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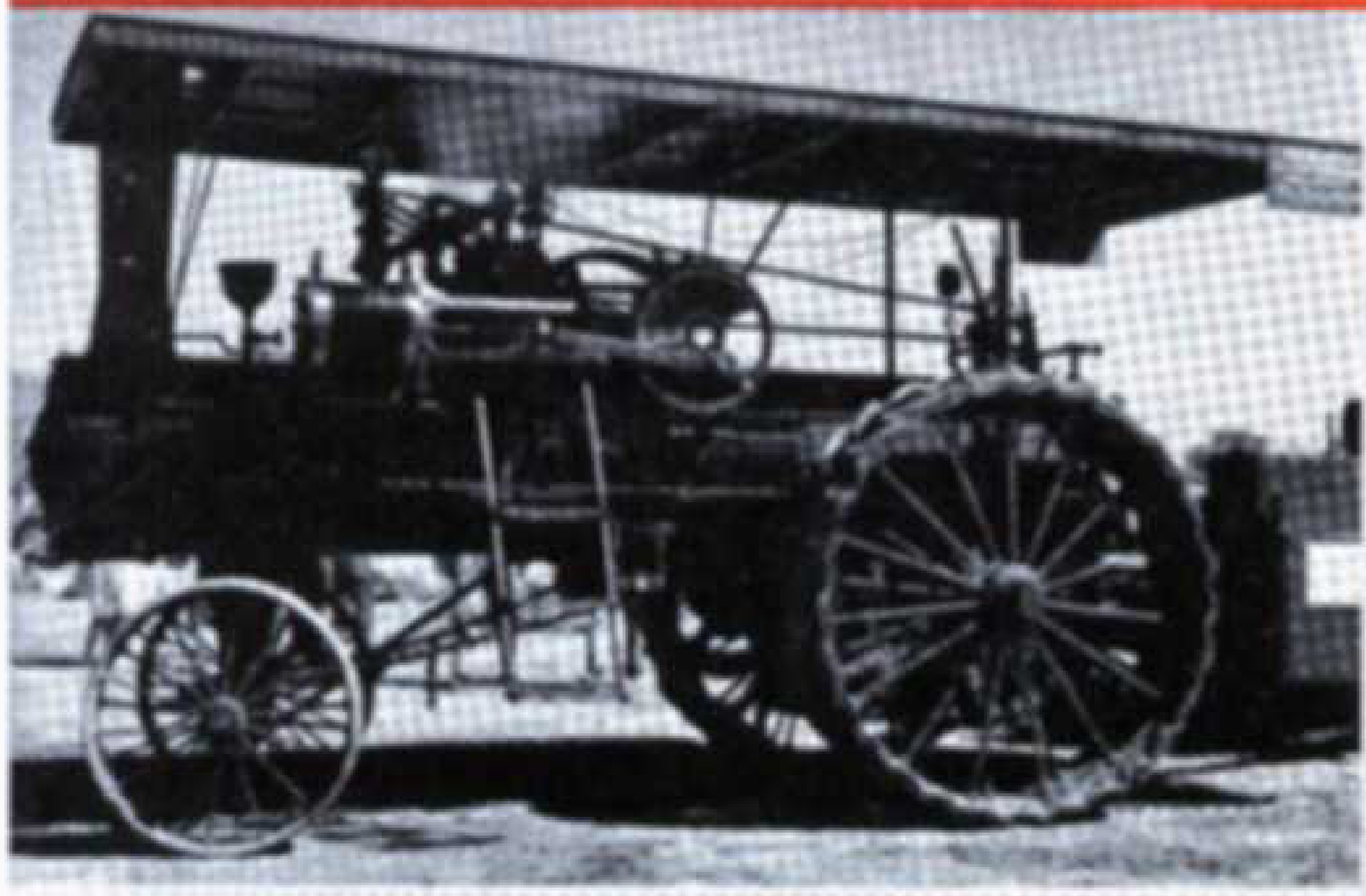
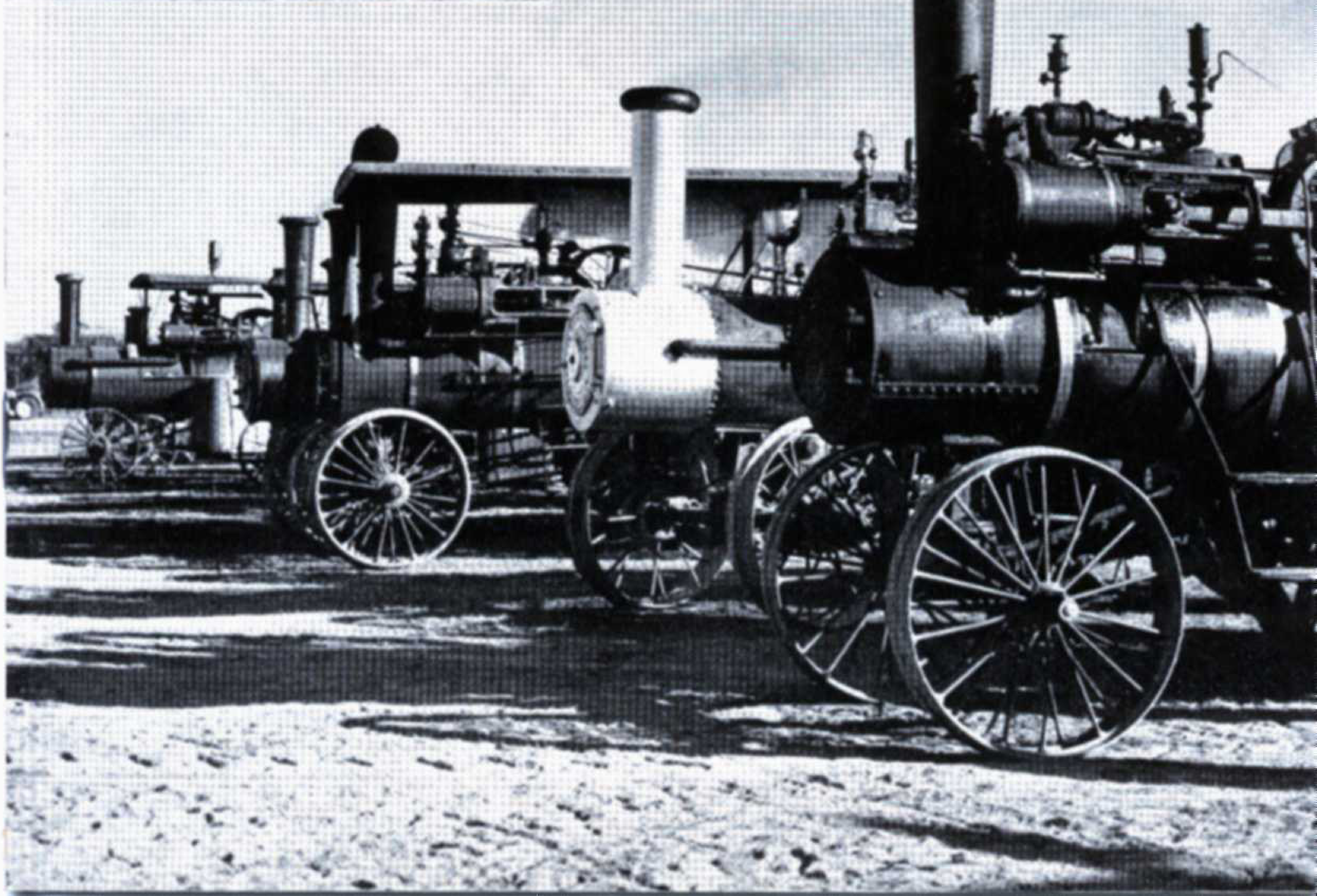
MODEL ENGINEER





CANADA'S STEAM TRACTORS

MODEL ENGINEER

Founded 1898

Incorporating Mechanics and English Mechanics and Ships and Ship Models

18 March 1966 Volume 132 Number 3293

CONTENTS

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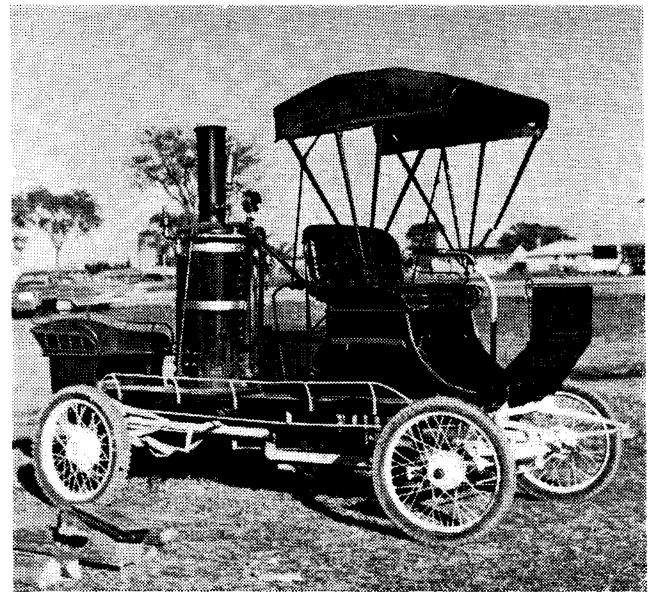

Cover picture

A line-up of old-time steam tractors at a meet of a Canadian Antique Steam Association. The picture above shows a steam car built by a Canadian enthusiast from an illustration he found in a book! Photographs by Harry McDougall.

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

Next issue

A power cross-feed is a useful addition to a small lathe. S. A. Belsey describes how to make one.

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This Insurance is the prudent thing for every modeller to take out, but it is a sad fact that until now, although the governing bodies of the hobby have offered this cover to their members, something like 90 per cent. of the modellers in the U.K. have never taken up this opportunity and are operating 'without insurance protection.' Those who wish to make the most of flying and other modelling opportunities must be insured not only for their own peace of mind—accidents do sometimes happen—but also because Local Authorities, Ministers and others are showing an increasing awareness of this need for insurance and are demanding proof of adequate cover. By joining M.A.P. ' Modellers' Accident Protection ' you come into the world's BIGGEST MODEL CLUB. For your initial subscription you obtain a lapel badge for identification and transfers to put on your model.

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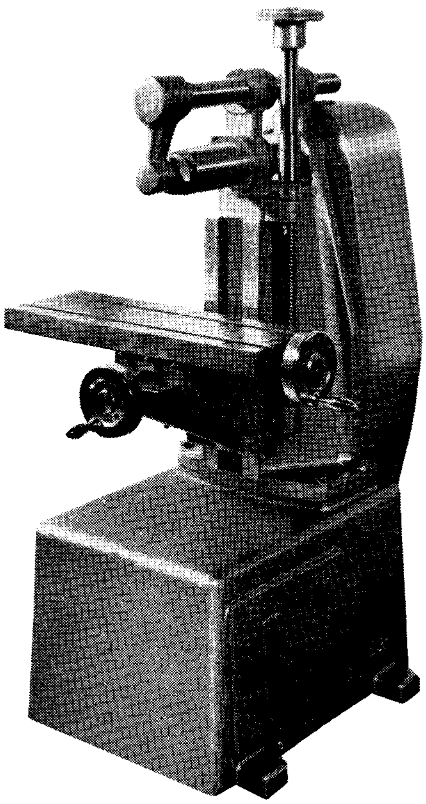

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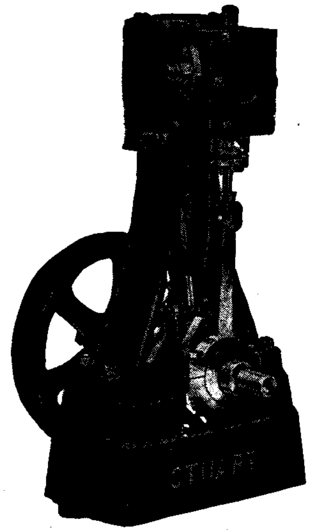

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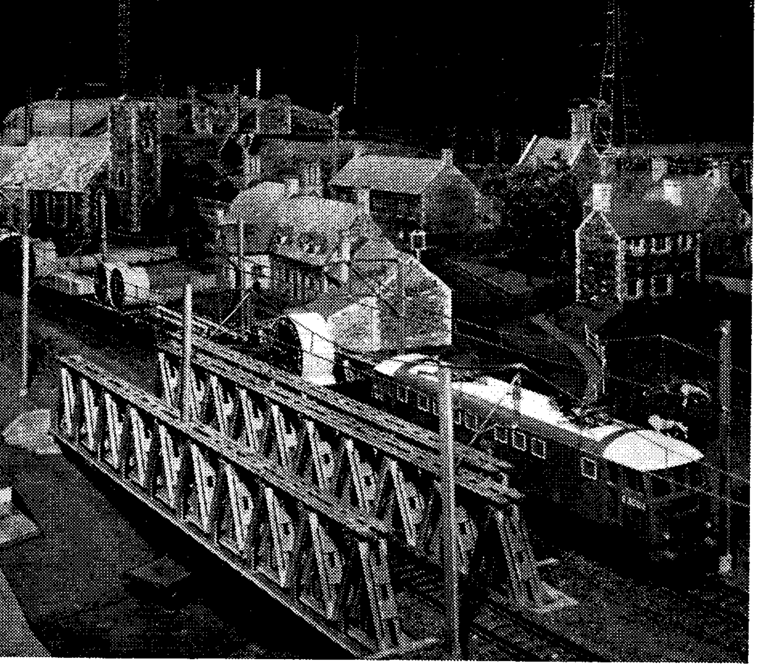


SMOKE RINGS

A commentary by the Editor

THE above picture shows part of a working model which will be seen in the British Pavilion at the Republic Festival Show, Johannesburg, South Africa, from March 29 to April 11.

The model shows many of the activities of the British Insulated Callender's Construction Co. Ltd., for whom it was made. An electric railway with high-voltage a.c. overhead equipment runs through a landscape which embodies an overhead transmission line on steel towers, a secondary transmission line on Painters Universal poles, and low voltage distribution on wood poles. In a village, power cables are being installed, while at another site a high TV mast is under construction. Other structures shown are a floodlighting tower and a unit construction bridge.

Worldwide model railroad meeting

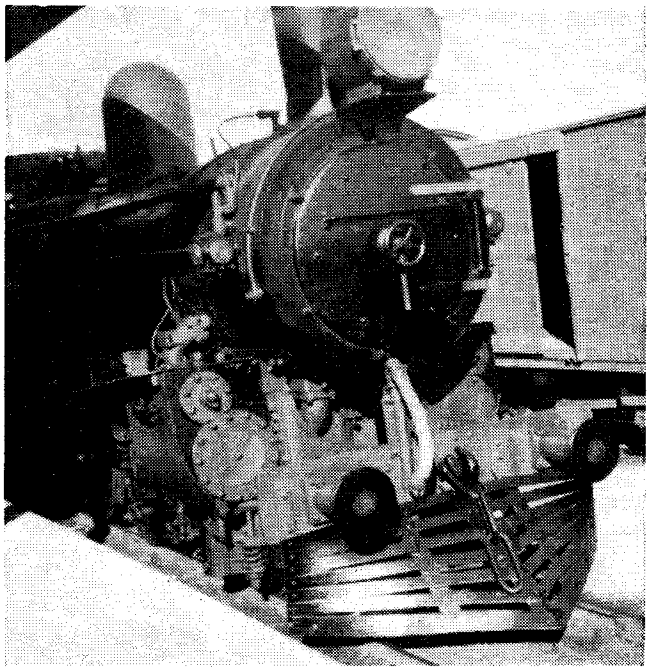
LINN WESTCOTT, Editor of the well-known model railway magazine *Model Railroader*, has suggested that a meeting should be held in this country, perhaps in London, of model railroaders from all over the world. This might be a wonderful opportunity for modellers to get together, to see each other's handiwork, to talk about the hobby as it is practised in many places, and to meet leaders of the hobby from Europe, America, Africa, Japan, Asia, Australasia, South America, and in fact in whatever country the hobby is practised.

This is an excellent idea, but it will need a great deal of organising, it will require the co-operation of hard-working committees in U.S.A., in Europe and especially in this country. It will have to have the consent of the National Model Railroad Association, of the similar European Association MOROP, and of the leading Clubs in Great Britain.

It may take several years of saving, for those who can go, to accumulate the cost of travelling. But if one is fortunate enough to be able to make a lifetime trip from America to Europe, why not at such a time as this ? MOROP has not yet decided on its 1971 meeting place, but must be invited wherever it is to go by a member club.

England has much to offer the visiting model railway enthusiast: fine Railway Museums at York, Clapham and Swindon, the Science Museum at South Kensington, great terminal stations such as Euston (which by 1971 should have been completely rebuilt), King's Cross, Paddington and Waterloo, the Bluebell Railway and the Welsh Narrow-Gauge Railways, and the bridges of Brunel, Telford and Stephenson.

I will be interested to hear readers' views on the proposal.



Tasmanian Rail Trip

I HEAR from Mr K. S. Kirton of Launceston, Tasmania, that a special steam-hauled train was recently run for the benefit of enthusiasts in the Island. The trip was organised by the Tasmanian branch of the Australian Railway Historical Society. My picture shows the locomotive, built in Manchester in 1890, which hauled the train from Launceston to Nabowla. Frequent stops were made to enable the passengers to photograph the train and the scenery passed en route.

Steam has almost disappeared from Tasmania; I understand that there are just two steam locomotives left on the T.G.R. roster.

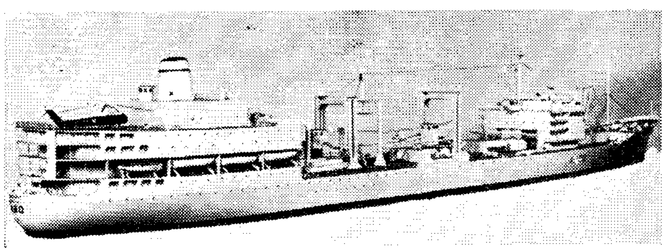
New Naval Vessels

TWO new ships for the Royal Navy were launched last month. They were the Fleet replenishment ship *Resource,* built by Scotts Shipbuilding and Engineering Company, Greenock, and the Leander class frigate H.M.S. *Argonaut,* built by Hawthorn Leslie at Hebburn-on-Tyne.

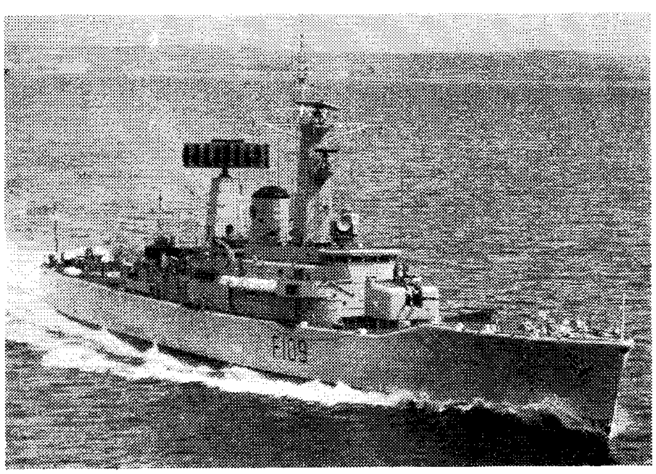
The *Resource* and her sister ship *Regent* are the first two vessels for the Royal Fleet Auxiliary which have been designed from the outset for their specialised duties. All previous ships of this type have been conversions of commercial vessels. The *Regent* was built by Harland and Wolff at Belfast and should be launched before these words appear in print.

Both these auxiliaries have an overall length of 640 ft, a beam of 77 ft and a displacement of 19,000 tons. Their holds are fitted with modern equipment to handle and stow the cargo, and special lifts for hoisting supplies from holds to the deck. A Wessex helicopter will also be embarked for vertical replenishment. Both ships are armed with Bofors guns.

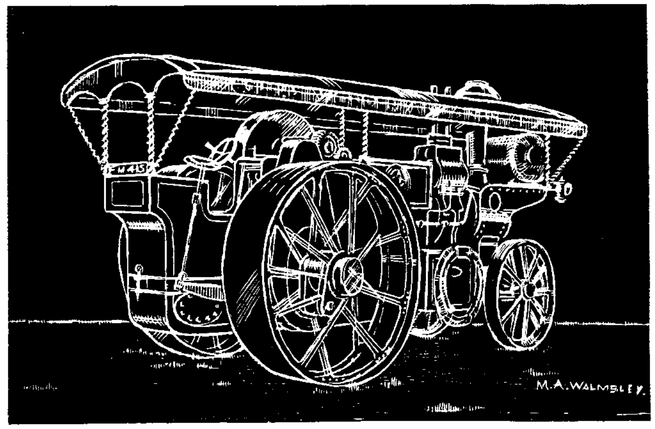
The Leander class frigates have a standard displacement of about 2,000 tons, an overall length of 372 ft and a beam of 41 ft. They are powered by steam turbines built by J. S. White, with gearing by David Brown. Their armament consists of 4.5 guns in twin mountings directed by automatic radar control. Seacat ship-to-air launchers and directors and anti-submarine mortars are standard fittings. Helicopters are also carried for anti-submarine use.



This is a model of one of the new Fleet Auxiliaries, the RESOURCE.



H.M.S. LEANDER *undergoing trials.*
(Photographs by courtesy of Ministry of Defence)



THE scraper-board sketch reproduced above is the work of an Isle of Man artist and a regular reader of *Model Engineer*, Mr. M. A. Walmsley. It depicts the Foster Showman's Road Locomotive No 12499 *Marvel.*

Mr. Walmsley tells me that there is a thriving model engineering society in the Isle of Man, the Douglas Society of Model Engineers, and readers who are interested in its activities are invited to contact the secretary, Mr. A. Tranter, Woodlea, 58 Whitebridge Road, Onchan, Isle of Man.

Albert Savage

IT is with regret that I have to report the death of Bertie Savage, Vice-president of the Birmingham Society of Model Engineers. A member of the Society for 16 years, Bertie spent a great deal of time helping in the management of the Club's affairs. He was a good committee man, and a fine model engineer with a keen sense for detail and finish as evidenced by his Stirling Single locomotive. The engine which Bertie was currently building was a $\frac{3}{4}$ in. scale Beattie 2-4-0 tank, the quality of the workmanship and finish being to his usual high standard.

Birmingham has lost a fine model engineer and a great companion.

Mr. L. G. Brough

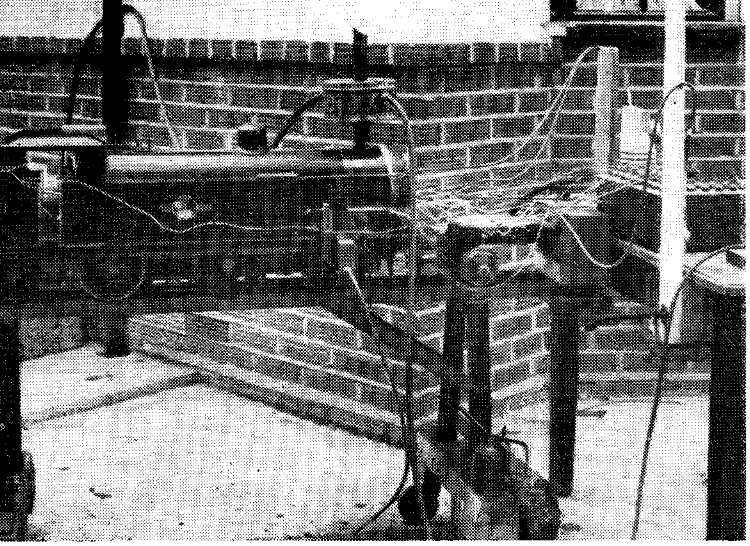
I AM also sorry to have to record the death of Leonard George Brough, a founder member of the Tyneside Society of Model & Experimental Engineers. George Brough was also a member of the Sunderland Model Engineering Society and a founder member of the Tyneside Radio Controlled Model Society. A versatile model engineer, his interests covered petrol-engined hydroplanes, radio control, model yachts, locomotives, and model cars.

He was one of the first to build the ME Road Roller and the 1831 engine, and was recently working on an experimental locomotive.

George Brough's enthusiasm was enormous, and his great experience was always freely at the disposal of the younger club members. His loss will be felt keenly in the North-east.

Mr C. T. Steeb

WOULD reader Mr C. T. Steeb, late of Seventh Avenue, San Diego, California, U.S.A., kindly let me have his present address ?



TESTING A LOCOMOTIVE BOILER

by J. Ewins

THE BOILER of a model locomotive is usually, apart from the firetubes, a scaled down version of that of the full-size prototype. The question, therefore, arises as to whether this design procedure produces the best working results.

A simple consideration of the theory of heat transfer suggests that the proportion of heat transferred through the firetube walls in a model boiler may be less than in full-size practice where it is about one third of the total heat transfer. If this were the case, it might be conducive to better working to make model boilers with shorter tubes and longer fireboxes.

The question of superheat in models is a matter of some conjecture. It is suggested by some that little or no superheating takes place, and if it did there would be lubrication difficulties especially with non-ferrous cylinders. Some designers are of the opinion that blast arrangements are critical and advocate the use of double or multiple blastpipes.

I have for some time thought that use could be made of some of the waste heat in the smokebox to keep the cylinders warm or to heat the feed water. These are very open questions and it was with a view to obtaining some definite answers that a series of tests were conducted.

Scope of the tests

The tests were carried out on a 5 in. gauge 0-6-2T locomotive and although they were concerned mainly with the boiler, measurements were also made of power output and exhaust conditions so as to correlate these with boiler performance. Tests were made to establish the proportion of heat transferred by the tubes and the distribution of temperature at various points whilst the engine was working under different loads. Conditions of draught were investigated to decide the proportion of energy absorbed in drawing air and the products of combustion through the firebed and firetubes respectively. The temperature and pressure of the steam delivered to the cylinders was studied to determine the degree of superheat. Back-pressure at the exhaust nozzle was measured and correlated with power output. The overall thermal efficiency was also determined.

Description of the locomotive

The locomotive tested was a 0-6-2T based on the *Minx* design of LBSC. The published design was departed from at a number of points:

(a) Superheater was made in stainless steel and projected about 7 in. into the firebox.
(b) Passages connecting the ports to the cylinder bores were more than double in cross-sectional area.
(c) Exhaust ways were greatly enlarged.
(d) Blast-pipe nozzle increased in diameter.
(e) Large snifting valve fitted.
(f) Boiler barrel shortened.

As originally built, the engine weighed 130 lb. in working order, but this has now been increased to 180 lb. by the addition of ballast to improve adhesion on alloy rails. The engine makes a surplus of steam on moderate and heavy loads, but with some coal needs a touch of the blower on very light loads. Notable characteristics are its free running with regulator closed, its high maximum speed under load (this has never been reached in the interest of safety), and its low water consumption.

Further particulars of the design are as follows:

Cylinders, (2) $1\frac{5}{8}$ in. bore, $2\frac{1}{4}$ in stroke.
Valve Gear, Joy, 80 per cent cut-off in full gear.
Grate area, 21 sq. in.
Firetubes, (16), 12 in. long, $\frac{7}{16}$ in. bore.
Superheater tubes, (4) 12 in. long, $\frac{3}{4}$ in. bore.
Driving wheels, $5\frac{1}{2}$ in dia.
Blast nozzle, 0.3 in. dia.
Superheater elements, (4) spearheads $\frac{1}{4}$ in $\times$ 22 gauge stainless steel.

Measurement technique

The power output was measured by greasing the rails and allowing the wheels to slip whilst the drawbar force was measured on a Salter balance and the speed by a Smith Tachometer. Various loads were obtained by taking some of the engine weight on ball bearing-mounted wheels which were adjustable. The friction of these wheels against the rails was small and was ignored.

It is not possible to measure directly the rate at which fuel is used for short test periods, since the firebox content cannot be accurately known. If, however, the rate of flow of flue gas is measured together with its chemical composition, it is possible to deduce the rate at which fuel is being used and heat generated.. The difficulty here lies in measuring the rate of flow of flue gas from the chimney when it is mixed with the exhaust steam. To overcome this, the flue gas and exhaust steam were passed through a water cooled baffle, caught in a large polythene bag and the time noted for this to be filled. The volume of gas caught was measured by a water displacement method. A slight error can occur with this technique because any water contained in the flue gas is also condensed along with the steam and therefore not measured. However, by using anthracite as fuel, little water vapour is produced and the error is very small.

The smokebox and firebox vacua were measured by water manometers, while the back-pressure at the exhaust nozzle was indicated on a mercury manometer.

Temperatures were measured by inserting Chromel-Alumel thermo-couples at the various points and bringing these out to a 12 way thermo-couple switch using a common cold junction and meter. In the case of the fire-bed temperature a Platinum/Platinum-Rhodium couple was used in a protective sheath and connected to a separate meter.

Steam chest pressure was measured by a 0-100 lb. per sq. in. Bourdon Tube gauge, the calibration of which was checked. The temperature of the steam delivered to the steamchest was measured by screwing a small copper thimble containing a thermo-couple into the steam pipe close to it. The thimble was arranged to project inwards about two-thirds of the pipe diameter and was made very thin.

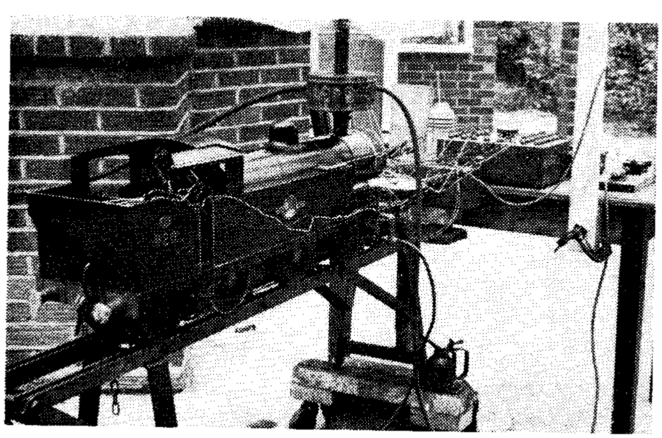
The exhaust temperature thermo-couple was inserted directly into the side of the exhaust nozzle and the exhaust back-pressure manometer connected to a point in the exhaust pipe about 1 in. from the nozzle.

The thermo-couple used to measure the fire-bed temperature was inserted through a hole in a plate covering the firehole.

Flue gas samples were collected in plastic containers that had previously been used to contain washing-up liquid. These bottles were provided with tightly fitting rubber bungs through which glass tubes were passed. Connection between these tubes and the sampling tube was made by means of a short rubber connector with pinch-clip. The sampling tube was $\frac{1}{8}$ in. dia. copper arranged to slide through one of the firetubes from the smokebox end and marked to indicate when its open end coincided with each end of the firetube. Each sample bottle was evacuated whereupon it collapsed. When connected to the sampling tube and the pinch-clip released, the gas was drawn gently in until the bottle resumed its normal shape. This procedure proved very convenient both in taking the sample and subsequently when the analysis was conducted by means of an Orsat apparatus. The reason for taking samples from both ends of the firetubes was to check whether or not combustion took place within these tubes. The tests indicated no combustion.

Right: In this view the steam chest pressure gauge can be seen and the meters for measuring temperatures at different parts of the locomotive

Below: The 0-6-2 tank engine under test



In order to simplify the thermal calculations, anthracite fuel was used since this contains about 90 per cent carbon, 4 per cent ash and moisture whilst the 6 per cent residue is only partially combustible material. The error in assuming that only the 90 per cent carbon takes part in the combustion is quite small.

When carbon burns in air, the oxygen contained in the air combines with it to form carbon dioxide, the reaction being accompanied by the liberation of heat. The chemical reaction for 1 lb. of carbon can be written:

$$C + 2O = CO_2 + 14600 \text{ B.T.U. of heat.}$$

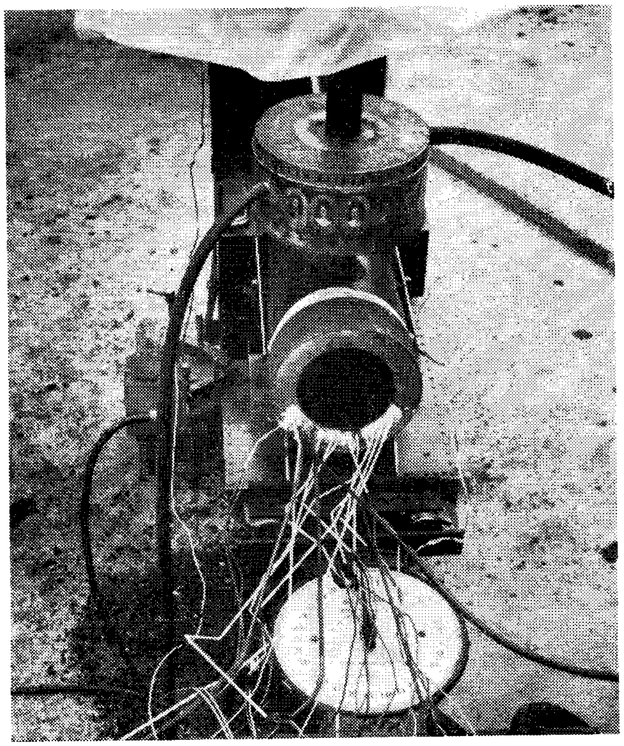
The proportions by weight are:

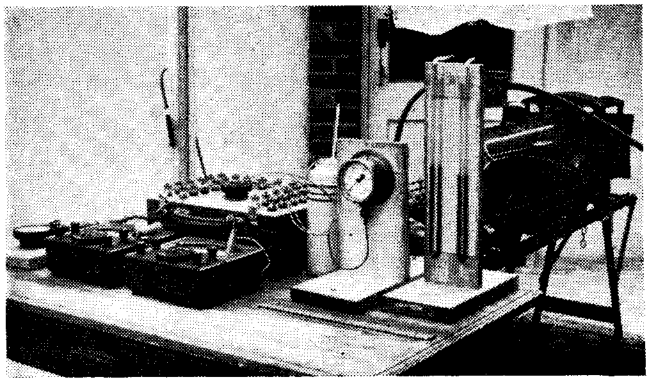
12 parts carbon + 32 parts oxgen = 44 parts carbon dioxide. Therefore, 1 lb. of CO_2 indicates the production of 4000 B.T.U.

The Orsat appartus used for the analysis was arranged to determine the parts by volume of carbon dioxide, carbon monoxide and oxygen in the flue gas. The presence of carbon monoxide indicates incomplete combustion whilst oxygen present shows that excess air was being supplied. The amount of carbon dioxide indicates the extent of combustion and the heat generated, the number of B.T.U. being obtained from the relationship given above. To do this, however, the mass of carbon dioxide must be found.

The volume rate of flow of flue gas having been determined by the use of the bag, it is only necessary to multiply the percentage of this volume due to carbon dioxide by the density of carbon dioxide (0.12 lb./ft 3) to obtain the mass flow of CO_2. Finally, as we have seen, the mass flow of CO_2 multiplied by 4,000 gives the rate of heat liberation in B.T.U./min., if the original volume were measured in ft^3/min.

The proportion of this heat transferred in the firetubes may be obtained from a knowledge of the temperature fall of the flue gas during its passage along the tubes. In order to do this the specific heat at constant pressure of the gas must be known and since this is a mixture of gases there is some difficulty. Fortunately, the major gases present are carbon dioxide and the constituents of air. The former has a specific heat of 0.201 and the latter 0.237. If separate calculations are made for these two components and the results added there will be no great error.





Above: Note water manometers to measure smokebox and firebox vacua.

Left: The flue gases and exhaust steam were collected in a polythene bag.

Knowing the heat transfer in the tubes and the total heat evolved, both the proportion transferred in the tubes and that rejected at the smokebox can now be deduced. This last figure enables one to calculate the boiler efficiency except that it will not take into account loss by radiation and unburnt fuel ejected from the chimney.

Most of the tests were carried out at a speed corresponding to 7 m.p.h. (400 r.p.m.), the measurements being taken after the engine had been running sufficiently long for conditions to have become steady with the boiler pressure at 80 lb. Owing to the resistance of the water-cooled baffle it was found that under certain loads there was a tendency for the pressure to fall unless the blower was used. It was, therefore, decided to limit this part of the testing to three outputs of approximately ½ h.p., ⅛ h.p. and zero output (driving wheels suspended), and to follow these with a series of tests at various outputs ranging from zero to 0.8 h.p. without the baffle.

Results

The observations of the first series of three tests are recorded on the accompanying diagram which shows also the results of calculations using the values obtained. The results from the second series of tests have been combined with some of those from the first series and presented on the graphs of Fig. 1 and Fig. 2.

Different aspects of the engine's operation will now be considered in the light of these results.

Heat transfer

It will be seen that the proportion of heat transferred in the tubes varies with the flue gas composition which in turn varies with the load. In test 1 with the very light load, there was an excess of oxygen, whereas in test 2 the combustion was better, 13 per cent CO_2 being produced with low excess oxygen. This caused an intense fire (not cooled by a large excess of air) which in turn gave rise to the high transfer in the firebox of 320 B.T.U./min. Also, in the absence of a large excess of air the total gas flow was relatively low, resulting in a relatively smaller proportion of the heat being carried in the flue gas and a boiler efficiency of 85 per cent which is comparable with full-size practice. Under the heavier load of test 3 the large value of excess oxygen appeared again giving a lower percentage transfer in the firebox and higher in the tubes with efficiency falling to 78 per cent. This is evidence that the fire was being over-driven, producing poorer combustion and little extra heat.

The graphs of Fig. 1 indicate the manner in which the temperature of the flue gas falls as it passes along the tubes. It will be noticed that generally the fall is very rapid for the first ⅓ of the tube length, although this is not so pronounced with the heavier output. At moderate loading, more than 80 per cent of the heat transfer in the tubes takes place in the first ⅓ of their length. In fact, the last ⅓ contributes practically nothing and the last inch or two only just about make up for the loss by radiation of the exterior of the boiler barrel surrounding this part of the tube bank. It is only at very heavy loading that the smokebox ends of the tubes make a positive contribution and this in a boiler which has a short barrel by normal standards.

Superheat

The figures for superheat are shown for the three tests as 270 deg. F, 320 deg. and 307 deg. respectively. They are somewhat greater than normal in full-size working where about 250 deg. F of superheat, i.e., a steam temperature of 650 deg. F for a boiler pressure of 220 lb. per sq. in. are obtained.

The cylinders of the model were cast in phosphor-bronze and the pistons made in drawn bronze. Recently, the pistons were withdrawn for the purpose of replacing the graphite packing and in spite of the high superheat and nearly 1,000 actual miles of heavy use, the pistons and bores were found to be in excellent condition. Shell Valvata J 78 has always been used for cylinder lubrication, fed by a mechanical lubricator.

Exhaust steam temperatures are seen to be very high showing a considerable degree of superheat. Under these conditions it is quite certain that no cylinder condensation takes place. Indeed, the cylinder wall temperature was in all the tests above the saturation temperature of the steam in the steam chest.

Exhaust back-pressure

As was stated earlier, the back-pressure was measured just behind the exhaust nozzle and as the results show never exceeded 1.5 lb. per sq. in. Under these circumstances there is no point in considering possible improvements in blastpipe arrangements since any gain here would have a negligible effect on the working of the engine. The reason for such low values becomes apparent when one considers the flow of gas through the firetubes. From the results of test 3 the velocity of the gas is found to be 570 ft/min in tubes of $\frac{7}{16}$ in. bore. Under these circumstances the flow is streamline and as a result the pressure difference across the tubes (smokebox vacuum minus firebox vacuum) to cause this flow is small (0.35 in. of water). In full-size the flow in the tubes is turbulent and therefore needs a much greater pressure difference, figures of 5 in. of water and 10 lb. back-pressure being obtained.

Firebed temperature

Here the values obtained were considerably greater than in full-size working and it is probably here that the model makes up for some of the disadvantage it suffers relative to full-size elsewhere. The problem of clinker formation at high temperatures is not so acute in models, because they are rarely in steam for such long periods as in full-size. The elevated temperature of 2,900 deg. F compared with about 2,500 deg. F in full-size greatly facilitates heat transfer in the firebox by radiation.

In test 3 the engine was well loaded and the coal consumption figure of 3.9 lb./D.B.H.P./Hour is very similar to that obtained in full-size. Under these conditions the grate loading of the model was 3.8 D.B.H.P./ft^2, whereas in full-size a value of about 30 D.B.H.P./ft^2 would be usual. If the fire of the model had been of scale thickness and the coal burning at the same rate per unit volume as in the full-size, then presumably the same temperature would have been attained. The temperature was however greater in the model thus indicating a greater rate of combustion and the B.B.H.P./ft^2 instead of being 'scale,' i.e. 30/12 = 2.5 D.B.H.P./ft^2 was 3.8 D.B.H.P./ft^2, which is greater, as expected.

Conclusions and discussion

In general, it appears that the operating characteristics of the model boiler are very similar to those of a full-size boiler. This comes about by compensating scale effects. For instance, heat transfer in the tubes in full-size is greatly aided by turbulence, whereas in the model where the flow is streamline the tubes are of much smaller diameter, resulting in reduced resistance to the radial flow of heat, which thus compensates. If the full-size engine were provided with the same size tubes as the model, better heat transfer would occur, but the tubes would choke up very quickly. Why do they not choke up quickly on the model? Because the gas velocity is about scale, i.e. 1/12 and therefore pieces of coal sufficiently large to choke the $\frac{7}{16}$ in. tubes are not lifted from the fire. Some coal is lifted, but only that which is finer and able to pass through without choking.

Again, the model is at a disadvantage due to its radiating surfaces being proportionally larger compared with the volume they enclose than on full-size. With most models this results in severe condensation in the cylinders, but as the results above show, this is readily offset by superheating the steam, provided a radiant superheater is employed, thus taking advantage of the propitious conditions in the firebox. The model is also favoured by the natural laws of gas flow resulting in exhaust back-pressure being negligible.

At the commencement of this article a number of questions were posed. Which of these can now be answered?

The answer to the question of tube length at first seems clear; it would seem difficult to make it too short. Even by halving the length—a pretty drastic measure—little would be lost in heat transfer. Drastically cutting down the barrel length in this way would adversely affect the free water surface from which the steam is released into the steam space and cause wetter steaming; but it is doubtful if trouble of this sort would be met if, say, the tubes had been reduced by $\frac{1}{3}$ of their length, because the rate of steam production in this last third is negligible and therefore the surface above this section is made little use of for steam release.

What is to be gained by cutting down the barrel and tube length? Before conducting these tests I thought the chief gain would be a reduction in exhaust back-pressure. I can see now that no significant improvement is possible since the back-pressure is so small. I think the major gain would be in reduction of water capacity where it cannot obtain its share of heat directly from a heating surface. Such water must gain most of its heat by mixing with water from elsewhere or by condensing steam from the steam space above. If the barrel is very long, mixing (by circulation) becomes less effective and the latter effect more pronounced.

Water capacity

Whether or not a boiler should have a large water capacity is a matter of debate. With a large capacity the energy stored is large so that the initial fall in pressure when the engine starts away with a load is less than with a smaller capacity. On the other hand, once a boiler with a large capacity has dropped in pressure it is slow to recover. In practice, experience indicates that provided an engine has cylinders of ample size, a small capacity (short barrel) boiler is advantageous because its pressure recovery is very quick due to all its heating surface being effective.

In view of the high proportion of heat transfer being in the firebox of the engine under test, it would seem advantageous to make this as large as possible. There is a danger here, however, that the grate would also be large—too large, in fact. I believe that grate area should be related to the size of the engine part of the machine and that this is a function of the cylinder bore and stroke and driving wheel diameter. I have devised the following formula by which this may be related to the grate area:

$$N = \frac{\text{Swept volume of the cylinders per revolution}}{\text{Grate area} \times \text{Driving Wheel diameter}}$$

Where N is a dimensionless factor.

In engines where N is high the grate will be driven hard and firebox heat transfer is more efficient, but the combustion is less efficient and the tendency to clinker more pronounced. Where N is low the fire will be dull, the boiler inefficient and sluggish. The value of N for the engine tested is 0.15 and this engine has run all day without excessive clinker formation. On the other hand the tests have shown that on very heavy loads there is a tendency for the fire in this engine to be over-driven. On the whole, I feel the position is satisfactory since an engine spends very little of its steaming time on these very heavy loads, but is mostly used at the intermediate loadings where, as we have seen, the combustion efficiency is greatest. I have observed the performance of many model engines and correlated this with the factor 'N' and conclude that the most satisfactory engines have value for N between 0.12 and 0.25.

Continued on page 283

FROMENT CLOCK

Continued from page 211

by J. R. L. Orange

THE STRIKER arm can be made from a suitable non-ferrous material about 0.025 in. thick; it has the same sort of bearing as the gravity arm. It carries a soft iron armature which is slotted and will eventually be fixed with Araldite, but that should be left until it can be lined up with the electro-magnet.

Using a needle file, make a notch in the rear edge of the striker, $2\frac{3}{16}$ in. from the bearing centre. This accommodates the latch sleeve. Tin the inside of the notch, lay the sleeve in it and solder them together. They can be held in their relative positions by being pushed into a piece of stiff clay while soldering. A touch with a hot wire near the junction will serve to join them.

Cutting the gears

The sides of two adjacent teeth form a right-angle and therefore a 90 deg. cutter is needed. I use a fly-cutter running at 20,000 r.p.m., but it is quite easy to plane the teeth of this wheel in the lathe if it is done in easy stages and the wheel is firmly backed up to a wide shoulder. If proper dividing apparatus is not available, a good 60-tooth gear mounted on the lathe spindle will do. The wheel is made from hard brass or bronze, $\frac{3}{4}$ in. dia. and 0.040 in. thick. Since it should have as little inertia as possible it should be " crossed out "—that is to say four or five sectors of metal should be removed, leaving spokes to connect the rim and boss.

The count wheel arbor carries a seconds hand and its height therefore determines the plane of the dial. The dimensions of the arbor and its pinion may be varied, of course, according to the form of the clock and the gear-train desired. Its pivots should not be thicker than 0.020 in. (No 76 drill).

A long ratchet spring bears against the count wheel to prevent its turning backwards. It should be set so that when the wheel is stationary the tip is in contact with it in one place only, its extreme end touching the underside of one tooth. The spring must not bear against the adjacent tooth except momentarily when the wheel is moving to keep friction as low as possible.

The striker arm is driven forwards by a ribbon spring of phosphor bronze beaten from wire to 0.003 in. thick. A strand of 0.015 in. bronze wire from marine throttle cable, as used in some outboard motors, can be beaten to this thickness without having to be annealed. In the form shown, the spring's pressure can be quite widely varied.

The positioning of the two stop screws conditions the action of the entire mechanism. The upper one, whose bearing surface should be rounded and well polished, limits the travel of the latch nosepiece by stopping it from rising with the wheel, and thus locks the wheel at each stroke.

In setting up the mechanism the upper stop screw is eased off so that with the striker arm fully engaged, the ratchet spring is just able to slide under the nearest wheel tooth. This makes it unnecessary to have the ratchet spring adjustable for length. Then the lower stop is screwed in to a point at which, when the striker disengages, the latch has just room enough to drop on to the next tooth. All this sounds much more complicated than it really is. The diagram did, I hope, make this quite clear.

Once this assembly is complete the most difficult part of the work is done. Mount it on a baseboard of resin-bonded fibre of the Tufnol type, $\frac{1}{4}$ in. thick, or of light alloy or brass. This baseboard carries almost all the rest of the mechanism.

Only one coil is used, combining the functions of driving the count wheel and actuating the gravity mechanism. Originally I had separate coils for each task, but the present method is neater and more economical of current.

The coil is wound in the lathe. Set up about 3 in. of 5/32 in. iron or mild steel rod (if you can get soft iron, so much the better). Support it at the tailstock. It carries two discs of any suitable non-ferrous material, $\frac{9}{16}$ in. dia. and about $\frac{1}{8}$ in. thick, which are forced over the rod to make the ends of the bobbin. They should be $2\frac{1}{4}$ in. apart, measured from the inside faces. Drill two small holes in one disc, one as near as possible to the rim and the other near the centre, to take the two ends of the wire.

Enamelled copper wire 30 s.w.g. (0.0124 in.) is used. With care it is possible to wind perfectly even layers. If any fault develops, unwind at once and straighten the wire, for the fault will be reproduced and exaggerated in the next layer. Wind directly on to the core. It is useful to have the lathe running backwards, so that the wire is fed over the top at slow speed.

There is no need to count the turns. Simply fill the bobbin to its full diameter. When that is done, run out the wire and put on a few coats of nail varnish or some other quick-drying lacquer while the bobbin is still in the lathe.

Make a jacket from thin aluminium or brass sheet to enclose the coil, bending the edges outwards to form a flange by which the whole is attached to the baseboard. The assembly should be free to slide up or down slightly so that it can be accurately positioned in relation to the striker arm, leaving a gap of not more than 0.005 in. when the striker is fully withdrawn.

Connect a 2-volt supply across the coil. The striker arm should withdraw sharply even against fairly strong spring pressure. When contact is broken the wheel should advance by one tooth. No matter how fast you make and break the circuit the striker arm should keep pace with you. Using a mechanical switch, I have run one for over an hour at 30 impulses per second.

At this stage the two principal assemblies should be connected. They are held about $\frac{7}{8}$ in. apart by a block of resin-bonded fibre; a piece of the same section as the main beam will do very well. Draw a line on each of the base-boards to indicate the plane of the pendulum rod; these lines should coincide when the assemblies are joined, or the pendulum will hang off-centre in the finished clock.

The link mechanism which is common to the two assemblies consists of long and short levers pivoting about a cross-shaft carried under the joining block. The long lever works between two small limit screws. The lower of these, insignificant though it may seem, has a very important function, for it determines the duration of the pendulum's impulse. At its outer end the lever carries a soft iron armature which is fixed and adjusted like its counterpart on the striker arm. The other end is permanently fixed to the cross- shaft.

The short lever is forked at its outer end, the fork carrying a piece of 0.050 in. steel rod whose function is to transmit motion to the steel tail at the end of the release arm. Though it may appear crude, this link is absolutely reliable. The two pieces of steel are always in contact, and their relative motion is so small that when the clock is working they appear almost stationary. The inner end of the short link is attached to the cross-shaft by means of a collar and grub-screw. The length ($\frac{5}{8}$ in.) given in the diagram should be regarded as approximate, for it will depend on the relative placing of the two assemblies. The lever should be so arranged that the transverse steel rod touches the steel tail as shown in the diagram. When the position is right, lock the lever with the grubscrew.

The release arm should now be holding the gravity arm in a horizontal position. If adjustment is needed, bend the upper part of the release arm.

Testing the link mechanism

Now the link mechanism can be tested. Closing the circuit should cause the contact end of the gravity arm to drop. The amount of movement should be very small, but perceptible. As long as there is *some* movement you may safely leave it until the time comes for final adjustment with the clock running. If there is too much movement (more than about 0.025 in.) close up the limit screw under the long lever.

Attach the pendulum assembly temporarily to the main beam, using a cramp. Then hold the main assembly against the front of the beam in such a position that the contact points coincide. Unless you have been very lucky it will almost certainly be necessary to move the pendulum hanger. When everything is about right, fix the main assembly to the beam with two 4 BA bolts, and finally fix the pendulum hanger. All this is a fiddling job, which can be made easier if small cramps are available. Support the beam on a temporary wooden structure with sides about 16 in. high and 5 in. apart, leaving enough room to put the pendulum bob on again when the rod has been hung.

When the pendulum is finally positioned the contact points should lie in the same vertical plane, and should not quite touch when the pendulum is at its lowest position. The final adjustment, which is made by moving the contact arm on the pendulum rod, is left until the electrical circuitry is complete.

Wires from the solder tags on the pendulum hanger and the gravity arm carrier are led to the battery via the relay trigger circuit. If the pendulum is now moved to the left the relay should operate. It remains only to connect the leads from the coil to the relay's main circuit, and the escapement is ready for testing.

Incidentally it will be as well to make up a small four-pin plug and socket, attached to the escapement baseboard, so that the leads can be removed without the need for unsoldering. Place a rule of some sort near the pointer on the end of the pendulum rod. Contact should be made when the pointer is moved not more than 3/32 in. away from the centre line, giving a swing of $\frac{3}{16}$ in. or a little over one deg. This should be regarded as the upper limit. It can with advantage be reduced a little, to just over $\frac{1}{8}$ in. A swing so small by comparison with conventional pendulum action may seem odd, but of course it is desirable in the interests of good timekeeping.

If the swing increases substantially, too much impulse is being given to the pendulum; the remedy lies in adjustment of the limit screw mentioned earlier.

The optimum duration of contact is arrived at automatically by adjusting the swing as described. The beat will sound lop-sided, but you will soon get used to it, and in any case the clock is very quiet.

Put a temporary pointer on the extension of the count wheel arbor. This will enable you to bring the pendulum to time and also to judge the action of the count mechanism. The pointer should have the least suspicion of recoil, to indicate that the ratchet is free. When it moves forwards it should do so quickly; sluggishness indicates insufficient spring pressure or lack of freedom in the count wheel.

When all is running well and the pendulum properly adjusted, the seconds pointer should be near the vertical at the Greenwich pip signal for day after day. I do not make any specific claim for the clock's accuracy because I haven't the time or inclination to put it through the necessary rigid tests; I will say only that it takes about a month for any significant error to show.

THE final shape of the clock is, of course, a matter for its constructor. The dial can be anything from 4 to 7 in. across, though I think both these sizes look wrong in relation to the one invariable length, which is that of the pendulum. It is important to realise that the distance between the count-wheel arbor and the clock centre will approximately determine the size of the dial, because the seconds circle should fall comfortably between the centre and the top numeral. The train I have used brings the seconds arbor to about $1\frac{5}{16}$ in. from the centre; this makes the width of the dial about $5\frac{1}{2}$ in., with a little more concealed behind the bezel.

Several trains are available. I used 10/120 and 30/150, having already made most of the gears for another experimental clock. The gears are of involute form, empirically contrived with home-made cutters. I suppose that anybody who has got this far will have realised that sooner or later he will have to cut some gears, and will not expect me to give more than general guidance.

Clock gears can be cut quite easily in a general-purpose lathe provided that a fly-cutting head and dividing apparatus of some sort are available. Both can be quite elementary in character. I have seen passable gears cut with an apparatus made from Meccano, the cutting spindle being turned by hand through three stages of belt drive. We ought to be able to do a little better than that, even if we do not aspire to the ideal of a spindle driven really fast, with an adjustable mounting of its own to go on the cross-slide. In passing I may say that such a spindle, driven by flexible shaft, can be made in four or five evenings by a moderately skilled person.

Whatever form of drive is used, the cutter head may well take the form that I have illustrated. Only one cutter is needed at a time, the opposite socket being to hold a balancing weight—a small piece of rod of about the same size as the cutter. Centrifugal force is quite large at 20,000 r.p.m., and a transparent cover should be used to screen the cutting head while it is running.

Cutter forms can be gauged from existing gears of approximately the size desired. Turn or file the end of a piece of silver steel until it exactly fits the space between two teeth, then file away half the thickness of the rod over the turned part, leaving a flat face bearing the cutter profile.

Harden and temper it to a light yellow colour, and be careful to mount it squarely in the head. At the optimum speed the full depth can be cut at one pass, the cutter going through the blank without perceptible check and leaving clean edges. More than one cutter will be required, of course, for a full train of wheels, but you can get away with only three if you make your train 10/60 by 10/100.

Dividing can be done if need be by using accurate gears mounted on the lathe spindle, with a detent to hold them firmly for each pass.

If the worst comes to the worst, existing clock gears can be used for the train, but this will involve a lot of searching and fiddling, and it is very likely that the gears will be worn.

Making arbors

An ordinary lathe can be used to make arbors with pivots as fine as .010 in. Success depends largely on having a tool of the right form, on using the right material, and on delicacy of touch. The top-slide must be nicely adjusted and set square, and to make sure that the tool is cutting and not rubbing in the final stages a magnifying glass is practically essential.

The tool must have a lot more front rake than usual, for there must be no possibility of any part of it other than the edge touching the work. Otherwise it should be shaped like an ordinary parting tool, but with the blade as narrow as you can make it and slightly rounded at the left-hand corner. Use this tool only for turning the actual pivots when the diameter is below .040 in.

Use the highest possible speed and the lightest possible feed-in increments of .001 in. if possible. The tool must be seen to cut at each pass. If it needs much more than .001 in. feed to make it cut, you will almost certainly be unable to get the diameter much below .025 in.; the tool will merely push the pivot off centre, and that will be that.

If you find it beyond you to turn pivots in this way, they can be rubbed down from about .030 in. with a strip of fine abrasive paper firmly glued to a flat metal surface, held underneath the pivot so that the track left on the paper will show whether contact is being made all along this surface. This is a third-rate method, however, and I recommend it only to those who cannot manage otherwise.

To turn the second pivot it will be necessary to reverse the arbor and to make sure that it is running quite true. This is much more easily said than done. For a start, the piece is too small and delicate to be held in the independent chuck. Therefore, set it in a subsidiary chuck which you know to be axially true and mount that in the four-jaw.

But there can be little objection to your taking the motion work from another clock. Many pre-war cars—notably Rileys and Rovers, to my recollection—had excellent dashboard clocks whose motion work would do very well for our purpose; doubtless many breakers' yards will have one. The centre arbor will have to be turned and nicked to take the cannon pinion. Copy the pivot from which the cannon pinion was taken, and be careful not to have the pinion running too easily when it is pushed home.

The dial may be made by spinning over a former, or it may be a piece of flat brass. Mine came from a nickel-silver dish long past its domestic usefulness.

Finally, the hands. I think it is desirable to counterbalance them all, but in particular the seconds hand must be balanced, or it will tend to run away with the counter wheel. I have said nothing about oiling. I will leave it to your common sense, with the warning that none must be allowed on the teeth of the count wheel.

The case

The design of the case must, of course, be primarily a matter for you. Remember that the clock is unlikely to keep really good time unless the case is either fixed to something immovable or is so heavy as to be proof against shake.

A simple experiment will show how important this is. Mount the movement firmly on a temporary stand, with the pendulum absolutely still. Then walk heavily near it, or slam a door. Look at the pendulum again; almost certainly it will be moving. This movement, added to or subtracted from the pendulum's natural swing while it is working, can be relied on to upset its accuracy. The Froment pendulum is, of course, quite free in the vertical position, and will beat for some hours if pushed through only a quarter of an inch, without further impulse.

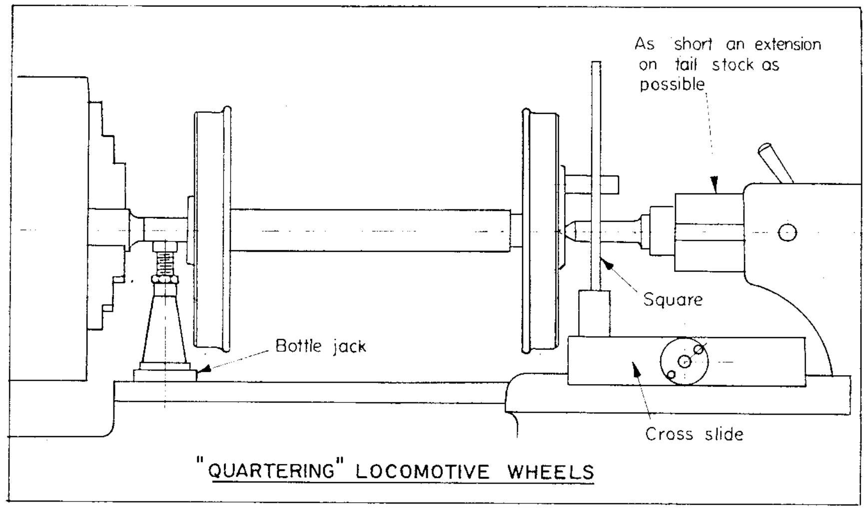
The easiest way to avoid unwanted movement is to screw the case to a wall. If this is to be done, the back of the case must be its strongest part. The sides, which bear the main suspension beam, should be very firmly fixed to the back. Provided that this basic structure is rigid, the rest of the case can be fitted quite loosely to it.

Suitable material for the back is inch-thick resin-bonded plywood, which will not warp. The sides, which presumably will be required to be more decorative, may be of some stable wood, well seasoned, at least ½ in. thick. I used teak for the sides and top and bottom, and was lucky enough to be given a piece of beautiful Ceylon satinwood, whose grain makes a pattern of russet brown on rich yellow, for the front. Unfortunately, though it was first sawn more than a century ago, it warped after being planed, and had to be reinforced. Since the front should be fairly thin (so that the glass does not stand too far off the dial) a veneered plywood may be as good as anything. But please, let it be honest wood, and do not insult the clock with that laminate whose proper place is on the kitchen table!

The front should be quickly detachable. If the top is hinged and spring-loaded, and the bottom fixed, the front can be held firmly between them by means of tongues fitting in grooves. Or the top and front can be joined as a unit and held in place by ball catches. Whatever sort of case you make, remember that most people will see little more than the case itself and will judge your work accordingly. It is worth taking trouble to get the surfaces really straight and smooth and the angles accurate.

A friend, whose firm produces the most beautiful woodwork you are likely to see anywhere, gave me a tip for finishing the surfaces. Apply (to the raw wood) one coat of polyurethane varnish; sand it thoroughly with the finest paper, and then wax polish it three or four times.

If anybody who makes this clock gets half the pleasure and education from it that it has given me, his time will not have been wasted. ▣



QUARTERING LOCOMOTIVE WHEELS

Put them between centres says *D. Marsden*

DURING the construction of *Maisie*, the problems of quartering wheels and the spacing of the centres of the bushed holes in the coupling rods to exactly coincide with the centres of the coupled axleboxes were overcome without jigs and with little trouble.

For quartering, the crankpins were pressed into the wheels and one wheel of each pair pressed on its axle. An old Morse taper drill was sawn off above the flutes and fitted into the lathe mandrel, where the plain shank remaining was turned down to the diameter of the largest (driving) crankpins and a centre formed on the end, the angle coinciding with the centre in the wheel axle. The job was then removed from the mandrel and the three-jaw chuck fitted.

A scrap piece of round rod was chucked and turned down to crankpin size and a centre formed in the end as before. The topslide was removed and the Morse taper centre fitted to the tailstock. The driving axle was then placed between the centres, with the wheel already pressed on towards the chuck, and the loose wheel placed over the tailstock centre. The axleboxes and eccentrics were, of course, in position.

The crankpin at the chuck end was positioned horizontally to the lathe bed by packing under it and the chuck centre, checking with feelers. (A small screw jack set under the chuck and then placed under the crankpin is an improvement). The tailstock handwheel, used judiciously, slightly end loaded the axle and assisted in keeping it from turning off the packing. The other wheel was then started on the axle with crankpin set vertically over the tailstock centre, by checking with the blade of a try square whose stock was placed on the cross-slide, and by just touching the blade against both crankpin and centre. The axle was then removed from the lathe and the 'starter' wheel partly pressed on, the whole assembly being then returned to the lathe centres to check that no radial movement had taken place.

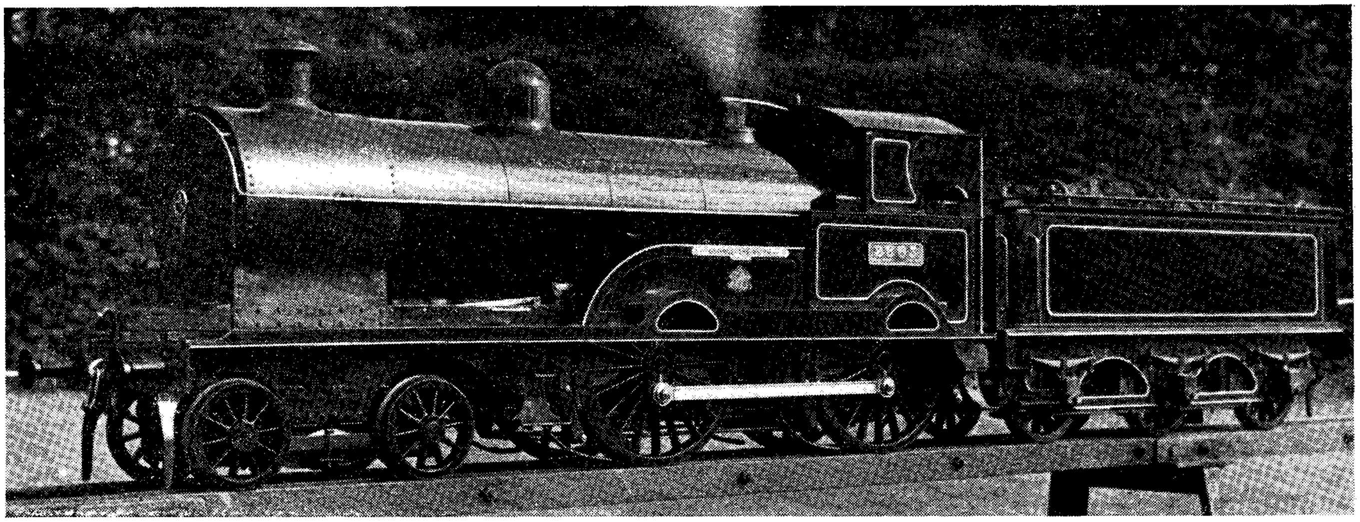
The operation was completed by pressing down the wheel and rechecking. The leading coupled axle was treated in the same way, but as the crankpins were smaller in diameter the machined centres had to be turned down to suit. Although this method does not guarantee the crankpins being at 90 deg. to each other on each axle, both wheels are exactly the same.

The wheels were erected in the frames, the axleboxes being jacked up to running position and the crankpins at dead centre on one side. The coupling rods were marked out for hole centres and drilled and reamed for the leading coupled wheel bushes, which were turned and fitted. The holes for the driving crankpins were then drilled to the size of the crankpin and the rods offered up. Any discrepancy between hole centres and crankpin centres were *partially* rectified by drawing the hole over with a smooth round file before drilling and reaming for driving crankpin bush. This operation was then carried out on the other rod with its crankpins at dead centres.

The bushes for the driving crankpins were first turned from bronze rod to a press fit for the holes in the coupling rods, this diameter being made about 1/16 in. over length and the extra length a push fit in the holes in the rods. The bushes were parted off and chucked in turn in the four-jaw, flange outwards, and brought to run a few thou. out of true (or eccentric) when each was centred, drilled and reamed a running fit on the crankpins.

One coupling rod was then offered up to its pair of coupled wheels which were again in dead centre running position. The eccentric bush was pushed on the crankpin up to the hole in the rod and rotated with the fingers until it would just enter the hole. A slight tap with a hollow drift secured the bush in the rod. The wheels were then carefully turned through 90 deg. and with the other pairs of wheels on dead centre, the other rod and bush were treated in the same manner. The wheels were spun to check for binding, its absence being the signal to press home the bushes and fit and re-check. Any binding means the removal of rods and bushes and a fresh attempt. When the bushing was completed to satisfaction, the excess material protruding through to the back face of the rod was removed, after bolting the rod to the faceplate.

These two operations, quartering and hole spacing, though lengthy to describe, are simple and quick to carry out, and require only simple equipment. The accuracy achieved by this method is all that can be desired.



G. M. Cashmore's superb 5 in. gauge LNWR George V; she has " Maid of Kent " cylinders and Joy valve gear.

Injectors are simple says LBSC

who goes on to clear up some more locomotive " mysteries "

IT STILL puzzles your humble servant as to why many good folk regard little injectors as gadgets with hidden secrets and mysteries in them. They are nothing of the kind, being merely simple bits of mechanism making use of the natural law, that a jet of liquid issuing from a small nozzle has a lot more kick behind it than a jet of steam at the same speed. To put the matter in a nutshell for the benefit of beginners, steam issues from a weeny cone with all the force of the boiler pressure behind it, condenses in cold water surrounding the cone, and in doing so, gives up its speed to the water. This water now has force enough to shoot from the nozzle of the mixing cone, jump a small gap, enter the nozzle of the delivery cone, push up the boiler clack, and get into the boiler. Long scientific dissertations have been written about it, but it is just as simple as that.

The success or failure of a little injector to feed a boiler, depends on the shape, nozzle diameters, and spacing of the cones. I found this out many years ago, and it is not the slightest trouble to me to make injectors that work every time. Since the end of the last war, I have made over 200—that's a lot, isn't it?—but it soon adds up when making a dozen or so at a time, Most of them have been given away as presents, to folk who were kind to us during the war, sending food parcels and so on; to personal friends for services rendered, and various other reasons. They are scattered all over the world, and I have yet to hear of one that failed to do the job. I have also re-coned and otherwise corrected goodness knows how many more for people who slipped up when making them; also corrected commercially-made injectors that were unsatisfactory. Experience teaches!

Not made to instructions

On page 33, January 7 issue, Brigadier Richards says that he made an injector to instructions, and it put the water on the track instead of in the boiler. Pardon my contradiction, but the injector was definitely *not* made to instructions, otherwise it would have worked. Many readers can confirm that! Some of the makers of non-injectors sent to me for examination, swore by all that was holy that they had followed the instructions exactly, but they had jolly funny ideas about what " exactly " really means! Cones of wrong shape and bore, spacing not correct, alignment all out, slack fits, leaking air valves and so on, are all causes of failure.

To take a typical example, one I received a few weeks ago, time of writing, had the following defects: Steam cone quite slack in the body, so that it didn't line up, and the nose turned to a blunt cone instead of a long curved taper. When pushed right home, it almost blocked the entrance to the combining cone. The bore was much too large, and not properly tapered at the end. The two halves of the combining cone were over $\frac{1}{16}$ in. apart, and consequently the tapers in the bore didn't line up to form a continuous cone angle. The delivery cone was not only loose in the body, but also turned to a blunt angle too large at the end, which was belled out to about twice the depth it should have been, the throat being oversize. To crown all, the outsize clumsily-made check valves, instead of butting up against the flange of the delivery cone when screwed home, butted up against the injector body instead, leaving the delivery cone free to slide back and leave a gap between it and the combining cone, a fault which in itself would have cattled up the whole works!

The workmanship on the body was so poor that it wasn't worth making and fitting a proper set of cones, so I just sent the gadget back to the maker, told him what was wrong with it, and advised him to have another go, this time following the instructions *exactly*.

Good advice

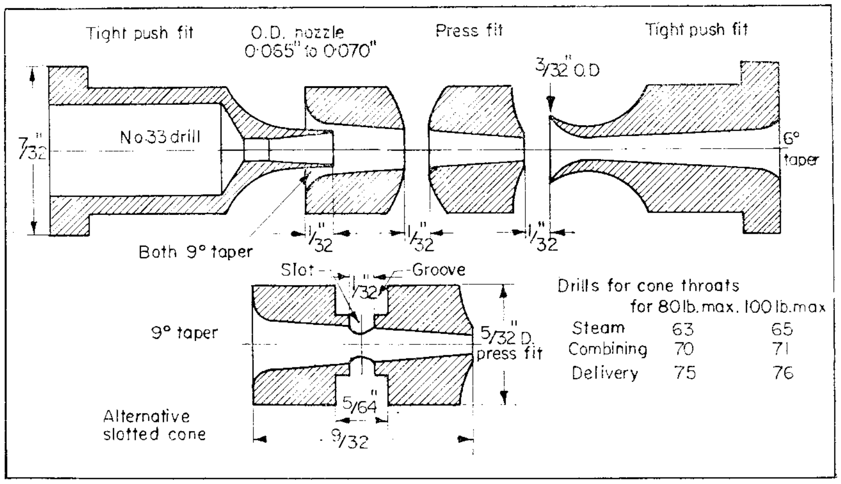
The Brigadier's friend Mr James was perfectly correct; perfect alignment and correct centring are esential. For centring, I use a scrap dental burr with the business end broken off, leaving the end with a taper like a sewing needle. This end is then ground to the shape of an arrow-head by hand on a fine-grit oilstone, under a good magnifying-glass. The stem of the burr is large enough to hold in the tailstock chuck of my 3 in. Leinen-Boley precision lathe, and as the 3 in. Burnerd three-jaw chuck is accurate to aero limits, I haven't the slightest difficulty in centring cone blanks with a weeny countersink accurate enough to start a No. 80 drill truly. If the chucks were not accurate, I should use collets, or home-made sockets.

My pin chucks are the same as used by watchmakers, and are also accurate, so I never have any trouble with drills wandering. A high speed is certainly desirable, and I work the handle of the lever tailstock back and forth like a pump. Mustn't speak out of turn, but it is ages since I broke a little drill; just can't afford to break them at present prices, anyway!

Making steam cones

Mr James's method of making steam cones is similar to my own, but I use a piece of flat steel $\frac{1}{32}$ in. thick as a gauge to get the right distance between flange and body. The turned end of the rod is then centred and drilled, the curved taper nozzle turned to shape, the diameter at the end being measured with a "mike," and the little taper reamer fed into the drilled hole until only a knife edge is left all around it. The cone is then parted off about $\frac{1}{8}$ in. behind the flange, reversed in chuck, the back opened out with a No. 33 drill to within a bare $\frac{1}{32}$ in. of the reamed end, and the flange faced off truly so as to make steamtight contact with the union.

To ensure getting a continuous taper in the combining cone, I turn a bit of $\frac{3}{16}$ in. rod to a press fit in the injector body for about $\frac{1}{2}$ in. length, centre and drill it No. 72, cut back the end very slightly, and part off to $\frac{5}{16}$ in. bare length. The blank is then reversed in the chuck, and reamed until the point of the taper reamer just shows through the nozzle end. I use a jewellers' saw to cut the blank in two halves, whilst revolving in the chuck. The sawn ends are then faced off, and the back of the nozzle half very slightly countersunk with the $\frac{3}{16}$ in. reamer. This half is then pressed into the body until the end is just past the middle of the ball seat. A sliver of



Details of injector cones

brass $\frac{1}{32}$ in. thick is then put down the hole, and the other half of the cone pressed in until it touches the sliver. That gives the correct spacing. Finally, I put the taper reamer into the pressed-in cone, and carefully turn it with a tapwrench until a No 70 drill will just go through the nozzle. That correctly lines up the tapers and makes sure of the right diameter of the nozzle.

For the information of new readers, I first described how to make injectors in my original Live Steam notes over 40 years ago. Since then I have done a lot of experimenting, and made various types, such as sliding cone, flap nozzle, combination and so on. I have also made exhaust steam injectors, but the trouble with these is the oil in the exhaust steam. If this gets into the boiler, you've had it! I tried separators filled with gauze, muslin, Turkish towelling, and goodness knows what else, but the oil either got through, or choked the separator. Our little engines use far more oil, in proportion, than a full-size one, and there's a lot of difference between a separator the size of your finger, and one nearly as big as a 5 gallon oil drum!

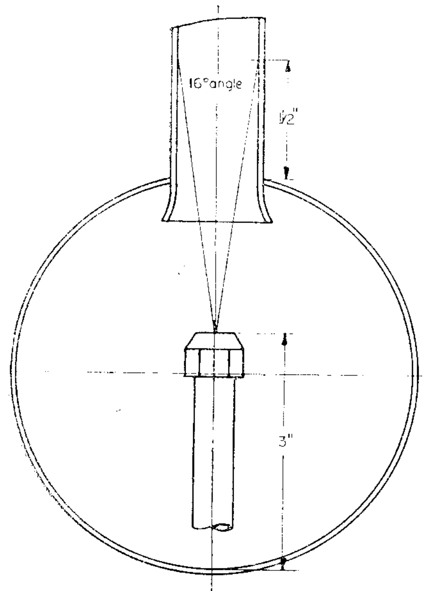
Mr R. Bacharach's blastpipe query

Neither Mr Bacharach nor Mr W. J. Lepley need worry about a reprint of the late G. S. Willoughby's articles on Stephenson link motion, because what virtually amounts to the same article was written many years previously by an eminent locomotive engineer named Zerah Colburn.

Colburn's work on *Locomotive Engineering* was first published in 1864, in 20 monthly parts, each containing three double-page engraved plates and 16 pages of text. The publisher was William Collins, Sons and Co., 139 Stirlings Road, Glasgow, and the price, two shillings per part. I have them right here, at the present minute, and can assure all our readers that they were wonderful value for money, even in those far-off days. The plates were the finest I have ever seen. The article on Stephenson valve gear begins on page 160 of part 10. Previous to that, there was a long dissertation on the proportions of valves and eccentrics, illustrated with numerous diagrams.

The complete work was later issued as a bound volume, and can still be obtained on loan from certain public libraries. My old friend Tom Glazebrook borrowed a copy from Croydon Public Library. They didn't have it in stock, but got it from another library. I don't know if American libraries have copies—incidentally, Colburn himself was American—but Mr Bacharach can soon find that out for himself. I happen to know that G. S. Willoughby had a copy, as he told me so himself when he visited me at my old home at Norbury in 1924.

Mr Bacharach's problem about the height of his blastpipe can be solved in two wags of a happy dog's tail. Being a newcomer to our craft, he naturally doesn't know the "tricks of the trade," or he could set his blastpipe at the right height by eye, same as I set mine, and I never get any steaming trouble. However, if he would rather do it on the drawing-board, he should draw a $5\frac{1}{8}$ in. circle to represent the smokebox, and draw the stack on top of it. Then, from a point about $1\frac{1}{2}$ in. up the stack above the smokebox, project an angle downwards as shown in the accompanying sketch. Where the lines cross, is the distance of his blast nozzle below the bottom of the stack.



ARRANGEMENT OF BLASTPIPE FOR GOVERNOR STANFORD

A good rule for engines with short chimneys is to divide the diameter of the smokebox into three. The top third is the amount that the liner should project into the smokebox. The middle third is the distance between the blast nozzle and bottom of liner. The bottom third is the height of the nozzle from the bottom of the smokebox. Simple, isn't it? If the engine has a long chimney, adopt Pat's formula; cut a bit off the bottom of the liner and add it to the height of the blastpipe. Hallo—what was that noise? Was it a rumble of distant thunder from the direction of Rustington, way down in Sussex, or just a diesel-hauled goods train going over the bridge at Purley Station?

A question of safety

All readers have probably seen the full-page advertisement of Araldite in recent issues of this journal. They show the front end of a steam locomotive in close proximity to two tubes of Araldite, and right opposite, are the words "Use Araldite for ALL your model making. Solve problems of riveting, screwing, soldering or brazing by using Aaraldite instead."

Now imagine a raw beginner, maybe a young lad, building his first locomotive. He hasn't much in the way of tools and equipment, and certainly no facilities for brazing the boiler. He reads the advertisement, and thinks "Well, it doesn't matter about brazing it if Araldite can be used as a substitute," so he goes right ahead, cuts out the pieces of copper for his boiler, shapes them, and sticks them together with Araldite.

Now—*what is going to happen when he starts to get up steam?* I'll take full responsibility for putting the following straight question to the manufacturers of Araldite. Do they seriously mean to assert that Araldite can be used to make the joints that are normally riveted or brazed in a small locomotive boiler, viz. firebox tubeplate, doorplate, smokebox tubeplate, tubes, backhead, foundation ring, and bushes? If they do—AND CAN PROVE IT—we might as well sell our oxy-acetylene torches, blowlamps, and other equipment. If not, then I submit that the wording of their advertisement is not only misleading and incorrect, but a source of danger to beginners and inexperienced workers, and should be corrected before somebody gets hurt. Nuff sed!

Too simple?

When I first started to write my Live Steam notes way back in 1924, at the invitation of the late Mr Percival Marshall, it was my aim to cut out all the "witch-doctory" business from locomotive building, and word my descriptions and instructions, and make my drawings as simple and clear as possible, so that the rawest tyro could build a successful locomotive by simply "following the directions on the label." I've had many a good laugh over letters sent by beginners who didn't know the first principles of steam locomotives, saying that they made the bits and put them together, just as I advised, and when they got up steam for the first time, to their great amazement and delight, the engine worked, steaming and pulling better than ever they expected.

Now I don't use drawings myself, and have never had a lesson in mechanical drawing in my life; but drawings of full-size locomotives, are such a complicated jumble of lines and figures, that it takes the proverbial month of Sundays to sort them out. That is one reason why I make my drawings as simple as possible, so that the average amateur builder can read and understand them at a glance.

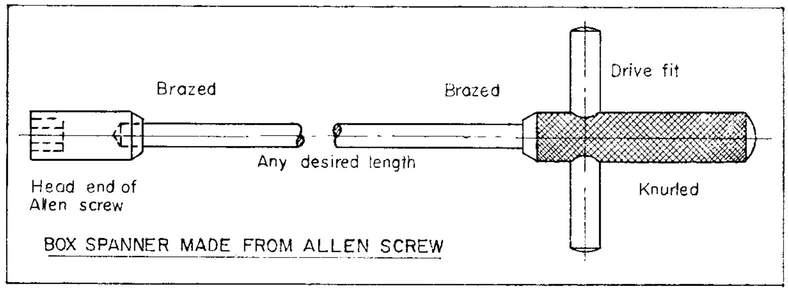
Alas! This procedure has landed me in trouble, for it appears that certain good folk who are so used to professional drawings and can't get on without them, are absolutely sunk if they try to work to my simple efforts! A case in point was the article by J. A. Plowman on what he called a *Tich-plus* in ME 15 October, 1964.

I should have taken this up at the time, had I still been writing for this journal, but "better late than never." Mr Plowman passed some scathing remarks about the Tich drawings, and then went to a lot of unnecessary trouble, and wasted much time, in making modifications, the result of which is that his engine uses far more steam and water (and presumably coal) than those built to my specifications, and will only run between two and three minutes without having to stop for refilling.

Tichs galore!

It so happens that *Tich* was one of the most popular engines that I ever described. Being a small four-wheeler, able to "run around the edge of a dinner-plate" in a manner of speaking, it was ideal for small back-garden lines, and didn't need a car for transporting if the owner wanted to take it for a run on a club track. It could haul three adults or several children without too much effort. Castings and material didn't cost overmuch; in fact, one advertiser told me he sold several cwts. of frame steel. The engine was simple and easy to build, and they sprang up in scores all over the world, even attracting feminine builders. One lady, Mrs Ruth Daltry, said that the job was just as easy as making a dress from paper patterns, a fact which I commend to the notice of Mr J. A. Plowman. Incidentally, I use paper patterns for certain jobs, such as the platework on my 4-6-2 *Polly O'Flynn*.

The builders of the several *Tichs* that have run on my own road, never had the least trouble in assembling the boiler fittings, or any other parts of the engine, and they could all run for ten minutes or more without stopping for water. My own *Tich* uses so little water that I had to reduce the diameter of the pump ram to $\frac{5}{32}$ in. in order to prevent flooding the boiler. The only time she ever used a lot of water was when some soda-water (not the kind usually added to whisky, I hasten to add!) got into the side tanks and was pumped into the boiler. She didn't like the taste of it, and promptly spat it out via the chimney, your humble servant getting the full benefit. She differs from the outline shown in the general arrangement drawing, having a short stove-pipe chimney and a low open-backed cab with side sheets, like some contractors' locomotives that have to work under low bridges, dock and wharf cranes and so on. She has a Belpaire boiler with a barrel only $2\frac{5}{8}$ in. dia., but is never short of steam, and outside Stephenson link motion. To enable her to make long non-stop runs, I built a 3½ in. gauge copy of a Southern 16-ton steel coal wagon—only it's brass, says Pat—the body of which is partly a water tank. The contents of this, plus what is in the side tanks, enables the engine to run two miles non-stop if desired. A section of the back of the engine bunkerplate is made removable to give easy access to the firehole when running. She will pull my weight around the line at a speed equal to any of my bigger engines, with the lever in next notch to mid-gear, and the speed at which the little coat-button wheels turn, makes me wonder how on earth the feed pump manages to suck water and feed it into the boiler. She has a fairly deep ashpan, with a kind of wheel-splasher at the front end, in which the pump eccentric works. This makes certain that plenty of air can get to the grate, even if ashes accumulate during a long non-stop run.



BOX SPANNER MADE FROM ALLEN SCREW

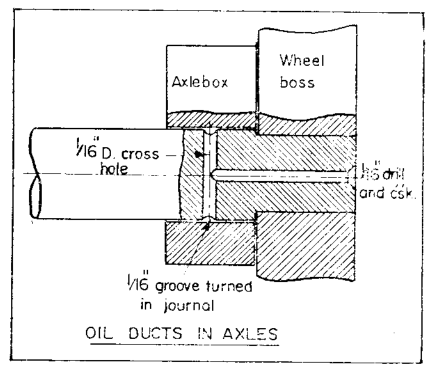
Extension drills

Referring to a letter from Mr Claude Geoffrion, page 88, January 21; over 40 years ago I described in my notes how to make extension drills and tap-wrenches, using 3/16 in. round brass or steel for the smaller sizes, and also showed how broken pieces could be utilised by mounting them in similar extensions. At this very moment there are two stands containing extension drills on my workshop shelf. The extensions vary from 2 in. to 10 in., the latter carrying a No. 40 drill which enables holes for stays to be drilled in a boiler throatplate, close up to a long barrel. The tap-wrench that I use for this particular job is a long piece of ¼ in. steel tube, in which the squared end of the tap was a tight fit. All I had to do was to hammer the end of the tube on to the square, drill a No 32 cross hole at the other end, and drive in a 4 in. length of ⅛ in. round steel to act as a handle.

It must be ages since I first described how to make box spanners from Allen socket-head screws, and there are several in my small-spanner drawer right now. Soften the screw, chuck, centre and drill it to take a piece of steel rod of any desired length, a little smaller than the screw. Ditto repeato on a piece of steel rod about the same diameter as the screw, knurl the end for about 1½ in. length, part off, and put it on the other end. Fit a cross-handle as shown, braze the joints, and clean up. The knurled end enables the lot to be spun between thumb and finger, the handle only being used for tightening, and you'd be surprised the time it saves when putting on steam-chest and cylinder covers, dome flange screws and so on. Stick little nuts and screws into the socket with a spot of motor grease, and they don't drop on the floor.

For larger box spanners, take a piece of mild steel of any desired length, and from 3/32 in. to ⅛ in. larger than the diameter of the hexagon over corners. Chuck, face, centre and drill it for about ½ in. depth, to a diameter that will allow the hexagon to be driven in. Soften the end, drive in a nut or bolt head, and hammer down on to the flats; fit a cross handle to the other end, and Bob's your uncle. A piece of steel tube may be used instead of rod if preferred, it makes a lighter tool.

Another chestnut is drilling a hole in the end of the axle, to a depth equal to the combined thickness of wheel and axlebox, then drilling a crosshole through the journal, level with the middle of the axlebox. The bit that Mr Geoffrion forgot, was that a groove should be turned in the journal at the point where the hole goes through, so that the oil when squirted in percolates all round the journal. I specified this system of axlebox lubrication in several of the locomotives described both in this journal and the others I used to write for, the last being the unfinished *Duchess of Swindon*, and also for my *Evening Star*. ▣



OIL DUCTS IN AXLES

NEW WORKING DRAWINGS NOW AVAILABLE

LO. 39. Highlander. 7¼ in. gauge L.M.S. 4-6-0 locomotive, sheet 6: general arrangement of valve gear, motion plates, expansion links, eccentric rods, 5s. 6d.; sheet 7: details of the bogie, 5s. 6d.

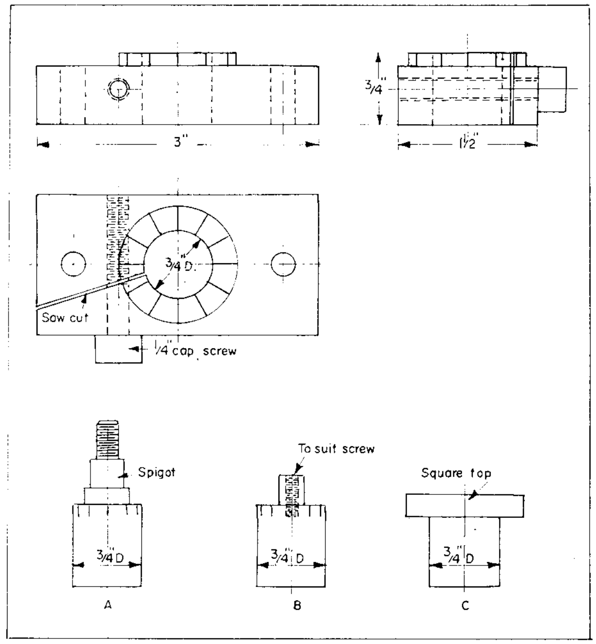
WE. 13. Small centre lathe by J. K. Mold. Full details on two sheets. The set, 9s.

WE. 14. Milling and Dividing attachment for the lathe, by Edgar T. Westbury. One sheet, 6s. 6d.

M. 26. Grasshopper Engine, by Sydney Owen. Three sheets. The set, 13s. 6d.

A USEFUL MILLING JIG

by Gilbert Lindsey



SOME years ago I made a jig for holding small components on the cross-slide while they were being operated on by an end mill held in the chuck. This has proved exceedingly useful and I think others may be interested in the device. Mine was made from available scrap steel and experience has suggested possible improvements, so I have made a drawing of a modified version.

The jig consists of a base which is bolted to the cross-slide and a number of workpiece holders which are clamped in position by the cap head screw. Their height can be adjusted by discs or washers under the holder. The design shown is for a small lathe with a distance of 1¼ in. between the top of the saddle and the lathe centre, but as none of the measurements are critical they can easily be altered to suit larger lathes. The holes for the holding down bolts must be arranged to suit the individual cross-slide. I have shown the centre hole in the base as ¾ in. so that standard bar can be used for the holders, but as it is essential that the spigots and holes in the holders are concentric with the outside diameter, it may be better to make the hole .725 in. unless your S.C. chuck is absolutely true. The ¾ in. bar is then turned down to this size and the spigots machined at the same setting.

While the base is set up for boring, mark the 12 (or better still 24) divisions round the hole with the aid of a change wheel or division plate. The holders will need marking with a line to register with these marks, but I find it an advantage to divide them into 12 as well, as they are easier to see.

Type A holder is used for making crank webs with rounded ends. The spigot is made to fit the hole in the web. If these are not the same size, either a second holder can be made or a bush can be used for the larger hole. The roughly cut out webs are clamped to the holder with a nut and washer. I have successfully held items with a hole as small as ⅛ in. dia. by this method. The forming is done by taking a series of tangential cuts, turning the web about 1/48 of a revolution between each cut. Very little dressing up with a file afterwards gives a good finish. With care it is possible to machine the flanks as well. The saddle should be locked during milling. An adjustable saddle stop is almost essential for some jobs.

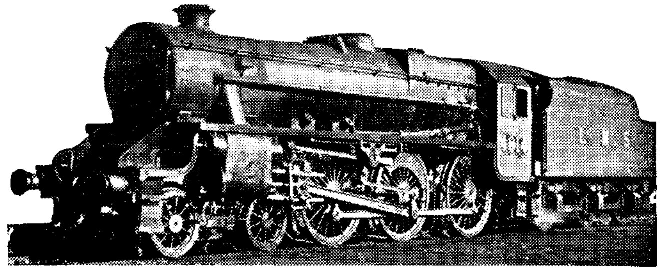
I have used a holder of B type for reducing the heads of commercial hexagon set screws to scale size, e.g., 6 BA heads on 4 BA screws. The screw is screwed into the holder as far as it will go. The holder is clamped with its register mark opposite one of the marks on the base. A trial cut is taken with the saddle hard against the stop. The holder is then turned 180 deg. and a second cut taken. The distance between the flats is measured with a micrometer. With the aid of feeler gauges the stop is moved half the excess size. Two more cuts are taken and if the measurement is now correct, you can proceed to mill the other four flats. Once the right setting is found you can make quite a lot of small headed screws in half-an-hour.

Type C holder has a flat square top and various holes are drilled and tapped as required to hold all sorts of small fittings. Sometimes where the components have no holes to fix them and clamps would be in the way I have attached them with soft solder to suitable holders.

One recent job that illustrates the versatility of this jig, was making split brasses for a locomotive connecting rod. These were flat at one end and rounded at the other, with flanges both sides. They fit into a connecting rod with a horseshoe end and are held in place with a gib and cotter. Two pieces of gunmetal were machined and soft soldered together. They were then bored and faced central with the joint. They were mounted on a A type holder and machined to the overall dimensions in a similar manner to the crank webs. The holder was then adjusted until the centre of the brasses was level with the lathe centre, and the groove to fit the rod was cut with an end mill of the required size. The correct depth was obtained in the same way as used for the screw heads.

This little jig has saved many hours work in locomotive building.

Cab reversing gear



HIGHLANDER a $7\frac{1}{4}$ inch gauge LMS 4-6-0 Class Five locomotive

Continued from February 18

by Martin Evans

BUILDERS of *Highlander* will recall that I dealt with practically the whole of the Walschaerts valve gear in the articles on November 1 and December 15. The only items I did not describe were the reversing arm, the cab reversing gear and the reach or reversing rod.

The reversing arm is quite a simple component, rather like the lifting arms, though the upper bearing is a single one, with the reach rod forked to embrace it. It can be cut from $\frac{3}{4}$ in. × $\frac{1}{2}$ in. b.m.s. As usual with such items, start by marking it out on the solid bar, drill and ream to finished size, then shape the outside.

As it is important that this arm should be a good fit on the weighshaft, which is $\frac{9}{16}$ in. dia. in its centre part, builders may prefer not to ream to finished size, but to bore it in the four-jaw chuck until it is a nice hand push fit on the shaft. If the arm is a good fit on the weighshaft, it is a much easier task to locate it at the correct angle for pinning; but should you find that it is a little slack, fit a small Allen grubscrew at right-angles to the hole drilled for the taper pin, as I described for the lifting arms.

Note that when the radius rods are in their central position, i.e., when the valve gear is in mid gear, the reversing arm does not stand up vertically, but at 14 deg. forward of the vertical. To turn the gear to full forward or full backward gear, the required movement of the reversing arm should be $29\frac{1}{4}$ deg. to either side of the central position, but before deciding on this exact angle for keeps, the motion should be gently turned and the actual clearance in the two full gear positions ascertained, to ensure that there is sufficient clearance between the die-blocks and the ends of the curved slots in the links.

Coming now to the cab reversing gear, I mentioned earlier that I preferred to fit the reversing stand direct to the mainframe, rather than use a built-up construction attached to the running board. It is most important that there should be no play or whip in either the reach rod or the stand, and as the stand in this design is bolted directly to the mainframe with no less than ten 2 BA bolts, and the reach rod has a proper central support, no one can say that there will be any weakness here! Incidentally, the central support is an essential fitting on the full-size engine. As the reach rod measures something like 8 ft long, it is of considerable weight, and with the section used, it would tend to sag in the middle, upsetting the setting of the gear, and causing unnecessary friction.

The reach rod is best made in three parts. The front section can then be cut from $\frac{5}{8}$ in. × $\frac{1}{2}$ in., if obtainable, otherwise from $\frac{5}{8}$ in. square b.m.s. The centre portion may be cut from $\frac{5}{8}$ in. × $\frac{1}{4}$ in. material, or the nearest wider available, and the rear part from $\frac{1}{2}$ in. × $\frac{1}{4}$ in. The three parts are then joined by lap joints, the last one inch or so of each end being reduced to $\frac{1}{8}$ in. thickness, a couple of iron rivets put through to hold things together, and the joints brazed.

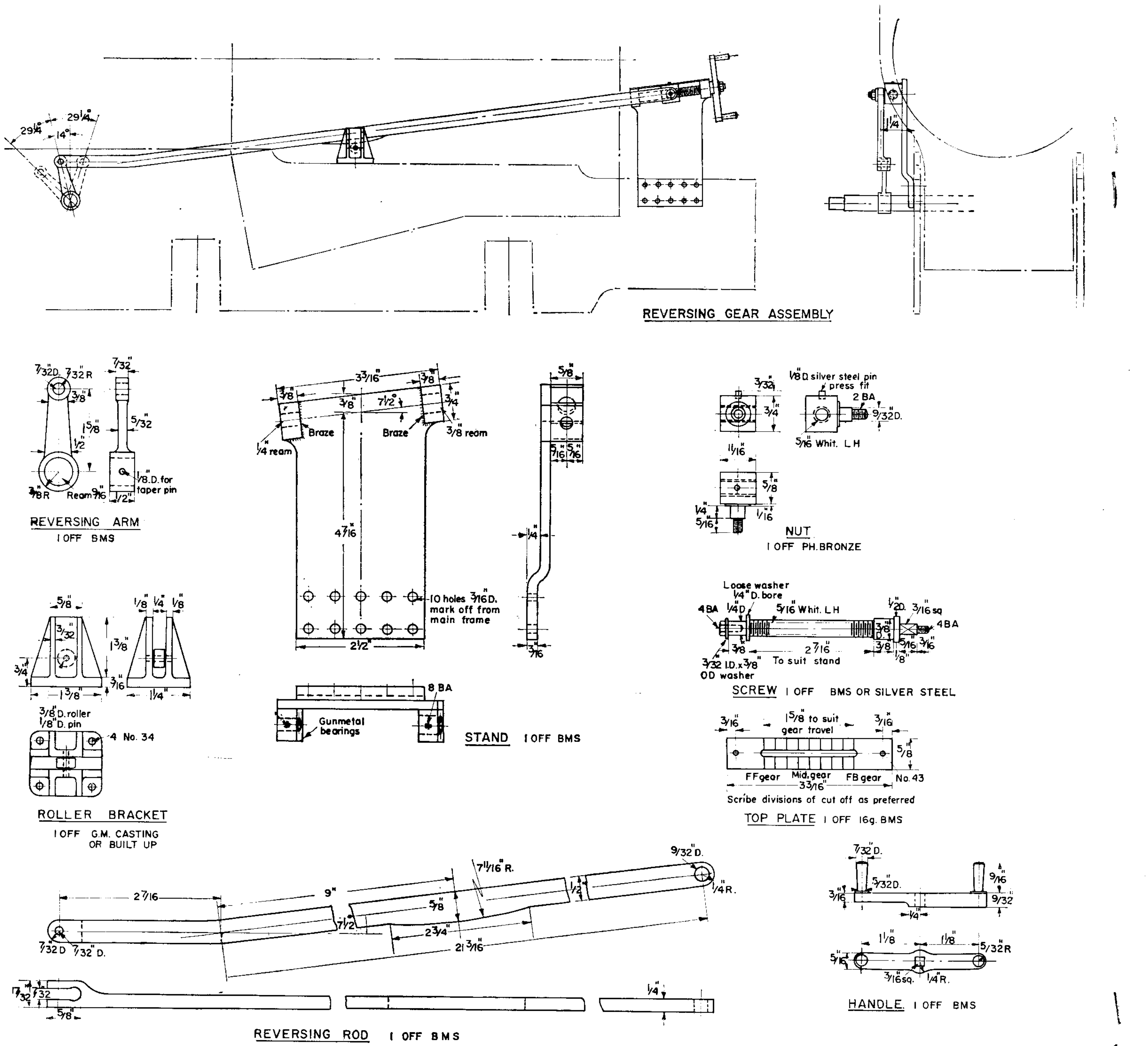
To make sure that the rod is made the required length, leave some excess material at the rear end, and do not mark out for the bearing pin on the reversing nut until the stand has been erected, and the desired length determined.

Readers will notice that the rear end of the reversing rod takes a bearing only on one side of the nut, whereas on the full-size engine, the rod is doubled at this point, embracing the whole of the reversing stand. This scheme may be open to criticism, but it will be noticed that the nut is very substantial. It is no less than $\frac{11}{16}$ in. long, and being made of drawn prosphor bronze it will not wear for a long time. In addition, the nut lies hard against the stand itself, so that any twisting effect set up by the valve gear and transmitted through the reach rod is eliminated.

The reason why I am specifying a single reach rod is simply one of clearances. The arrangement has enabled me to place the centre-line of the reversing screw nearer to the firebox, and thus to gain much needed room for the swing of the reversing handle next to the left-hand cab side—a point which may be appreciated by the driver later on!

For the stand we shall require b.m.s. plate $3\frac{1}{4}$ in wide × $\frac{3}{16}$ in. thick. Clamp the piece to the left-hand mainframe, and run the $\frac{3}{16}$ in. drill through the holes in the frame, making centres in the plate. After bending to the required offset, the top of the plate is cut at an angle of $7\frac{1}{2}$ deg. and the two bearings for the screw, which are cut from $\frac{5}{8}$ in. × $\frac{3}{8}$ in. drawn phosphor bronze, are brazed to the stand. The nut and the pin which carries the reach rod can be made from the solid: it is quite satisfactory to use a phosphor bronze pin working in a mild steel-case hardened rod, although it is the opposite way round to what we are accustomed to! In any case the pin is no less than $\frac{9}{32}$ in. dia., so it will be plenty strong enough for the job in hand.

The screw could be made from ordinary b.m.s. at a pinch, but silver steel, or a good quality tool steel would be better, and would give much longer service without attention. The thread should be $\frac{5}{16}$ in. Whitworth left-hand, to give a reasonably quick operation and to ensure that the nut is forward in the forward gear position.



I do not think I need say much about the handle. Although b.m.s. is specified on the drawing, stainless steel would be rather nice here. I find that mild steel fittings on the footplate go rusty very quickly.

Finally, we need the roller bracket, which takes the weight of the reach rod, and prevents any whipping. I hope that a casting will be available for this, but it could be built up by silver soldering a piece of $\frac{1}{2}$ in. thick gunmetal $1\frac{3}{8}$ in. wide, to a base of $\frac{3}{16}$ in. thick material, slotting right across with a large diameter $\frac{3}{32}$ in. slotting cutter, and then slotting again, $\frac{1}{4}$ in. wide, at right angles to the $\frac{3}{32}$ in. slots. The webs can be made from $\frac{3}{32}$ in. thick hard brass sheet, pressed into the slots and silver soldered.

The base of the roller bracket, if this is made from a casting, should be faced off in the lathe, or on the milling machine; but on no account fit the roller itself at this stage. The reason for this is that the roller bracket is bolted on top of the left-hand running board, and until this has been properly fitted, it is impossible to know quite how high the roller must lie in its bracket, to take the weight of the reach rod, without pushing it out of alignment.

As it is better to carry out valve setting after the roller bracket is in position, I propose to leave the description of this vital operation until later, and will now carry on with the final details of the chassis: the brake gear and the cylinder drain cock system.

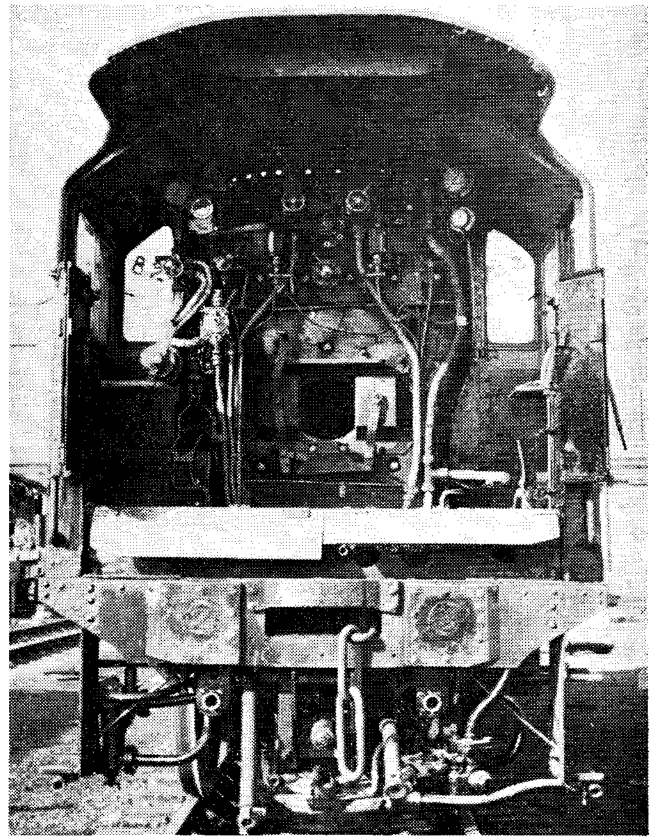
To deal with the latter first, the drain cock gear comprises four "plug-cock" drains, one to each end of each cylinder, operated by a simple system of rods and levers, in a similar manner to that used for my 5 in. gauge 4-6-0 *Springbok*.

Tapered plug cocks are sometimes thought to be rather a nuisance, but this is generally only true when they are used in steam fittings. When used as cylinder drain cocks, they are in a position where they receive adequate lubrication, so there is no reason why they should stick or seize up.

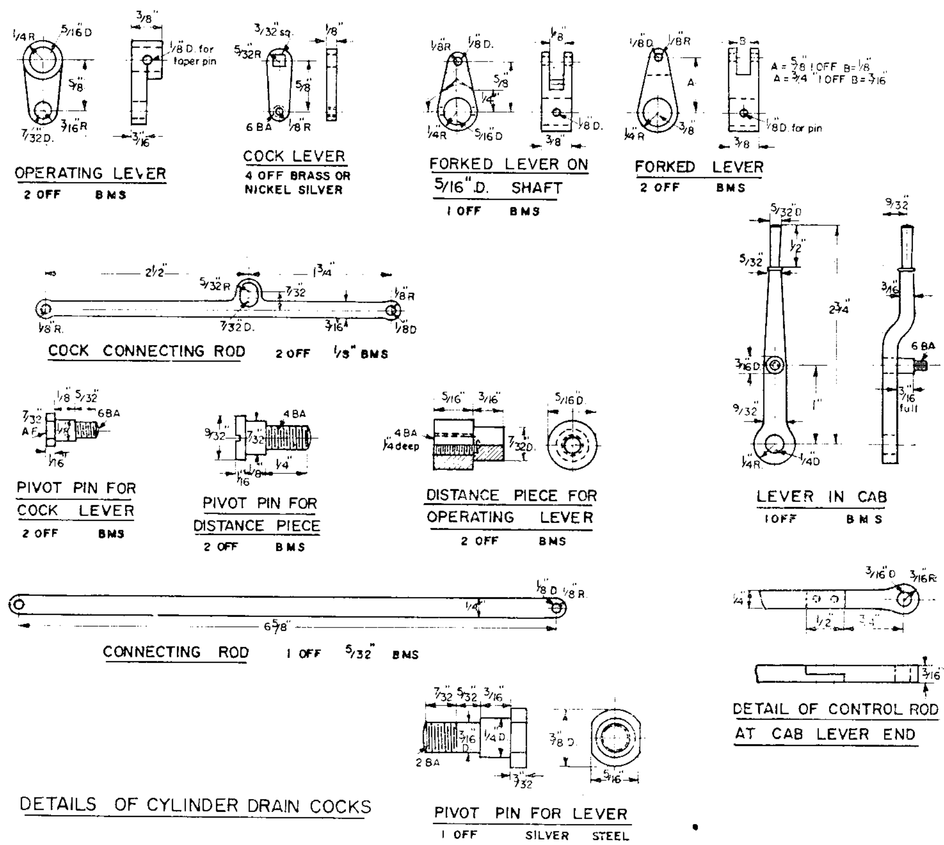
My drawing below shows the details of the various parts, while drawings showing the arangement of the control gear will be ready for my next article. Details of the drain cocks themselves were given on page 487, July 1, and the cock levers are fitted to the squared shank of the cocks by means of the square, plus soft solder. As the plug cock is in bronze and the lever in brass or nickel-silver, this method of fitting is perfectly sound. The lower ends of the cock levers are tapped 6 BA to take the steel pivot pins shown.

A straight "connecting rod" is used to couple the two cock levers, and this is made from $\frac{1}{8}$ in. b.m.s. The oval slot, approximately in the centre, allows for the angular movement of the operating levers, which are bored $\frac{5}{16}$ in. dia. for the cross-shaft, which itself lies just above the frame stretcher for the bogie, passing through its fixing flanges, as seen on page 74, January 21. As the operating levers cannot be placed immediately behind the connecting rod, (if they were, they would foul the cylinders) a distance piece is used, this being a steel turning, tapped 4 BA on its outside, to take the inner end of the distance piece-pivot pin. These details will become apparent when the assembly drawings are published.

To be continued.



Cab view of LMS class 5 4-6-0, reversing screw on left.

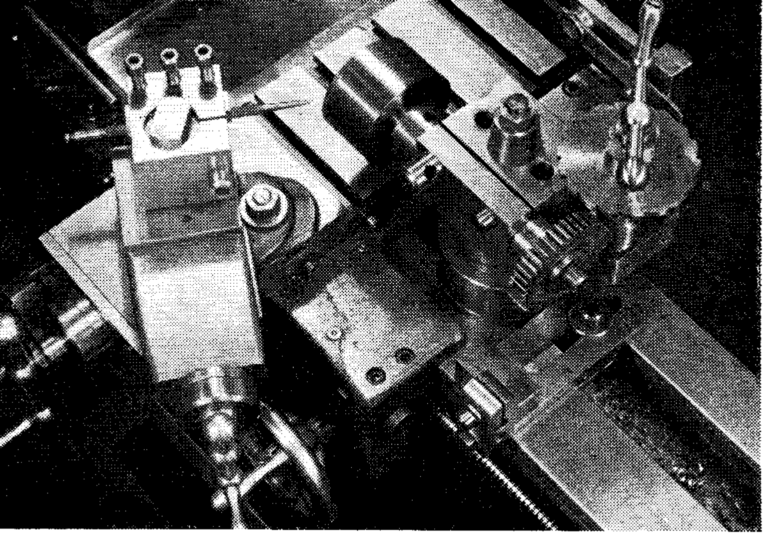


DETAILS OF CYLINDER DRAIN COCKS

Errata

On the drawing of the reversing rod, the diameter of the front forked end is given as $\frac{7}{32}$ in. This should, of course, read $\frac{7}{32}$ in. radius.

The square part of the end of the reversing screw, upon which the handle is fitted, is shown as $\frac{5}{16}$ in. long. This should be $\frac{1}{4}$ in. long, otherwise the nut, when tightened down, would not lock the handle in position. These corrections will be incorporated into the full-size drawings now in preparation.



Above: Fig. 22

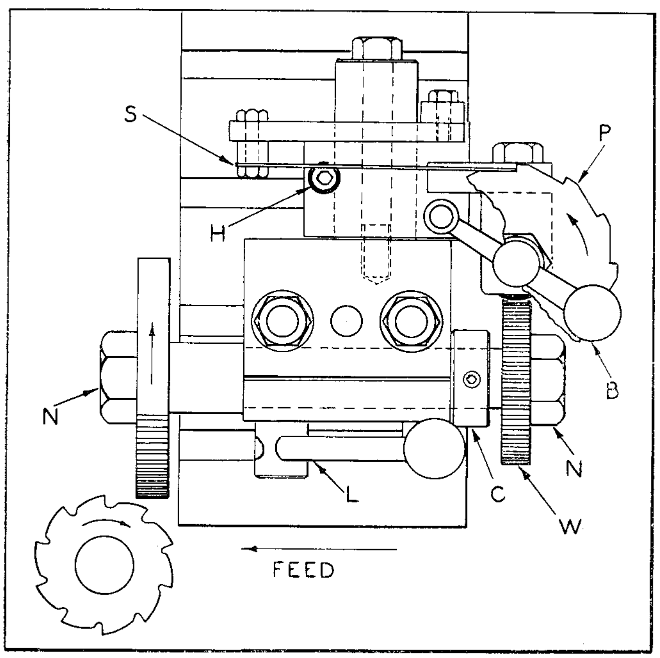
GEAR CUTTING AND INDEXING

Part Three

by Martin Cleeve

Continued from page 225

A TYPICAL worm-indexing set-up for cutting a gear is shown diagrammatically in Fig. 16. The blank and worm wheel *W* are each held to a suitable arbor by nuts *N*, but with the addition of a collar *C*, to eliminate end-play. Screw *H* locks the worm shaft holding assembly after adjusting the worm meshing with wheel *W*. The ball handle *B* is used to revolve the blank through one complete revolution as a check for smooth operation before commencing actual cutting. Indexing is done from plate *P* in conjunction with the spring index strip *S*, which is lifted by hand to allow *P* to advance in the direction indicated, and lowered as the appropriate notch approaches. As with direct indexing, the lever bolt *L* is released during indexing movements, and locked during cutting. It is most important to remember to release *L* before attempting to turn the index plate, otherwise an unnecessary strain is imposed upon the worm and its shaft holding assembly: a strain that could easily upset the accuracy of the remaining indexing. It is for similar reasons, too, that you should not make use of the self-locking properties of the worm to hold the arbor while you tighten or loosen nuts *N*. Lock the arbor by tightening *L*.



Left: Fig. 16

The index plates

The spring strip method of indexing on ordinary lathe change gears proved so simple and reliable that the ratchet type of index plate seemed to be a logical follow-up.

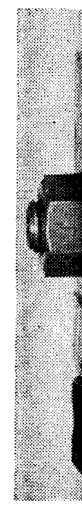
Amongst my plates I have 5, 6, 11, 18, 21, 22, 23, 24 and 25. The prime numbers, 5, 11 and 19 were made by direct indexing from lathe change gears. Primes 17, 23 and 29 were made by indexing directly from master plates of the bushing-and-disc type described on July 15 and 1 August, 1965. Remaining plates were made either by direct or worm indexing for convenience in subsequent direct indexing of those numbers. The photograph Fig. 17 shows my 23 master plate being used to make the more convenient ratchet-type plate.

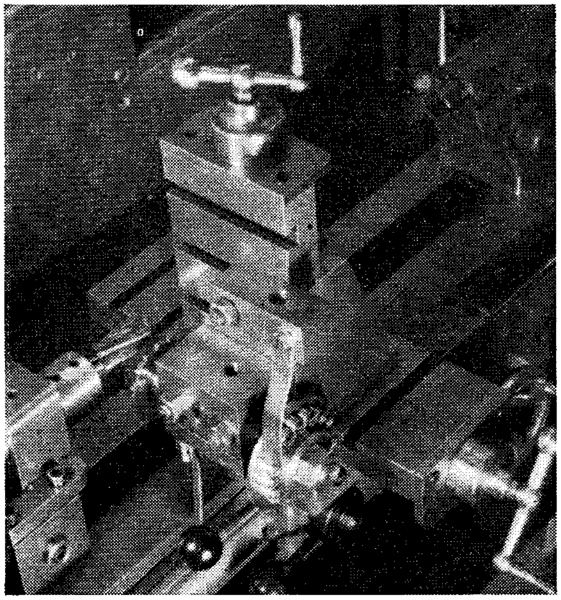
Indexing table

The indexing table Fig. 18 is a copy of my own which I keep in the workshop. It shows me at a glance whether or not I can index a certain number, perhaps for an experimental gear. You will see that, due to being able to mesh your worm with a variety of wheels, you can obtain some divisions that cannot be obtained from the standard type of index head without compound indexing. I might mention that compound indexing is a system where two rows of holes are used on one index plate, the plate being advanced or turned through so many spaces on one row, and then retarded, or again advanced, on another circle of holes. With a professional head it gives good results, but the chances of mistakes are very great.

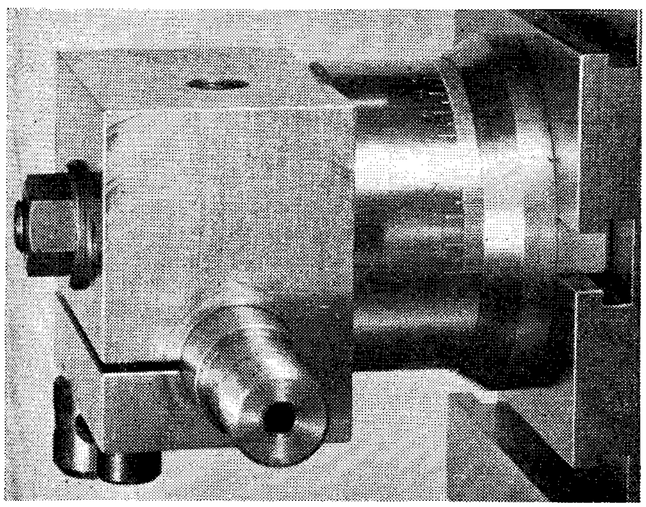
My own index head will also give other numbers of divisions without the necessity for large numbered primes, or for plates with an unduly large number of holes: for example I can index:

49 without a 49 plate
57 without compound indexing.
63 without compound indexing.
66 without a 66 plate.
69 without compound indexing.
77 without compound indexing.
78 without a 39 plate.
81 without compound indexing.
87 without compound indexing.
91 without compound indexing.
133 without compound indexing.



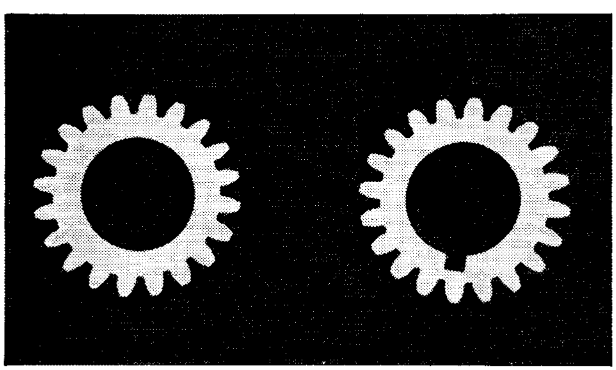


Above: Fig. 17



Above: Fig. 20

Below: Fig. 23



Spaces Required	Direct from Gear	Worm to	Index Turns	Alternative Worm to	Alternative Index Turns	Spaces Required	Direct from Gear	Worm to	Index Turns	Alternative Worm to	Alternative Index Turns	Spaces Required	Worm to	Index Turns	Alternative Worm to	Alternative Index Turns
7	70	35	5	(Pri	me)	56		40	5/7	40	15/21	105	35	2/6	40	8/21
8	40					57		38	4/6			106	40	20/53	(53 Pr	ime)
9	45					58		40	20/29	(29 Pr	ime)	107		(Pri	me)	
10	60					59		Pri	me			108		60	5/9	
11	55			(Pri	me)	60	60	40	4/6			109		(Pri	me)	
12	60					61		Pri	me			110	40	4/11		
13	65			(Pri	me)	62		40	20/31	(31 Pr	ime)	111	60	20/37	(37 Pr	ime)
14	70	35	2 3/6			63		35	5/9	35	10/18	112	40	5/14		
15	60					64		40	5/8			113		(Pri	me)	
16		40	2 3/6			65	65	40	8/13			114	38	2/6	60	10/19
17		Pri	me			66		55	5/6			115	40	8/23		
18		40	2 2/9			67		Pri	me			116	40	10/29	(29 Pr	ime)
19	38	Pri	me			68		40	10/17			117	45	5/13		
20	60					69		60	20/23			118	40	20/59	(59 Pr	ime)
21		35	1 4/6			70	70	40	4/7	40	12/21	119	35	5/17		
22		55	2 3/6	40	1 9/11	71		Pri	me			120	40	2/6		
23		Pri	me			72		40	8/9	40	16/18	121	55	5/11		
24		40	1 4/6			73		Pri	me			122	40	20/61	(61 Pr	ime)
25	50	40	1 3/5			74		40	20/37	(37 Pr	ime)	123	60	20/41	(41 Pr	ime)
26		65	2 3/6	40	1 7/13	75	75	40	8/15			124	40	10/31	(31 Pr	ime)
27		45	1 4/6			76		38	2/4	40	10/19	125	50	2/5	40	8/25
28		35	1 1/4	70	2 3/6	77		55	5/7	35	5/11	126	35	5/18		
29	58	Pr	ime			78		65	5/6	40	20/39	127		Pri	me	
30	60	40	1 2/6			79		Pri	me			128	40	5/16		
31		Pri	me			80		40	3/6			129	60	20/43	(43 Pr	ime)
32		40	1 1/4			81		45	5/9			130	40	4/13		
33		55	1 4/6			82		40	20/41	(41 Pr	ime)	131		Pri	me	
34		40	1 3/17			83		Pri	me			132	60	5/11	55	5/12
35	70	40	1 1/7	40	1 3/21	84		40	10/21			133	38	2/7	35	5/19
36		40	1 1/9	40	1 2/18	85		40	8/17			134	40	20/67	(67 Pr	ime)
37		Pri	me			86		40	20/43	(43 Pr	ime)	135	45	2/6	40	8/27
38	38	40	1 1/19			87		60	20/29	(29 Pr	ime)	136	40	5/17		
39		65	1 4/6			88		40	5/11			137		Pri	me	
40	40	35	7/8			89		Pri	me			138	60	10/23		
41		Pri	me			90		45	3/6	40	4/9	139		Pri	me	
42		40	20/21	35	5/6	91		35	5/13			140	40	2/7	40	6/21
43		Pri	me			92		40	10/23			141	45	15/47	(47 Pr	ime)
44		55	1 1/4	40	10/11	93		60	20/31	(31 Pr	ime)	142	40	20/71	(71 Pr	ime)
45	45	40	8/9			94		40	20/47	(47 Pr	ime)	143		Pri	me	
46		40	20/23	(23 Pr	ime)	95		38	2/5	40	8/19	144	40	5/18		
47		Pri	me			96		60	5/8	40	5/12	145	40	8/29	(29 Pr	ime)
43		40	5/6			97		Pri	me			146	40	20/73	(73 Pr	ime)
49		35	5/7	35	15/21	98		35	5/14	40	20/49	147	35	5/21		
50	50	40	4/5			99		55	5/9	45	5/11	148	40	10/37	(37 Pr	ime)
51		Pri	me			100		40	2/5			149		Pri	me	
52		65	1 1/4	40	10/13	101		Pri	me			150	40	4/15		
53		Pri	me			102		60	10/17							
54		45	5/6	40	20/27	103		Pri	me			360	40	1/9	45	1/8
55	55	40	8/11			104		40	5/13							

FIG. 18. CHART FOR USE WITH INDEX HEAD AS DESCRIBED IN THE TEXT

FIG. 19. CHART OF INDEX PLATES

A LIST OF SPACES OR DIVISIONS OBTAINABLE FROM PLATES UP TO 23 HOLES, TEETH OR NOTCHES, IN TERMS OF MINIMUM NUMBERS.

DIVISIONS OBTAINABLE / PLATES	4	5	6	7	8	9	11	13	14	15	16	17	18	19	21	23
	28	25	14	35	40	18	22	65	98	75	128	34	126	38	84	46
	32	50	16	49	64	36	55	91	112	150		68	144	76	147	69
	44	95	21	56	96	45	88	104				85		95		92
	52	100	22	70		63	110	117				102		114		115
	76	125	24	77		72	121	130				119		133		138
			26	133		81	132					136				
			27	140		99										
			30			108										
			33			360										
			6E													
			42													
			48													
			54													
			57													
			60													
			66													
			78													
			80													
			90													
			105													
			114													
			120													
			135													

ALL PLATES CAN BE OBTAINED DIRECTLY FROM CHANGE GEARS UP TO 65 TEETH, EXCEPT:

Plate Div.	How obtained	Remarks
14	By Worm Index	See Table A
16	By Worm Index	See Table A
17	Requires a Master	
18	By Worm Index	See Table A
19	From 38t. or Master 19	
21	By Worm Index	See Table A
23	Requires a Master	

Summary of index plates

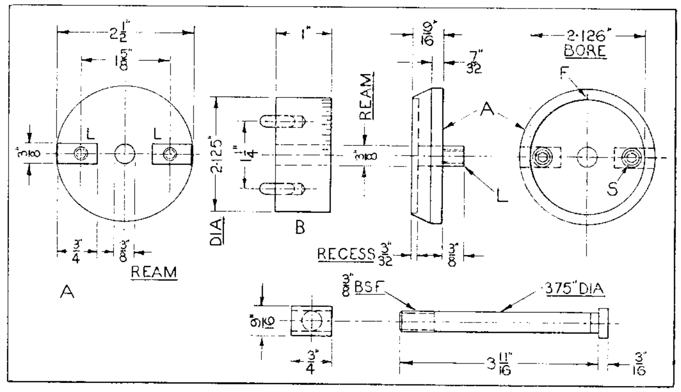
The chart Fig. 19 will assist in the selection of a range of index plates. It is not necessary to make all the plates shown, but in deciding how many plates to prepare, a balance may be struck between the minimised risk of error when using a plate with the least possible number of spaces, and the convenience of making a lesser number of plates each containing multiples of minimum required notches, or holes. Thus for instance, the one 16 plate would cover the divisions obtainable under the 4 and 8 columns, similarly, the 15 would cover the 5 column, and the 18 the 6 and 9 column.

I considered a 3 division plate not worth making, accordingly, in Fig. 18, where fractions of a turn are required in thirds they are shown as 4/6 instead of 2/3.

You will also see that there are some numbers (above 13) that you cannot obtain from the index head, either by direct indexing from a lathe change gear, or by worm indexing. These are the PRIME numbers, so unless you have the prime itself, or a multiple of it, you will have to make it up, although it is unlikely that you will require a prime in excess of 29.

Requirements for cutting bevel gears

So far, starting with a simple block of metal, we have seen how it can be converted into quite a versatile indexing head for cutting ordinary spur gears, or for graduating. For cutting bevel gears we must be able to tilt the head to various angles, and we need some means of bringing the mounting block away from the vertical slide to a sufficient distance to give clearance for the largest bevel gear likely to be cut, and for the largest lathe change gear likely to be used if you are directly indexing the wormshaft.



Above: Fig. 21

Fig. 20 shows how these needs can be met. Neglecting the Tee bolt, there are two main components: the graduated barrel, *B*, and the recessed backplate, *A*. As the backplate has to carry the fiducial line, means of always locating in the same position on the vertical slide have to be provided. This was achieved by fixing two short lengths of ⅜ in. square section mild steel, a close fit between the Tee slot lips. The pieces, *L*, Fig. 21, are each held by one ¼ in. BSF hexagon socket head cap screw, *S*, the heads being countersunk in the backplate from its front side.

Make the barrel from a 1 in. length of 2½ in. dia. mild steel. This should be faced so that both sides are parallel, and the hole reamed ⅜ in. to give a good fit to the Tee bolt, which should be specially made for the attachment.

On assembly, the recess in the backplate *A* also accommodates a fibre disc. This is placed between *A* and *B* to ensure a good frictional grip, and is an important addition, since without the fibre you would not be able to tighten the Tee nut sufficiently to prevent movement under the pressure of tooth cutting.

The outside diameter of the barrel *B* is best finished whilst mounted upon an arbor similar to that shown at *B*, Fig. 9—the whole will then be ready for mounting directly in the index head for degrees graduating. The drilling for and fitting of the dowel pins may be carried out after graduating.

A photograph of the set-up used to graduate the barrel may be seen at Fig. 22. The indexing arbor mounting block is used horizontally, and packed up by distance pieces with the axis of the arbor at lathe centre height. The whole is held to the lathe bed by one extra long bolt and nut and a stout plate which grips the underside of the lathe bed-ways,

Graduation lines are formed by a scriber in an adjustable height lathe toolpost. Scribing pressure is applied by advancing the cross-slide, and to ensure a uniform depth, the feed handle is provided with a stop. Lines are formed by traversing the saddle, and the lengths of the lines are decided by left and right-hand saddle stops. For a light operation such as this, the arbor is not locked between indexing movements, but the bearing split is adjusted to give a permanent slight drag.

On completion of degrees graduating and number stamping, the dowel pins may be fitted by drilling each component from a simple jig plate; then the whole may be assembled on the vertical slide, and, by referring the underside of the arbor mounting block to parallel packing resting on the bed-ways, the fiducial or zero line may be marked upon the bevel of the backplate. This operation is best carried out by arranging some form of clamp for a short piece of bright mild steel to act as a guide for the scriber which, in this case, is used by hand. When you have checked that your straight edge is dead in line with the first graduation line on the barrel, you can remove the barrel and then scribe the line.

Gear cutters

Although it is nice to have professionally-made gear cutters, they are rather expensive, and you can do a lot of useful work with fly-cutters made from high speed lathe toolbits. For instance, the stack of small gears at the rear centre of the photograph, Fig. 10, and the spoked gear in the foreground are similar to Meccano gears which are of approximately No 40 DP. and they were all cut with only one single pointed fly-cutter ground to an included angle of 47½ deg.—taken from the BA notch on a thread tool gauge. After grinding and getting both sides as symmetrical as possible, the point was given a radius of about 1/100 in.—which, for practical purposes, means slightly blunted with a slipstone.

Gears having larger teeth, such as Myford lathe change gears which are of No 20 DP, call for modified treatment if you are without professional cutters. If you examine the teeth of these gears you will see that whereas the 70 or 75 have nearly straight sided teeth, as you come down towards the 20 tooth gear, the profile of the teeth shows an increasing degree of curvature. Since it is very difficult to free-hand grind the curved profile, I devised a double-ended fly cutter which will produce a compromise profile by clearing away all metal that might interfere with proper meshing, but gives a tooth shape more nearly approaching that obtainable from a standard cutter. My photographer produced the shadow picture, Fig. 23, which gives an overall comparison between a Myford 20 tooth change gear (with keyway) and one of my gears made with the double-ended cutter, details of which are given in Fig. 25.

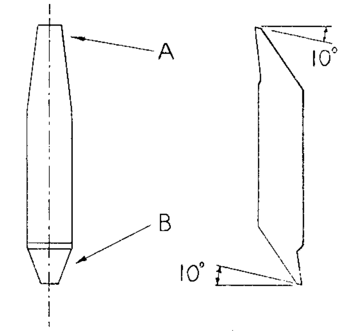
End *A* of the cutter produces the shaped space below the pitch line, *P*, (Fig. 24) and end *B* cuts the chamfered portion above the pitch line. As the number of teeth in a gear increases, so the chamfer angle at *B* becomes progressively less pronounced.

I have compiled a table that can be used in conjunction with Fig. 25. The following angles will give a reasonably close approximation to true tooth shape, and will serve for gears of about No 20 DP where the rotational speeds are on the low side, or until such time as regular commercial cutters can be obtained.

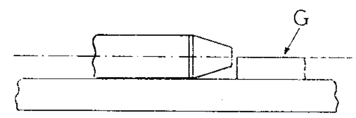
Number of teeth in gear.	Included angle of end *A*.	Included angle of end *B*
20 to 25	16 deg.	60 deg.
26 to 35	18 deg.	55 deg.
36 to 45	22 deg.	50 deg.
46 to 58	25 deg.	40 deg.
59 to rack.	Use a single ended cutter having an included angle of 29 degrees.	

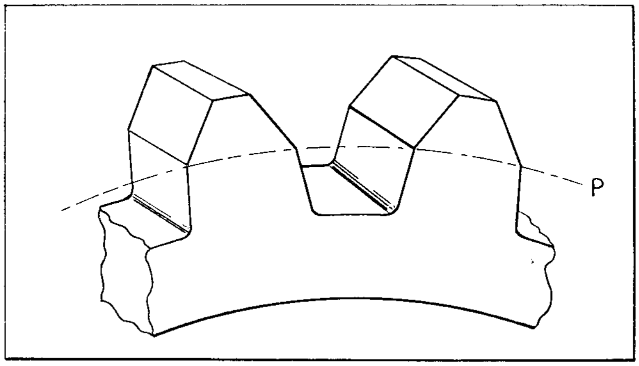
Some time ago, when my son was interested in a home construction kit, I wanted some bevel gears, but I found them rather expensive, so I put my attachment to good use and made some.

Top right:
Fig. 25



Below:
Fig. 24



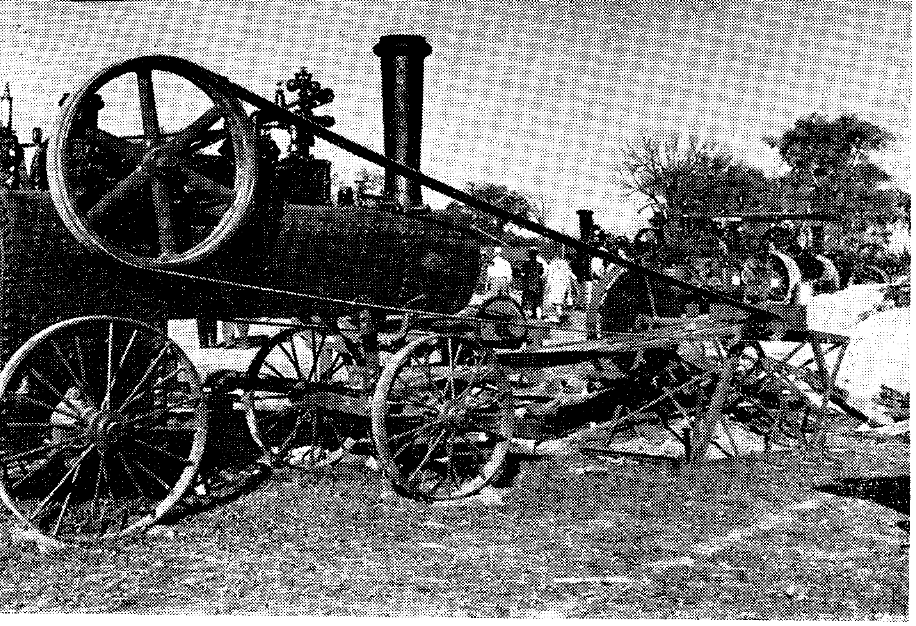


The procedure was as follows: Machine two steel (or brass) blanks in accordance with the instructions detailed in Fig. 26. At *A* you turn the largest diameter. You angle off at *B*, using the top slide set at 47 deg., and machine until the face width is 5/32 in. At *C* you form a recess, 3/32 in. deep and of a diameter that will just meet the inner boundary line of the bevel. *D* shows how you can neck down to form a boss, and indicates a centre-drilling from the tailstock. At *E* you chamfer off the back of the blank, taking care not to lose the 55/64 in. whole diameter first turned. You can also drill and ream, say 5/32 in., or, if you are going to use the gears in conjunction with Meccano, you should drill first No 23, then No 21. At *F*, of course, you part off. The parted side of the blank should be dead square by the bore: this is easily achieved by taking a light skim while the blank is mounted, by light force fitting over a short freshly turned spigot, held in the three-jaw chuck.

The blanks will be of a size suitable to cut 25 teeth in each, and you can index directly from a 50 tooth lathe change gear, taking two teeth at a time. You can mount the blank on an arbor similar to that shown at *D*, Fig. 9. Fig. 27 shows you the angle at which to tilt the arbor mounting block, and how the depth of the cut, *D*, is set by referring the point of the cutter *C*, in its highest position, to the corner edge *P* of the bevel blank, where the diameter is greatest. In this case, using a tool ground with an included angle of 47½ deg. and a point radius not exceeding 1/64 in. you can use the vertical slide to set *D* to 0.059 in. Fig. 27 was purposely drawn in an exaggerated way in order to show you how the depth of the tooth space increases from back to front. The cross-sectional size of the teeth also increases uniformly in a similar way.

After cutting the first two spaces you can examine the

Continued on page 276



CANADA'S STEAM TRACTORS

by Harry McDougall

THE STEAM traction engine, once such a familiar part of the Canadian landscape, has now been completely out-moded by the smaller, more compact, docile and efficient gasoline engine. Nevertheless, the Canadian farmer well remembers that it was the lineal descendants of James Watt's brain-child which first removed the sweat from his brow and turned farming from a work of crude labour into a modern mechanised industry.

If he is old enough to remember the pre-war years, the sight of a steam tractor lumbering across a field or standing in the sunshine, swaying rhythmically as if rocked by a gentle breeze, its flywheel driving a long belt which in turn drives a thresher, inevitably gives him acute nostalgia. And since nostalgia is one of the more pleasant forms of human emotion, Canadian farmers and their mechanically-minded sons—and many others who are intrigued by mechanisms that are now truly antiques—are keeping the steam engine very much alive.

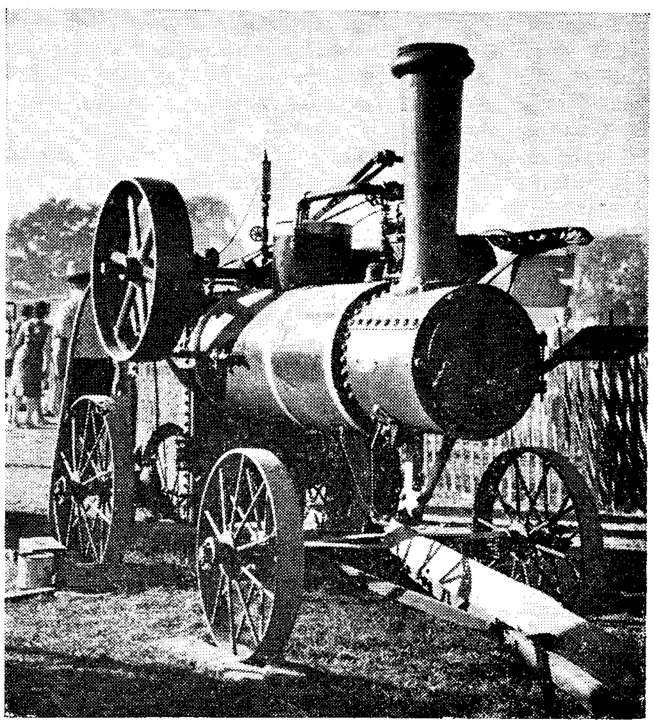
In barns and sheds throughout the country, literally hundreds of steam tractors, some little more than rusting relics, have been restored to all their former glory. Very few have yet found their way into museums; instead, they are treated as living organisms. They are operated at frequent intervals, lubricated, serviced and tended with care, as befits one of man's happiest inventions—for the steam engine is almost unique in that throughout the more than a century that it was used, it rarely lent itself to other than peaceful work.

The heyday of the steam tractor in Canada was from 1910 to 1930, after which wood and water could no longer withstand the onslaught of volatile fuels and the spark plug, but it is the very early days which are remembered with most affection. At the annual meets of Canadian Antique Steam Associations, tractors of the 1920's predominate—but there are usually a few of the real old-timers dating from the turn of the century.

One such engine is owned by Bill Johnson and bears a marked resemblance to *Puffing Billy*. It dates from 1899 and is one of the very early engines which were used only for threshing. Another old-timer, one of the oldest true traction engines in Canada, is owned by Gordon Smith, President of the Ontario Steam and Antique Association. It dates from 1898 and after more than 60 years of service still looks good for another 60 years.

A few years ago it was sometimes possible to discover an ancient and neglected relic of the age of steam at the back of some abandoned barn. No more! There is now so much interest in the hobby of restoring steam tractors that the chances of locating such an engine are almost nil. Virtually all the machines which languished for years at the back of barns, abandoned to rest in idleness, have now been brought back into the light of day and renovated. The steam traction fan wishing to indulge the hobby usually does so by buying some machine which has already been partially or wholly restored by some other enthusiasts.

The only remaining sources of true antique are the back-woods sawmills of Canada. Occasionally they yield some survivor of the last century still driving the huge circular saws which are needed to reduce giant Canadian trees to more manageable proportions.



These engines are a family in themselves, survivors of the many hundreds which were at one time used in semi-permanent installations, and were drawn by horses to each new work-camp as logging operations penetrated deeper into the forests. In their day they were regarded as portable engines. Two of this type, Case engines built in 1910, are owned by Vince Riddell who is still able to hook them up to a saw and make short work of modest size logs. According to the maker's plate, they each develop 18 h.p., but such are the vagaries of methods of measurement that they are only considered to develop 6 h.p. by present day standards.

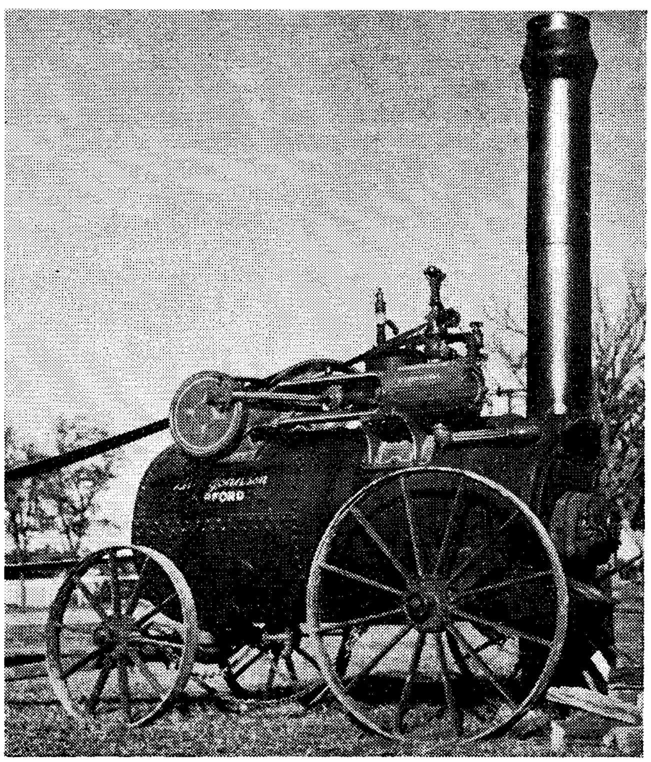
Although farmers still form the core of the hobby, some younger men are beginning to take an interest. Earl Carpenter had accumulated a collection of antique cars including a Grant, a Jewett, a Durant and a Hupmobile, when he decided to branch out into something a little more virile. From Bill Johnson, who already owns several steam tractors, he purchased his first, a machine built in 1923 by John Goodison of Sarnia, Ontario. Because it was originally used primarily to drive a sawmill, the wheels and drive mechanism are in almost mint condition.

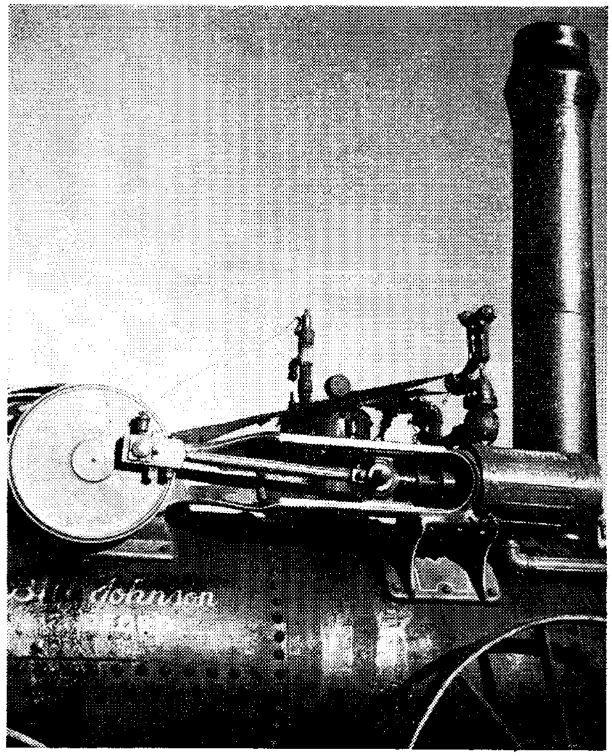
Left above: *Vince Riddell's Case engine can still do a good day's work.*

Left below: *A real old-timer, this Case engine was used in the forests of Northern Canada.*

Right above: *A close-up of Bill Johnson's engine, showing its excellent condition.*

Below: *Bill Johnson's steam tractor bears a striking resemblance to "Puffing Billy."*





The principal problem faced by the steam traction fan is one of transportation. Tractors are not allowed on the highway unless they ride on rubber—and older types invariably rolled on steel rims fitted with lugs which enabled them to traverse fields with ease but are ruinous to asphalt roads! Moreover, even when a tractor is fitted with rubber treads, as are some of the lighter types, the police do not take kindly to having the speed of traffic on the highways reduced to the slow lumbering gait of the steam tractor.

Solution to the problem? Transport the tractor on the back of a lorry—or in the case of the big ones, a float of the type normally used to carry earth-moving equipment. It is a measure of the enthusiasm of many devotees of the hobby that they will pay the not inconsiderable cost of having their steam-powered pride-and-joy carried thus, sometimes for hundreds of miles, to attend an annual meet.

Loading a tractor on to the back of a float is a task which, in itself, is a good test not only of the controllability of the machine, but also of the skill of the driver—and skill in manoeuvring steam powered machines comes only from practice.

I recently watched a young and enthusiastic driver trying to load a massive steam roller that was obviously built long before he was born, on to the back of a float. He had to drive it up an inclined ramp made from packed earth and stones. Three times he got it part way up before changing his mind, either through lack of power or because it was not positioned quite right to go over the edge of the ramp and on to the float. Finally, a weatherbeaten farmer, old enough to be his grandfather, climbed aboard, took the controls and made it the first time in a clean smooth run, up and over, that positioned the juggernaut neatly on the back of the float ready to be anchored in position for the journey home. Manoeuvring an oldtime steam roller is not a task to be learned easily—and if one was accidentally overturned the result could be disastrous. Perhaps oldtime machines have an affinity for oldtime drivers!

To be continued.

W. L. Barton built two large models of the GOLDEN HIND

Photographs by courtesy of the Daily Mail

DURING the last 40 years I have made many models. For financial reasons I gave up making model aeroplanes in 1937, because elastic was not realistic enough and at that time aero engines were dear and very temperamental.

Why I decided to build a model of the *Golden Hind* no one knows. I have no patience for ornamental models and the size must be worth while, so having bought some blue-prints from Bassett-Lowke, I began to redraw them three times larger: I soon came across difficulty in curvatures, for this was to be a working model.

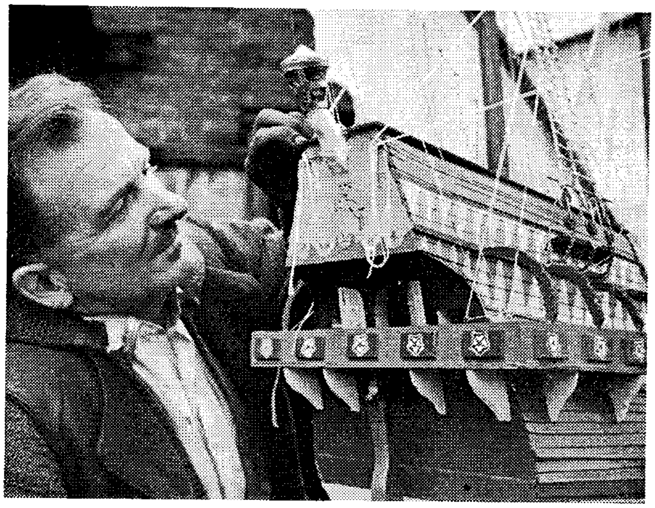
After two months' work the plans were redrawn and I was ready to begin work. I laid the keel down with 24 bulkheads, 12 each side, then instead of planking her with tiny $\frac{1}{16}$ in. hand-cut plywood planks, I pasted brown paper over her and heavily painted her for testing purposes. The inevitable happened; she turned completely over!

I then began working out displacement problems, and after many weeks and two more tests the waterline was almost right (important for the rake of the masts). Then began the task of making each plank to fit just where required. The middle part of the ship was not so bad, but bows and stern templates had to be made for each plank to fit correctly.

She took four years to build during the war starting about 1940. She proved a great attraction and was used in War Weapons Weeks, but was accidently damaged beyond repair in 1945.

As my family grew up, my boy, when about 12 years old, seeing some of the old pictures of my *Golden Hind*, began to ask for another model to be made. Not until three years ago was work started, and the new ship was finished and launched on July 24, last year.

Everything went off perfectly and she sailed beautifully and, as I was told by a sailor friend, to perfection. A



Church of England Minister, who had watched her being built, held a launching service over her, remembering the sailors of today, as well as those of long ago. Unfortunately, I had sent her out fully rigged, and after sailing for about one-and-a-half hours she was caught by an adverse wind, and as there was no crew on board to release the ropes, she was slowly blown over on her side where she lay for about ten minutes before disappearing below the water. This was a wonderful sight!

This event was wrongly reported in the Press: it was claimed that my ship had sunk immediately after launching. This was not true, as photographs showed. She was launched in weather such that less than half her sail area was necessary.

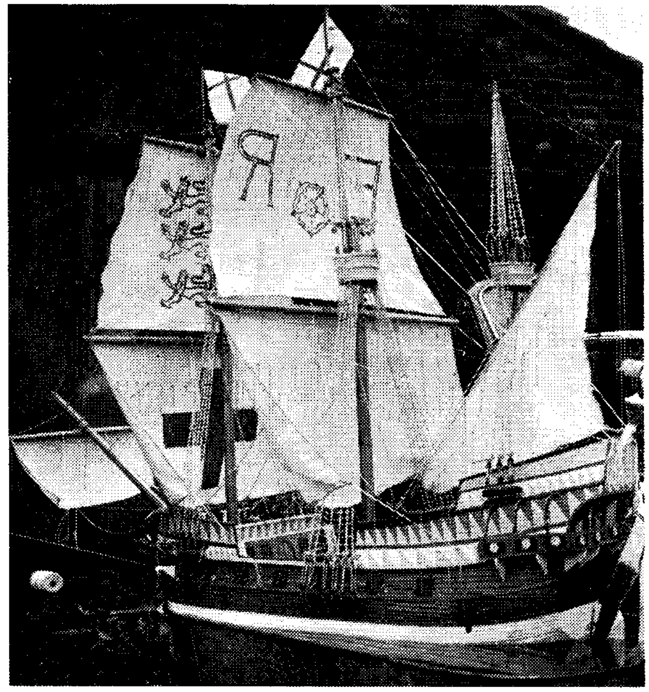
Granada T.V. came over to film her, and on this day, in worse conditions than ever, she sailed beautifully.

Briefly, all one has to do to build such a model is to buy a good set of drawings, gather together every possible bit of information, then draw out the plans three times larger. Of course, everything on her must work properly; nothing must be dummy. About 90 lb. of lead is required in the keel which, as the pictures show, bring her to about 1 in. down below her correct water-line.

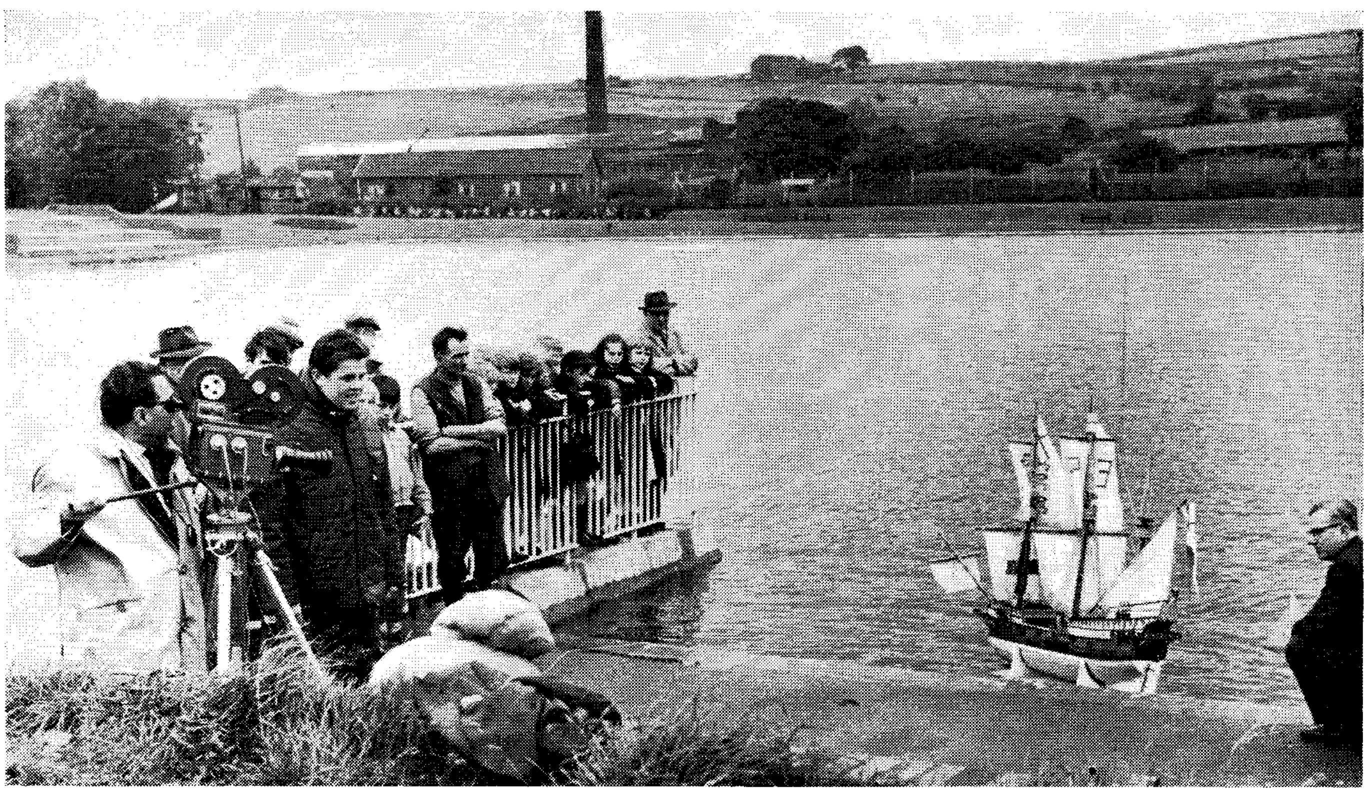
The Golden Hind, as readers will know, was first a merchantship named *The Pelican.* She was refitted with captain's stern walk and cannons, and according to our English halfpenny she had three fighting tops. After these, and possibly other alterations, she was renamed *Golden Hind.* Such ships must have been death traps, and the sailors of those days men of iron.

Seamen of the day were hung on their own riggings in rough seas. There are records of whole fleets being harbour-bound for as many as 53 days, bcause of the weather. If they were already at sea, they were sometimes blown hundreds of miles off course. It is recorded that an average of 15 cargo ships were lost without trace, together with 600 men, every year.

I am at present working on *Doris*, a $3\frac{1}{2}$ in. gauge LMS 4-6-0 locomotive, to instructions in ME. ▣



Top right: *A port side view of the model* GOLDEN HIND.



Below: *Filming the launching of the model.*

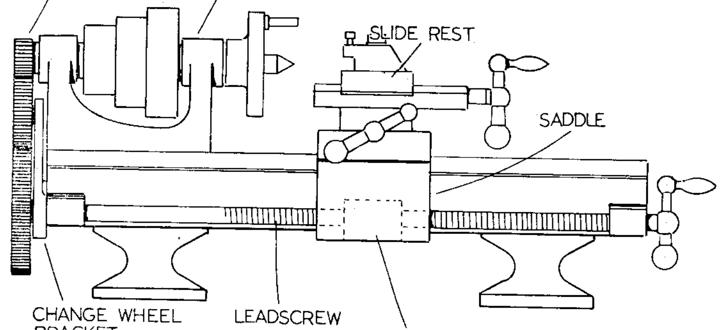


Fig. 41

FOR THE SCHOOLS

SCREW THREADS

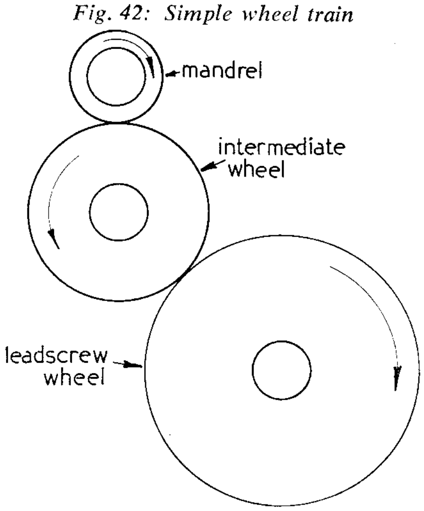
PART FIVE — SCREWCUTTING IN THE LATHE

BY DUPLEX

As has been explained earlier in this series of articles, screw threads are formed both by hand and machine methods so it is this latter aspect of the matter to which we shall now turn. Screws may be produced by a variety of machine methods, but the lathe is, of course, the original machine tool for the purpose and it still has, perhaps, the greater versatility in this respect, In any case it is the first machine tool that the novice will use for thread production, so some consideration must be given to the function of the lathe in this context.

The simple lathe, as most readers will know, consists of a bed upon which are mounted firstly, the headstock comprising a pair of bearings supporting a mandrel to carry the work. Secondly, a moving carriage or saddle to hold the lathe tool itself with the assistance of a compound slide rest. The saddle is moved along the lathe bed by means of a screw called the leadscrew. This screw usually runs the full length of the lathe bed and is sometimes operated by a hand wheel. All these elements are seen in the illustration, Fig. 41.

Fig. 42: Simple wheel train



Lathe leadscrews normally have pitches or leads of ½ in., ¼ in. and ⅛ in. that is 2, 4 and 8 threads to the inch resepctively, but it is the latter that is supplied with majority of light lathes most likely to be encountered by the newcomer. Whilst the main purpose of the leadscrew is to move the slide rest along the work, a little thought will show that, if instead of turning it by hand, we couple the mandrel to the leadscrew by means of gearing, then the progress of the slide rest along the bed of the lathe, apart from being automatic, will be directly proportional to the pitch of the screw and the ratio of the gearing. If we consider this in relation to a leadscrew of ⅛ in. pitch or 8 t.p.i. it will be clear that by gearing the mandrel to the screw in the ratio 1 : 1 the saddle will move along the work for a distance of ⅛ in. for each revolution of the mandrel and will produce a thread 8 turns to the inch on any work mounted on the mandrel. Similarly an alteration to the ratio of the gearing will produce a corresponding alteration in the pitch of the thread produced.

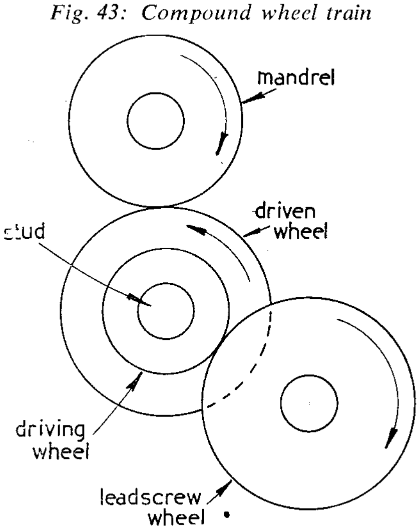
For example, an alteration to the gearing in the ratio 1 : 3 will produce a thread of 24 turns to the inch. In order to effect the coupling we are considering, lathes are provided with sets of gears designed to be mounted on the end of the mandrel and leadscrews respectively. An additional gear, mounted on an adjustable stud fixed to a bracket called the change wheel bracket, is placed between the mandrel and leadscrew gears so that they may all drive together. The use of this additional gear has no effect on the ratio of the two other gears.

For the most part lathes are provided with tables showing the change wheel combination for any given thread pitch; there would therefore seem to be little need to work out these wheel trains. Nevertheless, it may sometimes happen that a thread is required having a pitch not covered by the tables, so a knowledge of the method used to calculate gear trains may be useful.

Suppose then that we wish to cut a thread of 26 t.p.i. on a piece of work. The ratio of the change wheels will be as 8 : 26 or as 80 : 260 when the leadscrew has 8 threads to the inch. Divide the last two figures by 4 giving two wheels of 20 teeth and 65 teeth respectively; the first wheel to be mounted on the end of the mandrel and the second on the leadscrew. Such a train of gears is known as a simple train and is seen in the illustration, Fig. 42.

A full set of change wheels commences with a 20 tooth wheel and the number of teeth in the wheels increases by increments of five to a total of 100. In addition there are sometimes included some special wheels such as a 38 tooth wheel. With such a range of wheels a large number of pitches can be dealt with using a simple train. The majority of light lathes, however, are

Fig. 43: Compound wheel train



only supplied with wheels from 20 to 65. It follows then that a number of pitches can only be cut using what is known as a compound train.

The compound train

This train consists of four wheels, the first mounted on the mandrel, two coupled together on a stud attached to the change wheel bracket, and the fourth secured to the leadscrew as seen in Fig. 43. As an example of a thread pitch needing a compound train to satisfy it, let us suppose that a screw of 25 t.p.i. is to be cut. The ratio of this pitch to our leadscrew of 8 t.p.i. is as 8 : 25. If we had the wheels this ratio could be satisfied by a simple train; but there will certainly be no wheel having only 8 teeth though one having 25 teeth would be in the range supplied.

In order, then, to find a wheel train that would suit we could try multiplying both halves of the 8 : 25 ratio by five. This would give us a 40 tooth wheel suitable for the mandrel, but we should also have to find a 125 tooth wheel for the leadscrew, again a size not supplied as standard. Recourse must therefore be had to a compound train, the combination being arrived at in this way:

The ratio $\frac{8}{25}$ is factorised to give $\frac{4 \times 2}{5 \times 5}$

and then both halves of the fraction are multiplied by 10. From this we get: $\frac{40 \times 20}{50 \times 50}$ These are the wheels to be used in the combination, those on the numerator being the drivers whilst those on the denominator are driven. They are arranged in the following order: the 40 tooth wheel is attached to the mandrel, the 20 and 50 tooth wheel are coupled together on the stud and the second 50 tooth wheel secured to the leadscrew. The mandrel gear (40 teeth) drives the stud gear (50 teeth), and its coupled gear (20 teeth) drives the leadscrew gear (50 teeth).

If, as is most likely, there is only one 50 tooth wheel in the set the first pair of wheels in the train may be reduced to 20 and 25 without upsetting the gear ratio. The wheel train may then be written down graphically as follows:

Mandrel	*Stud*	*Leadscrew*
20	25	
	20	50

The gear train may be proved in the following way:

$$\text{Threads per inch to be cut} = \frac{\text{Driven wheels multiplied together}}{\text{Driving wheels multiplied together.}} \times \text{Pitch of leadscrew expressed in t.p.i.}$$

For example:

$$\frac{25 \times 50 \text{ The driven wheels}}{20 \times 20 \text{ The driving wheels}} \times 8$$

$$= \frac{1250}{400} \times 8$$

$$= 3.125 \times 8 = 25 \text{ t.p.i.}$$

It is always advisable to make this check to avoid spoilt work resulting from an error in calculation.

The Hendey Norton change gearbox

It will be appreciated that setting up a train of wheels for screwcutting is not a rapid operation. For this reason most modern lathe manufacturers can supply a gearbox that enables the gear ratio to be changed in a fraction of the time taken to set up wheels on the change wheel bracket and make sure that they are meshing correctly.

The system employed, and illustrated in Fig. 44, was invented by a Mr Norton in America about the year 1892. The arrangement consists essentially of a box bolted to the headstock end of the lathe bed casting, furnished with the necessary bearings to support the drive shaft A and an extension to the leadscrew to which a set of cone gearing B is keyed. The drive shaft has a sliding gear C attached to it and this gear may be moved along the shaft and brought into engagement with any one of the gears attached to the leadscrew.

The sliding gear is carried along the drive shaft by means of a forked member D having at its outer end a handle and a spring detent to lock the gear in the correct relation to the cone gearing.

The drive shaft is provided with a gear at its outer end so that it may be driven from the mandrel through gearing similar to that found on screwcutting lathes having no Norton box.

By varying this gearing, sometimes known as 'pick-off' gearing, it is possible to extend materially the range of the Norton gearbox. The extent of pick-off gearing required is usually reduced by incorporating in the Norton box two or three gear trains affecting the drive shaft A; these may be selected at will by operating levers on the top of the gearbox itself.

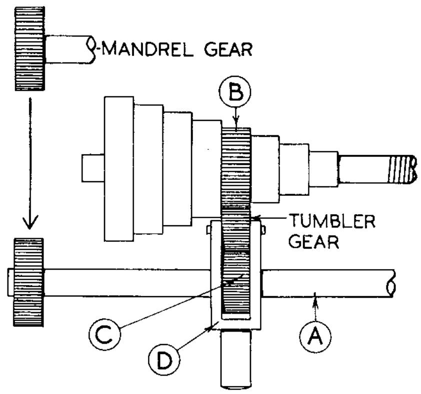


Fig. 44: The Norton gearbox

The tumbler gear

Most leadscrews have left-hand threads, that is to say if they are turned clockwise the saddle will travel along the lathe bed from right to left and produce a right-hand thread on the work. But in order to do so when driven from the mandrel it will be

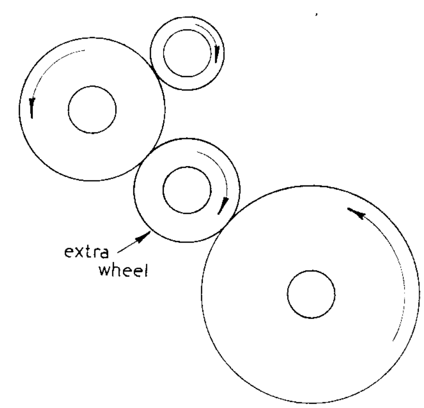
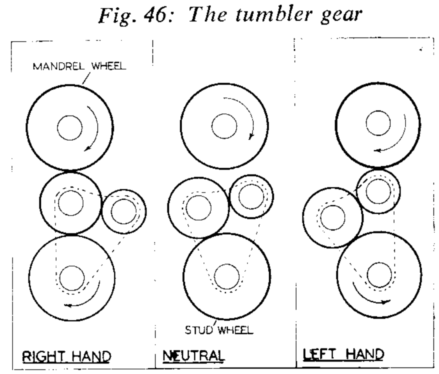


Fig. 45: Simple wheel train with reversing wheel

necessary to impose one further gear in the change wheel trains as illustrated in Fig. 45. This will ensure that the leadscrew turns in the opposite direction to the mandrel.

In practice this gear interposition is performed by what is known as a

Fig. 46: The tumbler gear



tumbler gear, shown in Fig. 46. Here it will be seen that the device, very old and exceedingly simple, consists in essence of a swinging frame carrying a pair of wheels that are in mesh with one another. These two wheels are sometimes of the same size, sometimes of unequal sizes, but in either case these two wheels are arranged on the frame so that either may be brought into mesh with a gearwheel permanently mounted on the lathe mandrel itself, a lever forming part of the frame being used for the purpose. One of these tumbler gears is also permanently in mesh with a gear set on the centre of the swinging frame. This gear has the same number of teeth as the wheel fixed to the mandrel. In this way three positions of the tumbler gear are available, namely one for right-hand threads, a neutral position, and one for left-hand threads.

The tumbler gear system fitted to the Myford ML7 lathe is illustrated in Fig. 47. The tumbler gear frame with its detent handle may be seen marked 1, the two tumbler pinions 2, the mandrel gear 3, whilst the stud gear lies behind the small change wheel marked 4. The remaining gears seen in the illustration form a compound train suitable for a fine feed.

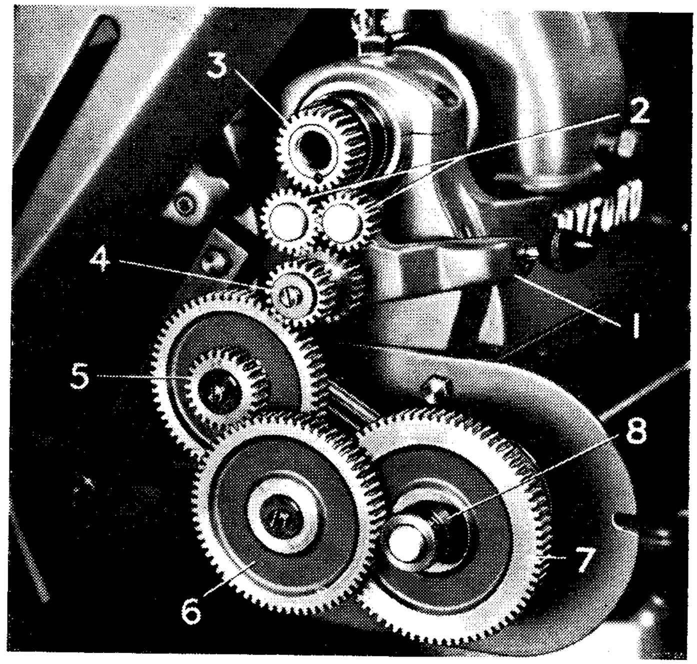
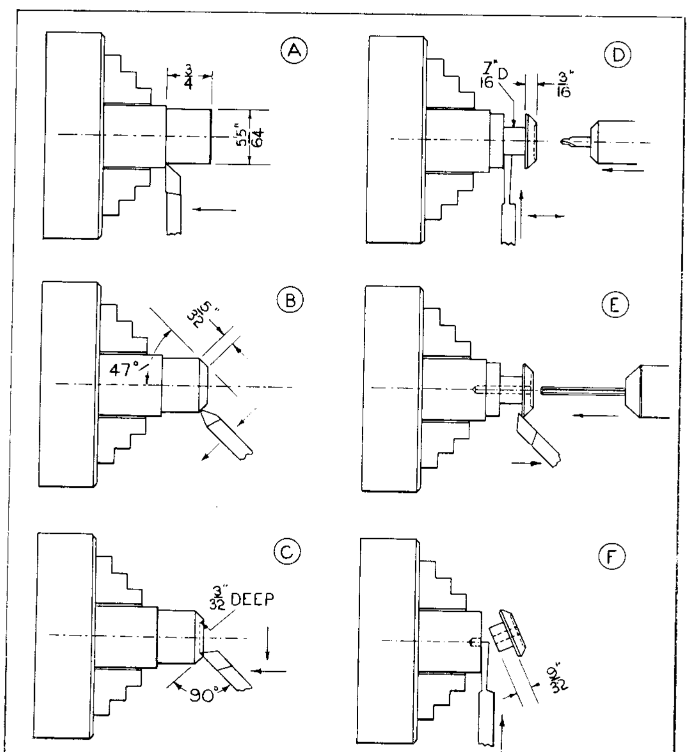


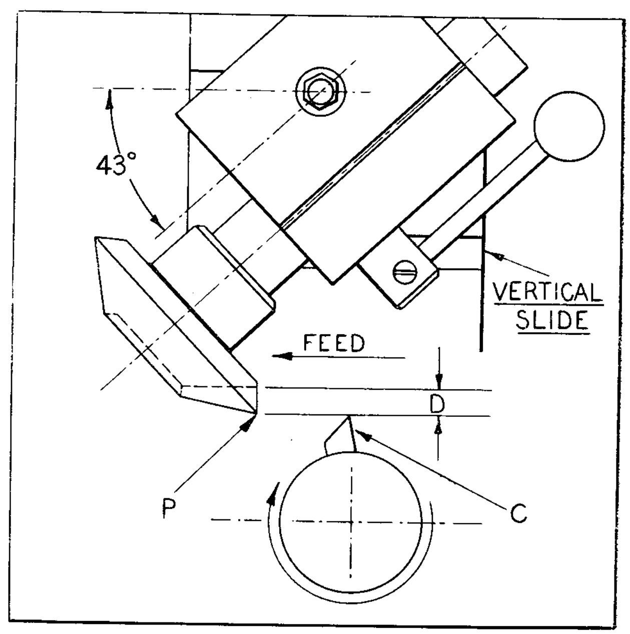
Fig. 47

Gear Cutting and Indexing

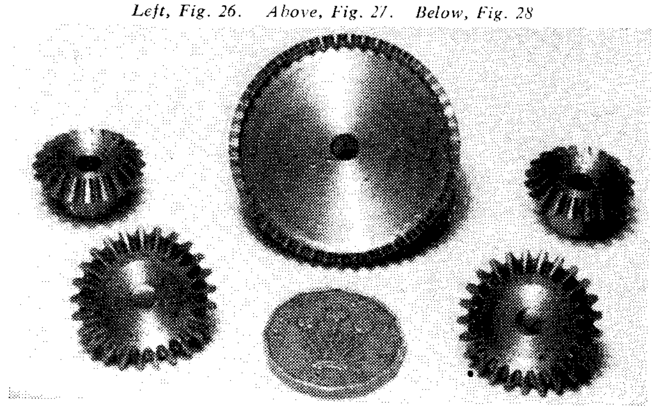
(Continued from page 269)

shape of the resulting tooth by means of a small hand mirror. My samples, illustrated in Fig. 28, bottom left and right, have a tooth tip 1/32 in. wide at the outside, and tapering to just under 1/64 in. at the inner end. Of course if you have given your tool an end radius much in excess of 0.059 in., you may find that the inner ends of your teeth have come to a sharp knife-edge. Accordingly, you can first set to cut to a depth of say, 0.040 in., form two spaces and examine the tooth, then gradually increase the depth, until the tops of the teeth approximate to the sizes given. You will find that the gears run well together, and for light power work, where rotating speeds are never high, bevels made by the "working in the field" method will give you every satisfaction.





Left, Fig. 26. Above, Fig. 27. Below, Fig. 28



The author during the first World War.

MY HOME WORKSHOP

by Jack Davies

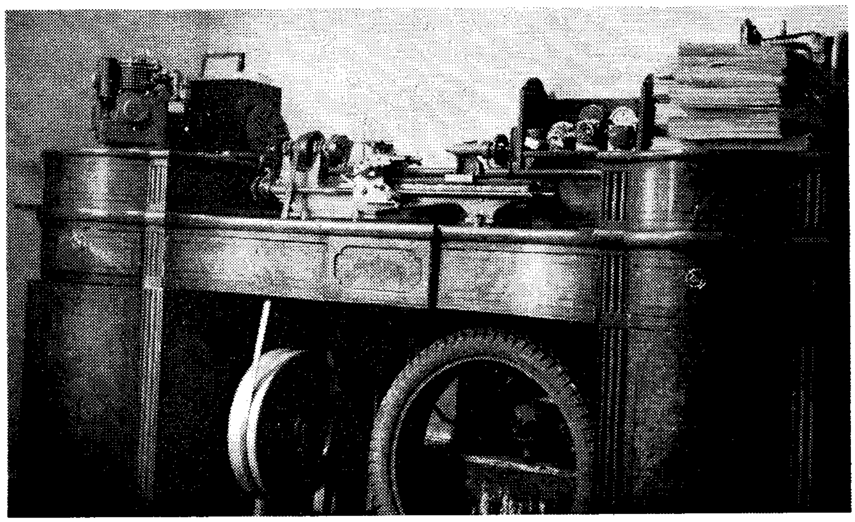
ALTHOUGH I now qualify for the OAP and have retired from active employment, I often look back to the days when, as a youngster, I had to be content with very meagre equipment, and an old file, a hammer, and sundry pieces of material I found on the scrap heap.

Model aircraft of the paper and string type with rubber bands for propulsion were all I could manage in those far-off days. Farnborough aircraft sheds were only three miles away, and Mr S. F. Cody and his box kites were near, too, and many a Saturday had me walking there to see the latest flying machines. The 1914 war came, and I joined the Royal Navy and later the Royal Naval Air Service and this helped me to acquire plenty of knowledge in what was to be my trade and calling in later life.

Who, with any mechanical leaning, could resist the lure of the Big Guns or the internals of the Clerget Rotary Engine. My job in the R.N.A.S was the machine guns and the Constantinesco Fire Control and Interruptor Gear that enabled the gun to fire to miss the propeller.

On my return home, I gave serious thought to a workshop in which I could do those things that were near my heart, making something that I could look upon as being my very own creation. I had bought myself a 3½ h.p. *Mohawk* motor-cycle which gave me some incentive to do repairs, and at the same time I purchased a Relmac lathe.

I had already acquired an assortment of hand tools, the lathe was treadle-driven and gave me a lesson in tool grinding: it was very hard work if the tools were not ground properly. About 1926, a series of books was published by Percival Marshall entitled 'Wonderful Models' and when bound became a sort of dictionary in two volumes.

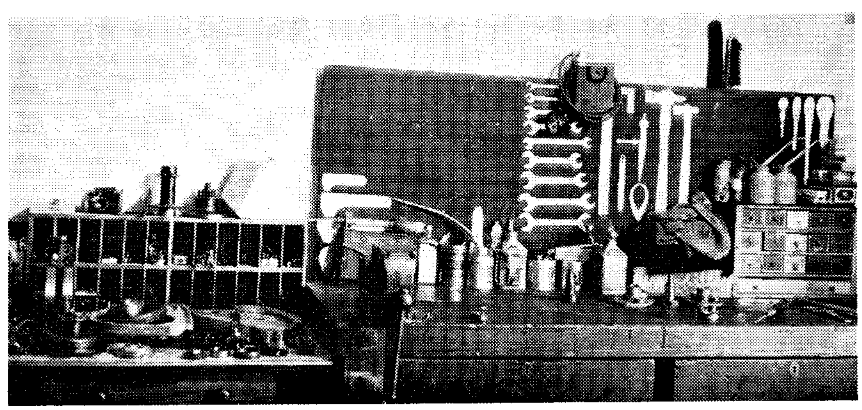


Among other folding plates there was one on the building of a model traction engine to 1½ in. scale; this model became what I proudly call my first *real* entry into the hobby. I did not know at the time how long it would take to complete, but it is the pride and joy of my collection and as my younger daughter was my company when working on it, it bears her initials and birth date as the number plate, together with her pet name Bunty carried on the smokebox door.

I disposed of the old but faithful Relmac before the war and in its place purchased a set of Winfield lathe castings advertised in *Model Engineer* at £3 16s.; 3 in. centre height and 20 in. between centres. Some modifications were carried out on building the lathe, which by the way, was partly machined as purchased; the alterations being a proper saddle and apron with double clasp nut for the lead screw, and rack and pinion hand traversing. This lathe was also treadly driven, the drive being made up from a heavy lorry flywheel, an Austin 7 half axle case as the stand, with loose chain drive over two magneto sprockets, one fixed and the other revolving. It was fascinating to watch the driving chain running around the sprockets.

During the war, my hours of working were very irregular and as I needed some form of transport other than a push-bike, I cast around to see what was available. Most transport had been commandeered, but a friend in the works gave me the main parts

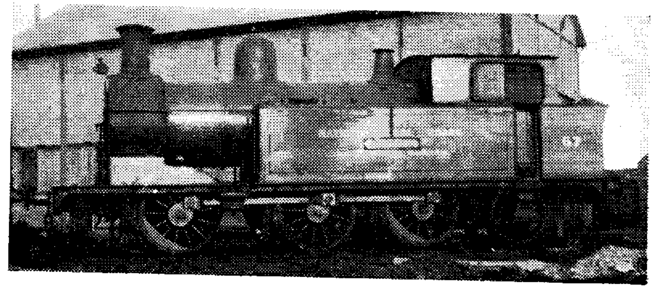
Continued on page 283



Jeynes' Corner

A commentary on current topics

E. H. Jeynes on Return Cranks



THE RECENT remarks on the return crank by K. N. Harris cannot be improved upon. The position of this crank must be exact, both in the model and in full-size. This applies especially to Walschaerts gear.

Apart from this, some of the models so fitted have proportions which entirely spoil the scale effect; even to the point of making the valve gear look clumsy. The gear would certainly foul the edge of a scale platform.

In his article "The problem of the Return Crank" the late J. N. Maskelyne (*Model Engineer,* 19 May, 1960), stresses this point, saying that most of the offenders when questioned on why they exaggerated the details, say that they wanted the gear to be strong and long lasting; therefore it was necessary to depart from scale sizes in order to gain robustness. This he dismissed as a fallacy, pointing out that given reasonably good workmanship and fitting, the stresses to be withstood by a miniature valve gear are less in proportion than in the prototype gear; therefore, there is no necessity for miniature valve gear to be exaggerated in any way. Mr Maskelyne gave four dimensioned sketches of types in common use in full-size practice, pointing out that in miniature, scale reductions of these dimensions should be ample.

The finest workmanship should be put into fitting the crankpin into the wheel boss, so much so that Mr Harris advocates boring the holes in the wheel boss in preference to drilling. It will be recognised that there is great torsional force exerted on a crankpin carrying not only the coupling rod, and big-end of connecting rod, but also the return crank at the extremity; the crankpin has also to withstand the shearing effect of the connecting rod applied in two directions continuously, also the hammer-like blows from slack bearings in both connecting and coupling rods.

There are also other severe strains imposed when engines negotiate tight curves which possibly have never been considered. Examination of wheel bosses on an engine which has been subjected to this treatment show some peculiar effects of wear, which have to be seen to be believed. I have seen many loose crankpins on locomotives which have too long a fixed wheel-base for the tight curves they have been worked on.

Mr Harris goes well into the mechanics and mathematics of the return crank, which should be a great help to those laying out Walschaerts valve gear.

It is of interest that the return crank was in use many years before Walschaerts invented his valve gear, being fitted in the same position on the end of the crankpin, but for a different purpose. The early locomotives built by Stephenson were fitted with two cylinders fitted fore and aft so to speak, these cylinders were sunk in the top of the boiler each in line with the axle it had to drive. Each cylinder was connected to its appropriate axle by two connecting rods working vertically, thus requiring the cranks on each axle to be set in unison, providing as it were two separate single cylinder engines. To render the combination of these two engines self-starting, it was necessary to phase the crankpins of the front axle and the crankpins of the rear axle at 90 deg.

In the first engine, *Blucher*, Stephenson used spur gears to effect this, later he tried chains and sprockets, finally adopting side rods and return cranks. The coupling rods were very slender, but were not really intended for coupled adhesion, but simply to give the required 90 deg. to enable the engine to be self-starting; these rods must have been under severe strain if one pair of wheels failed to grip the rails.

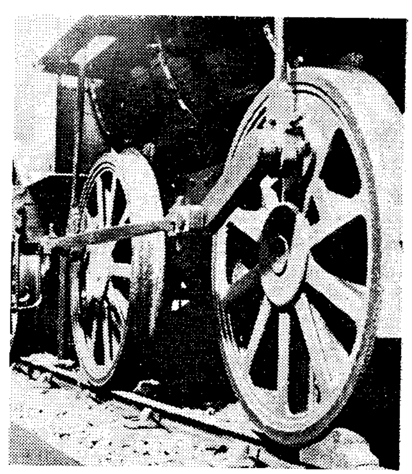
Stephenson fitted the return crank of the front axle on the right-hand side, and the return crank for the rear axle on the left.

Of course, this problem of phasing the cranks of separate axles had not occurred on locomotives built before Stephenson's, as Trevithick's had only a single cylinder, while Blenkinsop's two cylinders both drove the same countershaft which drove the large gear wheel which in turn mated with the rack rail; Hedley's *Puffing Billy* also had two cylinders driving a countershaft, thence to driving axles by spur gears.

The return crank which is the subject of my photograph is on Stephenson's locomotive *Billy* (not to be confused with *Puffing Billy*) which was completed in 1826 for Lord Ravensworth.

This locomotive was presented to Newcastle upon Tyne Corporation by Sir Charles Mark Palmer (one of the partners of John Bowes and Partners who succeeded to the coal empire of the Grand Allies) on the occasion of Stephenson's centenary, and stood on a plinth near the High Level Bridge for many years. Later, it was removed to the Central Station, where it stood on a platform. Finally, it was removed to the Museum of Science and Engineering of the Newcastle Corporation, where is now stands on some of the original Stockton and Darlington malleable-iron rails complete with their chairs, and square stone blocks; a silent monument to the method of trial and error.

Top: This picture shows the result of wear on the wheel-bosses



Bottom: Showing one of the return cranks on Billy, an engine built in 1826 to the order of Lord Ravensworth.

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.

Articles in ME

SIR,—I agree with K. N. Harris when he says that the "asumption that the more elaborate models described in ME can only be made by retired folk or people with lots of leisure," is correct, though I doubt that it is quite what Mr Storey meant.

It is probably true that 75 per cent of the models shown at exhibitions are built by people who have to earn their livings, in the first place there are more of them, and in the second place there are many retired folk, myself included, who have lots of leisure and a fair amount of know-how, but who cannot afford to make models in that class.

I agree, too, that the progress and development of model engineering has been largely through the influence of ME, but is that not due to the sort of articles that Mr Storey writes?

In my opinion, "a constant raising of sights" by ME will produce a magazine that will frighten the young tyro away from the hobby for good. I would give more space to instructions for building models that are within the scope of time and cost to scholars.

Bearing in mind that there are only half the number of issues now for each term, they need more space per issue to cover the same amount of instruction. Don't let them down; the future of ME depends on them.

Alford, Lincs. P. R. BARLOW.

Locomotive design

SIR,—In a recent article, K. N. Harris stated that Churchward did not use exhaust clearance in his cylinder and valve gear design.

It is true that drawings show "line-and-line" setting, but the railways were always careful not to give away their secrets, and drawings were not always accurate; a good example being the G.A. of the *Kings*, which shows not back-set on the swinging link, but front-set!

I am not at present able to examine a full-size locomotive, which is, after all, the final authority, but I have always understood that exhaust clearance was used. Experimental work in small gauge has proved the advantage of this to get maximum power and acceleration. There is also direct evidence of my point in the question asked of LBSC by C. B. Collet—"How much inside clearance has she got?"—referring to one of his engines.

One must remember that mere thermal efficiency is at best a secondary consideration in any locomotive. The most important points are that she will steam, pull and go. Reliability and easy maintenance come next. If all this can be combined with efficiency, so much the better.

An engine which was 100 per cent efficient would be no use to any railway unless it could also do a useful job of work without heavy maintenance costs.

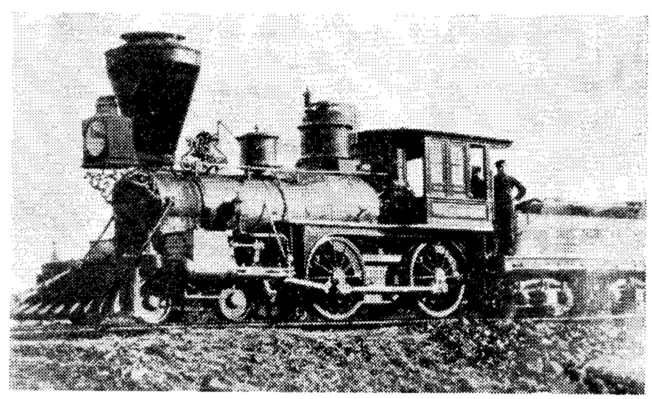
Harefield. K. E. WILSON.

Readers may be interested to know that in "Steam Locomotive Design, Data and Formulae," by E. A. Phillipson, it is stated that on the GWR Castle class engines, the valve details were as follows:
Piston valves 8 in. dia. Steam lap $1\frac{5}{8}$ in. Exhaust lap NIL. It is also stated that these dimensions were obtained by measurement of AN ACTUAL ENGINE.

Phillipson, one of our best authorities on the subject, says "Exhaust clearance (in valves) has inherent disadvantages and careful consideration should be given before adopting it. With exhaust clearance, the toe of the indicator diagram tends to degenerate into a heel, and if carried to excess may lead to appreciable loss of power.

With link motions, the early release becomes premature. Again, when the valve is in its central position, both ports are open to exhaust and inter-communication takes place. Should the exhaust clearance be large, the exhaust from one end of the cylinder baffles that from the other, and the exhaust line of the indicator diagram will show a rise or hump.

However, in cases where insufficient steam lap is provided, or where the lead is excessive, a small exhaust clearance, not exceeding $\frac{1}{16}$ in., may be beneficial in reducing the risk of bearings running hot in the event of an engine with link motion being excessively notched up; the resultant premature point of compression is then delayed by the exhaust clearance."—EDITOR.



Blastpipe location

SIR,—With reference to D. E. Lawrence's letter, February 4, and Mr R. Bacharach's letter, January 7, I have managed to dig out of my large collection of old photographs taken during the building of the Central Pacific Railroad in the 1860's this picture of CPRR No 1, *Governor Stanford*, taken in 1864, built by Danforth Cooke in 1863.

All these early Central Pacific engines were wood burners, and the balloon stack shown would have an inner chimney with a fine mesh net covering the top of the stack. The wood ash accumulated around the sides of the coned stack, to be let out through a pipe (not seen in photograph) on the right-hand side of the stack.

Aldeburgh, Suffolk. MAURICE W. GRIFFITHS.

Steam cars

SIR,—Your contributor LBSC is a truly wonderful writer and his recent outburst on steam cars confirms this. It rather reminds me of the man who "proved" to his employee by summing up holidays, Saturdays, Sundays, time spent in bed, and so on, that the man only worked about ten days in the year. I think most of us have heard before the old worn out statement that "if only the amount of money, etc.—we should now be using steam cars instead of i.c. engined vehicles."

The fact is that the steam car was beaten fairly by its much more reliable and efficient competitor. By burning the fuel in the cylinder, the boiler and all its attendant accessories (and troubles) were eliminated. Please do not assume from the above that I am not a steam car enthusiast. During recent years I have driven more miles than most people in both ancient and modern steam vehicles in Britain and the U.S.A. I will not take up too much of your valuable space by trying to reply to all LBSC's erroneous claims, but let me assure him that his 2 in. × 3 in. bore engine with a steam presure of 180 lb. would develop about one dog power in a road vehicle. I have often enjoyed the thrill of standing at traffic lights with my 1911 10 h.p. Stanley, alongside Bentleys, Jaguars, etc., waiting for the moment when I could slam open the throttle and leave them all behind, but such excitement was only short-lived for, alas, within 300 yards my wonderful 500 lb. of steam pressure had dropped to 100 and the Stanley was left a long way behind trying to make up for its tremendous burst of enthusiasm. The water-tube boilers LBSC mentions are useless for road work since the continuous surge of the small amount of water causes priming and other troubles. When LBSC writes about the power of his little locomotives he must remember that a vehicle running on level steel rails has very little friction to overcome, but on the road with rubber tyres conditions are quite different.

Recently, in the U.S.A., I had a run in one of the very latest American steam cars, the performance of which left much to be desired, the roaring of the burner plus the stench and the heat was such that long runs were quite out of the question. Some day, perhaps, the steam car may be a proposition, but it will have to be a very wonderful machine to even equal the modern, cheap motorcar in performance, convenience and reliability.

Wells, Somerset. LEONARD TAYLOR.

SIR,—As the owner of the nucleus of a steam car— a light steam chassis—I was naturally interested in LBSC's article and his attractive 1914 design, but I think that his general comments and summing up leave out some important considerations such as relative capital cost, fuel economy and the problem of adequate heat dissipation with an air-cooled condenser. Automatic controls are only touched on and the problem of maintaining heating surfaces free from excessive sooting and scaling while in regular use are not mentioned.

The charm of steam to which he refers is really that of the orthodox double-acting engine (with packings, to be accessible) supplied by a boiler at moderate pressure, having reserve capacity and adequate water and mud spaces—like his 1914 design—for which the penalties of size, weight and long thermal efficiency must be accepted. This would be my choice, even accepting what some would regard as the inconvenience of solid fuel firing for the sake of economy, silence and simplicity, resulting in a satisfying steam vehicle but hardly a steam car in the accepted sense.

The other alternative, which he infers but does not elaborate on, is a compact high efficiency design, using a higher speed single-acting engine working at high pressure and controlled superheat with a monotube or similar steam generator of negligible capacity and with limited spaces, depending for satisfactory operation on clean, soft water and quite elaborate automatic controls to achieve reasonably constant steam pressure and temperature under the varying power demand of any road vehicle. In the petrol engine this is achieved (within the limits he mentions) by no more than a throttle and carburettor needle valve, while no mention is made of automatic gear boxes or of that much closer approach to the characteristics of steam—the very simple infinitely variable drive of the DAF of which I have 20,000 miles experience.

On the subject of transmission it should not be forgotten that Clarkson, who did as much for steam as anyone, used a clutch and three-speed box on his goods vehicles to achieve economy.

Finally, he does not mention cylinder condensation, familiar to ME readers, but not to the average motorist, nor the much more important difficulty with a condensing engine of removing oil from the condensate. The only real advantage left to this type of steam car in the contemporary world is slow engine speed due to high torque and the resulting long life, also due to the exclusion of products of combustion from the cylinder. This is more than offset by high initial cost, greater dependence on automatic controls and greater space needed for the steam generator and its lagging and for the water tank.

The comparison is very different in the case of the steam boat, yet there are few even of these.

Sutton Coldfield. J. R. HARDING.

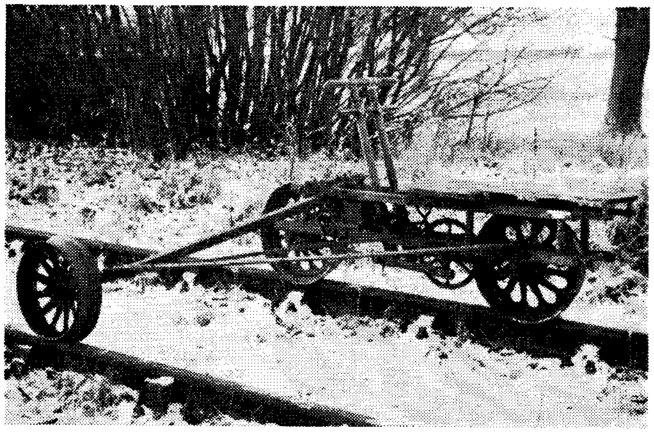
Gnome Monosoupape engine

SIR,—I read with considerable pleasure Edgar T. Westbury's article on the scale working model of the Gnome engine built by Frank Boler (January 7). The account instantly took me back over the years to 1919 when, as a very young student apprentice at the R.A.E. Farnborough, I served a period of training in the aero-engine erecting and fitting shop. Here I worked at the bench under the guidance of George Pimm, a skilled aero-engine mechanic from Silvertown, London. This was the period when a large number of "Liberty" engines were passing through the shop for maintenance. But I well remember that during a lull in the supply of engines for overhaul, Pimm was given the job of reconditioning three or four of the seven-cylinder radial Gnome engines. Needless to say, "monosoupape" was soon added to my limited French vocabulary! The arrival of these unusual engines was a welcome change from the orthodox eight-cylinder engines we had been handling for some time.

Of the origin of the "Gnomes" I have no recollection, but undoubtedly they had seen service on the Western Front. Our job was to give the engines a thorough overhaul —but with a difference! Pimm's instructions were simply to carve out portions of the cylinders and crankcases for demonstration purposes. We had no drawings and no instruction book to guide us. My instructor was given an entirely free hand. Care had to be taken to ensure that no vital internal part could drop out. The cylinders still had to be free to rotate about the fixed crankshaft. Needless to say, it was a job that would have put any apprentice in excellent spirits.

The drawing on page 11 of ME is a fair representation of the Gnome as I remember it, and likewise the photographs of the models. Of the subsequent history of these particular engines I have no knowledge, although at the time it was said one was to be used for exhibition purposes.

Teignmouth. ERNEST A. STEEL.



Platelayers' trolley

SIR,—I would be grateful if any of your readers could give any information, especially the date of manufacture, of the old three-wheel platelayers' trolley seen in my picture. It used to work on the old Great Western line from Leominster to Kington.

Letchworth. M. ROPER.

Aid for the handicapped

SIR,—On reading a recent copy of *Model Engineer*, it occurred to me that the following might interest some of your readers and perhaps some of the Clubs.

We at this school have a small group of boys taking part in Social Services as a voluntary occupation, and in the school workshops we have offered to undertake the construction of small articles in woodwork and metalwork which are badly needed for use by handicapped people. They are quite simple aids which are needed by the County Organisers for the Handicapped, but unfortunately are not easily obtained as they are too simple and in too small a quantity to show any profit for a manufacturer. I am quite certain that there will be model making members who would be willing to give some of their time to making these aids, as any model maker would have the facilities and ability.

We were given another instance recently where a small workshop can help the disabled. We were asked if we could help to repair a calliper type of artificial leg which had broken and needed welding. The parents had to wait six months for a new calliper and the present broken one was needed urgently for the child to sit an examination. On closer investigation the problem was not only that the calliper was in need of welding, but it was also too short as the child had grown and was therefore dropping his weight on to this leg. It was a simple operation to repair it and adjust its length, as provision had been made for lengthening. Two hours work saved the child and his parents a lot of waiting.

Any clubs interested should contact their County Association for the Welfare of the Handicapped who are always willing to pay a small price for the aids made which will cover cost of materials.

Merchant Taylors' School, G. L. BEACH.
Sandy Lodge, Northwood,
Middx.

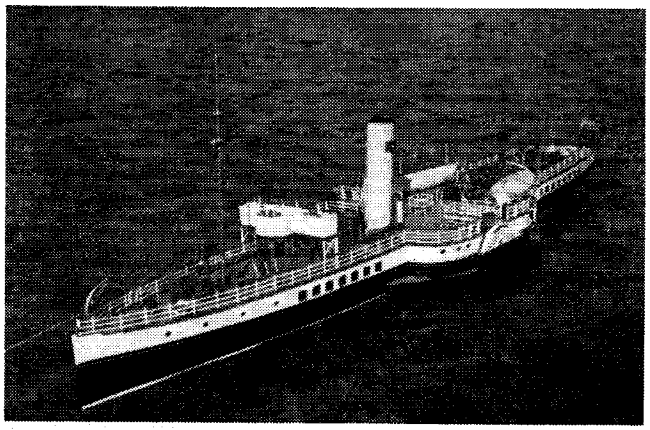
Stanford University

SIR,—In answer to D. E. Lawrence of Dorchester, Postbag, February 4, Stanford University was built by Senator LeLand Stanford, President of the CPRR, and his wife, Jane Lathrop Stanford, and endowed with their entire fortune, as a memorial to their only son, who died young. I am in a position to assure Mr Lawrence that this information is correct, as my father's eldest brother, the (late) Rev. D. Charles Gardner, D.D., was Professor of Theology at Stanford, and Chaplain to the University, from the time of its opening at the turn of the century, until his retirement in the late 1930's.

My uncle emigrated to the U.S.A. in the 90's, studied theology there, and was ordained a Minister of the American Episcopalian Church. His work amongst the poor, when he was a curate in San Francisco, California, greatly impressed Senator Stanford who was at that time planning the University; and as a result he offered my uncle the appointment as Professor of Theology and Chaplain to the College.

Mr Lawrence probably knows that Stanford University is situated at Palo Alto—Spanish for "Tall Tree"—about 30 miles from San Francisco, in most beautiful surroundings. The campus is very extensive, occupying the whole of what was at one time a 9,000 acre ranch. The scientific and technical departments of Stanford University include the Ryan High-Voltage Laboratory and the Guggenheim Aviation Laboratory, and a point of interest to mechanical engineers is that Professor S. Timoshenko, whose "Vibration Problems in Engineering" is so well known, was for a number of years head of the Faculty of Engineering at Stanford University.

Birmingham. NORMAN GARDNER.



Model paddle steamers

SIR,—I was delighted to see the picture of Mr Robson's paddle steamers. Your readers may like to see this picture of my model of the *Medway Queen* to $\frac{3}{8}$ in. scale, which is powered by Mr Westbury's diagonal engines. It is a full-time job sailing a paddle steamer, and difficult to obtain a good action shot.

Wood Green. R. C. JACKSON.

Paddle steamers

SIR,—May I take this opportunity of answering the question of Brian Hillsdon regarding paddle steamers operating in U.S.A.

My comment in the last paragraph of the article on the *Robert Fulton's* engine was in reference to beam engines only. Fortunately, several paddle steamers still exist in the U.S. today.

The *Alexander Hamilton* is still in operation, although at the end of each season we wonder if it will be her last. Patronage on the river had fallen off badly, but showed some indication of picking up after an advertising campaign. At any rate she is supposed to operate next year. Her route is up the Hudson river from New York, stopping at Bear Mountain and West Point, then sailing to Poughkeepsie (72 miles from New York) turning without landing and then back to West Point, Bear Mountain and New York. Ten years ago when I was with the Dayline we made a total of 13 landings on this run per round trip. This gives some idea of how traffic has fallen off on the river.

I am happy to say that the *Lansdowne* of 1885 is still very much alive on the Detroit river, running between Windsor and Detroit in Railway ferry service. She now carries freight cars only, although years ago she handled all. Her consort on this run is the *Huron*, a twin-screw steamer with non-condensing engines. *Huron* was built in 1875 and is probably the oldest steamer in commission in North America. She operates from about April to September with *Lansdowne* operating in the winter months because of her good ice-breaking ability. *Lansdowne* has wooden radial wheels with iron sheeting on the wood. She has two horizontal cylinders 48 in. × 108 in. with poppet valves, operating each wheel independently. The engines were built in 1872.

Among some of the other paddle steamers operating we have the following:

Belle of Louisville. A stern wheel day excursion steamer based in Louisville, Kentucky. Two 16 in. × 6½ in. non-condensing horizontal cylinders. Built 1911. Poppet valves.

Delta Queen. A Mississippi River cruise steamer Built 1927. Cross compound engines, stern wheel, poppet valves.

Admiral, President. Day excursion steamers, *Admiral* based in Cincinatti, *President* at New Orleans. Both were rebuilt from packet steamers, the *Admiral* being streamlined and air conditioned. They are sidewheel steamers with independent inclined tandem compound engines, poppet valves on the L.P.'s. *President* and *Delta Queen* share the honour of carrying steam calliopes.

Suwanee. A small Mississippi type stern wheeler operating on a lagoon at the Ford Museum, Dearborn, Michigan. She has two slide valve non-condensing horizontal cylinders, and is a replica of a southern steamer once ridden by Thomas Edison.

Mark Twain. A ⅝ full-size replica of a Western river passenger packet, operating in Disneyland Park, California. Although she is steered by an underwater guide rail she is propelled by two simple non-condensing engines.

Lone Star. Believed to be the last of the stern wheel towboats. Operates somewhere on the Upper Mississippi river.

Edwin N. Bisso, Leo B. Bisso. Automobile ferries operating across the river at New Orleans. These vessels are catamaran-hulled with a stern wheel mounted between the hulls. They have poppet valve, non-condensing engines. The third ship of the line, *Thomas Pickles*, simply vanished during the September hurricane and has not yet been found.

A number of paddle steamers are preserved at various towns along the western rivers including the *Sprague*, the largest stern wheeler ever built. Her wheel is 38 ft dia. × 40 ft wide. In 1907 she pushed a coal tow consisting of 60 boats and containing 67,307 ton of coal. The barges covered an area of 6½ acres!

One of the most prominent features of paddle steamers on the Western rivers was the mellow chime whistles which were fitted. These usually consisted of three separate whistles tuned to produce a very pleasing sound.

Long Island, N.Y. CONRAD MILSTER.

Old stern-wheelers

SIR,—It was with great interest that I saw your sketch of the old Arrow Lakes stern-wheeler. I spent some years on the Arrow Lakes at Edgewood in the 30s' and she was our contact with the outside world.

I am almost certain she is the CPR *Minto*. There were two steamers on the Lakes, the *Minto* and the *Donnington*, the later and more modern one was laid up. I never saw her, but I believe she had a permanent wooden awning over the upper deck, which made her look as if she had another deck.

The *Minto* made two round trips a week on the Lakes (there are two lakes by the way, the Upper and Lower Arrow Lakes, separated by the Narrows, just north of a village called The Needles, where there was a ferry across the narrows which took the road from Edgewood up to Nakusp and then down the Slocan to Nelson). She took one day from Nakusp, where she overnighted, the next day she made the round trip from Nakusp to Arrowhead and back, and the third day went south again to Nelson.

On second thoughts, looking at the sketch again, I wonder if she isn't the *Donnington*, as the *Minto* had the saloon forward and it appears to be aft on the sketch. Also the *Minto* had a cargo deck at least 30 ft long, and the forward bulkhead was a square across the ship.

Just aft of the forward bulkhead which had doors, port and starboard was another cargo space, aft of this was a shallow well with the boilers. These were locomotive type with the firedoors forward. Aft of these was more cargo space. On both sides were crew quarters. The mess room ran athwartship right aft, with the galley on the port side. I ate with the crew on my trip from Arrowhead to Edgewood and the noise from the wheel was terrific.

The cylinders were just ahead of the mess room and the motion quite open, only a rail on the inboard side.

The draught was, I believe, 3 ft loaded. I was told she had three rudders, and as far as I can remember they were well forward, about under the wheelhouse.

The landing on the lakes, while level at the top where a freight shed stood, ran down into the water at an angle between 20 to 30 deg. This was because the water level varied as much as 26 ft between summer and winter, being low in winter and highest in July when the melting of the snow reached its peak. The lakes which are about 160 miles long and from ½ to 3 miles wide are really just a widening of the Columbia river.

Is it possible that the CPR could supply more information about the *Minto*? She must have put up a stupendous mileage. I believe she passed the half-million mark while I was there.

Ashford, Middx. OWEN SCOTT.

My Home Workshop

Continued from page 277

of a 150 o.h.v. New Imperial. This was not much to go on, but it had me thinking: no number plates, no log book. Finally, I decided to try and complete the machine. It would take too long to detail this job, but for those interested, full details were given in *Motor Cycle*, 6 May, 1943, with some pictures of my workshop.

After the war, I still had the Winfield lathe with treadle, so a start was made on LBSC's *Bantam Cock*. All holes were drilled by hand or in the lathe as I had no drilling machine; I had a hand-driven grinder for sharpening tools, but in exchange for a gauge 1 spirit-fired locomotive, I acquired a ¼ h.p. BTH electric motor and a small bench drill with a flywheel, unaffectionately known as a drill breaker!

The BTH motor was rated for intermittent use, so I wrote to the makers for advice as I wanted to run the motor for lengthy periods. They kindly suggested I drill six ½ in. holes in the end cover, which I did; the motor now drives my ML7 lathe and has done so ever since I carried out the suggested modification.

When the design for the ME high-speed drilling machine appeared, I bought a set of castings. I consider this one of my best investments as it is 'just the job' and easy to make up; I certainly would not like to be without it now. About six years ago a friend in North Devon sold me a double-ended grinder and this with the lathe and drilling machine constitute all the power-driven tools I have today.

To sum up: what tools are really required to enable a beginner to enter this most interesting hobby? And to make a genuine live-steamer that will give such pleasure for years on end? My workshop equipment has evolved through the years by acquisition and disposal and has gradually settled down to the minimum requirements.

In the past I have considered other power tools such as a bench shaper or milling machine, and although I do not decry their usefulness, are they *really* necessary? I think not; so do not be downhearted if you haven't the necessary cash for more equipment. I have achieved the following in my years of endeavour: One model traction engine, two 2½ in. gauge locomotives, six 3½ in. gauge locomotives, one motor cycle, one ½ second battery-driven electric clock. All the locomotives except one are coal-fired. And I have on the bench at this very moment a 5 in. gauge American old-timer (I already have a *Virginia*) and a 1½ in. scale Manning Wardle locomotive for 3½ in. gauge.

I am not saying this just to show off, but merely to point out that a great deal can be accomplished with meagre equipment. A lathe, drilling machine and grinder are the essential power tools, plus the usual assortment of hand tools, and some heating apparatus for boiler making.

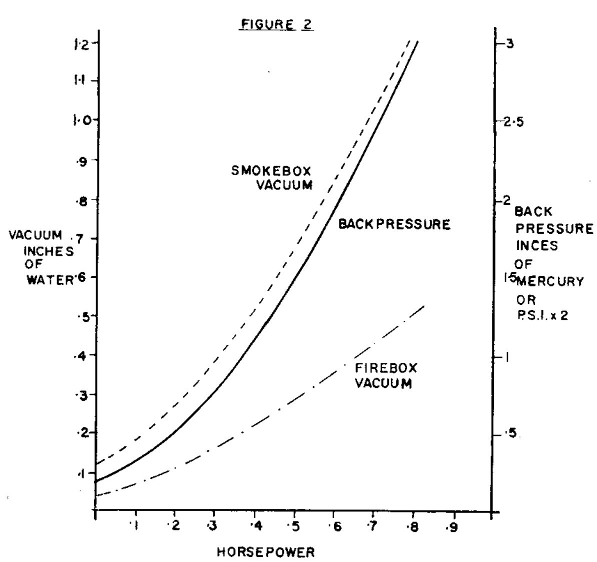
I will agree that my models would not win any international prizes, but they all perform to my entire satisfaction, and the enjoyment I have had throughout the years has kept me young in mind.

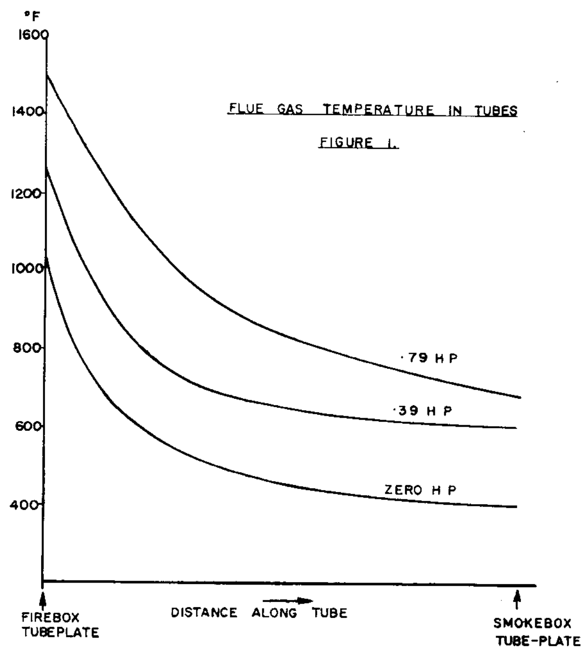
They have also helped me in my profession, as it was my custom to state that I was a model maker in any application for a serious post. In one instance my model engineering activities were the sole topic of conversation of a Board of Officers before whom I was called to appear for promotion. I was given the post immediately. Just one more case of the benefits of our hobby! ■

Testing a locomotive boiler

continued from page 253

In designing a boiler along the above lines, the problem is to keep the grate area down and the firebox size up. With narrow fireboxes this is not too difficult and is helped by sloping the throatplate and using a wide foundation ring. In wide fireboxes the problem is more severe and apart from the above techniques and using a combustion chamber (which has constructional difficulties), the only solution lies in the use of thermic syphons. *To be concluded.*





CLUB NEWS

News from down under

I have just received a copy of the New Zealand Model Railway Journal, the official publication of the N.Z. Model Railway Association. From its "Live Steam Corner," I hear that there is a model engineer's workshop on one of the Chatham Islands—500 miles from New Zealand. Unfortunately, the author does not say who are the (apparently) two brothers in this far-away spot. They have a workshop which boasts three lathes between 6 in. and 1½ in. centre, the two smaller being treadle operated. The largest was worked by a beautiful marine diesel engine.

From the Hutt Valley Model Engineers comes news that Phil Davis' 1 in. scale Ka class locomotive is making good progress. Phil is about to braze the boiler, and cylinders and motion are completed. Stan Hicks, the well known engineer of the tug *Tapuhi*, is finishing off a 3½ in. gauge *Caribou* 0-8-0, the Martin Evans design described in ME recently. The club's *Speedy* is also nearing completion, in the hands of Colin Scott. Most members have had a hand in this job, but Colin has been responsible for the lion's share.

There has also been much activity at the Otago Society. Their already long track is being extended; the new one should be the longest and most elaborate in either Island.

Society for Ipswich?

There will be a meeting in the Tudor room of Oxborrow's Hotel, St. Peter's Street, Ipswich, at 7.30 p.m. on Tuesday, April 12, when it is hoped to form a Model Railway Society to cater for those living in the district. Readers interested should contact J. Noble at 10 Bent Lane, Rushmere, Ipswich, Suffolk.

Wirral M.E.S.

From Donald Parr, the recently appointed secretary of the Wirral Model Engineering Society, I hear that there are now good prospects for a permanent site for their track at Royden Park, Frankby. The site is an exceptional one, with a picturesque mere, surrounded by woodland, and ideal for picnics.

This society is very active, with at least ten locomotives under construction, and as many more completed. R. Stone, who recently received an award for his Aveling & Porter road roller, is now building a pair of 1½ in. scale ploughing engines. One is already nearing completion.

New Club Locomotive at Wigan

The A.G.M. of the Wigan M.E.S. was held on January 22, with an excellent attendance. The chairman was able to report the virtual completion of the 5 in. gauge track at Haigh and the acquisition of a club locomotive. Mr Shepherd brought along a very fine model Francis Barnett motor-cycle to ¼ in. scale, built by Mr Tatlock of Bolton, and explained details of construction of this unusual project.

Johannesburg

According to "Live Steamer," the club Christmas party of the Johannesburg L.S.C. was a great success. Neville Murray brought his engine *Natalie Ann*, Henry Hetyl had his *Jubilee*, Eric Rowbottom steamed his *Kudu*, and Paul Young his *Heilan Lassie*. Altogether, 28 were present, enthusiasts of both sexes, and a good time was had by all. Angus Walker of Natal has apparently fitted out his workshop in a way that is the envy of his friends. So we will expect some really fine locomotives to emerge before long!

While on the subject of Africa, I have heard from a Salisbury, Rhodesia reader that he has not been getting his ME regularly the last few issues, and wonders if he is being hit by sanctions! Well I can assure this enthusiast that as far as we at *Model Engineer* are concerned —whatever Governments may get up to —there are no sanctions on model engineering!

West Midlands Federation

At the meeting of the West Midlands Federation on February 5, it was decided to hold the W.M.F. Rally for this year on Sunday, September 4, on the track of the Rugby M.E.C. in the Community Centre, Hillmorton, Rugby.

The Campbell and Addenbrook Cup competitions will also be held, and it is hoped that there will be a good turnout of models, both finished and unfinished. Judges will be Mr Burtenshaw of the Birmingham Science Museum, A. W. G. Tucker of Stockport and Mr Cox of the "home" club. There will be facilities for steaming model traction engines, and a film and slide show will follow the meeting.

The A.G.M. of the Federation will be held at 3 p.m. on Saturday, April 2, at the G.E.C. Sportsfield, Brindle Avenue, Coventry. The usual social evening will follow.

CLUB DIARY

Dates must be sent at least four weeks before the event

March 18 Rochdale SMEE. "Railway Topics,". F. Coy. Lea Hall, Smith Street, Rochdale. 7.30 p.m

March 18 Greenwich & Dist Ship Model Society. "Model Sailing Barges," Mr Fisher. Newton Room Charlton House, SE7. 8 p.m.

March 18 Junior Institution of Engineers. Informal meeting: Arthur Boylan. 33, Ovington Square, SW3. 6.30 p.m.

March 18 North Staffs & Cheshire Traction Engine Club. Annual dinner and dance. Foden Motor Works, Recreation Club. Elworth, Sandbach, Ches. 7.30 p.m.

March 19 Wigan Model Engineering Society. Meeting. Co-op Guild Room, Thompson Street, Whilley, Wigan. 7.15 p.m.

March 21 Leicester SME. Ordinary meeting. The Museum, New Walk, Leicester. 7.30 p.m.

March 22 Chichester & Dist SME. Film evening (Industrial), Lancastrian County Secondary School, Basin Road, Chichester. 7 p.m.

March 23 Southampton & Dist Society of Model Engineers. Track discussion. 8 p.m.

March 23 Harrow & Wembley Society of Model Engineers. Loco section meeting. Heathfield School, College Road, Harrow. 7.45 p.m.

March 23 Birmingham SME. Meeting at Endwood Hotel. 7.30 p.m.

March 24 Hull Society of Model Engineers. Model of the Year Show. Trades & Labour Club, Beverley Road, Hull. 7.45 p.m.

March 25 Colchester SMEE. Lecture by Don Cardy. Subject not to hand, but it is hoped that it will lead to a lively discussion between steam and diesel protagonists. HQ, Old Allotments, Straight Road, Lexdon. 7.30 p.m.

March 25 Greenwich & Dist Ship MS. Meeting. Newton Room, Charlton House, SE7. 8 p.m.

March 25 Brighton & Hove Society of Miniature Locomotive Engineers. American locomotive colour slides, by K. E. Wakeford. Elm Grove School, Elm Grove, Brighton. 8 p.m.

March 25 JIE. "Channel bridge project," J. C. Maxwell-Cook. 33, Ovington Square, SW3. 6.30 p.m.

March 26 SMEE. Rummage sale, Marshall House. 2.15 p.m.

March 26 York City & Dist SME. Competition for the "Best work of the year." British Legion Club. 7.30 p.m.

March 26 Brighton & Hove Society of Miniature Locomotive Engineers. Hove Park track day. Hove Park.

March 27 Harrow & Wembley Society of Model Engineers. Preparing track. BRSA (LMR) Sports Ground, Headstone Lane, Harrow. 2.30 p.m.

March 28 Clyde Shiplovers' & Model Makers' Society. Show of work: models, drawings, photos, etc. Meetings at the YMCA Club (Coffee Room), 100 Bothwell Street. Members and prospective members only.

March 31 Harlington Locomotive Society. Locomotive night. High Street, Harlington. 7.30 p.m.

April 1 North London SME. General meeting. Rummage sale.

April 1 Greenwich & Dist Ship MS. Talk by Mr Cragh. Newton Room, Charlton House, SE7. 8 p.m.

April 1 Rochdale SMEE. Meeting at Lea Hall, Smith Street, Rochdale. 7.30 p.m.

April 1 JIE. "Glass—its manufacture and uses," L. S. Newton. 33, Ovington Square, SW3. 6.30 p.m.

April 2 Southampton & District Society of Model Engineers. Track open day. 10.30 a.m.

April 3 Southampton & District Society of Model Engineers. Start passenger season. 2.30 p.m.

April 3 Harrow & Wembley Society of Model Engineers. Preparing track. BRSA (LMR) Sports Ground, Headstone Lane, Harrow. 2.30 p.m.

April 3 Birmingham SME. Cup competition Illshaw Heath. 3 p.m.

April 3 Malden & Dist SME. Tune up day.

April 4 Leicester SME. Discussion on agenda for AGM. The Museum, New Walk, Leicester. 7.30 p.m.

April 6 Southampton & District Society of Model Engineers. General meeting. 8 p.m.

April 6 Norwich & Dist SME. Talk: Model locomotive boilers, Martin Evans. Assembly House, Theatre Street, Norwich. 7.30 p.m.

April 6 Wimbledon MRC. "Slides and recordings," J. Spencer Gilks. Methodist Church Hall, Worple Road, SW19. 8 p.m.

April 6 Bristol SMEE. "Screwcutting," talk and film, D. O'Nions. Unitarian Hall, Lewin's Mead, Bristol 1. 7.30 p.m.

April 7 Eltham & District Locomotive Society. AGM. Beehive Hotel, New Eltham, London, SE9. 8 p.m.

April 7 Hull Society of Model Engineers. Annual meeting. Trade & Labour Club, Beverley Road, Hull. 7.45 p.m.

April 7 Warrington Model Engineering Society. Film show by Commercial Producers. Cemetery Hotel.

April 9 Brighton & Hove Society of Miniature Locomotive Engineers. Hove Park track day. Hove Park.

April 10 Harrow & Wembley Society of Model Engineers. Track opening meeting. BRSA (LMR) Sports Ground, Headstone Lane, Harrow. 2.30 p.m.

April 10 Warrington Model Engineering Society. Track day at Earlestown.

April 10 Malden & Dist SME. Grand Easter opening day.

April 11 Malden & Dist SME. Track day.

April 11 Brighton & Hove Society of Miniature Locomotive Engineers. Hove Park track day. Hove Park.

April 12-16 SMEE. Model Railway Club Exhibition. Central Hall, Westminster.

April 12 Proposed Ipswich Society. Meeting—Tudor Room, Oxborron's Hotel, St Peter's Street, Ipswich. 7.30 p.m.

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WORKSHOP EQUIPMENT

Buck & Ryan for Lathes and Workshop Accessories, drilling machines, grinders. electric tools, surface plates, etc.—101, Tottenham Court Road, London, W.1. T/C

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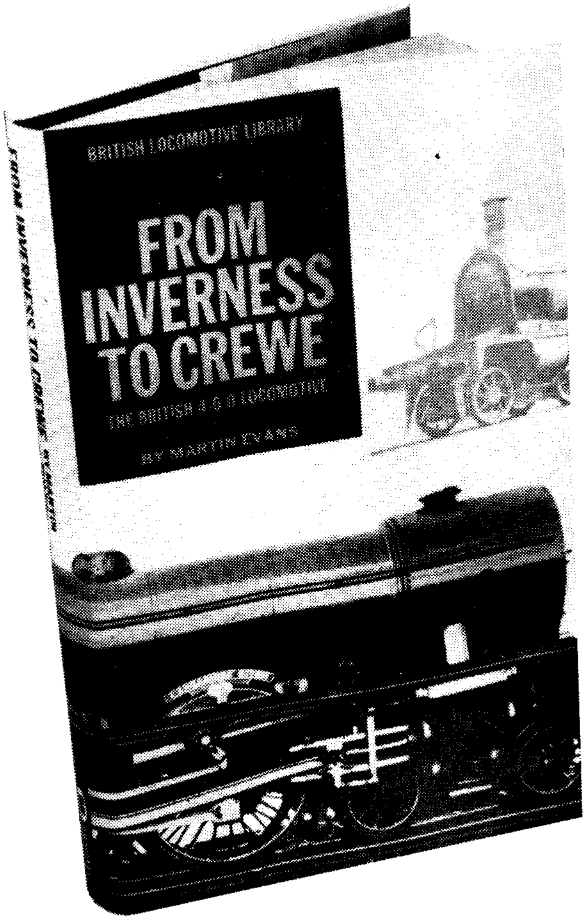

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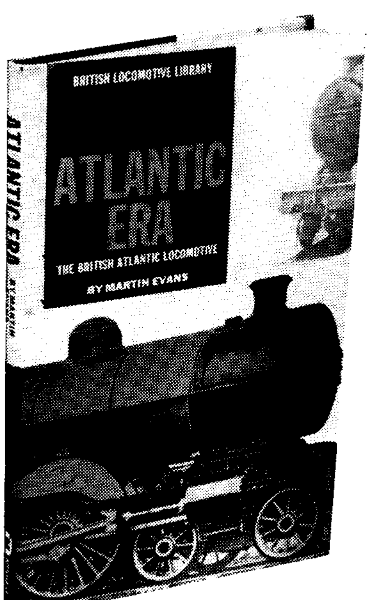

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