space of a gear, lift the index strip clear of the index plate ratchet teeth and rotate the plate in the direction of the arrow to take up worm and wheel backlash, then lower the strip so as to bring the plate to a stop with any one of the index teeth abutting the strip end. Call this point *A* (Fig. 1). Set the pointer opposite the strip end. Form your first tooth space.

Now to index your blank by turning the index plate through $1^1/_9$ turns, lift the index strip, rotate the plate through one complete revolution, *A* to *A*, set the pointer to *B*, to show the required 1/9th of a turn, raise the index strip and rotate the plate until *B* can be brought to rest by the strip end. You are then ready to form your next tooth space. Should you accidentally over-run on any setting, the pointer will show you where you ought to stop after you have first taken up all backlash by a liberal reverse movement.

Of course, if you want to index say 81 spaces, which call for a 45 T. gear to be driven by the worm and 5/9th of a turn on the index plate, after you have taken up backlash and made your initial setting for the first tooth space or 1/81 mark as at *A* (Fig. 1), you may rotate the pointer to indicate position *C* on the plate, and for the next index movement you merely lift the index strip and rotate the plate from *C* to *A*, then reset the pointer to *C* for the third index movement.



When the worm reduction is not being used and an index plate (or gear wheel) is being used on the same shaft as the blank to be indexed, you can index around in the opposite direction to the arrow in Fig. 1, and reverse the plate as a final movement to abut the appropriate notch against the strip end, because there will be no worm back-lash to take into account.

To return for a moment to the indexing of 36 spaces, if you have no nine division plate you can, of course, index one from a 45 T change gear, or you can use the gear itself in which case your distance from *A* to *B* should include five tooth spaces. There may be no room for the collar to allow of fixing the index pointer, but it is possible to manage by making pencil marks to indicate subsequent movements.

Finally, the index chart shows that you can use an 18 space plate for 36 spaces, and this would require one whole turn, *A* to *A* and two spaces between *A* and *B* for the 1/9 movement.

Index Calculations

Although my index table is fairly comprehensive, it is as well to have an understanding of how it was calculated, then you are ready for any eventuality, for straightforward worm indexing, at least.

With a standard index head where a single thread worm meshes with, or "drives" a 40-tooth gear in the index head, the number of divisions or spaces that an index plate should have for giving X spaces or teeth on a gear to be made is found by the formula:—

$$\frac{40}{X}$$

To illustrate this further, let us suppose that it is desired to increase the range of a standard set of lathe change gears (which normally stop at about the 75-tooth size) to go to 100 teeth, either for the pleasure of the job, or to allow of the setting for a larger screw-cutting range, using simple instead of compound quadrant gearing; we should need five gears—80, 85, 90, 95 and 100 teeth, and the index plates required will be for:—

(1). 80 $T=\frac{40}{80}=\frac{1}{2}$. This means that the index plate must be capable of being rotated in steps of exactly ½ a complete turn to move the 80 T gear blank through 1/80th of a revolution for each tooth space. A special plate is not strictly necessary here; another change gear could be used, say one having 50 teeth, each indexing movement being made by taking 25 teeth at a time to obtain the half revolution. However, the chances of a mistake in counting are rather great and it is therefore preferable to use a plate with six spaces and to take three for each index movement.

(2). 85 $T=\frac{40}{85}=\frac{8}{17}$. The denominator here shows that an index plate with 17 holes or spaces is required, and the numerator that eight of these spaces must be taken at a time for each 1/85 division required on the gear. Since you are most unlikely to have a 34-tooth gear of sufficient diameter to give the necessary indexing accuracy by taking 16 of the 34 teeth for each indexing movement, you would need to make up a 17-space master index plate.

(3.) 90 $T=\frac{40}{90}=\frac{4}{9}$ A nine space plate, taking four spaces at a time for each index movement. (Or an 18-space plate, taking eight spaces at a time.)

(4). 95 $T=\frac{40}{95}=\frac{8}{19}$=a 19-space plate, taking eight spaces at a time. The Myford change gear set contains a 38 T and it is quite easy to use this to index a 19-space plate for general use.

(5). 100 $T=\frac{40}{100}=\frac{2}{5}$=a five-space plate taking two spaces at a time. A five-space plate may be made by indexing directly from a 65 T change gear, taking 13 T at a time.

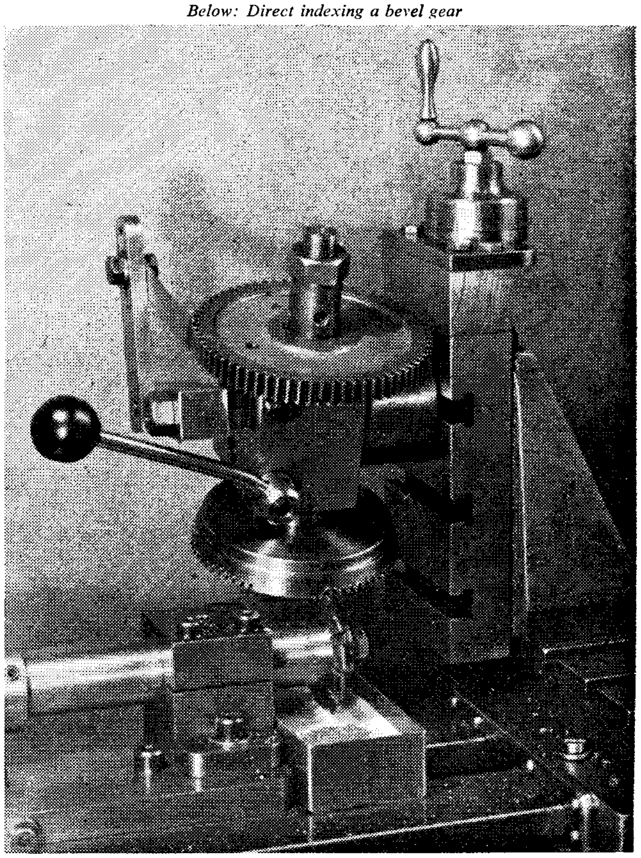
Awkward Numbers

Sometimes the formula $\frac{40}{X}$ will indicate that an index plate beyond our range is called for, *i.e.*, when it is required to cut a 182-tooth gear: $\frac{40}{182}$ will only reduce to $\frac{20}{91}$ but although 91 is divisible by seven or 13, 20 is not, so apparently an index plate having 91 divisions is called for. However, by making use of the adjustable-height feature incorporated in my indexing head, we are not restricted to the standard worm and 40 T gear, and may select a gear having a factor in common with one of those contained in 91 (seven and 13). As our lathe change gears usually rise by fives, we may try multiplying the seven by five, giving 35 teeth, and meshing the worm with this. The index movement then becomes $\frac{35}{182}$ (instead of $\frac{40}{182}$). Now $\frac{35}{182}$ reduces to $\frac{5}{26}$ showing that we can use a 26-space plate, taking five spaces at a time for each 1/182 division required.

Going a step further, if we have no 26 division plate, we can halve this by doubling the size of the worm-driven gear, the indexing movement then becomes $\frac{70}{182}$.

To be continued

Below: Direct indexing a bevel gear



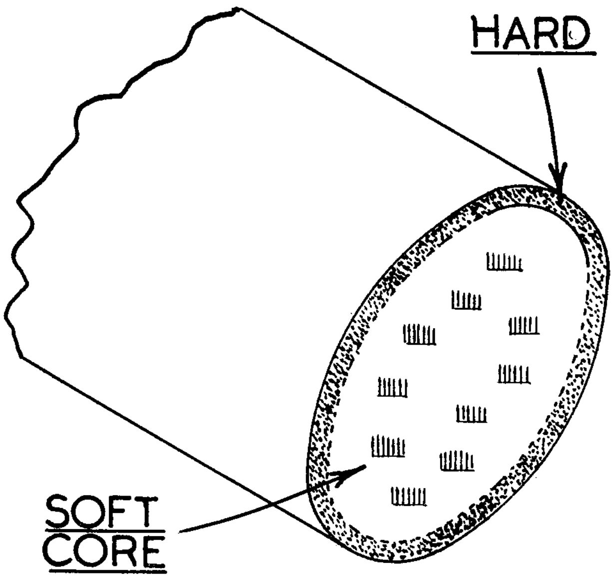
FOR THE SCHOOLS

CASE HARDENING

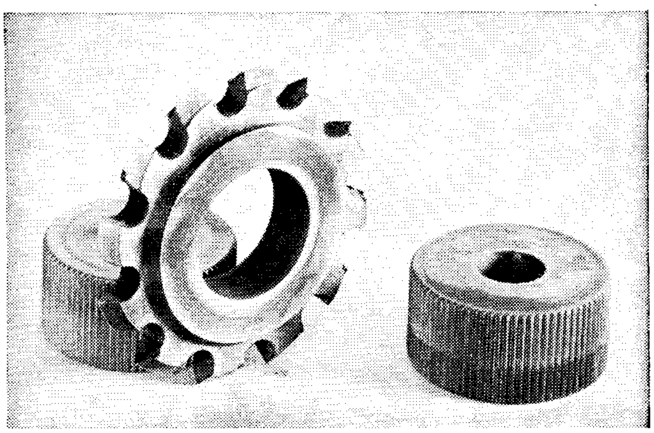
by

Duplex

CASE-hardening, as its name implies, is a process whereby steel parts are given a hard surface layer, leaving the central core as unaltered soft metal. A typical example is a machine spindle, furnished with a hard skin to resist wear and a core of normal steel to maintain the strength of the part.



Above: Fig. 1, *below Fig.* 2



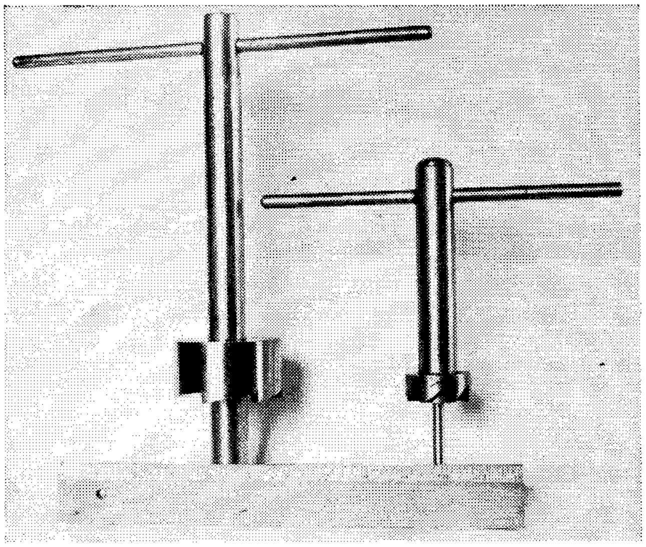


Fig. 3*: Small case-hardened tools.*

Other instances are: small cutting tools and the service nuts fitted to machine tools where case-hardening resists wear and damage from the continual use of the spanner. Examples of small case-hardened tools made in the workshop are shown in the accompanying photographs, Figs. 2 and 3. These require to be finally tempered to remove brittleness from the cutting edges and, although useful for dealing with small batches of parts, they stand up for a surprisingly long time, particularly when machining non-ferrous metals.

The toolmakers' clamp, Fig. 4, and the parts of a knurling tool, Fig. 5, are left untempered after case-hardening, since resistance to wear and not localised edge strength is of primary importance.

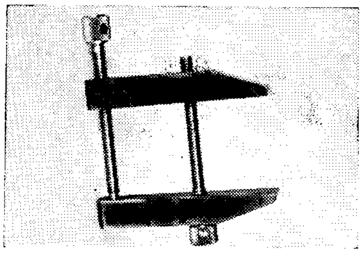
No difficulty has been experienced in case-hardening components made of the ordinary mild steel used in the workshop; for although this has a low carbon content, the carbon added during the process is sufficient to convert the outer layer into a carbon steel capable of being hardened when quenched in the heated state.

In commercial practice, special steels are usually employed where parts have to be case-hardened in bulk. These steels are of high strength and contain nickel or nickel and chromium. There are various proprietary case-hardening compounds in common use, of which Kasenit and Antol are, perhaps, the best known. Excellent results have been obtained in the workshop with bone dust, and all the mild steel parts illustrated were case-hardened with this material. Bone dust, free from fat, is or used to be a by-product of the Birmingham button-making industry. Before use it should be parched by heating on a stove until it resembles ground coffee.

On advantage of this substance is that it produces an attractive, mottled finish with a fine play of colours. In addition, bone dust does not cause corrosion or scaling of the steel surface. These characteristics are of importance in the gun-making trade, where the breech parts and lock plates are case-hardened after they have been elaborately hand-engraved, and surface damage is, therefore, inadmissible.

One of the simplest case-hardening operations is that used for protective fittings, such as service nuts, from damage when in constant use. At the outset, it is available to shield the screw threads by plugging the nut with fire clay.

The hardening operation that follows is known as the open-

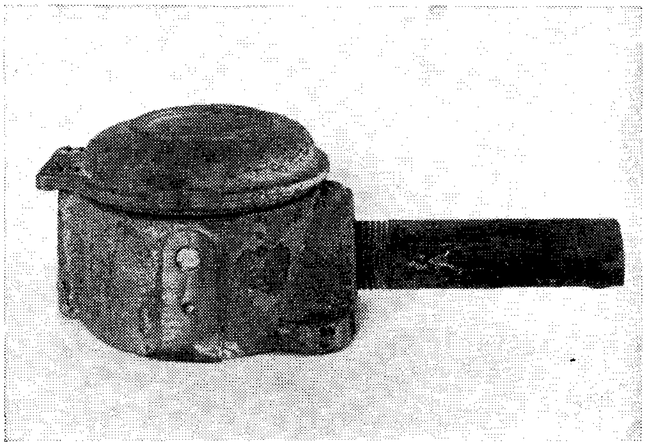


Left: Fig. 4

Right: Fig. 6

Below left: Fig. 5

Below right: Fig. 7



hearth process. The part is placed on a fire brick in the brazing hearth and coated with a thick layer of a fusible compound, such as Kasenit or Antol. When heated with the blowpipe, the compound melts and forms an adhesive coating that excludes the air. Several further applications of the compound should be made, and the heating continued, before the part is quenched in water. This results in forming an attractive, silvery finish on the work.

The more usual method of case-hardening is to heat the components in a box firmly packed with the hardening compound. Cast-iron lidded boxes are best for this purpose, and the electrical switch box, Fig. 6, is useful for dealing with small parts. A length of conduit tubing is screwed into the opening provided to serve as a handle, and any other holes should be sealed with metal plugs or fire clay.

The larger components illustrated were housed in the electrical junction box shown in Fig. 7. Parts for case-hardening should be well cleaned, and the mottled effect obtained with bone dust will show to the best advantage on surfaces that have been highly finished or even polished.

The components for hardening are firmly packed in the bone dust or other compound, so that they are evenly surrounded by a thick layer of the medium. This is not only excludes air and ensures direct contact with the parts, but it also gives some support to slender components. If an estimate of the depth of case is required during the heating process, rods of similar material are inserted in holes drilled in the box lid. These, when withdrawn, quenched and broken across, will show clearly the extent of the hardened layer.

The simplest way of heating the packed box is in an open domestic fire or stove. This was the plan adopted when case-hardening the parts illustrated. The coal or coke should be maintained at an even bright-red heat throughout.

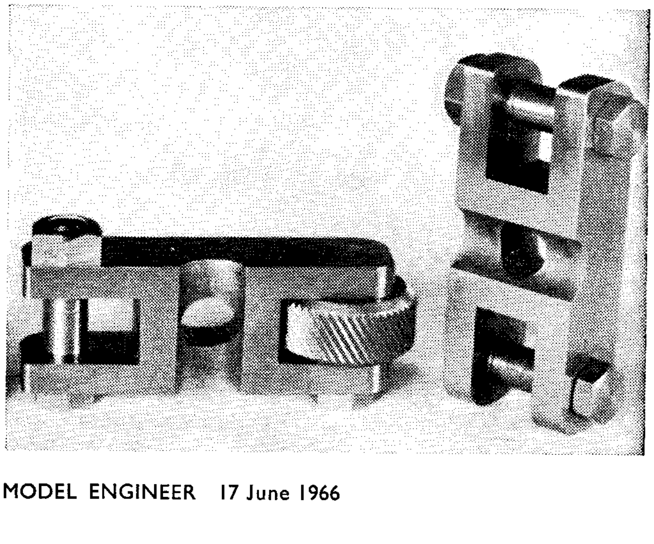
The box is buried in the glowing embers for a period of from one to two hours to obtain a hardened layer several thousandths of an inch in depth. On removal from the fire, the contents of the box are at once tipped into a bucket of clean, cold water, but splashing should be guarded against. Slender parts are apt to suffer some distortion on heating and quenching. For example, the camshaft fitted to the model shunting locomotive 1831 designed by Edgar T. Westbury.

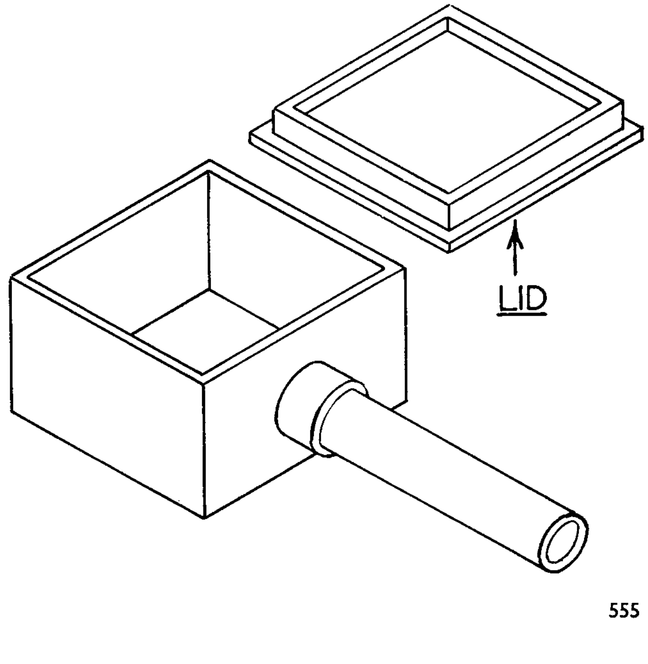
This shaft was inserted in a short length of steel tube fitted with a metal plug at one end. After careful packing with bone dust to give some support to the shaft, the other end of the tube was sealed with clay. To lessen the possibility of sagging, the container was stood vertically in the fire. After heating, the contents of the tube were poured vertically into the bucket of water which had been well stirred with a circular motion to promote even quenching and prevent the formation of steam pockets.

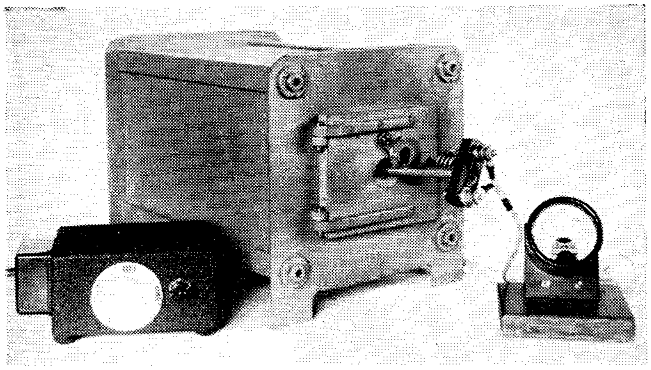
The small amount of distortion found when the part was checked, was corrected without much difficulty, and the shaft has since given good service without any sign of wear.

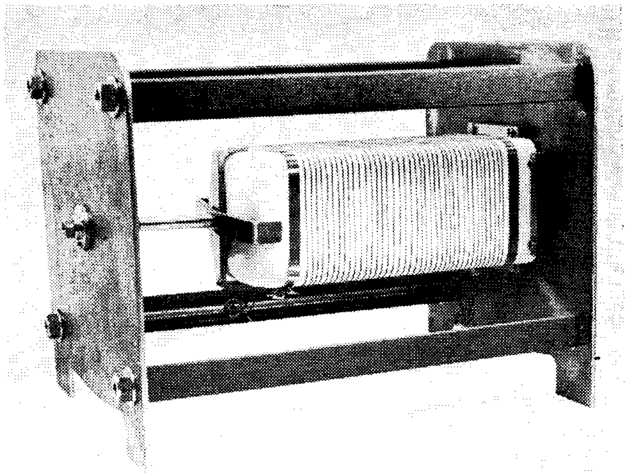
In keeping with the more advanced methods of heating used commercially, the electrically-heated muffle furnace, illustrated in Fig. 8, was made in the workshop. This has a heating chamber 6½ in. long, 4 in. wide by 2½ in. high, made of fused silica under the proprietory name of Vitreosil.

The consumption of the furnace is approximately 800 watts and a temperature of 1,00G deg. C. can, if required, be reached in 30 minutes. The internal construction of the muffle is shown in Fig. 9. The central heating chamber is wound with









Above: Fig. 8, *Right: Fig.* 9

an insulated heating element of Nichrome wire and is attached to the outer steel casing, which is furnished with a firedoor and mica inspection window. The space between the heating chamber and the outer casing is closely packed with insulating material to prevent heat loss.

An adjustable Simmerstat thermo-switch in the supply circuit controls the temperature of the heating chamber, and enables the case-hardening box to be maintained at a cherry-red heat, termed worm-red by the old-time gunmakers. The temperature attained can, however, be recorded by a pyrometer of the kind made in the workshop and shown in Fig. 8 when in position in the muffle. This instrument consists of a thermo-electric couple, and the voltage generated, corresponding to the temperature attained, is measured by a millivoltmeter, which is fitted with a shunt to enable direct temperature readings to be recorded.

The meter can be calibrated, with sufficient accuracy for all ordinary purposes, by using Segar cones. These are made of a fusible compound which softens and allows the tip to droop when a critical temperature is reached. The series of cones used indicate temperatures of from 600 deg. C. to 1,000 deg. C. at intervals of approximately 100 deg.

The following are the temperature changes corresponding to the colours shown by heated steel: dark-red, 700 deg. C.; cherry-red, 790 deg.; bright cherry, 900 deg.

A cherry-red heat is satisfactory for case-hardening and also for hardening tools made of silver steel when quenched in water or oil. Bone dust is best used in the muffle since, unlike some compounds, it has no corrosive action on the wiring or other metal parts.

In addition to the use of the muffle for hardening and case-hardening, it also provides a convenient means of tempering hardened work. The surface colour changes can be controlled by direct observation as the heat of the muffle rises. But where a pyrometer is used, the readings of the meter can be recorded, for future reference, by noting the tempering colours corresponding to the settings of the temperature regulator.

Small electric muffles are largely used in laboratories, particularly for metallurgical work; they are also employed in various industries for the fusion and heat treatment of metals. These furnaces are manufactured on a commercial scale, notably by Messrs Wild, Barfield of Watford and by Messrs Gallenkamp of London, but this equipment is necessarily somewhat expensive. However, the muffles made in the workshop at small cost have given satisfactory service for many years past.

NEW JUBILEE BOILER

(*continued from page* 547)

three points I should emphasise: the superheater elements must be in steel—stainless steel for preference, the steam collecting point for the regulator should be sited well away from the thermic syphon, and the water gauge should be of as large a bore as possible—perhaps even mounted on a column as in American practice, otherwise the water level may be inclined to jump up and down all the time the boiler is in steam.

One further point—on the *Jubilee* locomotive, the cab reversing stand, lever or screw, must be moved about ½ in. to the rear, to give clearance for the driver's fingers when in forward gear. There is plenty of space for this modification to the original design.

The photographs hardly do justice to Mr. Farmer's superb workmanship. Needless to add, the boiler was hydraulically tested to 240 lb. per sq. in., without the slightest trouble or anxiety.

With regard to 7, this is only made possible by Mr. Farmer's ingenious method of assembly. We have become accustomed to fitting both the backhead and foundation ring and completing their brazing before fitting the firebox stays. But his method is to fit all such stays that can be put in, before the backhead is even put in place.

In this way Mr. Farmer is able to obtain sufficient ventilation to enable him to use an oxy-acetylene blowpipe inside the firebox to deal with these stays, which, by the way, may be additionally threaded through both plates before the blowpipe is brought into use.

An advantage of the thermic syphon which may not be immediately apparent is that should the water level be accidentally allowed to fall below the crown of the firebox, no damage will be caused, as water will still pass upwards through the bottom tube of the syphon, and spread out over the crown, keeping it to a reasonable temperature whatever the state of the furnace.

A full-size drawing of this new boiler will shortly be available. Ref. LO. 23/5a. Price 5s. 6d.

FOR YOUR BOOKSHELF

Bioscope Shows and their Engines by Arthur Fay (The Oakwood Press) *Price 9s. 6d.*

THIS book has been published to celebrate the seventieth anniversary of the first showing of cinematograph films in Britain, which took place in February, 1896 at the Polytechnic. But, as the author points out in his preface, "at this period there was not, of course, a picture house in the whole of Great Britain, and it was left to the travelling showmen to blaze the trail of the cinematograph . . ."

Mr. Fay was among those pioneers, and he tells his story with plenty of fact and a good leavening of anecdote. The earliest shows were horsedrawn, and many were "ground booths", with no seating. A typical example was Ingham's, with a booth about 20 ft. × 16 ft., and giving a 15-minute programme of drama, comedy and interest, costing 2d. for adults and 1d. for children. A hand-turned trumpet barrel-organ and a big drum were used to attract the audience.

The proprietors of other attractions, such as Peppers Ghost Illusions, Marionette Shows, Waxwork Exhibitions and Menageries, were not slow to realise the draw of animated pictures, and in many cases it was not long before the shows went over to films entirely.

In the nineties the lime-light had to be used for projection-purposes, and the naphtha-flare for illuminating the booths inside and out. Then came the portable electric light engine, of which a few still exist, and the showman's task was easier. Horses were still frequently the means of haulage, but on long journeys, rail might be used.

But now the shows were getting bigger, and the loads bulkier, and so the showman took to the steam road locomotive, complete with dynamo. Mr. Fay gives an excellent account of the showman's trials and vicissitudes with them, and they were many, with muddy fields, stone setts, steep hills and icy roads, district permits and water cartage, all playing their part.

A graphic description is also given of some of the great fairs, such as the Bolton New Year Fair, and of course, of the magnificent shows themselves. A fine example was Mrs. Annie Holland's Palace of Light, with seating accommodation for 600, and standing room for a further 400 in the gallery. The upholstery was in green figured cloth, and the side linings in blue figured plush with gold tassels. The proscenium was carved and gilded, with winged angels, lion's heads and masques of wine and women, comedy and tragedy. The organ on the front of the show was one of Gavioli's finest, with seven figures.

The illustrations are well-produced; they include many showman's engines and several show-fronts, with Pat Collins' Wonderland and Jacob Studt's Bioscope among them. Quite a number of the illustrations are new to me, and I think will be to most readers.

At first sight, 9s. 6d. may seem rather a high price for a mere 36 pages. But this is a book full of knowledge and interest and personal experience, and in my opinion, the value is there. In fact, for devotees of the fairground, or even of the showman's engine alone, I would say that the book is a necessity.

W. J. H.

POSTBAG *(Continued from page 562)*

is assuming, of course, that the thickness of the cylinder wall was decreased in the same scale. If anything, the fact that the surface area of the cylinder does not decrease as rapidly as the volume when scaling down, means that the model cylinder should be capable of better cooling than the prototype.

However, I feel that Mr. Caldwell's suspicions are justified and I too would be interested to hear of a working model Newcomen engine. One of the difficulties I envisage is this:—it may be hard to get adequate injection, because the head of water available from the tank would be insufficient to produce an ideal atomised spray. It is no good thinking that the vacuum in the cylinder would help, because this is produced *by* the injection water, and if this can't be got into the cylinder to start with, there will be no vacuum. In the prototype, the head of water available from the cistern was large enough to overcome the resistance of the nozzle, and so produce a good spray.

One solution which comes to mind is to enclose the cistern and pressurise it by some means (e.g. feed pressurised air from a hand pump into the air space above the water in the cistern). This might destroy the authenticity of the model somewhat, but at least it would make it work. The air pipe could always be hidden (in the bob-wall for example). Under these circumstances the injection water pump would either have to work to a higher pressure (which would mean using a heavier plug rod), or become a dummy fitting.

Just as "windlogging" was troublesome in the full-sized Newcomen engines, it would be even more so in models. The air which is released from the water in the boiler cannot be 'condensed' and, therefore, tends to destroy the cylinder vacuum (there is no air pump on these engines!) In the prototype the 'snifting valve' was used to signify the expulsion of unwanted air from the cylinder, when a fresh charge of steam was introduced. In models the effect of this air might be overwhelming. It was this problem amongst others which teased James Watt for so long while he was trying to get that famous model working at Glasgow University.

The problem might be greatly reduced by using well-distilled water, from which the air has been boiled out. This should be used in the boiler and the injection water supply. The air in the space above the boiler and in the cylinder should be expelled by allowing steam to pass through the system before starting the engine. Also, the seal around the piston would have to be sufficiently effective to prevent leakage of air into the cylinder. It would be interesting to see if the genuine water seal worked in a model engine of this kind.

For several reasons I think that a good working model would have to be fairly large. Despite my criticism of Mr. Caldwells' remarks, the cylinder *might* remain too hot to act as a condenser, due to the proximity of the boiler fire if the original 'haystack' type were adopted. It might even be wiser to model the later engines which used waggon boilers in an adjoining house.

Finally, let prospective modellers be encouraged by the fact that Newcomen himself built a working model of his invention in Dartmouth before constructing the first (?) full-sized engine in Staffordshire. However, ten years is quite long enough for any modelling project!

Nottingham. R. G. WILLIAMS.

NORTHERN MODELS EXHIBITION

Reported by NORTHERNER

(continued from page 515)

An exhibition in the North would not be complete without a mill engine or two, and there were in fact several. Two of them came from H. Oddy of Rochdale—a beam engine of mid-nineteenth century and a single-cylinder horizontal Corliss engine of a later period. However, these are shortly to be fully described in *Model Engineer*, so I will not anticipate here.

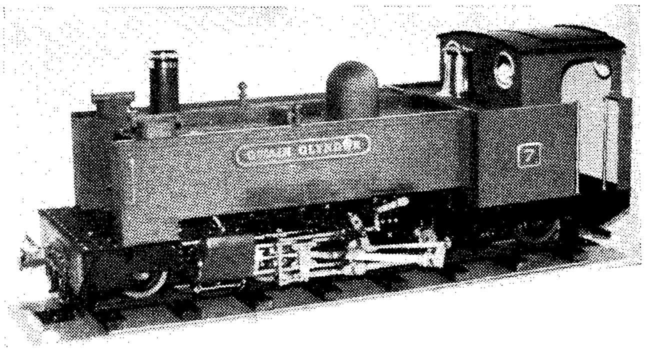
A horizontal cross-compound mill engine was exhibited by engineer A. Roberts of Leeds, with Corliss valves on the high-pressure cylinder and slide valves on the low-pressure—quite common in full-size practice, of course. The cylinders were $1\frac{1}{8}$ in. and $1\frac{7}{8}$ in. bore $\times$ $2\frac{1}{2}$ in. stroke, and the baseplate was 21 in. $\times$ 13 in. Twenty-two rope grooves were turned in the 10 in. dia. flywheel, which could be turned by a barring-engine. A Whitehead governor and Edwards air pump were also fitted.

In a different category, but still a mill engine, was a model of an early "inverted vertical" single-cylinder steam engine, exhibited by Alfred Nuttall, a retired maintenance foreman of Littleborough, Lancs. Mr. Nuttall saved it from the scrap drive of the Hitler War, when the model was already over sixty years old, and he performed a public service by doing so. It was built by a fine craftsman, and is obviously a replica of an engine he knew and loved. Mr. Nuttall himself has restored the engine.

The crankshaft is supported in delicate cast iron A-frames, and the nicely-moulded cylinder has a separate valve-chest connected to it only by the cast steam passages. A forked rod connects the crosshead to an overhung crank outside the main bearing, and the valve eccentric is on the inside. At the other end, outside the A-frame, is the water pump. All the rod ends are correctly gibbed and cottered.

Another mill engine, though as yet far from complete, was the uniflow single cylinder which Arnold Throp of Sheffield is building. It is based on a prototype built by Cole, Marchent and Morley of Bradford. Arnold also exhibited a part-finished $3\frac{1}{2}$ in. gauge *Caribou*. I cannot leave mill engines without at least a mention of the small beam engine (half-size of the M.E. design) which was exhibited by D. W. Mylchreest of Liverpool. Attractive and neat, this engine had won a "bronze" at London in 1964.

An excellent model of a Fowler Big Lion road locomotive is being built by A. Turner, an engineer's fitter of Dewsbury. It is in the comparatively small scale of 1 in. to 1 ft., and is thus just over 19 in, long. This scale must have brought some problems to Mr. Turner: for example, in the narrow space between the crankshaft bearings he has had to work in two balanced cranks, five eccentrics (four between the cranks), and the second speed sliding gear. The model definitely has Fowler character.



Alan Green's Owain Glyndwr

Some time ago in these pages the model engineering of William Ogden of Oldham was described; one of his works was the fine $1\frac{1}{2}$ in. scale Burrell showman's road locomotive *Lilian*. We now saw this model win the N.A.M.E. Trophy, and, with all its lights burning, proving a great attraction to the visitors. Bill also exhibited his beautiful steam-driven tug *Margaret*, which was fully described in the same article.

It has been surprising to me that one so rarely sees examples of the 5 in. gauge Sentinel shunter designed by J. J. Constable of Cardiff and described by him in *Model Engineer* a few years ago. It is not difficult to build, is reasonably light to handle, and quite powerful. Perhaps it looks rather too much like a diesel shunter to attract live steam fans! But John Ingleby, a wool sorter of Bradford, evidently likes the out-of-the-ordinary, and is making a nice job of his Sentinel. It is now nearly complete, and I am told that it runs very well on the track. If Mr. Ingleby completes the painting as well as he has the mechanical detail, he will have an engine of which to be really proud.

Several other engines I was pleased to see again included Gilbert Lindsey's 2–4–0 well-tank of the 1860's and E. F. Holden's Lancs & Yorks Aspinall Atlantic. This latter was on loan, having won the major awards at the Northern Models Exhibition several years ago, but to examine again its perfection, with the black livery set off by fine lining and touches of brass and bright steel, would give pleasure to anyone. Similar sensations were aroused by another model of perfection—the inch-scale Hudswell-Clarke contractor's locomotive *Lord Mayor*, with which F. J. Dupen won high award at the Model Engineer Exhibition. This little engine was greatly admired, with its beautiful finish and its complete set of accessories.

In the "General" section the trophy was awarded to A. A. Smith for the magnificent single-cylinder Robey vertical steam engine which had won him a Silver Medal at the 1964 Model Engineer Exhibition. Another "Silver" was won there by H. C. Roughton for his Harfield pump by Merryweather, and this too was seen at Saltaire. Messrs. Smith, Dupen and Roughton are all from "down South", and all members of the S.M.E.E. They were very welcome exhibitors, and we of the North hope that we shall see more entries from that area at future Northern Model Exhibitions. After all, many northerners are unable for one reason or another to visit the London exhibition, and those of us who do have that pleasure can always enjoy a second view of *any* beautiful model.

Perhaps I might say also for the consideration of southerners that, just as anyone from Bradford or Sheffield or Manchester finds a visit to the Model Engineer Exhibition worth while, so would anyone from Croydon or Purley or Woodford find his time not wasted in visiting the Northern Models Exhibition. Not only would he find a warm welcome, but also that the models are well worth looking at. ▣

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.

Small Lathes

SIR,—May I be permitted to make some comment regarding the letter by J. L. K. Mann with reference to small lathes (May 6). I agree with him that many of the small lathes which have suddenly appeared during the past year or so are little more than toys and it is hardly worth wasting money on them. I was recently in the position of requiring a small lathe of $3\frac{1}{2}$ in. centre height to supplement the 5 in. Drummond lathe (built exactly 50 years ago, in 1916) which forms the main machine tool in my workshop. To pay £80 for a ML7 was beyond my pocket, so I got in touch with Charles Portass & Son Ltd., Buttermere Works, Sheffield, 8., and after some correspondence purchased their $3\frac{5}{8}$ in. Model "S" back-geared, screwcutting lathe. This cost just over £40, and I am paying for it at the rate of £5 per month, with no interest charges, no forms to fill up, just a personal arrangement between me and the firm, all on a very pleasant and friendly basis.

The lathe is first class value for money and is being used in building a 5 in. gauge *Ajax* locomotive. The design of the machine is simple but robust with no die-castings used anywhere, all good hefty iron castings. Admittedly nothing is chromium-plated, but then the model engineer who lets his lathe rust from lack of use doesn't deserve to have one.

I do not make the usual disclaimer—I *am* connected with Portass Ltd., the connection being that of a very satisfied customer.

Saltford, Nr. Bristol. A. SMITH.

Field Gun

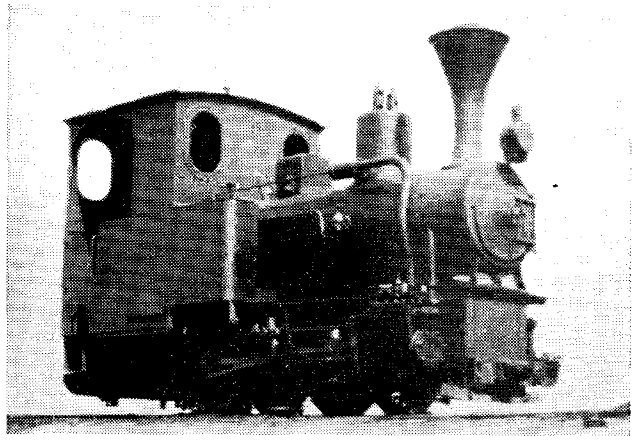
SIR,—I found Mr. A. Wilkinson's article on 'building a model nine-pounder field gun' very interesting. It was appropriate, as C. S. Forester, the author, died less than a month ago. The gun Forester wrote about was of the same period. It was an eighteen-pounder bronze gun used in Northern Spain.

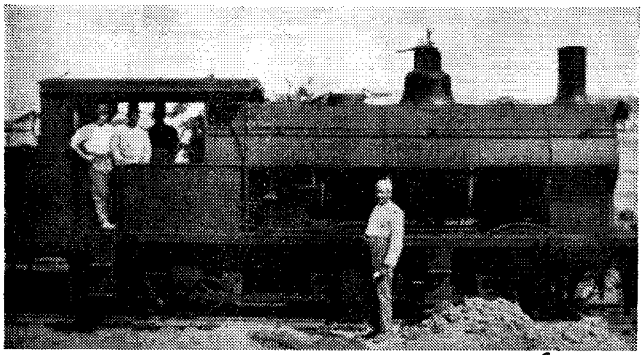
In 'The Gun' there is a vivid description of the making of the wheels and carriage:—

"There were iron rims to be made, fitting so exactly the broad wooden wheels, that only when they were strongly heated would they slip over the felloes. The screw handle which forced in and out the elevating wedge beneath the breech had to be painfully forged by hand out of bar iron, and, more difficult still, the threaded sockets in which it had to revolve. The cheeks on which the trunnions were to rest were of four inch oak, and the notches themselves were faced with beech. The spokes of the wheels were of the finest ash. The trunnions entered into the sockets and bedded themselves down. Everything was perfect. Zero on the newly-forged scale exactly corresponded with the groove in the gun's breech."

C. S. Forester (like the late Nevil Shute) has left much cultural reading for engineering minds.

Elton, Stockton on Tees. FREDA E. COUPE (Mrs.)





Old Engines

SIR,—During a recent search through some old snapshot albums I came across two snaps of old railway engines which may be of interest to the readers of what I consider is the most interesting magazine on the bookstalls i.e. *Model Engineer*.

The original snaps were taken during the time my wife and I lived in Egypt in 1934, but I doubt if the engines are there now. The small engine was made in Germany in 1894 and was in use on the Libyan desert, the other with the Egyptian Railways.

Staines, Middx. L. E. TURNILL.

Steam Cars

SIR,—Once again there appears to be a revival of interest in the subject of steam cars, and in the feasibility or otherwise of constructing such a vehicle capable of useful and economical work, and without complicated auxiliaries.

Initial cost, and the uncertainty of any measure of success is no doubt the main reason for so little experimental work in this field by private individuals, but what has become of commercial ventures in steam road vehicle propulsion since the last war?

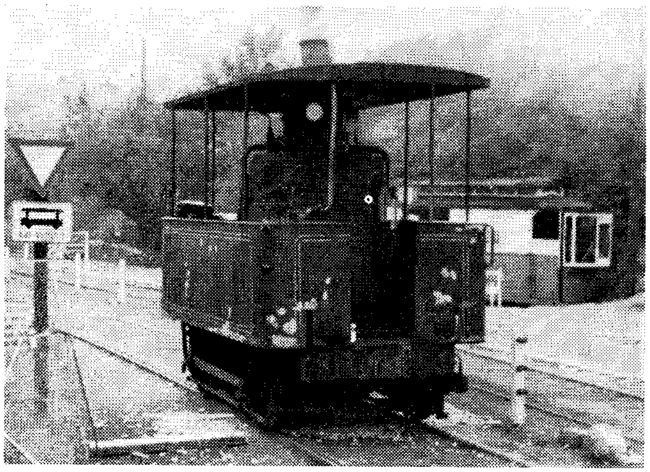
Authentic information regarding commercial, or indeed any, experimental work of this kind is very hard to come by. Most steam enthusiasts are aware that a limited number of road rollers were built for export in the late 1940s, and that

Sentinel (alas no more) built some S6 steam wagons to order for the Argentine. An account of the test trials of one of these S6 wagons was published in "Commercial Motor" about 1949. Apart from these two instances, steam vehicles actually built would seem as rare as hen's teeth!

Some readers will recall an article published in M.E. about 1944, which described in some detail the conversion of a Fordson tractor from I/C to steam power. The prototype, of which there was a photograph, was reported to have proved superior both in power and economy to the I/C tractor, and the patentees Messrs. Bolsover, Rodgers & Geary intended to carry out further conversions as a business venture. As some twenty years have elapsed since this article was published it would be interesting to know exactly what did become of the project—was a. the converted tractor not the success in operation that it was at first held up to be. b. the patent for conversion bought up by Fords or some other I/C firm, to eliminate a threat to the marketing of their own products. c. lack of capital for development or conversion on a commercial basis. or d. Lack of market for steam vehicles due to prejudices against steam by users?

Perhaps, Sir, through your columns, readers might be able to throw some light on this matter to the mutual interest of all.

York. W. H. ANDREWS.



Thimble-tube Boilers

SIR,—The recent correspondence on "thimble-tube" boilers prompts this letter and accompanying photograph.

The photograph was taken on 25th of September last year at the Tramway Museum Society's premises at Crich, Derbyshire, and shows the preserved Tram-engine in steam. This engine, built in 1885 by Beyer-Peacock of Gorton to William Wilkinson's Patents, was retired by its makers in 1959 and later given to the T.M.S. for restoration.

Its present interest is that the boiler incorporates some 121 "thimble" or "Field" tubes containing an equal number of open-ended inner tubes to promote free circulation of the boiler water. The pressure tubes are 2 in. dia. and approximately 2 ft. 3 in. long. The boiler readily makes steam but has not, of course, to provide steam for continuous working in its present location. Maintenance is a problem as the pressure tubes hanging in the fire collect scale deposits internally and the resultant build-up causes a local hotspot with subsequent tube failure. What is needed is some form of tool (yet to be devised) which can be lowered into the tube to pick up scale from the hemispherical bottom. Of course the age of the boiler (1930) is against it; when new I should imagine that it performed very well.

Steam is supplied at 100 p.s.i. to two vertical cylinders $9\frac{1}{2}$ in. × 12 in. stroke which drive the 2 ft. 6 in. dia. coupled wheels through 19/33 ratio spur gears.

Restoration is a slow business but in the not too distant future it is hoped to operate the engine with a suitable trailer in passenger-carrying service, thus portraying an interesting interlude in street transport. The untidy exterior will be forgiven I hope, but does serve to indicate some of the problems.

Morley, Derby. E. V. COOPER.

Battle of the Boilers

SIR,—Regarding Mr. B. J. Wilson's desire to see some of the older model locomotive designs re-published,—most, if not all, of these designs are out of date, and in any case if Mr. Wilson is sufficiently interested, his local lending library can obtain for him ANY bound volume of M.E. that he may wish to borrow. It is a great pity that this almost free service is not more widely known: much more use of it might be made.

If Mr. Wilson really thinks that the *Challenger* was a masterpiece, perhaps he can explain why it was scrapped as useless soon after the famous "Battle of the Boilers", whereas its conqueror is still running; also why it put up such a poor performance in this contest?

Actually Henry Greenly designed some much better locomotives than his *Challenger*. For example his $7\frac{1}{4}$ in. gauge GWR "King", as built by Mr. Hunt of Johannesburg. Again the pseudo-Great Western 2–6–0 designed for Mr. Schwab of Saltwood, Hythe, which as far as I know is still running today. The Romney, Hythe and Dymchurch, as well as the Ravenglass and Eskdale have further examples of locomotives still at work, though in fairness it must be remembered that when *Green Goddess* on the RH & D.R. was modified to include superheating, the published figures showed a 20 per cent improvement in performance.

Harefield. K. E. WILSON.

Valve Gears

SIR,—Your contributor K. N. Harris (M.E. March 4 1966) refers briefly to J. T. Marshall's valve gear of 1902. Being driven through two eccentrics, the angularity of the connecting rod, (as it must effect—through the combination lever—steam distribution in Walschaerts gear) is avoided and for this reason, primarily I think, it remains a clever and most interesting valve gear.

However his reference 'to numerous tests showing that it gave increased power with decreased coal consumption in everyday working' probably related to comparison with contemporary engines using, for example, Link motion, as distinct from any which might then have been equipped with Walschaerts gear.

The late E. L. Ahrons, when describing this gear in The Locomotive Magazine (December 15, 1909), stated that it had for its object 'fast opening and sharp cut-off, with slow movement of the valve when steam and exhaust ports were fully open! He concluded however by saying that in these respects it gave a steam distribution 'similar to that of the Walschaerts valve gear'.

Thus one might believe, had comparison been made specifically with engines using Walschaerts valve gear, there might not have been the same notable difference in performance,—meaning it is questionable, perhaps, whether any fractional differences in port opening, as evident in Walschaerts gear, would have made it to the same extent inferior to Marshall's gear in tests of this particular nature. Perhaps Mr. Harris and/or others would comment.

Bewdley. J. T. D. SPENCE.

Maid of Kent

SIR,—Perhaps Mr. Harris will be kind enough to give me his aid in rectifying the valve gear of my *Maid of Kent*. I note that he has rescued some members of the Derby Club and he is without doubt an expert on steam engine valve gears. Let me say at once that I am not a "beginner" in the field of engineering having now retired from the bench as a working Tool and Gauge maker and, by the way LBSC, an engineer never refers to a job of work as "kiddies practice", he holds his trade in too great a respect and would not wish to humiliate those under his control by the use of such childish expressions.

One other point with regard to the valve gear of *Maid of Kent* why did LBSC not show the eccentrics "crossed"? I have viewed the layout of the valve gear on the 4-4-0. D.11. "Director" ex.Gt. Central built to the design of Mr. Robinson. The eccentrics are "crossed" and confirms what our Editor has written on this subject. It seems to me that LBSC has still a lot to learn about valve gears.

Finally, let me say how I agree with all that has so far been said with regard to the great improvement in presentation and informative articles in the new *M.E.* Long may it prosper.

Buckingham. F. H. MARSHALL.

Model Locomotive Design

SIR,—I have had the good fortune to read all copies of *Model Engineer* published since 1938 and it appears that during this time LBSC has been subjected to a great deal of criticism by a very large number of people. However, he has always managed to withstand the literary bombardment and still continue with the design of miniature steam locomotives which could be built by a person with average engineering skill. Errors on drawings are always bound to occur and I would think that a modeller with the perseverence to undertake the construction of a locomotive would take the trouble to check such drawings as construction proceeded, this is surely the way an 'Engineer' must work.

The construction of such a model is a task not to be undertaken lightly and many weeks should be spent studying the design before work proceeds. Only in this way can one be sure that the design chosen is the right one.

The article by K. N. Harris in M.E. May 6 in which he replies to a "Challenge by LBSC" is good as far as it goes but Mr. Harris keeps harking back to the world of the big steam engine. What is needed is indicator diagrams for small cylinders. This is a simple task and I would be glad to assist in the design of such a device. The minimum cylinder bore that could be accommodated would be about $\frac{3}{4}$ in. How about it model engineers, let's eliminate the guesswork and speculation.

Warmley, Bristol. J. L. CANNER.

SIR,—I think that the Editorial comment in your issue of May 6 has been made under some misapprehension of the points I was trying to make. The operative word was "Slavish" and so far as my criticisms are concerned, applies primarily to the constant reiteration of the stale old slogan that "Scale or overscale-sized cylinders are necessary to obtain power at speed", which is fallacious.

The essential point of the matter, as I see it, is that *any* machine required to operate efficiently should be designed from first principles, and should *not* be slavishly scaled down (or up) from some similar machine, quite irrespective of its efficiency. This principle applies with particular force to the case of a self-contained prime mover, such as a steam locomotive. Just consider what happens if "Scale" (linear) is blindly followed.

Suppose it is required to build a twice full-size Johnson *Princess of Wales* single driver locomotive. These engines had cylinders $19\frac{1}{2}$ in. × 26 in., 7 ft. $9\frac{1}{2}$ in. dia. driving wheels, 180 lb. per sq. in. boiler pressure, with an adhesive weight of $18\frac{1}{2}$ tons. At 85 per cent. working pressure this gives a tractive effort of say 16,200 lb.

Our proposed double-sized engine will have cylinders 39 in. × 52 in. and driving wheels 15 ft. 7 in. dia. Its weight will be eight times that of the original and it should have eight times the tractive effort, but to attain this, it will require the boiler pressure to be doubled.

The volume of the cylinders is eight times that of the prototype, but the boiler heating surface and firegrate area will be only four times those of the original, so the boiler will be quite incapable of supplying the requisite amount of steam. The bearing areas will be four times those of the original, but the loads on them eight times as great as those of the prototype; in short, if you follow the linear scale principle, you will simply produce a machine which would be a hopeless failure.

Now consider the opposite condition taking a 5 in. gauge $1\frac{1}{16}$ in. to 1 ft. scale model (linear size 1/11.3 of the prototype) and assume we decide on a boiler pressure of 90 lb. sq. in., half that of the original.

Our model will have cylinders 1.73 in. bore by 2.3 in. stroke, whilst our driving wheel will have a diameter of as near as makes no matter, $8\frac{1}{4}$ in. The nominal tractive effort, again at 85 per cent. boiler pressure, will be 64 lb. The scale weight on the drivers will be 28.6 lb. Thus we have produced a model in which the tractive effort is more than twice the adhesive weight.

I am familiar with the facts (*a*) that working models almost invariably come out over-scale in weight (because we depart from strict linear scale!) and (*b*) that in many cases it is possible to place more than its scale proportion on the driving wheels, but to be able to absorb a tractive effort of 64 lb., we should require an adhesive weight at a minimum, of 160 lb., which is more than the scale weight of the whole engine. Allow a 50 per cent. overscale weight on the drivers, giving say 43 lb., the biggest tractive effort this can be relied upon to absorb will certainly not be greater than 17-18 lb. Where do we go from here? You have two alternatives, (*a*) work at scale pressure or thereabouts, say 17-20 lb. per sq. in., (*b*) forget the "scale sized cylinder" shibboleth and do the sensible thing and reduce the cylinder bore. Most people will not hesitate long between these alternatives, and they are unlikely to choose the Scale Pressure one!

You simply have to face up to the fact that if you insist on scale or overscale-sized cylinders, you can never work your cylinders at a MEP remotely comparable with your boiler pressure, and hence they will be operating, from the thermal angle, most inefficiently.

With respect, I think that the Editor's choice of a connecting rod, to support his argument, was not a happy one. Firstly, the stresses on the rod in the model induced by the piston load will only be around $\frac{1}{3}$ to $\frac{1}{2}$ those of the prototype (depending on the boiler pressures) whilst the very heavy inertia stresses occasioned on the full-sized rod, are almost non-existent on the model rod.

continued on next page

CLUB NEWS

Send news and notices to:—
CLUBMAN, Model Engineer, 13-35 Bridge Street, Hemel Hempstead, Herts.

North London S.M.E.
The club membership has now risen to 190 and covers most forms of model engineering including locomotives, model railways, electric and diesel cars, aeroplanes and a marine section. The locomotive section is to hold trials at Arkley in the near future, and it is also hoped to hold an exhibition next year.

New Society in Cornwall
A new Model Engineering Society is proposed, to cover the Penzance and Land's End area. Those interested should contact Mr. J. Pethick, 24 High Street, Penzance, or come along to meetings on the second Wednesday of each month in the Football Club Committee Room at the London Inn, Causewayhead, Penzance, starting at 8 p.m.

Long Island, U.S.A.
A Long Island (U.S.A.) Society of Model Engineers has now been established, and meets every other Friday at 8 p.m. Membership is limited to those over 18 who are serious craftsmen and have some sort of workshop. Membership has now reached ten and anyone interested should contact T. Fishman, P.E., of Mott Lane, Brookhaven, Long Island, New York, 11719, 516 at 6-0614.

Traction Engine Rally
The sixth Annual Rally of the Chiltern Traction Engine and Historic Commercial Vehicles Clubs is to be held on 25-26 June at Tring Park, Tring, Herts. Steam rollers, traction engines and road locomotives, together with vintage and veteran petrol vehicles will be there. In addition, model engineering, model railway, narrow gauge railway and railway preservation societies will be represented. Steam gallopers and a fairground organ will add to the display. Hon. Secretary: D. M. Norris, 19 Orchard Lane, Amersham, Bucks.

New Jersey Live Steamers
This club operates two tracks, one an elevated circuit for ¾ in. and 1 in. scale locomotives of which there are now 18 operating at the club, and the other, a large 1,000 ft. ground-level track has 24 steaming bays, radial to a turntable mounted on two 8 in. ball races and a spur for engines taking coal and water. There are five 1½ in. scale locomotives completed and more being built. They will be housed in a shed which is to be constructed in the future.
The club now has 80 full members and 100 associate members and produces its own monthly magazine 'The Whistle Blast'.

New South Wales Track
Clubs from New South Wales, Queensland, South Australia and Victoria were present at the opening of the Sydney Live Steam Locomotive Society track at Ryde, N.S.W.
Ten 5 in. gauge engines were present, including two *Springboks* and Mr. Green's freelance "Pacific". There are three tracks, two elevated multigauge and a 5 in. gauge ground level line. A meeting was also held to discuss the formation of a boiler safety committee.

News from Pompey
Meetings of the Portsmouth M.E.S. are being held in the Staff Room, Portsmouth Central Library, Guildhall Square, on the first Wednesday of each month, excepting August, at 7 p.m. Visitors are welcome.
The club's 3½ in. and 5 in. gauge portable track was a great attraction at local fetes last summer and has been well booked this year, bringing the society much favourable publicity.
Hon. Sec. — Frank R. Hammond, 59, Bedhampton Road, Bedhampton, Havant, Hants.

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Secondly, the bearing areas (big and little ends) will be to scale and with a working pressure of ⅓ to ½ that of the prototype, their specific loadings will be reduced in due proportion.

Thus, if you use a scale connecting rod, it will be amply strong, and given adequate lubrication, have a long, practically wear-free life.

I am not suggesting that we want merely the most efficient type of machine on our passenger tracks (though it would be quite an interesting exercise to design and build an engine with this sole end in view), but I am convinced that it is perfectly feasible to produce a good-looking model locomotive following the general proportions and outline of the full-size article, either free-lance or to an existing prototype, which would be a good deal more efficient than the majority of engines operating our tracks today. If steam coal cost 10s. a pound instead of about 1½d., we should long ago have set about improving overall efficiency; we should jolly well have had to!

It has always been a cardinal principle of engineers to seek to improve efficiency, if it had not been so, we should still be in the *Rocket* age.

Those who are satisfied with the model locomotive as it is today, are perfectly within their rights and entitled to their standpoint; so I should have thought are the minority who seek to improve the breed; actually, these latter folk have for years been the targets for sneers, cheap witticisms and general denigration from the self-styled "Practical" school, who can tolerate no ideas differing from their own, and who have an obvious vested interest in keeping things as they are. For more than forty years, model locomotive design has been in a groove. "The mixture as before", admittedly in varying shaped and multi-coloured bottles, but always the same old mixture. Certainly it "works", which seems to be the alpha and omega of its progenitors, but I contend that it could be made to work a great deal more efficiently, and there are encouraging signs that quite a few people are taking a serious and intelligent interest in this phase of the matter. The more the better, and the sooner higher efficiency will be achieved. Our boilers are already quite reasonably efficient, it is to the cylinders, valves, valve gear and steam and exhaust lines that we must give attention.

Rustington. K. N. HARRIS.

Model Newcomen Engine

SIR,—Referring to Mr. J. W. Caldwell's letter in the last issue of M.E., I feel that he is a little misled as to the reasons why a model Newcomen engine might not work. The heat capacities of both cylinder and steam are proportional to the weights present and hence to their volumes. When the engine is scaled down from full-size, both the weight of steam and the weight of the cylinder decrease in the same proportion. This

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