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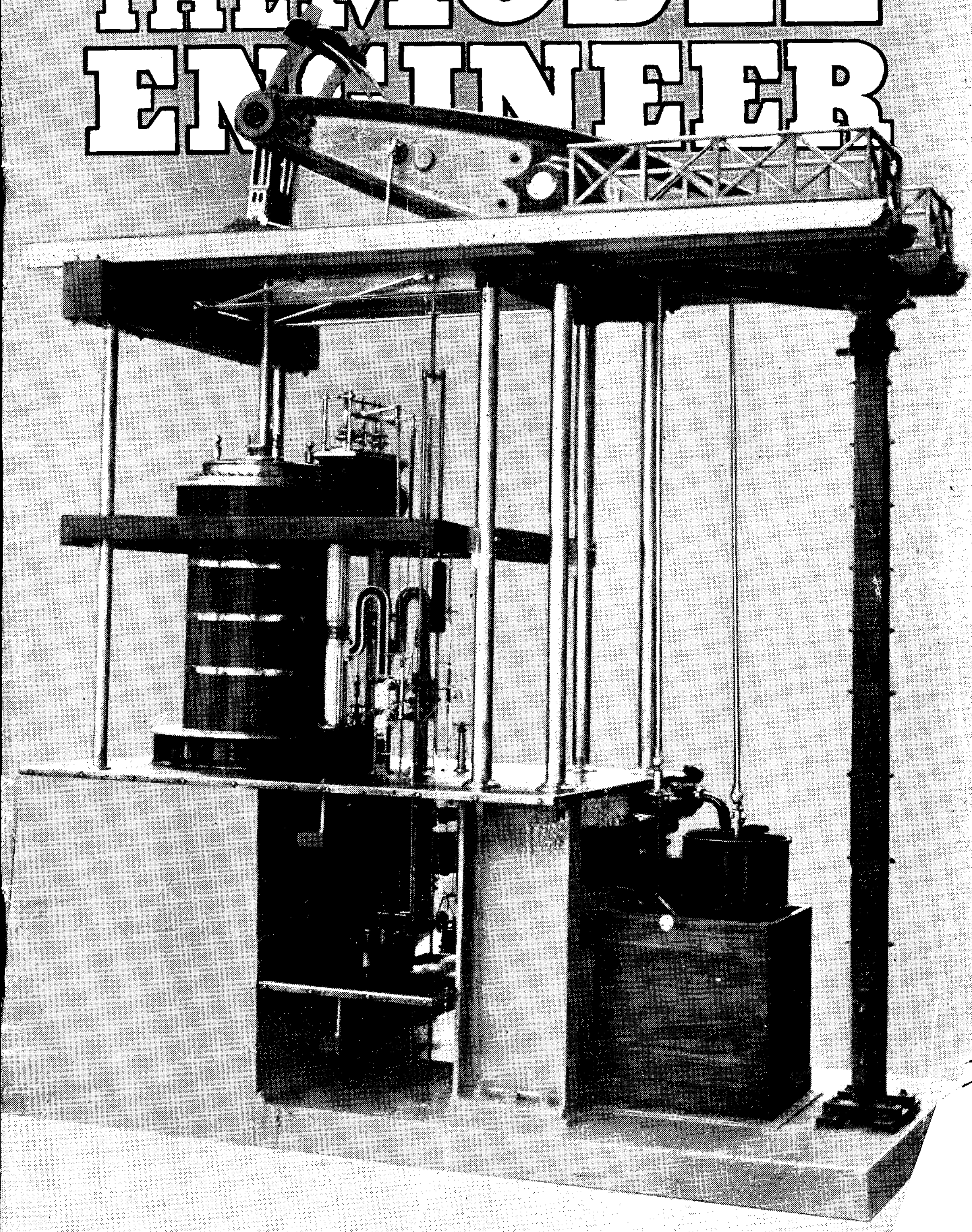
THE MODEL ENGINEER



The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

24TH JANUARY 1952 VOL. 106 NO. 2644

SMOKE RINGS

Our Cover Picture

● AS ANOTHER reminder of the old Cornish Giants, Mr. R. Jarvis's excellent model of an 80-in. pumping engine will take a lot of beating. Those who saw it at the 1951 "M.E." Exhibition expressed terrific enthusiasm for the completely authentic execution of even the most minute details.

We believe that this is the only working scale model of its type in existence, and we commend Mr. Jarvis's foresight and initiative in carrying out the copious research necessary to produce the model.

An illustrated description appeared in the issue of THE MODEL ENGINEER dated February 1st, 1951.

"Gadget-worship?"

● ONE OF our readers, in a long and interesting letter, expresses approval of the general subject-matter of THE MODEL ENGINEER, but gives us a sharp rap on the knuckles in respect of certain of its features. He suggests that far too much space is devoted to the construction of fearfully and wonderfully conceived "gadgets" for the workshop, and not enough on how to use them (or more orthodox tools) in pursuance of the purpose for which our workshops are (presumably) mainly intended; namely, the construction of models. There is a danger, he fears, that model engineering may be degenerating into mere "gadget-worship." Many readers, we know, will disagree with these conclusions, for we have found that articles of the type criticised have a very wide popularity; and the construction of tools gives scope for craftsmanship of the highest order, which is applicable also to making models of any kind. If readers enjoy this class of work, and regard it as a satisfactory end in itself, there is no reason why they should not indulge in it, even to the exclusion of what our friend calls "legitimate model engineering." There is, however, food for thought in his criticism, for, to paraphrase Ecclesiastes' dissertation on human vanity, "of the making of many gadgets there is no end," and model engineers may question the practical advisability of stocking the workshop with a formidable array of appliances which, though useful enough for their intended purpose, may only be used once in a blue moon. There is a happy medium in all things, and speaking for ourselves, we construct gadgets when we really need them, as means to an end, rather than the main or sole object of our endeavours.

Craftsmanship—Ancient and Modern

● THERE ARE many people nowadays who believe that the era of the craftsman is over—that there is no room in mechanised industry for the individual skilled worker, and that the craft and dexterity of our forefathers have departed from us. There is also a common conception that the term "craftsman" is only applicable to those who work with the traditional hand tools, or the primitive appliances of the past, and that true craftsmanship is incompatible with the use of modern tools and machines. We believe that these ideas are in error, and that craftsmanship has not declined, though it has changed, as all things must change in a changing world. A man does not cease to be a craftsman when he employs an improved tool, or a machine which enables the products of his hand and brain to be produced more rapidly, or even multiplied a thousandfold. In modern industry, the craftsman is more than ever necessary, though his work is in the background, and the superficial scrutiny of the non-technical critic may lead him to the erroneous belief that what is unseen does not exist. There is not a single modern industry which could run efficiently, even for a short period, without its "key men"—in other words, craftsmen—and progress of any kind would be still more impossible without them. In the drive for greater production, the necessity for which is so constantly brought to our notice, the effort of every worker, skilled or unskilled, is of supreme importance, but the craftsman is ever in the van of the attack on new problems and difficulties, in the endeavour to achieve higher quality and improved methods of production in all branches of industrial manufacture.

Tune Disposal

● IT IS extraordinary how, often in the midst of quite tense circumstances, when nothing could be further from our thoughts, an item of humour will dance merrily into the scene and smash a large percentage of our misgivings to smithereens.

A good example was received recently from a reader, Lieut. D. Stretton-Smith, R.N.V.S.R., and we quote the relevant portion of his letter in the belief that it may help recall similar incidents in the lives of others, though not necessarily in connection with the same subject!

"During the war I was engaged on bomb disposal and mine clearance work for the Navy, and in this capacity I worked on the Normandy beaches and port areas to facilitate the landing and the subsequent occupation of the port buildings. In one sea-front hotel, I had nearly completed my 'de-lousing' when I found a leather-bound book in the centre of an otherwise empty attic, with a small pile of tiles on top. Examination showed that the pages were dummies, and a test with a mine detector disclosed metal inside the book. I will gloss over the details of the procedure; but when the cover was finally raised, I nearly died of heart failure—to the strains of "La Marseillaise"! Unfortunately, I gave the book away on my way home to a chance acquaintance, the Second Officer of an empty tanker on whose bunk I slept for about 12 hours. He had a young daughter; I was still single at that time. I hope she was not as frightened of it as I was, at first acquaintance!"

A Famous Winding Engine Retires

● ANOTHER OLD railway engineering marvel is to join the company of famous railway relics in the York Railway Museum.

It is the historic stationary winding engine which, since 1833, has hauled trucks of coal up a 1 in 17 gradient at Swannington (Leicestershire).

Built for the Leicester & Swannington Railway by Robert Stephenson, this engine was equipped with one of the earliest examples of the piston slide valve, which, in improved form, is extensively used today on modern locomotives. It is a single-cylinder engine 18¼ in. dia. × 3 ft. 6 in. stroke with a working pressure of 80 lb. per sq. in. The "gab" gear, used by hand, enabled the engine to be started in either direction of rotation irrespective of the position of the crank.

Proposed Society for Merthyr Tydfil

● MR. R. J. MASON, of 26, Bethesda Street, Merthyr Tydfil, Glam, informs us that a society is about to be formed in the Merthyr Tydfil district.

So far, some dozen or more enthusiasts are attending a model engineering course, sponsored by the local Education Authority, at a finely equipped machine shop. The models under construction are:—one "Hielan' Lassie," one "Flying Scotsman," one "Doris," and three "Dots," as well as other various models.

Here is a chance for other local readers to join what appears to be a lively band of model engineers, and those interested should get in touch with Mr. Mason at his address given above.

The Same Old Story

● THE FOLLOWING note, which seems to have quite a familiar ring, even today, is taken from *Mechanical Progress* of March 16th, 1885:—

"Judging from the following, the editor of the Jersey City *Evening Journal* has been taking a trip on the Fontaine locomotive. 'The new-fangled locomotive with wheels all over it, and which was to run 90 miles an hour without half trying, is a failure. It is able to make this tremendous speed, but it doesn't do to handicap it with any dead weight such as cars, tender, or a plump engineman. Besides, it needs 63 miles to get under full headway, and 30 miles in which to stop. In going around a curve it is necessary to stop and spit on its hands, and take it altogether, the new idea doesn't pan out well. After all, there is no superior to the ordinary engines which have been in use for years and which have a wholesome way of attending strictly to business and making good time'."

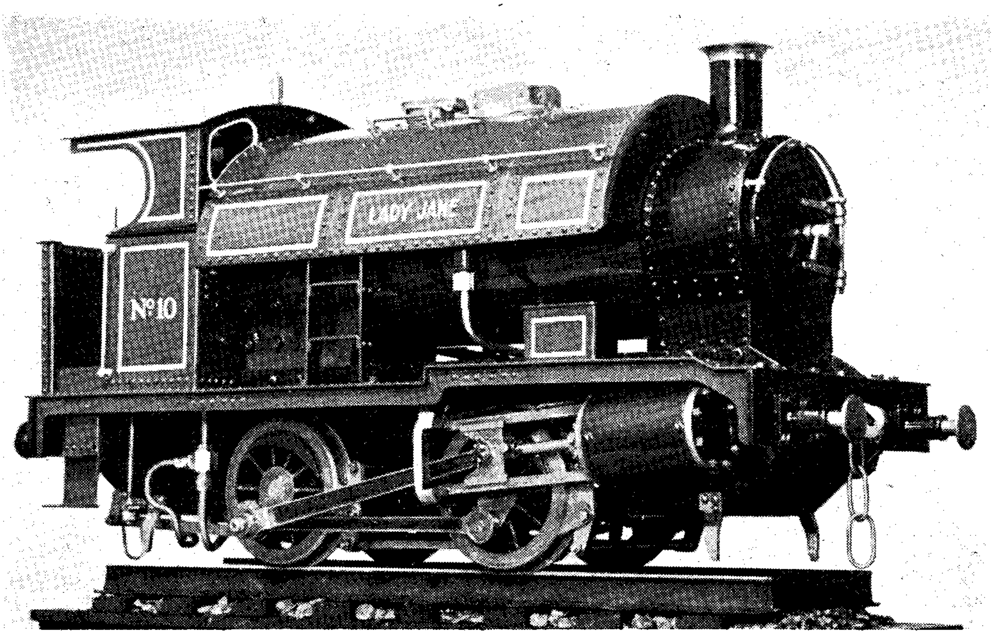
The Fontaine locomotive was an American example of the many attempts that have been made to "improve" the basic design of the orthodox steam locomotive, and was even less successful than other such attempts. The above note may be taken as typical of its normal performance, which was scarcely suitable for railway requirements.

"LADY JANE"

The Story of a First Attempt—the Outcome of an Accident

by D. Holland-Bowyer

MAY I have the pleasure of introducing *Lady Jane*, a $3\frac{1}{2}$-in. gauge 0-4-0 saddle tank locomotive? This model is my first attempt at model engineering, and is actually the rather strange outcome of a sequel to an accident I wherein I was unfortunate in "sustaining" a fracture to the radius of my right arm. The injury proved to be a very stubborn one, as the broken bone persisted in moving, and the process of setting had to be repeated three times. Due



View from road level

sustained five years ago. Had it not been for that accident, *Lady Jane* would never have existed. But please let me commence at the beginning.

I would like to mention in passing that I am 41 years of age and as far back as my childhood days I have always been a keen admirer of model locomotives. Often have I thought how nice it would be to become the proud possessor of such a model, particularly an actual working model of which one could say "Yes, I built that myself." But, although there existed throughout all these years this subdued urge to possess, the opportunity to produce such a model never seemed to become a reality. Then five years ago there occurred the accident!

At that time I little realised that the ultimate outcome of the sequel to this would actually result in the full realisation of my desires. The accident in which I was involved was a car smash

to this my arm was out of commission for a period of 19 weeks, and the state of the injured limb can be well imagined upon the final removal of the plaster case. It was literally just skin and bone and I thought that never would my arm be of use again, but after weeks of painful perseverance the muscles eventually began to show signs of restoration. My constant thought was how to strengthen those withered muscles, and I began to consider what form of exercise would produce the greatest benefit.

It was about this time that a friend began taking in THE MODEL ENGINEER and, knowing that I possessed an interest in this direction, duly passed on the copies for my perusal. Then it happened!

In one of the copies there appeared the first instalment of "Juliet" by that "grand old master," "L.B.S.C." The urge which had lain subdued for so many years now suddenly burst with life. Lo and behold, here was that opportunity which had so often eluded me! Yes, here was the very form of exercise which would do the needful regarding my arm—model engineering. Furthermore, here was a very attractive subject upon which to start.

In the eagerness and excitement of the moment, however, one vital factor was overlooked, and I suddenly came down to earth with my plans abruptly brought to a halt, with the realisation that to accomplish this venture, certain tools and equipment were needed. Apart from a few old files, a hacksaw, hand-brace with one or two drills (mostly broken), such equipment was sadly lacking. Furthermore, I did not at that time possess any form of workshop, not even a vice.

However, a very dear friend came to the rescue by kindly putting his workshop at my disposal.

So, with this offer, I made a start on a venture which was to prove extremely beneficial in more ways than one. The frames and buffer beams were the first items to be tackled. Two pieces of 1/8 in. thick steel plate together with a length of 1 1/4 in. × 1 1/4 in. × 1/8 in. angle were obtained from which these items could be cut. At this stage I decided also to make those other parts which could be produced from flat plate such as connecting- and coupling-rods, valve-gear links, rods, etc. I made this decision for two reasons: one that the exercise derived would be very beneficial and also that at this juncture I had no access to a suitable lathe whereby turned parts could be produced.

Progress, however, was rather slow and painful, but eventually, after many hours of perseverance, these parts were completed.

Three or four months elapsed since I started on this venture, and by this time my right arm had become very much stronger. The frames were duly assembled and castings for the cylinders, wheels and smokebox were purchased from an advertiser in THE MODEL ENGINEER.

Hearing of the formation in Worcester of the Worcester and District Model Engineering Society I decided to become a member. Here I found great help in the form of new friends eager to give what assistance they could. It was not long before facilities were forthcoming from certain members whereby I could machine the castings which I had previously purchased.

Many enjoyable hours were spent on the machining of these castings and thanks to the generous and friendly assistance of the members concerned, the cylinders, wheels, and smokebox were eventually completed. Such generosity and help was gratefully appreciated, but even so I decided it would be better and much more convenient to have a workshop of my own with tools, etc. where I could come and go as I pleased, without causing inconvenience to anyone. So, for a time, concentration was made in this direction.

A structure was erected at the end of my garden with bench, shelves, and racks to accommodate the tools which would eventually be needed. These were purchased as and when they were required. At this juncture expense was the great "bogey" and as the main castings had already been machined, I decided that a small lathe would suffice my requirements for the time being.

With this in view I purchased an 1 5/8-in. centre lathe and also an *ex*-W.D. converted rotary transformer as the driving unit. This was fitted up, small fixtures made out of odds and ends, bits of angle and so forth in readiness to produce some of the smaller parts of the model. The little lathe proved to be a very useful machine; in fact, I was quite surprised at the performance and what could be done with so small a lathe. The axles, cylinder covers, pistons and rods, eccentrics and straps, pump barrel and ram, axleboxes, bushes for connecting- and coupling-rods, crankpins, buffers, chimney, and numerous union nuts and tail-pieces were produced on this 1 5/8-in. centre lathe.

Eventually the stage was reached where the bits and pieces which had been made so far, could be assembled, and for the first time something like a locomotive began to take shape.

During this assembly a few rather perturbing snags began to present themselves. Due perhaps to over-eagerness and also no doubt a little carelessness, the inevitable had happened inasmuch as some of the bits and pieces refused to fit together. After much struggling and head scratching, in which I almost got my fingertips full of "splinters," it became evident that some of the parts would have to be remade. This time extra care was exercised to ensure that the new parts were correct, and upon assembling a second time, things began to go together with more ease.

With wheels quartered, cylinders erected, valve-gear, etc., fitted, I proceeded with setting the valves. Here I came up against a most awkward situation; at least, that is what I thought at the time, for during this operation one of the expansion links in the Stephenson motion became jammed and cracked. The cause of this was due to a high spot in the slot of the link which had escaped my observation before hardening, together with the fact that the link had been hardened just a little too much.

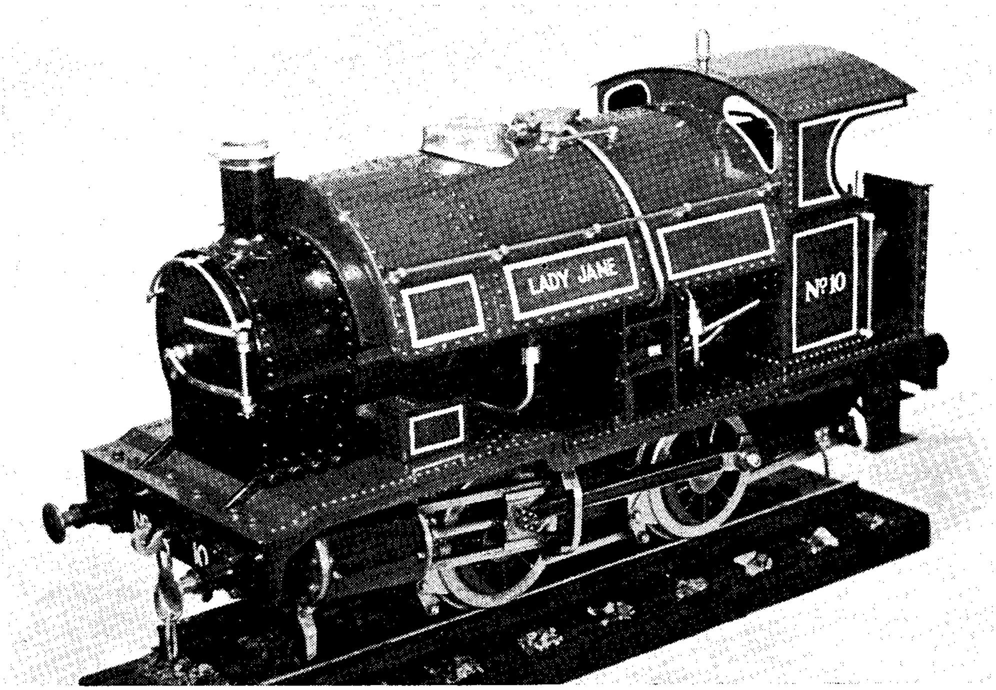
I did not entertain the idea of having to strip down all the gear again, so having removed the faulty link I considered as to the best and easiest way of overcoming the difficulty. The situation was mentioned to a friend who suggested having the broken link electrically welded. In view of all the work which had already been spent on the model up to this point, it was worth consideration, and if the worst came to the worst, new links would have to be made. I decided, therefore, to try the welding, and to my great relief it proved successful, inasmuch as the only operation needed was to remove with emery-cloth the slight scale formed during the process of welding, and to replace the repaired link back in position.

Eighteen months had now passed and by this time I had accumulated quite a number of tools of varying sorts, and also a vast amount of knowledge, together with plenty of exercise for my arm which was now more or less normal. There arose at this juncture an opportunity for obtaining a larger lathe, in fact, a 3 1/2-in. centre lathe complete with motor and accessories. This meant re-arranging the workshop which was now looking more like the proper thing. So, for the period o a few months, *Lady Jane* was put on one side while means for her completion were duly installed. This installation and re-arrangement took longer than I had imagined, as numerous difficulties and snags had to be overcome, such as grouting in and lining up the lathe, fitting of chucks, and generally preparing the machine for working conditions. Also the purchase of a small power drilling machine was added to my equipment. At last, all this was completed, and I was ready once again to proceed with the model.

So far everything had been made in accordance with the "words and music" as detailed for "L.B.S.C.'s" "Juliet." Before long all was ready for an initial air test to "see if the wheels went round." They did ; the test was successful, and I surveyed the result of my labours up to this stage with a very pleasant feeling of satisfaction. It was, however, during this initial test that I received the first impression of *Lady Jane's* power. Coupling a small truck to the chassis by a piece of cord, and connecting a motor-cycle tyre pump to the steam pipe, I instructed my five-year-old son to sit on the truck behind the chassis. Putting the reverse gear in the forward position, I applied pressure with the pump. *Lady Jane* moved off with a healthy beat, hauling her load across the floor of the room.

By now the "bug had bitten" and I was more anxious than ever to proceed.

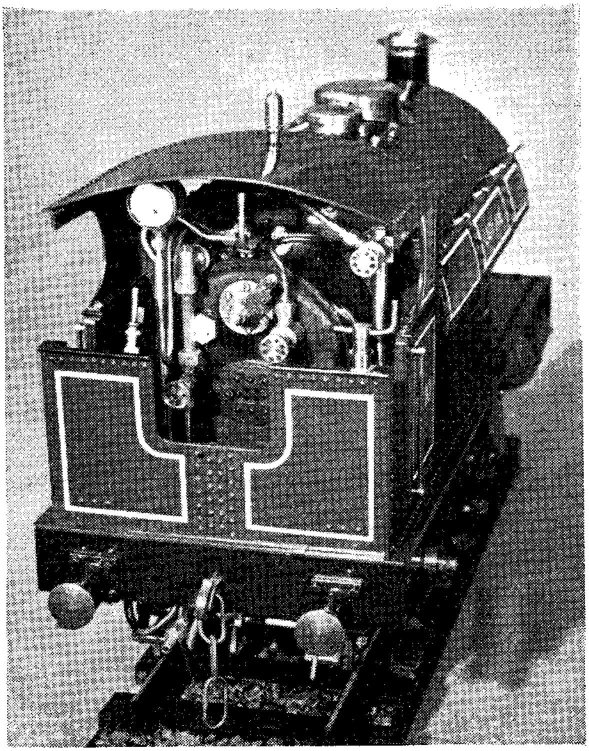
With the chassis and "works" completed, my attention was concentrated on the details of the boiler. As this is perhaps the most vital part of a locomotive it was essential that the construction should be undertaken with every care. Suitable material being obtained, the plates for the firebox, throatplate, backhead and tubeplate were cut to shape and in turn flanged, drilled and temporarily riveted together. The barrel, wrapper, and tubes were formed, cut to length and the barrel and wrapper butt strap riveted. The operation of brazing, however, had to be postponed for a time, as I lacked the necessary equipment. Still, this would keep for a while and there remained plenty to do.



Her ladyship, "Lady Jane"

In studying the design as originally set out in THE MODEL ENGINEER I considered that fitting of a working brake gear would improve the appearance, as without brakes, the model seemed to be incomplete. I sorted out some odd bits of steel plate from a collection which, by this time I had accumulated, and set to work to make the parts forming the brake assembly. Blocks were cut and turned to the correct radius, hangers, pins and rods were filed up, drilled and fitted into position. The brake is hand operated by means of the usual screwed shaft engaging in a swivel nut mounted on one arm of a bell-crank lever. All the necessary pieces being made, the final fitting of the operating column completed the assembly. And, yes, it worked efficiently too, locking all four wheels upon application.

Time was passing, in fact, two years had now elapsed since the commencement of the model, but due to other certain pressing duties, domestic and otherwise, *Lady Jane* had to be put once again on the shelf. It was somewhere in the region of eight months later that progress on the model could proceed.



The driving end of "her ladyship"

During this time I had acquired a large number of obsolete copper half-tone printers' blocks, knowing that such would be extremely useful, inasmuch as the tanks, running boards, cab, backplate etc. could be made from these plates. They proved to be nice soft workable copper, in fact, a joy to use. I mention "tanks," as I had originally intended fitting side tanks as per "words and music," but at this stage a departure from the original was made. I calculated the difference in capacity between side tanks and saddle tank and concluded that the fitting of a saddle tank would provide almost twice the amount of water. Further, my contention was, that fitted with a saddle tank, the model presented more the appearance of what I considered she should be—"an industrial shunting locomotive." To acquire correct detail for this change in design, I required an illustration of such a locomotive and eventually I found this in an advertisement of a locomotive building firm in one of the well-known engineering journals.

The running boards were cut from the half-tone electrotype plates, drilled and riveted together, then fitted to the chassis. Again my attention turned to the boiler, as the saddle tank could not be made until the boiler had been brazed together, and fitted on the frames of the chassis. But still I was without brazing equipment and something had got to be done about it. It is strange how certain things happen, particularly the unexpected. In the course of wondering which type of equipment would best do the job, blowlamp or oxy-acetylene, the question was raised during a conversation with an interested acquaintance. Upon learning of my dilemma he immediately offered help in the direction of getting the boiler brazed for me. This was undoubtedly a most kindly and generous offer of assistance. Under my supervision this was accomplished with little difficulty and after testing, the completed boiler was erected in its place on the chassis. The progress of the tank was now plain sailing, and again the copper half-tone plates were brought into use. To make the tank, thirteen pieces were cut, flanged, bent, drilled, and riveted together. This was a rather tedious job, as the plates forming the fabrication had to be temporarily assembled and dismantled several times in order to obtain the correct shape and size. While the cab was in course of production, the cab and backplate were fabricated at the same time to ensure the one fitting with the other. Final sweating of the tank seams with soft solder completed the operation. Strainer boxes were made and fitted, one on each side of the base of the tank with twin feed pipes connected to the axle pump between the frames. An inner dome was turned up, drilled and fitted to the pad on the boiler, passing through a tubular opening in the saddle tank. The safety-valve passes through a similar opening at the rear end of the tank. An outer dome of the squat pattern secures the tank in position by a countersunk central screw, screwing into the top of the inner dome. Over six gross of $\frac{1}{16}$-in. copper rivets were used in this fabrication. There now remained the backhead fittings, the grate, regulator, superheater and piping. With the exception of a few small details here and there, these were all made in keeping with the original design. The clack valves were situated, one each side the blow-down valve on the backhead due to lack of space on the sides of the boiler barrel. The grate also had a slight modification in the form of a hinge one-third along its length, giving a tipping action into the ashpan, the latter being a fixture to the base of the firebox. This was so arranged to prevent ash falling on to the eccentrics directly underneath.

So, with the remaining bits and pieces, and the usual trimmings, such as handrails, etc., being duly fitted, I surveyed the work of my labours extending over $4\frac{1}{2}$ years of real happy time. Here, at last, was the realisation of my desires. Only one

(Continued on page 105)

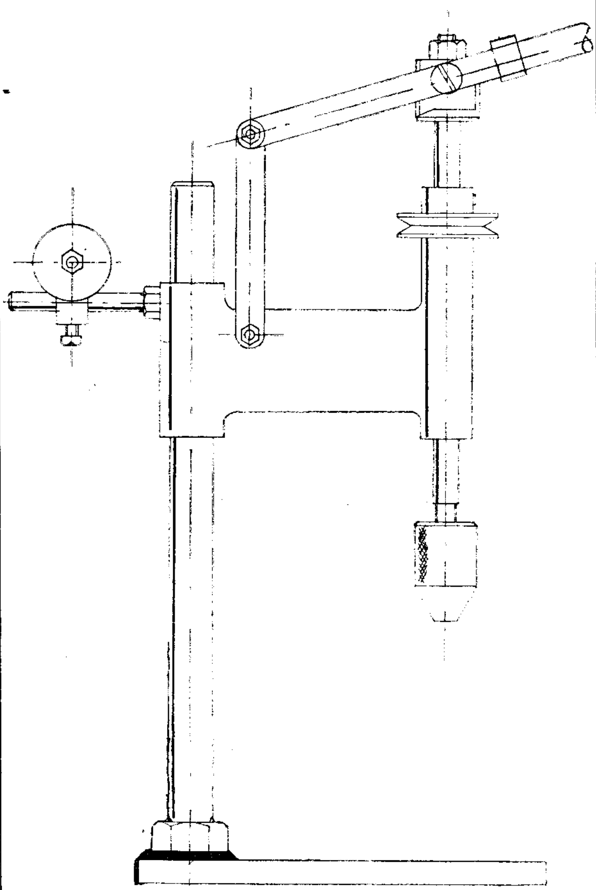
A $\frac{1}{4}$-in. CAPACITY DRILLING MACHINE

by F. T. Leightwood

ALTHOUGH I have a hand-ratchet with a capacity far in excess of my requirements, but which was more than useful when I installed my lathe, I had nothing better for drilling small holes than a $\frac{1}{4}$ in. Stanley wheel-brace. This useful tool is very handy for drilling wood, aluminium, and other soft materials, but I wanted something that would drill small holes safely in any material, and, utilising the Stanley chuck, would take up to $\frac{1}{4}$ in.

First of all I turned a mandrel, No. 2 Morse-taper to fit the tailstock of the lathe (and the headstock, too) screwing the nose $\frac{7}{16}$ in. × 26 t.p.i. to suit the chuck. This took care of drilling in the lathe, and also by mounting an angle-plate on the boring-table, I could drill holes in work held against the plate with the chuck in the lathe mandrel. This method was a big improvement for $\frac{1}{4}$ in. to $\frac{3}{16}$ in. but for smaller sizes, I couldn't treadle fast enough.

This state of affairs existed until one day I noticed a small casting on the scrap-heap at work, consisting of two cylindrical portions connected by a thick web. One of the cylindrical portions was drilled and reamed $\frac{7}{8}$ in., and a boss on the side was drilled $\frac{5}{16}$ in. (for a $\frac{1}{8}$-B.S.P. lubricator) which was simply asking to be tapped $\frac{3}{8}$-in. B.S.F. for a locking screw. This then was the start of my drilling machine. I gained permission to take the casting, and so it came about that I put my models to one side while another addition was made to my equipment.



General arrangement

The casting was first mounted on the boring-table with the $\frac{7}{8}$-in. bore parallel with the lathe's axis and the spindle bore opened out to $\frac{1}{2}$ in. in easy stages, the last two being a 31/64-in. drill and a $\frac{1}{2}$-in. reamer. Before using the reamer, the top of the hole was counter-bored to $\frac{3}{4}$ in. for the phosphor-bronze bush, using a flat-cutter to finish this, as a machine-reamer of that size would be an extravagance which I cannot afford, the $\frac{1}{2}$-in. reamer being one of my very few.

The drilling end tapping of a $\frac{3}{8}$-in. B.S.F. hole near the top of the casting for the arm which carries the jockey pulley and the tapping of the holes in the side for the clamping-screw completed the machining of this component and the next job was the phosphor-bronze bush. This is just a simple turning job. The bore is a shade more than $\frac{1}{2}$ in., as it is not intended to take any thrust and the outside diameter is a good press-fit in the head.

In order to save myself some hard treadling I made the pulleys of aluminium alloy, the jockey-pulley running on phosphor-bronze bushes, $\frac{5}{16}$-in. bore, $\frac{1}{2}$ in. outside diameter, and the driving pulley is pressed on to a steel boss or centre. This centre is bored out $\frac{1}{2}$ in. to fit the spindle and counterbored a running fit on the bush in the head-casting. In order to transmit the drive to the spindle a key $\frac{1}{4}$ in. × $\frac{1}{8}$ in. × $\frac{1}{8}$ in. was made by screwing a high-tensile bolt ($\frac{1}{4}$-in. B.S.F.) into the hole drilled and tapped in the steel centre (see section drawing) up to the end of the thread. This was then marked and cut down so that only

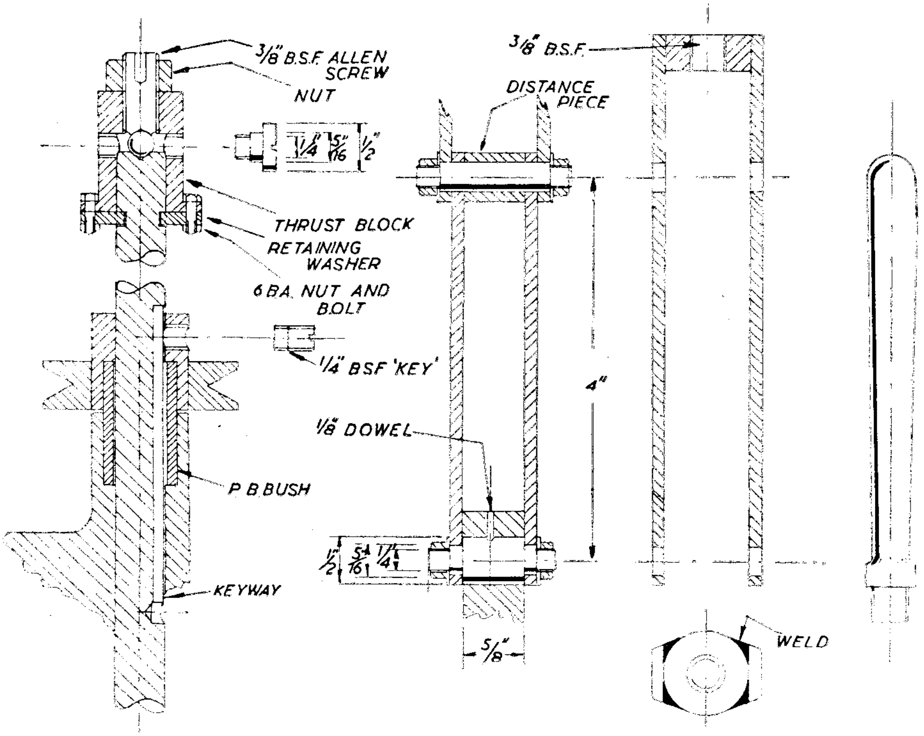
$\frac{1}{8}$ in. of thread protruded into the bore, this part being filed to $\frac{1}{8}$ in. wide to form the key.

The spindle itself is a length of $\frac{1}{2}$-in. silver-steel reduced to $\frac{7}{16}$ in. and screw-cut to suit the chuck and grooved at the other end to $\frac{3}{8}$ in. diameter × 9/64 in. wide to take the retaining washer.

In the "Stanley" wheel-brace (like, I suppose, a good number of other machines of its type) the thrust is taken by a single steel ball, and as it seemed to be doing the job all right and couldn't be any simpler, I decided to use this method, too.

The thrust block, a chunk of $1\frac{1}{4}$ in. diameter mild steel, was bored $\frac{1}{2}$ in., and drilled and tapped $\frac{3}{8}$-in. B.S.F. for the Allen grub-screw at one setting to ensure accurate alignment of the tip of the Allen-screw and centre in the end of the spindle, between which the steel ball is positioned, and the bottom face which carries the retaining washer is also faced up at the same time. The sides of the thrust block were milled to $\frac{7}{8}$ in. wide and the $\frac{1}{4}$ in. B.S.F. holes for the thrust-screws were drilled and tapped in the lathe in order to ensure they were at right-angles to the bore and the milled faces.

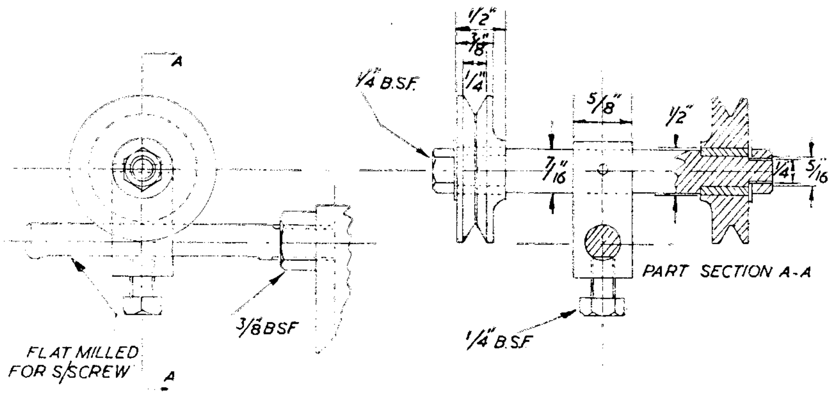
As the retaining washer is divided to fit the spindle I used two pieces of $\frac{5}{8}$-in. × $\frac{1}{8}$-in. B.D. mild-steel $1\frac{1}{4}$ in. long roughed to shape with hacksaw and file and sweated edge to edge on a piece of plate. This was then turned on the faceplate, the hole being 25/64 in. to clear the bottom of the groove. Before removing from the plate, the washer was clamped to the thrust-block by a $\frac{3}{8}$-in. bolt and the 6 B.A. clearance holes drilled (by hand). The lever and the links were drilled together in the lathe to ensure accurate alignment in order that the lever will work correctly and not cause the thrust-block to bind on the spindle. To complete the lever, a short piece of $\frac{7}{8}$-in. bar was drilled, tapped $\frac{3}{8}$-in. B.S.F. and faced, this was then clamped between the sides of the lever, and, along with the baseplate to which was clamped a $\frac{7}{8}$-in. nut, was placed in my saddle-bag and off I went to see a man about a welding job.



Thrust block, pulley and spindle *Links* *Lever* *Handle*

On my return I screw-cut the lower end of the column to suit the nut and the column was polished to allow the casting to slide freely. To complete the machining, the links, thrust-block and pulley were assembled to the head casting and the spindle fitted. The limits of the vertical movement were then marked off on the spindle through the $\frac{1}{4}$-in. B.S.F. hole in the pulley. A 17/64-in. hole was drilled below the lower mark, $\frac{1}{8}$-in. deep, and this was used for the start of the keyway. For want of a better tool I used a $\frac{1}{4}$-in. end-mill, but I could have used a lot more speed than I attain with the treadle, and I think a fly-cutter might have been an improvement.

The jockey-pulley bracket consists of a short piece of $\frac{5}{8}$ in. square bar drilled $\frac{3}{8}$ in. for the arm and $\frac{7}{16}$ in. for the pulley spindle. The pulley spindle is cross-pinned in position while the assembly is locked after adjusting the belt, with



Jockey pulley assembly

a set-screw (as there is only one step on the driving pulley this is set and locked).

To assemble the spindle, the thrust block is placed over the end of the spindle and the retaining washer is fitted. The steel ball is dropped in (with a dab of grease) and the Allen-screw fitted, with its nut. The Allen-screw is eased off until the spindle is free and the nut locked.

The pulley is slipped over the spindle and the 17/64-in. hole in the spindle lined up with the tapped hole in the pulley and the key screwed in. At first the key fouled the bottom of the keyway and careful filing cleared this. The spindle was next fitted to the head and the links connected up to the thrust-block.

At this point I realised that I had no means of lifting the spindle to the top of its stroke and so I fitted a light spring round the spindle, between the pulley and a small collar locked on the spindle with two 6-B.A. screws, just below the thrust block. This way, the pulley is kept down on the bush by the spring against any tendency to rise with the spindle, without the need of any other device (outboard bearings, etc.).

To drive the machine I use ¼-in. round belting passed round a groove turned in the rim of the "driver" plate. This gives a spindle speed of over 1,000 r.p.m. which is much better for handling small drills than any other method I possess, and when the great day arrives when I can use an electric motor, well, there will be six changes of speed and the top r.p.m. will be much higher.

Lubrication is a simple matter. The spindle is lubricated by lifting the pulley against the spring and squirting a little light oil down the keyway, the 17/64-in. hole acting as a reservoir distributes this oil throughout the bearing.

The thrust-block is best lubricated by removing one of the thrust screws which allows oil to be applied directly on to the ball.

A modification which I have found necessary is to lengthen the links for the thrust-lever and fit a longer spring. The original movement was rather restricted but this spindle has over 2 in. travel now. Finally, I intend to fit a longer column to allow room to fit a table, maybe a tilting one at that.

"LADY JANE"

(*Continued from page* 102

thing was now lacking—a coat of paint. So with paint and brush the final touches were applied and finally *Lady Jane* stood before me in all her glory of green, black and maroon, and as I gazed a pleasant feeling of immense satisfaction and pride possessed me. I had accomplished my desire. I had built *Lady Jane*.

Up to the time of writing she has only been tried out on air and she certainly runs most beautifully. Her steam trials are yet a further thrill in store.

Yes, this is my first attempt at model locomotive building and I may say that the urge to continue is stronger than ever. So much so that some day in the not very distant future *Lady Jane* will have a big sister to keep her company. This will be "Britannia" which already is making progress.

Did I hear an enquiry regarding my right arm? Well, I am pleased to say that apart from being somewhat distorted it is perfectly normal, thanks to model engineering. I had almost forgotten it was ever broken. It is most certainly very strange what can be the outcome of an accident!

CAMERA DESIGN

An article of great importance to every reader whose interest centres on the field of photography

by Raymond F. Stock

THERE is a growing interest amongst model engineers in the construction of their own cameras and photographic equipment, and the following notes are intended to help those who may be less familiar with photography than with modelling.

An article of this nature can do no more than suggest a few of the problems of design and indicate some of the common solutions, and it is earnestly suggested that any intending constructor should borrow from the library a good standard work on photography and study chapters on lenses, shutters and types of camera before deciding on a layout.

In order to appreciate certain factors in design it is necessary to cover the essentials of camera optics, hence the ensuing section on lenses: this contains only the minimum theory and the simplest of mathematics, for which I apologise to more photographically-minded readers.

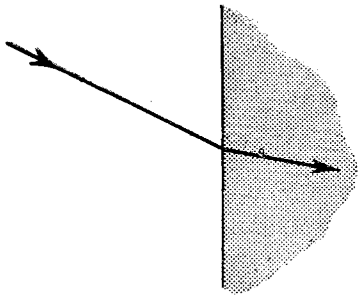


Fig. 1(*a*). *Refraction at a glass surface*

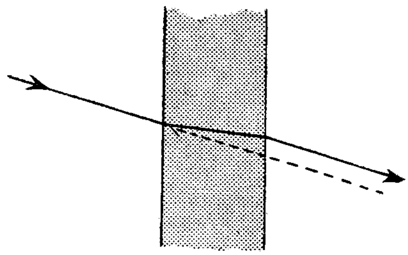


Fig. 1(*b*). *Parallax*

Optics

When a ray of light passes from air to glass at any angle other than 90 deg. it is bent or *refracted* as shown in Fig. 1(*a*).

If the ray emerges from the other side of a parallel glass block it is refracted equally in the opposite direction so that it continues parallel with its original path but displaced to one side as in Fig. 1 (*b*). This effect is known as *parallax.*

When the sides of the glass block are not parallel the ray of light is permanently refracted from its original direction as in Fig. 2 (*a*).

This effect is the basis of lens action. A lens is a glass solid bounded (on its working faces) by portions of spheres of any radius to infinity (i.e. a flat plane) and rays incident on one face are converged toward the centre line or *optical axis* as shown in Fig. 2 (*b*).

Lenses of this type which converge rays of light are known as *positive* lenses, and may be divided into three basic classes, named in Fig. 3(*a*).

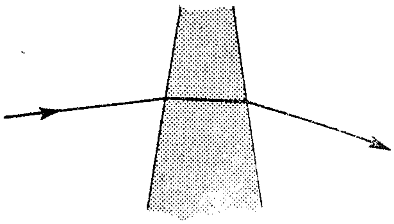


Fig. 2(*a*). *Refraction of light through a tapered glass block*

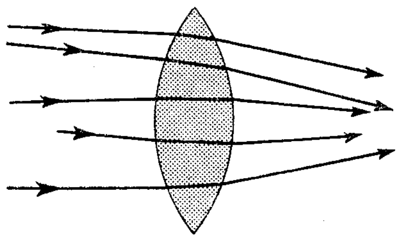


Fig. 2(*b*). *Converging effect of a positive lens*

Lenses may also diverge rays of light from the axis and are then known as *negative* lenses—the corresponding classes being illustrated in Fig. 3(*b*).

Positive lenses are "magnifying" lenses and, except such examples as will be shown later, are the only type used in photography. For the purpose of this section a double-convex lens will be illustrated, but the principles and theory apply

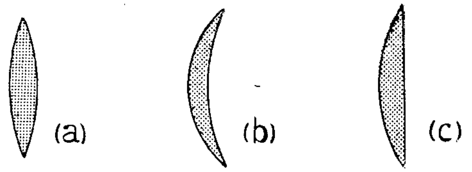


Fig. 3(*a*). *Positive lenses* (*a*): *double convex* ; (*b*) *meniscus* ; (*c*) *plano-convex*

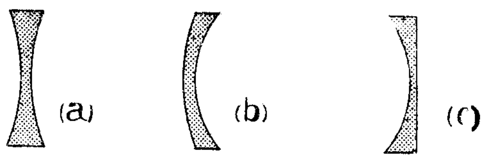


Fig. 3(*b*). *Negative lenses* : (*a*) *double concave* ; (*b*) *concavo-convex* ; (*c*) *plano-concave*

to any form of positive lens, however constructed.

In Fig. (4) it will be seen that parallel rays of light are falling on one face of a lens : it is an inherent property of such a lens that these rays are refracted towards one point : this point is called the *principal focus*, P.F.

The distance from the *optical centre** to the principal focus is the *focal length* of the lens.

It will be seen that any incident ray coinciding with the optical axis is unchanged in direction ;

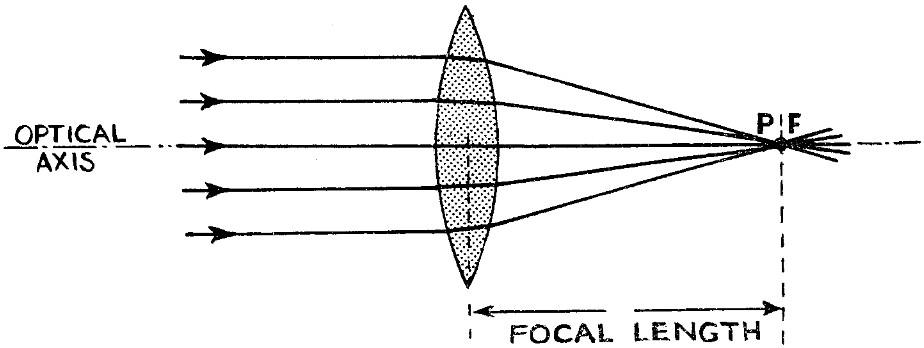


Fig. 4. *Principal focus*

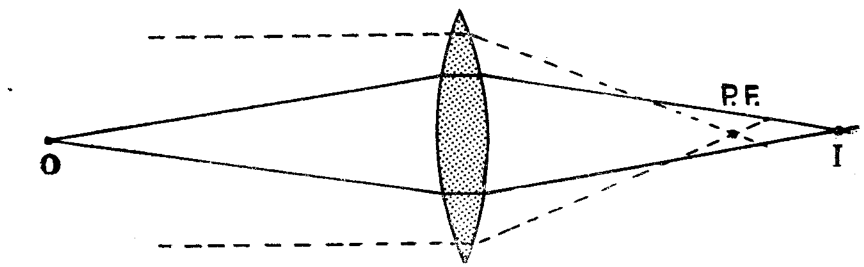


Fig. 5. *Object and image points*

and it is found that any ray originally directed towards the optical centre of the lens retains its original track. (This is only true of a lens with negligible thickness, but is a sufficiently close approximation for practical examples.)

The parallel rays incident on the lens in Fig. 4 might be supposed to come from a very remote point source of light, e.g. a star, but in photography we are generally concerned with photographs of objects rather nearer than this : Fig. 5 shows an object **O** and its image **I** and it will be seen that the image point lies farther from the lens than the principal focus : it is, in fact, a general rule that the closer the object to the lens, the farther away is the corresponding image, and naturally the two distances are related by a simple formula :

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v} \qquad \qquad (1)$$

where F = focal length
u = object distance (to optical centre)
and v = image distance (to optical centre).

Thus with a lens of 6 in. focal length an object point 30 in. away is brought to a focus $7\frac{1}{2}$ in. away :

$$\frac{1}{6} = \frac{1}{30} + \frac{1}{v}$$

$$\text{or} \quad \frac{5}{30} = \frac{1}{30} + \frac{4}{30}$$

$$\text{i.e. } \frac{1}{v} = \frac{4}{30} \text{ hence } v = \frac{30}{4} = 7\tfrac{1}{2} \text{ in.}$$

* The optical centre of a double convex lens is its physical centre. It is less simple to find in other types of lens (though it always lies on the optical axis) but fortunately its exact position is seldom needed in practical work.

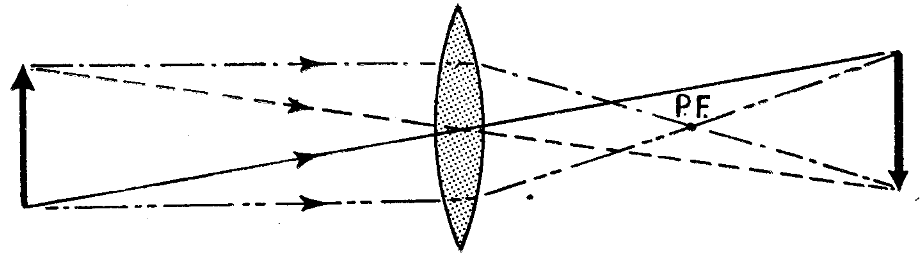


Fig. 6. Image formation

Equation (1) may for convenience be expressed as :

$$v = \frac{u \times F}{u - F} \quad \ldots \quad (2)$$

The terms F, u and v are in common use and, together with the indispensable equations (1) and (2) should be noted.

Practical photography is concerned with real objects rather than points, and Fig. 6 shows how an image of a real object is formed. Two points only are plotted, but these are sufficient to fix the limits of the arrow : similar reasoning could be applied to fix the position of any number of object-image points, in any planes, so that a three-dimensional image could be built up from a corresponding object. It will be seen that the position of any point is fixed by drawing two of the rays supposed to be radiating from it : one parallel with the optical axis (and therefore refracted towards the principal focus) and one through the optical centre (and therefore unchanged in direction). The intersection of the emerging rays provides the image point required.

It is on this basis that all camera lenses form images, and provided the principle is understood it will not be necessary to use the geometrical construction in practical work.

It should be evident that the closer the object approaches to the lens the larger the image will be, and image size is connected with u and v by the following simple equation :—

$M = \frac{v}{u}$ where M = magnification of image (generally a fractional quantity).

In the example quoted before, v was $7\frac{1}{2}$ in. and u was 30.

Thus $M = \frac{7\frac{1}{2}}{30} = \frac{1}{4}$

That is, the image would be $\frac{1}{4}$ full size.

The image is full size when $v = u$ and at this point v (and u) is found to be equal to $2F$.

Thus in order to photograph an object full size (on the negative) the lens must be capable of being moved away from the plate to a distance of twice the focal length of the lens.

So far the diameter of the lens has not been mentioned, as it does not affect the process of image formation : it is, however, most important in determining the "illuminating value" of the lens, i.e. the brightness of the image.

The value of an image for producing the necessary chemical changes in the plate is determined by the diameter of the lens and the focal length, thus :—

$$f = \frac{\text{Focal length}}{\text{diameter}}$$

where f is the standard symbol for lens *aperture*.

Thus different lenses may have the same f value, e.g. an 8 in. lens of 1 in. diameter = $f8$ and a 4 in. lens of $\frac{1}{2}$ in. diameter = $f8$.

It is important to be able to know and to vary the effective aperture of a lens in order to control the exposure : hence the fitting to most lenses of a *diaphragm* to regulate the working diameter.

Apart, however, from questions of exposure it is most desirable to be able to reduce the aperture for the following reason.

Any three dimensional object produces a three dimensional image inside a camera, and since a film or plate presents a plane surface most of the image lies within or beyond the position of the plate, i.e. it is "out of focus."

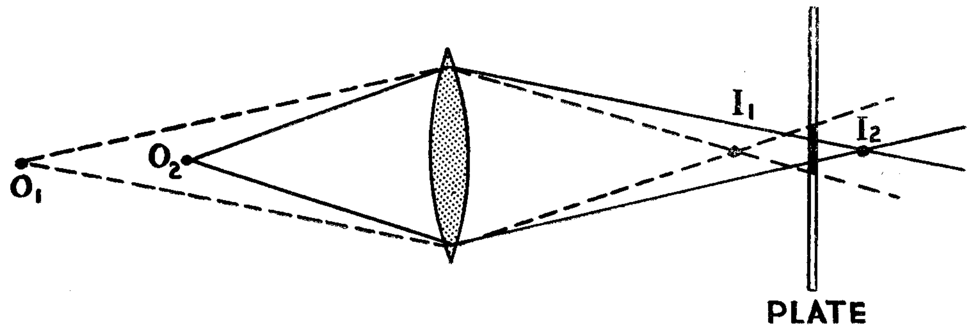


Fig. 7. Circles of confusion (shown black on plate)

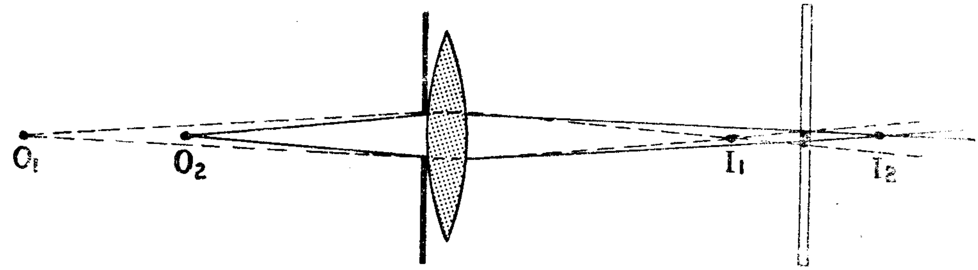


Fig. 8. Effect of reduced aperture

This is demonstrated in Fig. 7 where image points I_1 and I_2 (from object points O_1 and O_2) are represented on the film by small circles, actually cross sections through the cones of rays.

This effect is unavoidable but if the diameter of the lens is reduced as shown in Fig. 8 the circles are smaller; these small circles, representing actual points, are known as *circles of confusion.*

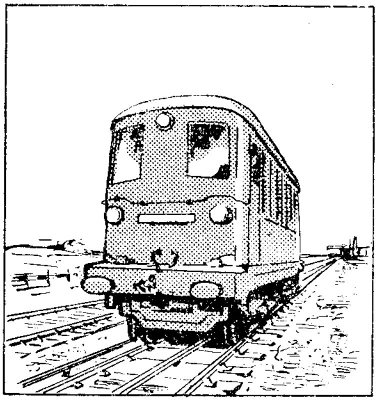


Fig. 9

Only one plane in any photograph can be truly sharp but generally a region within certain limits can be accepted, and the limits will depend upon the *stop* or diaphragm size in use, and the degree of sharpness expected: obviously, a greater degree of clarity is required in a photograph of a machine than in a portrait (where, indeed, it may be quite undesirable).

A circle of confusion of about 1/100 in. is commonly regarded as "sharp" but it must be remembered that this is in the final print: if the negative has to be enlarged the circle of confusion acceptable in the negative must be reduced proportionately with the degree of enlargement.

Fortunately, it is not necessary to make calculations on this subject as photographic manuals invariably give "depth of focus" tables which show the limits of acceptable sharpness either side of the focussed distance, for various combinations of f number and focal length. It is nevertheless a most important factor in the photography of models and it may be worth while to digress from theory for a space to illustrate the practical effect.

Assume that we photograph an electric locomotive, 30 ft. long, and the effect obtained is as in Fig. 9. The perspective is such that the further end appears half the size of the nearer end—indicating that the camera was twice as far away, i.e. 30 ft. from the cab front. The plan view of the arrangements is as in Fig. 10 (*a*), and assuming we use a lens of 6 in. focal length the image distance (v) of the front end will be from (2)

$$v = \frac{360 \times 6}{360 - 6} = \frac{2160}{354} = 6.102 \text{ in.}$$

For the rear end

$$v = \frac{720 \times 6}{720 - 6} = \frac{4320}{714} = 6.050 \text{ in.}$$

a difference of .052 in.

If the film is arranged to be midway between the focal limits the maximum error will be .026 in., which, with the lens working at 1 in. diameter (f6), means a circle of confusion of about 3/1000 in.

Assume that we now wish to photograph a 1 in. scale model of the locomotive, the distance of the camera must be scaled down in proportion, to obtain the same perspective and viewpoint. The corresponding arrangements are shown in Fig. 10 (*b*) and here the difference between the focal points for front and rear is enormous.

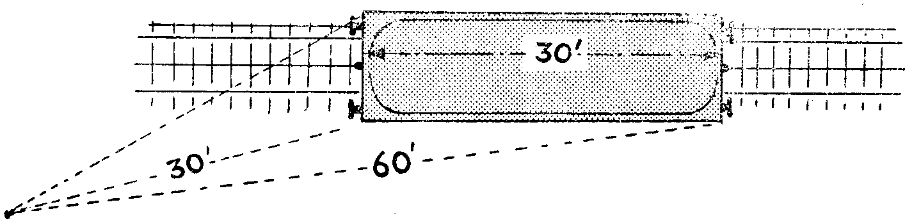


Fig. 10(a)

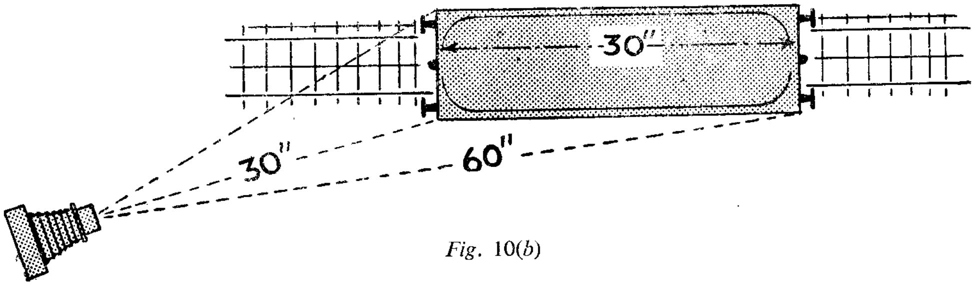


Fig. 10(*b*)

u (front) = 30 in.

$$v = \frac{30 \times 6}{30 - 6} = \frac{180}{24} = 7.5 \text{ in.}$$

u (rear) = 60 in.

$$v = \frac{60 \times 6}{60 - 6} = \frac{360}{54} = 6.666 \text{ in.}$$

a difference of 0.833 in.

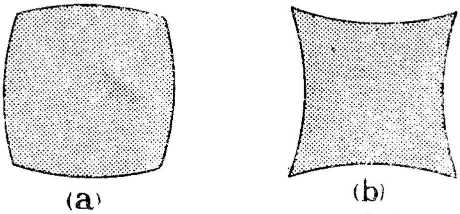


Fig. 11. *Exaggerated illustration of distortion produced by using a stop* (*a*) *before and* (*b*) *behind a single lens. Image should be square*

Applying the same reasoning as before, the circle of confusion will be over 50/1000, a quite unacceptable figure.

Thus to get comparable results in photographing a model, one would require a scale camera making scale size prints—and then scaled down eyes to see them !

This being inconvenient, the practical alternatives are to (1) use as small an aperture as possible—*f*32 is usually the minimum size fitted—and (2) to avoid such extremes of distance as are used in the above example.

The best results are obtained by using the smallest stop available, and then arranging the subject to lie within the limits denoted by a depth of focus table.

Practical Lenses

No camera lenses are as simple as those previously described. Box cameras and the cheaper folding cameras are often fitted with a single meniscus lens which is generally cemented together from a positive and negative lens. This compounding of different types of single lens—positive and negative, and from different types of glass—is a process commonly employed. The combinations used are often most complex and the aim is to reduce all the faults or *aberrations* of the complete lens to negligible proportions.

The single meniscus lens referred to above is generally not used with apertures above *f*11, and if acquired separately from its mount should be fitted with a suitable diaphragm to restrict its aperture. The diameter of the stop may easily be found once the focal length is known, and the latter is simply arrived at by the obvious process of focussing a distant object (e.g. the moon) on to a sheet of card and measuring the distance from lens to image. Although the optical centre may not be known it will be sufficiently accurate to measure to the back of the lens (the concave surface).

Though a relatively " slow " lens the meniscus is capable of producing excellent results on subjects such as models, where, in any case, a small stop would be employed ; an additional virtue is cheapness.

Generally, this type of lens is retained in a counterbore by a spring circlip or thin flange on commercial cameras, but if a mounting ring or holder is provided this may be incorporated with the diaphragm mechanism.

With any single lens the diaphragm must lie to one side or the other, and it is found that some

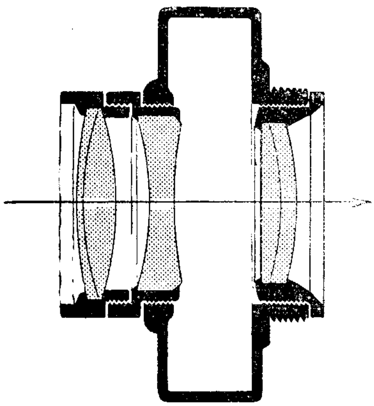


Fig. 12. *Three lens elements in shutter housing*

distortion of the image occurs either way, as shown in Fig. 11. Generally, the stop is used in front of the lens, and the resulting distortion is quite small.

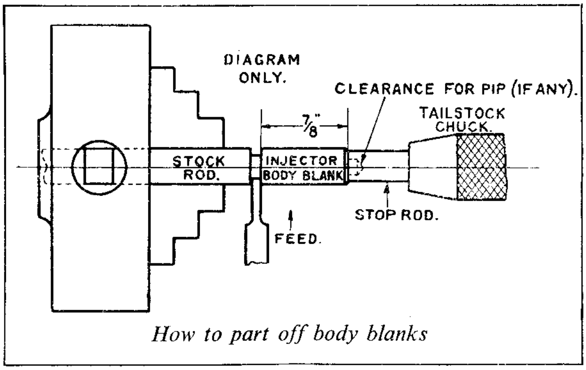
The more complicated lenses used on expensive cameras consist of two, three or more separate elements each of which may consist of more than one lens cemented together. The individual elements are fitted into brass or duralumin mounts which have fine threads cut in them so that they may be screwed accurately together and to the lens backplate or other supporting member, as for example in Fig. 12.

(*To be continued*)

"L.B.S.C.'s" Lobby Chat

How it is Done—Hints on Mass-producing Small Injectors

THIS week, by way of a change, I propose to take you, in fancy, into my workshop, and spill a few beans on a matter that apparently puzzles most of my correspondents, especially new readers. It used to puzzle my few personal friends, too, until I did a bit of explaining and demonstrating; and even now, they find it hard to believe. The writing, drawing, and correspondence involved in these articles, and the bit of experimental work that must be undertaken to guarantee results, is a full-time job for a much younger person than your humble servant. In addition, there is my railway to maintain, and improve where possible; for example, the automatic signalling that I installed some time ago, wasn't exactly a "five-minute" job, and took a little scheming out, beside the actual work involved. My fleet of locomotives sometimes need running repairs, same as their full-sized sisters; things won't last for ever, and my engines work hard. *Ayesha* is now busy burning out her tenth set of firebars! Also there is new construction; I'm building, not only a 3½-in. gauge *Britannia*, but two other experimental locomotives. Then there are domestic chores; in my workshop is a No. 3 Ideal boiler that heats the house *via* radiators (learned that trick in U.S.A.) and sees to the domestic hot-water supply. This merchant takes over an hour each day, cleaning the fire three times, and emptying the ashpit twice. It wouldn't, if we could get some decent coal; but the awful muck dished out for boiler fuel (at nearly £7 per ton, when we can get it!) simply clinkers the bars, and bits break up and fall through, so that every bit has to be sifted and picked. Even if we could afford to throw away half-burnt cinders, the shortage of coal makes it imperative to sort them out of the burnt residue, and put them on the fire again.



How to part off body blanks

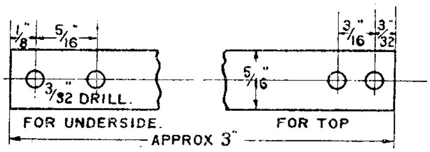
I not only do all the small house repairs (including plumbing, but not painting and decorating) but maintain my gasoline buggy and keep it clean. I've got the maintenance down to a fine art, inasmuch as my record time for decarbonising, start to finish, is 1½ hours. The car is a Series 2 Morris Twelve, which I bought new in January, 1937, and goes as well today as it did then, as our Technical Editor and Commercial Manager both can testify! My neighbours consider me plumb crazy when I do a bit of locomotive testing in cold, wet, foggy or otherwise bad weather, or in the dark; but they forget all about that when their garden shears need grinding, or the lawn-mower breaks down, or the kettle springs a leak, or the bathroom cistern suddenly overflows—circumstances alter cases! The puzzle is, how do I manage to do it all? Well, my hours are long; I have to be up before 7 a.m. in case the postman rings the bell—as he very often does—with something that won't go through the letter-box; and I seldom go to bed before midnight, after being "on the go" practically all the time. Enough to break the heart of any trade union official, isn't it? As to health—bless your hearts and souls, I've no time even to *think* about being ill; any time lost, would have to be made up afterwards.

The Solution is just "Speed"

The only way I can get through the work, is to *make speed*, and I can do this on everything except writing and drawing. Incidentally, people who write to me, and expect a reply as long as one of these weekly articles, will now know why they are disappointed; and I'll have to cut them shorter still, from now onwards. They will also understand why I can't entertain visitors, apart from my natural "company-shyness." I manage pretty well by running to a sort of timetable, and by employing methods such as I am about to describe. For some years past, around Christmas time, I have made a dozen or more weeny injectors, in a batch, to distribute as friendly gifts to good folk who have been kind to me during the year. Most readers of these notes shy pretty badly at the idea of making *one* injector (my correspondence tells a tale!) let alone a dozen; yet, tackled the right way, it is no trouble at all, as I'll endeavour to explain.

A Lesson in Home-workshop Mass Production

As those who have visited me know full well, I have a fully equipped workshop. It is known as "little Crewe," or Swindon, or Doncaster, etc., among the "heads," according to where they come from. I can build locomotives with a pedal lathe, a hand drilling machine, and a few hand tools, but couldn't make the "job-speed," as I call it, as I can with my present equipment. For new readers' benefit, this consists of four lathes (Milnes, Drummond, Boley, and Wolf-Jahn) horizontal and vertical milling machines, planer, pillar and sensitive drills, power hacksaw, jigsaw (metal cutting), small precision bench vertical mill with revolving table, two tool



Marking-off jig for body blanks

grinders, guillotine shear, bending brake, rod, tube and channel bender, rod parter, linisher, and one or two more oddments, all time-savers. The Diacro rod parter, for example, will knock off a hundred boiler-stay blanks, to precision limit of length, in less than two minutes, and all the ends will be dead square, no sign of burr, ready for screwing. I have small tools in galore, but not much in the way of jigs and fixtures—in that respect I agree with our cartoonist!

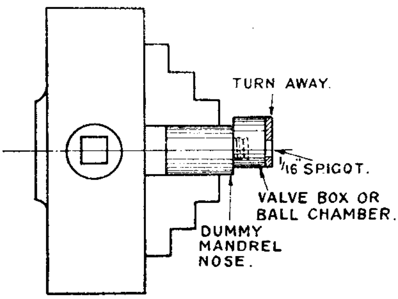
This is how I set about the injectors. First of all, I part off a dozen $\frac{7}{8}$ in. lengths of $\frac{5}{16}$ in. square brass rod for the bodies. The rod is chucked in a four-jaw self-centring chuck (useful gadget that) on the Drummond, the parting-tool set $\frac{7}{8}$ in. from the end, and a piece of ordinary round rod put in the tailstock chuck, and butted up against the end to act as stop. Part off, slack chuck jaws, pull out rod till it hits the stop, tighten chuck, part off again, and ditto repeato until there are 12 blanks lying in the tray. Next spasm, turn and screw ends, drill and ream; so over to the high-speed Boley precision lathe. Set one blank truly in four-jaw, turn the end to $\frac{1}{4}$ in. diameter for 5/32 in. length, and set both of the "mike" collars (cross and top slides) to 0 when right diameter and length are obtained. Screw $\frac{1}{4}$ in. × 40 with die in tail-stock holder. Centre, drill through No. 24, and ream 5/32 in. Put centre-drill, 24 drill, and reamer on bench where they can be grabbed easily; ditto die holder. Slack jaws 1 and 2 of four-jaw chuck, reverse piece of $\frac{5}{16}$ in. rod, tighten same jaws, and turn down other end to dimensions above, no measurement being needed, simply setting the "mike" collars to 0, and taking the one cut. Run the die on, and there is a body blank, drilled, reamed, and screwed both ends. Slack jaws 1 and 2 again, pop in another bit of rod, tighten same jaws, and repeat sequence of operations, which can be done like greased lightning, as the tools are right under my hand, and there are no measurements to make.

Drilling Bodies and Fitting Ball Chambers

A jig (courtesy title!) is used for marking where to drill the holes. This is a strip of 16-gauge metal $\frac{5}{16}$ in. wide, about 3 in. long. At one end there are two 3/32 in. holes spaced for water union nipple and overflow; at the other, for ball chamber and air release. The strip is laid on the embryo injector body, and a spring-operated centre-punch applied to the holes. This doesn't make pop marks deep enough for drilling, so they are enlarged with an ordinary centre-punch. I drill the 3/32 in. air release holes first, then the $\frac{1}{8}$ in. holes for the ball chambers, then the No. 30 holes for water union nipple, and overflow pipe. The bodies are held, four at a time, in a machine-vice with a ledge at the top of the jaws, so the drilling is very quickly done. The ball chamber holes are then pin-drilled $\frac{3}{16}$ in. diameter and $\frac{1}{16}$ in. deep, to take the spigots on the bottom of the ball chamber. As the quill on my pedestal drill is graduated, it is an easy matter to regulate the drilling depth, no stop being needed.

For the ball chambers, 12 pieces of $\frac{1}{2}$ in. round rod are parted off to $\frac{3}{8}$ in. length, by aid of the stop described above, the rod being held in three-jaw. One only, has a centre pop made on it, $\frac{1}{16}$ in. away from the true centre indicated by the tool marks. This piece is chucked in the four-jaw, with the pop mark running truly. It is centred, drilled through with No. 34 drill, opened out and bottomed to 7/32 in. diameter for $\frac{1}{4}$ in. depth, slightly countersunk, and tapped $\frac{1}{4}$ in. × 40. A $\frac{1}{8}$ in. parallel reamer is put through the remnants of the No. 34 hole.

Drills, tap and reamer are placed where they can be grabbed easily; then Nos. 1 and 2 jaws are slacked off, the piece removed, and replaced by another, the same two jaws being tightened. Operations are then repeated; and although the fresh piece hasn't been marked, the chuck locates it correctly, and all pieces will be exactly the same as the first. A dummy little mandrel nose, screwed $\frac{1}{4}$ in. × 40, is then put in the three-jaw, each ball chamber screwed on it, and a $\frac{1}{16}$ in. spigot turned to fit the pin-drilled recess in the body. The first is turned by "trial



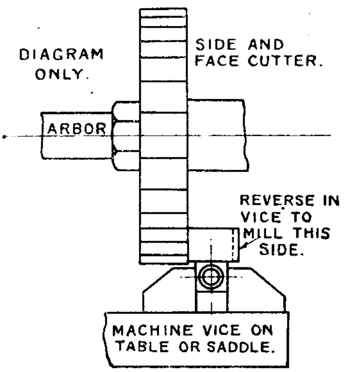
How to turn valve-box spigots

and error"; the reading of the "mike" collar on the cross-slide noted, and all the rest turned to the same setting. Centre-pops are then made at 3/32 in. from the edge of the spigot, and a 3/32 in. hole drilled on the slant, into the ball chamber. I just put each one in the V in the middle of the machine-vice jaws, and cock up one end of the vice on a bit of $\frac{1}{2}$ in. square rod. The drill then goes slap into the ball chamber without the least risk of damaging the seating, and they are all alike. Any burring is smoothed off with a fine file, and the spigots pressed into the pin-drilled holes in the body blanks, the slanting holes lining up with those in the blanks, further along.

Water Nipples

I make these from ¼-in. brass rod held in three-jaw, and don't turn it for the screwed part; I simply run on the ¼ in. × 40 die for ¼ in. length, then centre deeply, drill No. 40 for $\frac{5}{16}$ in. depth, and part off at a bare $\frac{5}{16}$ in. from the end, 5½ turns of my top-slide handle moving the parting tool along for the correct distance from the end of the threaded part. When all the lot are parted off, I chuck one, holding by the threads (it doesn't hurt them, if the chuck jaws are not tightened excessively) and turn the other end for a bare $\frac{1}{16}$ in. length, to a tight fit in the hole in the body blank. The "mike" collar reading is then noted, and the others turned to the same setting, the lot then being pressed in.

The whole lot are then placed on a bit of $\frac{3}{16}$ in. asbestos sheet, with the nipples pointing skywards. Some "Easyflo" flux, mixed to a paste with water, is then applied to each side of the body, where it rests on the ball chamber, and around the water nipple. A one-pint blow-lamp is used for silver-soldering; you need only a mild flame for these "jewellery jobs." The flame is played on the end one, and as soon as it glows dull red, the "Easyflo" is applied. I use the wire form, for these jobs, touching the body at each side of the ball chamber, and then giving the nipple a small dose. The "next man in" has already become well warmed up, so the flame is transferred to that, and the process repeated, and so on, all along the line. As the redness dies away from the ones already done, they are picked up with small tongs, and dropped into a small jar of pickle. When they are all done, the lot are washed in the kitchen sink to remove all traces of the acid, and then cleaned up by

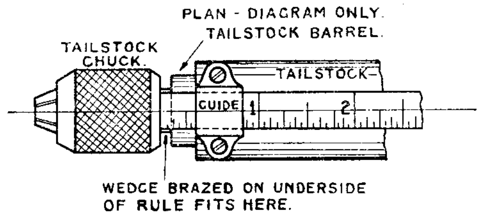


How to mill flats on valve boxes

holding against a circular wire brush, on an arbor stuck in the end of the spindle of one of my tool grinders. As the speed of this merchant is 2,990 r.p.m. it soon creates a bobby-dazzle. The overflow holes are then tapped 5/32 in. × 40, and the reamer put through the bodies again to remove any burr. The reamer is put in the three-jaw, and the body run on it by hand, with the lathe running at a good speed.

Finishing Ball Chambers and Fitting Ball Valves

The flats on each side of the ball chamber are milled. One embryo injector is held by the body, in the machine-vice on the miller table, and



Drilling depth gauge

run past a 3 in. × ⅜ in. side-and-face cutter on the arbor, the table being adjusted so that the flat projects about 1/32 in. from the body. Each one is then given a dose of the same medicine, on both sides, without altering the sideways setting of the table; just one traverse apiece, and only a few minutes' job for the lot. This could also be done in the lathe, with the cutter on a spindle between centres, and the injector bodies in a machine-vice, regular or improvised, bolted to the saddle, or boring table. Each body is then numbered; I number all my injectors with a set of small figure punches, and keep a record of when tested, and where they go.

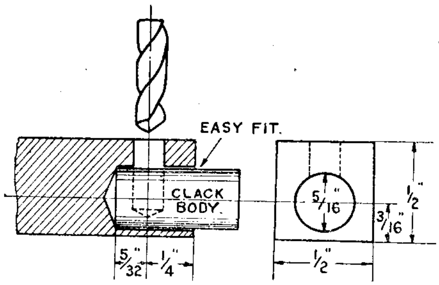
The 5/32 in. balls are then fitted exactly the same as those in a clackbox, and the caps turned from $\frac{5}{16}$ in. brass rod; I did the last dozen in roughly 25 minutes, measuring the first one, and turning all the rest to the same reading of the "mike" collars, as mentioned previously.

Cones

All the combining cones are next fitted. They are all the same diameter and length, as the bodies are all reamed with the same reamer. The steam end of each injector body is slightly broached, with an ordinary taper-pin broach, and the end of a piece of $\frac{3}{16}$ in. brass rod turned down until it just enters the broached end, so as to be a press fit in the parallel part of the reamed hole, the reading of the "mike" collar on the cross-slide being noted. The end of the rod is faced, centred, and drilled No. 72 for $\frac{5}{16}$ in. depth. I have a small Starrett rule attached to the lever tailstock barrel of the Boley lathe, working through a guide, which indicates depth of drilling at a glance. The end of the rod is cut back slightly to form the weeny nozzle then the piece parted off to a full ¼ in. length. Operation repeated 11 times, to same setting; no further measurements required.

Each is then rechucked, back outwards, and reamed with a little cone reamer (these have been fully described) with a stop on it; as the cones are set halfway out of the chuck jaws, a jewellers' hacksaw held close to the jaws, cuts each in half, after reaming. The cut halves are slightly backed off, removing the sawmarks, and the bits pressed into the injector bodies, under my bush press. I "sight" the first half, down the hole at the bottom of the ball chamber; then put a sliver of metal, a bare 1/32 in. thick, down the hole, and press in the second half until it just grips the sliver a little; the metal is then pulled out, leaving the spacing correct. The taper reamer is then put in by hand, to remove any burr, and a scrape taken out, to ensure that the taper is continuous (very important that) after which, a 70 drill is poked through by putting it in a pin chuck and twirling with my fingers.

The delivery cones are then fitted, measuring the first one, noting the reading of the "mike" collars, and turning all the rest to the same



Jig for drilling clackbox bodies

setting. A 76 drill is used first, the 75 being put through after the taper reamer. The steam cones are fitted similarly. The outside diameter of the nozzle of the first one is gauged by an ordinary hand "mike," the reading of the collar on the cross-slide handle noted, and all the rest turned to the same setting.

Clackboxes or Check Valves

Finally, I make the clacks. Twelve pieces, each $\frac{5}{8}$ in. long, are parted off a $\frac{5}{16}$ in. rod, using a stop in the tailstock chuck, same as first mentioned for the bodies. Each has a 5/32 in. hole drilled halfway through it, 5/32 in. from bottom, in a simple jig, same as I use for drilling handrail knobs (described); then each is chucked, centred, drilled, tapped, and reamed as described in my injector construction notes, noting the depth rule readings when doing the first one, and making all the rest same size. Depths for drilling are regulated by the little sliding rule on the tailstock barrel. Then the little cup that screws on to the injector body is made and fitted to each. The $\frac{5}{16}$ in. rod is chucked again, faced, centred, drilled, bottomed, and tapped, and parted off $\frac{5}{16}$ in. from the end; then each is reversed, and a $\frac{1}{16}$ in. spigot turned to fit the hole in the side of the clack body, turning the first to size, and the rest to the same setting of the "mike" collar. They are all pressed in, silver-soldered at one heat, and pickled, washed, and cleaned up. The clack balls are then fitted, each with the "hammer-and-brass-rod" operation; and, finally, the screw caps, with union, are made from $\frac{5}{16}$ in. hexagon brass rod. The depth from ball to top is gauged first, and the end of the rod turned to suit, screwed $\frac{1}{4}$ in. × 40, and parted off at $\frac{1}{2}$ in. from the end, all the others being turned to same setting, as all the clack boxes are drilled to same depth. Then each is rechucked, plain end outwards, centred deeply for union, drilled through, turned down outside and screwed $\frac{1}{4}$ in. × 40. The part that screws into the clackbox is cross-slotted, to prevent the ball blocking the entrance to the way out when it lifts, and the caps screwed home. Each clackbox is then screwed on to the delivery end of an injector; and if it doesn't stand up straight, a weeny bit is taken off the flange of the delivery cone until it does. Finally, the overflow pipes are fitted. We then have a dozen little jiggers all ready for testing under service conditions; and if the weather is fine, Curly and old *Ayesha* spend a happy time testing them on the little railway. If the weather isn't so fine, well, they get tested just the same—a full-size railway doesn't worry about the weather! Incidentally, I can do what a full-size railway finds practically impossible, viz. run at full speed with perfect safety in a dense fog.

Well, that is all there is to it. Get the job "lined up," in a manner of speaking, have your tools handy, and all you have to do, is to go right ahead. The last dozen injectors that I made, the week before Christmas, have all departed hence, most of them far afield, one even to Valparaiso, Chile. My "exports" don't bring in any dollars, but they bring something far more valuable—to me, at any rate—and that is, a dickens of a lot of goodwill.

A Handy New Anvil

We have recently received from Messrs. John Harper & Co. Ltd., one of their anvil sets, the advent of which will undoubtedly be of great interest to a large number of our readers.

Fitted with a useful vice attachment, the uses to which this equipment can be put are almost without number, and for those who either already specialise in, or are contemplating the approach to amateur cobbling, the foot irons will be indispensable.

With an overall length of $10\frac{1}{4}$ in., a width of 3 in. and a height of 4 in., the anvil itself weighs 12 lb. 12 oz.

Full particulars, price, etc., may be obtained on application to the manufacturers, John Harper & Co. Ltd., Albion Works, Wittenhall, Staffs.

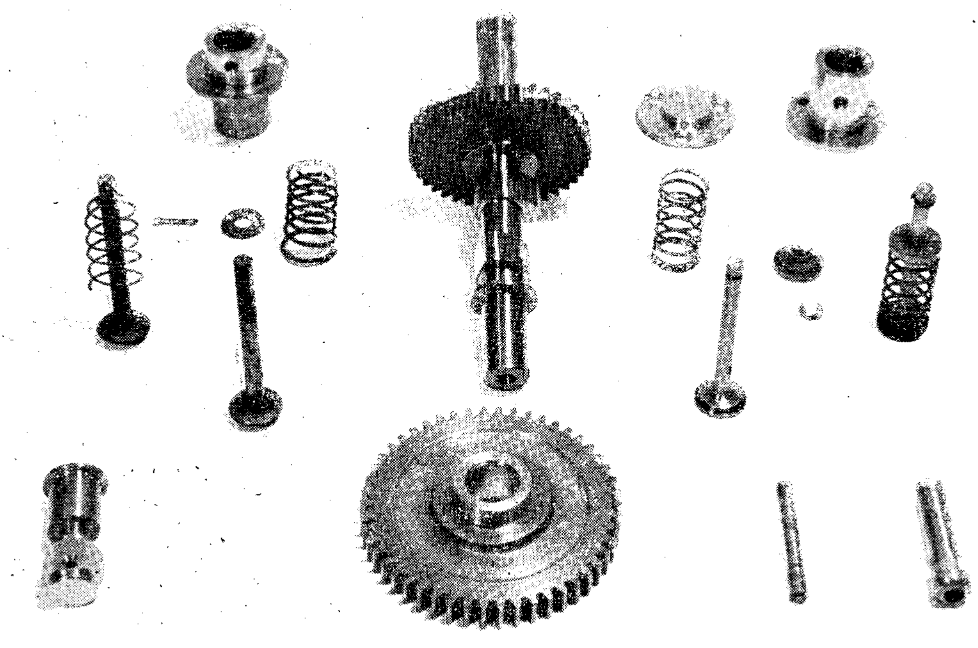
PETROL ENGINE TOPICS

*"New Engines for Old!"

How an Ancient Gas Engine was Improved, Modernised, and Given a New Lease of Life

by Edgar T. Westbury

HAVING completed the valve chamber assembly, attention was now given to improving the valve operating mechanism, which, to say the least, had originally been somewhat primitive. Apart from details of designs, such as the bent strip used for a valve rocker, and the pin in the side of the spur gear which had served the purpose of a cam, it was felt that the entire layout of the mechanism called for drastic modification, especially in view of the desirability of operating both valves mechanically, which was hardly possible at all with the existing location of the gearing.



A group of valve operating gear components, old and new

Incidentally, it may be mentioned that some of the examples of this type of engine which have been encountered—presumably of a later date than the one under discussion—embodied one or two detail improvements, though no changes were apparently made in general layout. One such engine, owned by Mr. Bradshaw, of Chelsea, the valve rocker is a fairly robust gun-metal casting, with a wide central boss which affords a good bearing for the pivot; it is, however, still operated by means of a pin in the spur wheel. This engine is fitted for running on petrol and equipped with a float feed carburettor of a type which was once common for all types of model petrol engines including those intended for speed boats. It has a plain fixed jet and a rotary plug throttle with an extra air disc valve mounted on it. Electric ignition is provided for by a simple wiper brush operated from the pin in the disc valve, acting as a contact-maker for a trembler coil, and a full-size (18 mm.) sparking-plug is screwed directly into the valve chamber, over the inlet valve.

*Continued from page 54, "M.E.," January 10, 1952.

Reverting to the engine now under discussion, it was decided to fit a camshaft with two cams, operating both inlet and exhaust valves through rockers of somewhat similar type to the original, but more substantial in design. It was obviously impossible to retain the same gear centre location as the original spur gear, as an extended camshaft at this point would have fouled the connecting-rod. The only practical alternative, therefore, was to shift the camshaft towards the cylinder, where it was out of the sweep of the rod, and use an idler gear to transmit motion from the crankshaft pinion to the camshaft spur gear. While it had the disadvantages of complicating the gearing, this was more than outweighed by the possibility which it offered for shortening the valve rockers, providing means of clearance adjustment, and also locating the cams immediately under the mouth of the cylinder, where their lubrication would be assisted by the constant dripping of oil scraped from the cylinder wall by the piston.

Here, there arose the problem of mounting the camshaft, which must necessarily project some distance from the available point of support, namely the vertical side web of the body, and for convenient layout of the valve rockers, it was desirable to locate the cams in parallel alignment with the valves. A single bearing in the web *might* have been more or less satisfactory, if of sufficient length, and there was plenty of room for it, but the idea of overhung cams did not seem very attractive.

A possible alternative, which was also given careful consideration, was to fix a rigid stud in the web, with a plain shank extending across the crankpit, and make the camshaft hollow so that it would run thereon. This would probably have been more rigid than the former arrangement, but it still involved overhung stress, and there are disadvantages in the use of " dead " shafts for continuous running under heavy loads, not the least of which is the difficulty of keeping them lubricated. It is futile to drill oil holes in a sleeve bearing which is intended to rotate, as any oil put into it will only be flung out promptly by centrifugal force ; the only way to introduce oil is from the inside, by drilling up the centre of the stud. The room available for a really substantial hollow stud, plus bushings in the camshaft sleeve, was much too limited for comfort.

Eventually it was decided to use a solid camshaft, and to provide an " outboard " bearing to supplement that in the main web. To do this, it was necessary to build an outer web on the open side of the crankpit, which could be bored to take a bearing housing. As little side stress (i.e. end thrust on the bearing) was anticipated, this could be made of sheet metal, $\frac{1}{8}$ in. thick ; steel would have been the most suitable material, but as it was not available, aluminium was used, and has proved quite satisfactory.

The exact shape of the top edge of the web was not decided right away, so it was made larger than was necessary, and attached along the bottom edge and one side with 4 B.A. countersunk screws. As the edge of the vertical flange was tapered, it was necessary to fit a tapered wedge strip behind the plate at this point to keep it square with the shaft axis.

In determining the location of the camshaft axis, it was not necessary to consider the matter of gear centre dimensions, as the position of the idler gear could be adjusted to mesh with both the pinion and the camshaft gear. The set-up for boring the housings was, therefore, fairly simple, the body casting being turned on end and the vertical rear face clamped to the cross-slide by a single bolt and strap, as shown in the photograph.

To line up the camshaft with the crankshaft, a parallel mandrel was inserted in the main bearing, having extended ends long enough for sighting against a similar mandrel running truly in the lathe chuck. The preliminary drilling of the housing bores was done with a twist drill similarly mounted.

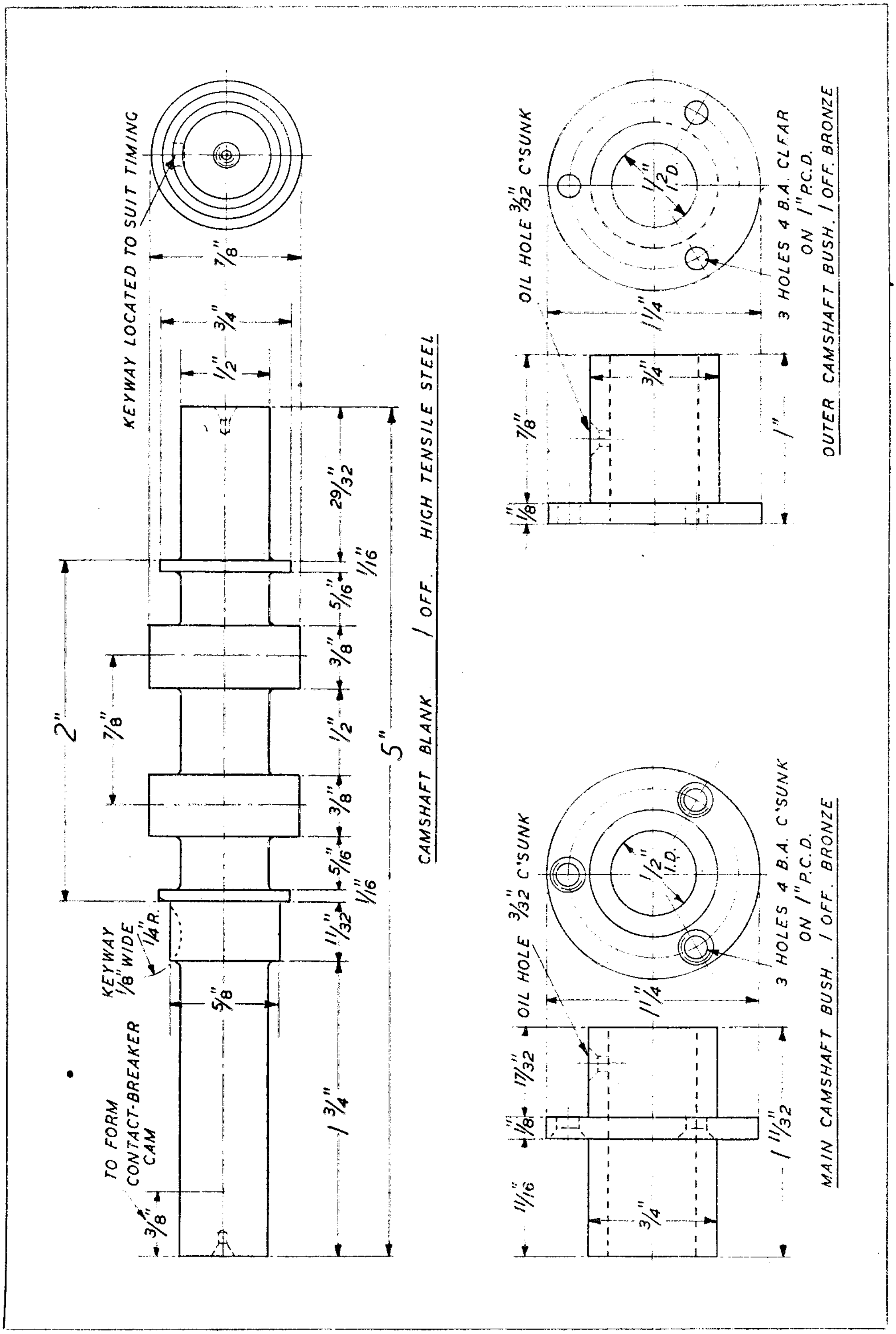
A long boring bar was then used to true the bores and open them out to the correct size, after which a facing cutter was used on the outside of the main web, to produce a seating at exactly right-angles to the bore for the flange of the bearing. This was the operation in progress at the time the photograph was taken.

Bearing Bushes

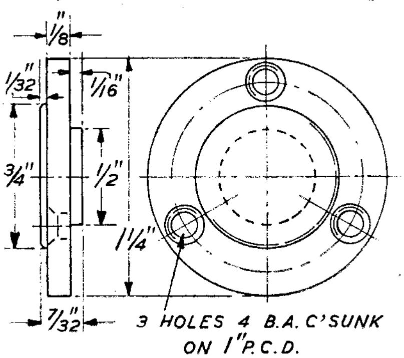
These were machined all over from solid phosphor bronze cast stick, though a softer bronze or " gunmetal " (a very vague term, by the way) would have served at least equally well ; but on no account should ordinary brass be used, as this has very poor wearing qualities when used as a bearing. In each case they were turned all over and bored at one setting, and finally parted off. The bearing on the main web side is, of course, the more important of the two, as it takes the driving thrust of the gearing, and it is, therefore, made much longer than the outboard bearing ; the latter only forms a steady for the outer end of the shaft, which does not project through it. A blind bush could be used here, but the disadvantages of blind bores have already been referred to, and it is much better to bore it right through, and afterwards fit an end cap, as is done here. There is, of course, no serious objection to an open-ended bearing here, but the closed end is neater, clearer, and conserves oil.

The outer diameters of the bushes are turned to a neat fit in the housings, and each is attached by means of three 4 B.A. countersunk screws, which in the case of the outer bearing, hold the cap on as well. Before fitting the latter, however, the bearing was held in position by temporary screws, and a reamer passed through both bearings *in situ* to correct any minute misalignment which might possibly occur. The flanges are marked so that they can always be assembled right way up, though this purpose would be served equally well by the oil holes, which are obviously located at the top of each bearing. On the outside of the flange of the bearing in the main web, a concentric spigot is turned to form a seating for the contact-breaker housing.

With the exception of the spur-gear, the camshaft is all in one piece, both the valve operating cams and the contact-breaker cam being machined from the solid. It would be quite satisfactory, in a moderately stressed engine of this type, to


KEYWAY LOCATED TO SUIT TIMING
CAMSHAFT BLANK 1 OFF. HIGH TENSILE STEEL
TO FORM CONTACT-BREAKER CAM
KEYWAY 1/8" WIDE
1/4 R.
OIL HOLE 3/32" C'SUNK
3 HOLES 4 B.A. CLEAR ON 1" P.C.D.
OUTER CAMSHAFT BUSH. 1 OFF. BRONZE
OIL HOLE 3/32" C'SUNK
3 HOLES 4 B.A. C'SUNK ON 1" P.C.D.
MAIN CAMSHAFT BUSH. 1 OFF. BRONZE

make the cams separately and key or pin them on the shaft; but from long experience in the construction of small engines, I have found that the double problem of making accurate cams, and locating them at the correct relative angles, more than outweighs the "once-for-all" task of machining from the solid. The methods employed are the same, in principles and general procedure, as those for the more complicated



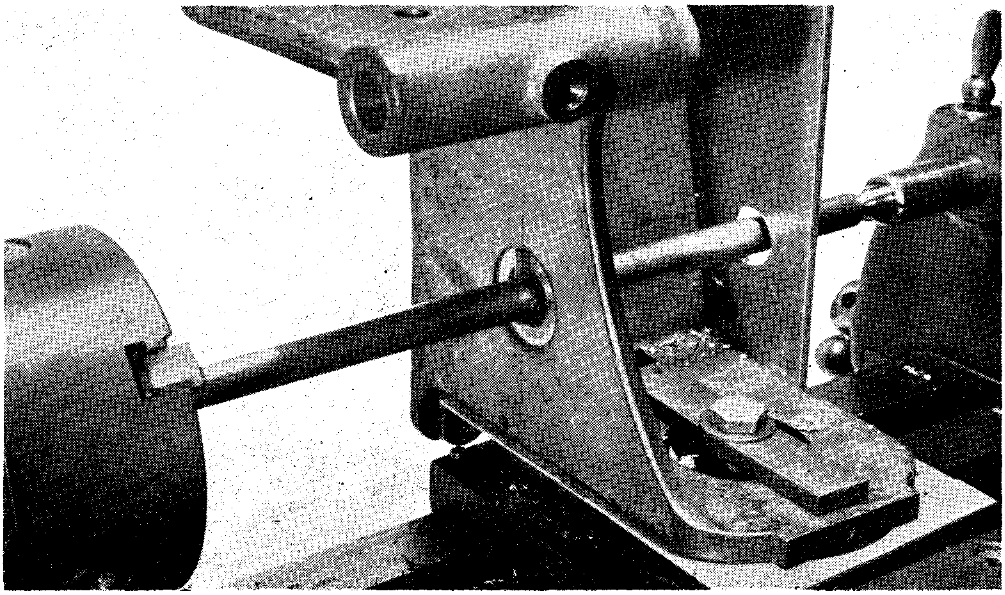
END CAP. 1 OFF. BRONZE

camshafts of the "Seal" and "Seagull" engines, and call only for the use of a simply-constructed jig. I may mention that Mr. Message, who carried out the actual work of machining the cams, had never undertaken a job of this nature before, but found no particular difficulty in obtaining the desired result.

The material which would normally be used for such a camshaft would be low carbon or alloy steel, afterwards case-hardened on the working surfaces, and this is, of course, equally important in the present case. But in view of the risk of distortion which is always encountered in the case-hardening process, it was desirable to avoid this if possible. Experience has proved that even in fairly highly stressed engines, unhardened cams of tough steel, if used in conjunction with hardened followers, give excellent results and long wear. A piece of scrap steel from an old car axle (believed to be nickel chrome steel) was, therefore, used, and has been found satisfactory. In spite of its toughness, it machined quite nicely—better, in fact, than many steels of lower quality—and was capable of taking a good finish straight off the tool.

The machining of the shaft, with its cam blanks, was carried out between centres, and calls for no special comment. It will be seen that two end-locating collars are formed, one as an abutment location for the spur gear, which was made a moderately tight press fit on a $\frac{3}{8}$ in. diameter seating, and the other to limit end play between the bearing bushes. The journal surfaces at the ends of the shaft were lapped to a high finish and a close running fit in the bushes, but this operation was not carried out until all other machining work was completed. Similarly, the angular location of the keyway could not properly be decided till the gearing was meshed up, as the centre of the idler gear, not being in line with the other gear centres, produced a displacement of the gearwheel teeth, which could only have been allowed for by complicated setting-out; it was considered easier to time the gears by trial, and cut the keyway to suit.

(To be continued)



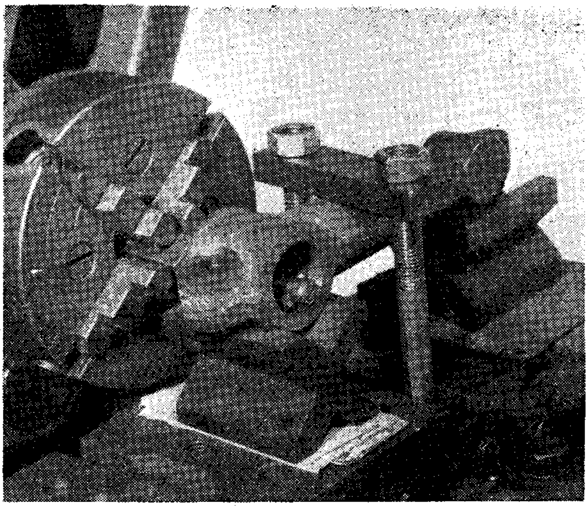
Body casting, with sheet metal side web attached, set up on cross-slide for boring and facing camshaft housings

*A Universal Dividing Head, PLUS

by A. R. Turpin

BOTH bosses are now drilled and tapped ¼ in. B.S.F. for the clamping-screws, spot-faced and then slotted; for the later operation, the support may be gripped in the pillar machine vice, and the slot cut with a metal slitting saw mounted between centres.

The centre proper is a short length of ½-in. B.M.S. which is gripped in the four-jaw and adjusted to run dead true. The top-slide is set over, and a 60 deg. point turned. The tailstock is fitted with a female centre, and brought up to support the rod and the ½-in. B.S.F. thread machine cut. The square on the end may now be filed up using the filing rest, or if preferred the centre may be parted off and a screwdriver slot cut instead. The point is now case-hardened.



Photograph No. 30. Boring the back centre support

When using the centre, the final adjustment is made by screwing it in or out, and it is then clamped.

All unmachined parts should now be painted, and the head proper is complete except for the indexing of the pillar, the carriage, and the feedscrew thimble; before this can be done, the bracket for mounting the head on the rear of the mandrel must be made.

*Continued from page 85, " M.E.," January 17, 1952.

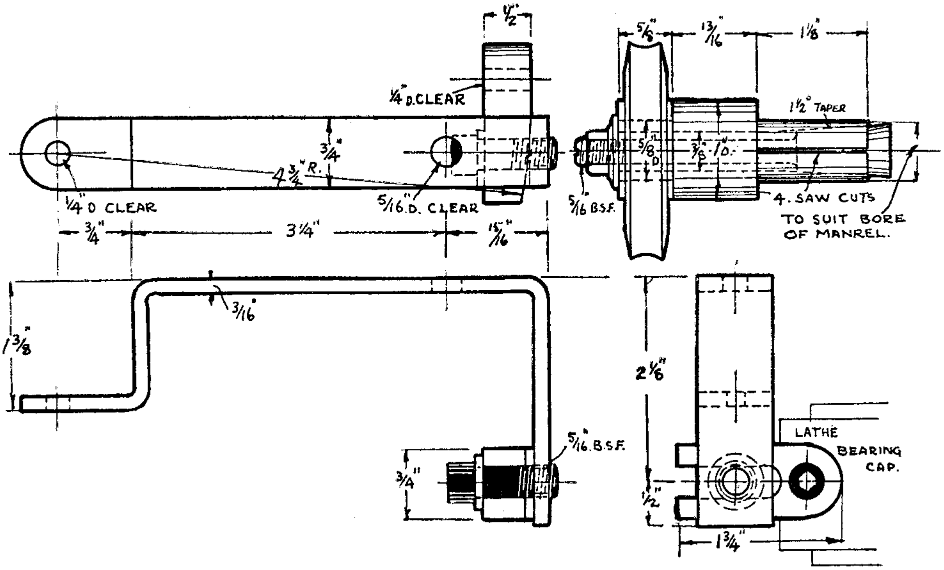
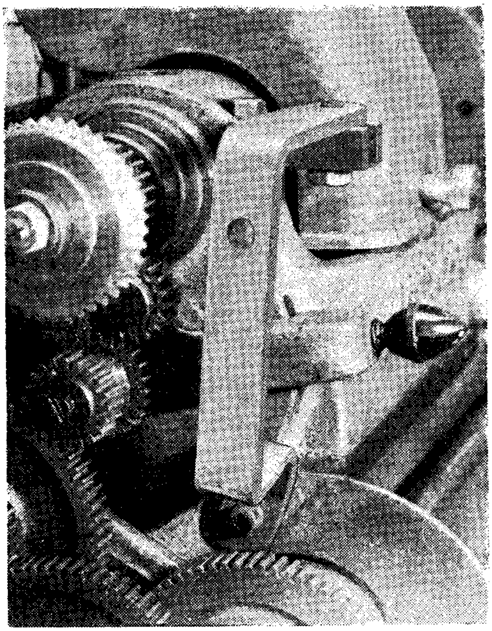


Fig. 30

Rear Bracket and Worm Wheel Support

This is shown in Fig. 30 and in photograph No. 31. Commence by turning up the worm wheel support, which follows the usual lines,



Photograph No. 31. Bracket for supporting head when used on the rear of the lathe mandrel

except that it is extended rearwards so that the division plate is clear of the oiler, and the bracket will clear the tumbler gears and lever. It consists of the usual expansion bolt, which is drawn into a slotted sleeve, which in turn is an extension of the hollow worm wheel arbor. This wheel is similar in all respects to that on the end of the dividing head mandrel except for the bore, which is $\frac{3}{8}$ in. diameter.

The bracket is bent up from $\frac{3}{4}$ in. × $\frac{3}{16}$ in. B.M.S. strip, and the dimensions given are only approximate, because the lower fixing utilises an existing tapped hole in the back of the lathe normally used to secure the gear cover, and this may not be jig drilled, and may vary in position on different lathes.

The top end of the bracket is secured to a short slotted length of $\frac{1}{2}$ in. × $\frac{3}{4}$ in. B.M.S. which is held in position by the rear bearing cap holding-down screw of the lathe mandrel.

The seating of this screw has to be counter-bored to remove some of the surrounding metal so that it will house the end of this slotted bracket, which would be accurately milled $\frac{3}{8}$ in. radius. The top of this bracket should also have a radius filed on it as shown in the drawing, so that the dividing head may be swung clear of the worm wheel if desired. The bracket is drilled with a $\frac{5}{16}$-in. hole to take the Allen screw securing the spindle bracket, using a nut and washer to secure it. Other points should be quite clear if the drawing is studied.

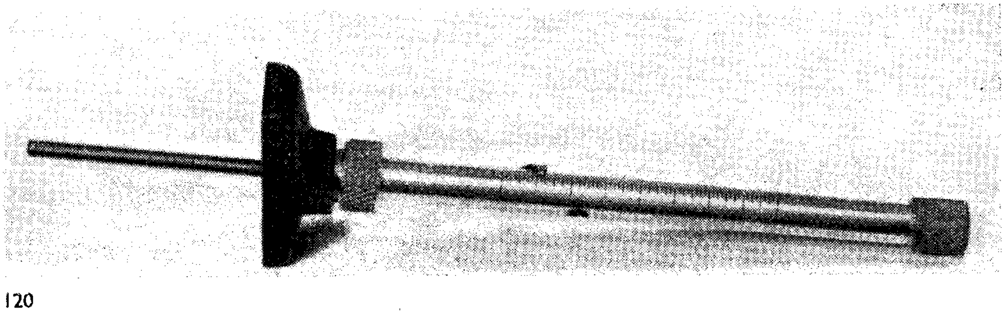
To index the pillar, it should be mounted between centres as before, using the same plugs, and the carrier bar tightly tied with wire to the driving dog on the catch plate. A "V" tool is now mounted sideways at centre height in the toolpost, and fed up until the tool point touches the pillar, and then a further 0.004 in. of feed is given. It is indexed every 5 deg., every other division 0.05 in. longer, the feed being sufficient to bring them clear of the recess in the bottom plate.

The circular boss is divided in the same way, but in this case it is mounted on an angle bracket on the faceplate, and is only divided for 90 deg. either side of a zero.

AN INGENIOUS GAUGING DEVICE

Messrs. Chorlton Bros, Poynings, Hassocks, Sussex, have submitted to us a sample of their patent general-purpose gauge, which is ingenious in design and useful for many purposes in light engineering and toolmaking. Primarily, it may be described as a type of depth gauge, but it is applicable to the measurement of steps or recesses and can be used for many purposes where the standard form of depth gauge cannot be admitted, such as in narrow grooves or small diameter holes.

The stock of the gauge contains a spring plunger, to which is attached a sliding index which moves over a scale, giving a direct reading of the distance which the plunger projects beyond the stock face. This is a handy and inexpensive little gauge, which will undoubtedly find a place in many model engineering workshops.



THE OSCILLATING PRINCIPLE

by H. H. Nicholls

MR. RENDALL, in his interesting description of an oscillating-cylinder winch, in THE MODEL ENGINEER of July 26th, 1951, remarks upon the neck bushes of these engines wearing quickly.

Now an oscillating-cylinder engine, or pump, need not have a neck-bush. Mr. Rendall is quite right when he points out that the oscillating-cylinder is not a toy ; it answers very well for certain kinds of compressed air motors, and as a pump for oil and chemicals in small quantities, so if we develop its design, we find that we can have, as shown in Fig. 1, a wide piston *A*, a block embracing the crank-pin *B*, joined by a plain rod *C*, a space *D* being left between the guide surfaces, shown by thick lines, *E*, *F*, and a groove for a sealing-ring, *G*.

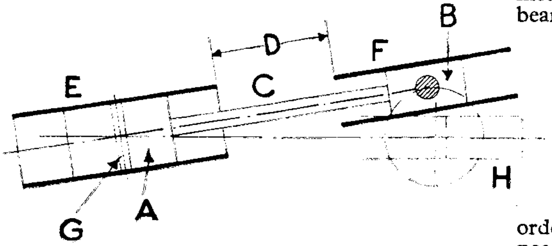


Fig. 1

In practice, the pair of guiding surfaces *E*, are the sides of the cylinder, and the surfaces *F*, a pair of guides bolted to the cylinder, or they are the opposite side of a trunk guide sitting upon the cylinder cover. One must take care to make provision for the block *B* moving out to the position *H*, when it should come out a fraction of an inch beyond the guide, so that no step is formed in the guide by wear from the sliding member moving in it.

In the space *D*, we can have a floating gland so made that no side thrust comes upon it, and this will be explained in detail in a later paragraph.

The writer remembers seeing in an old American book on mechanism, a launch engine like Fig. 2, where we have the trunk guide shown ; as will be seen this sits well in a boat, and is extremely simple, and the same book shows a pair of the engines thus made, with teeth on the peripheries of their flywheels, giving a twin-screw installation which should, given good port design, be self-starting.

In Fig. 3 we have a cross-section of the trunk-guide, at the position of the crank-pin. Let *A* be the crank-disc with its crank-pin, *B* the frame of the engine, *C* the guide, *D* the block working on the crank-pin, and optional anti-friction metal lingings or bushings *E* and *F*.

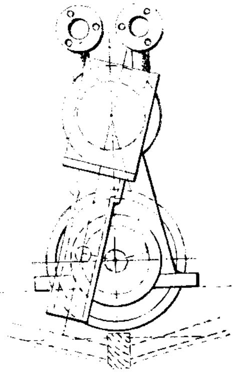


Fig. 2

E works on the crank-pin, and the arrow indicates a step against which the bush must be forced home, while the flange of the bush would be turned to the cylindrical form of the block *D*. The liner *F*, if fitted, would be brass, or white metal cast in. The "Torrington" needle bearings, praised by "L.B.S.C." would do well instead of the bush *E*, in the case of an application for continuous duty.

Needle bearings could probably be applied to the trunnion also, Fig. 4, bearing in mind the following consideration. If we call the arc of oscillation *A*, then a needle would roll over a part of the circumference of the trunnion-pin, represented by the distance *a* to *b*. And in order to ensure the whole circumference of a needle wearing evenly, the circumference of any needle should thus be less than the distance *a* to *b*. There are very interesting notes on needle bearings, and their application, in *Machine Design Construction and Drawing* (Spooner), of which editions appeared between 1908 and 1938.

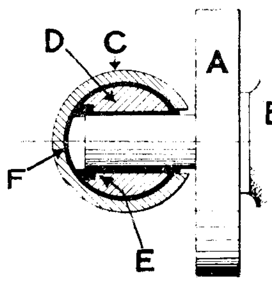


Fig. 3

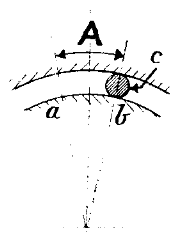


Fig. 4

In Fig. 5 I have sketched the way in which an oscillating cylinder without a neck-bush to wear, can be made, which might be useful for a compressed-air engine, or an oil-pump application for the oscillating cylinder principle at the present day. Of course, it would do for steam also.

A is the piston, *B* the block for the crank-pin

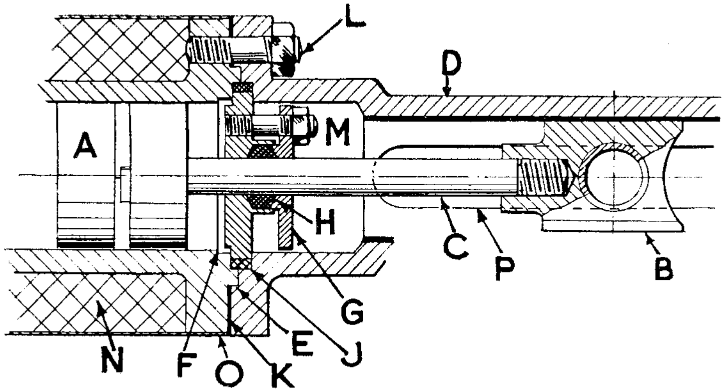


Fig. 5

(one can hardly call it a " big-end ") *C* the piston-rod. *D* the trunk guide, *E* the register which locates the guide on the cylinder flange, *F* is a relief turned in the cylinder, so that the piston *A* passes a fraction of an inch beyond it at ends of stroke, so no step can be formed in the bore—a very important point.

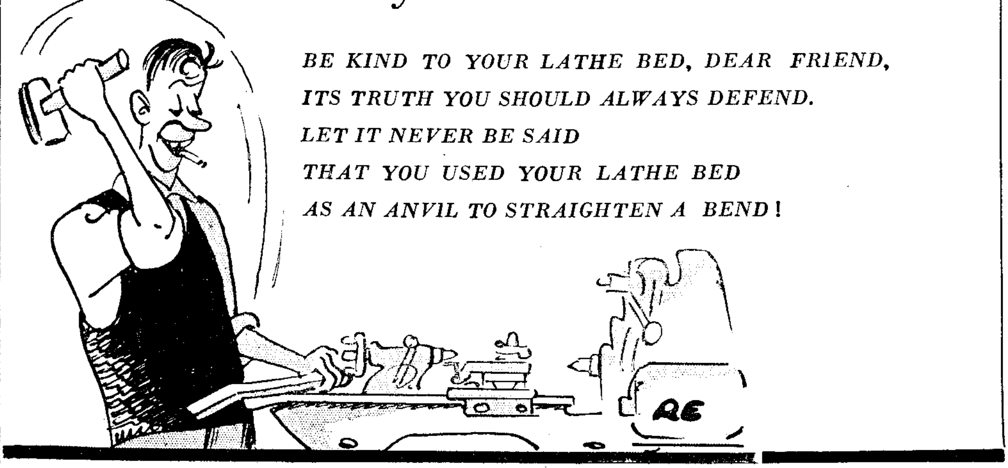
Now the gland *G*, consisting of two flanges, and compressing between them the packing *H*, is free to slide sideways in the rebates turned in the cylinder, and guide *D*. If we surround this with a ring of packing *J*, the leakage of air or steam is prevented, but the sideways movement is not prevented. *K* is ordinary jointing material (oiled paper in a model engine), *L* a stud holding cylinder and guide together, of which there should be a greater number, and stronger, than for an ordinary cylinder, owing to the stress caused by the long guide *D*, *M* a stud in the gland, of which there would probably be three, *N* the lagging of the cylinder, and *O* the " Russian iron " over all. *P* is the slot in the guide for the crankpin. Of course, with this design, one must take the guide off to repack the gland, but having no side-thrust, that should very seldom be needed. In addition to the studs *L*, there should be three " forcing screws," or tapped holes for them, in the flange of the guide *D*. These are very necessary when the cover of a cylinder sits in a rebate as at *E*, and such registers ought to be well coated with graphite grease or compound on assembly, otherwise, separating such parts may be a matter of great difficulty, especially in the case of a cylinder used with liquids. And compressed air may have water with it.

I hope that these notes may lead anyone who wishes to experiment to obtain practical results from such a simple mechanism. But there may be room for instructive experiment to find the best part forms ; there is no reason why they need be just drilled holes.

Whimsical Workshop Warnings

by Rick Elmes

BE KIND TO YOUR LATHE BED, DEAR FRIEND,
ITS TRUTH YOU SHOULD ALWAYS DEFEND.
LET IT NEVER BE SAID
THAT YOU USED YOUR LATHE BED
AS AN ANVIL TO STRAIGHTEN A BEND!



FLEXIBLE ADHESIVES

by P. W. Blandford

UNTIL recently the successful joining of such flexible materials as leather cloth, various fabrics and canvas, was a near impossibility for the amateur. Now there are a number of adhesives which will make waterproof flexible joints in almost any material, joining similar and dissimilar materials, flexible to rigid substances, and even such unlikely things as polished metal surfaces, with a chance of success.

Rubber-to-rubber joints are best made with rubber solution, using the tyre-patching technique ; applying a thin layer of solution to each surface, allowing them to become tacky before pressing them together. With this method the parts must be fitted correctly at the first contact, as they cannot be slid about afterwards. If the parts are joined with the solution runny so that they can be moved about, the solution is unlikely to make a secure joint. For conditions where adjustment must be made after joining, it is better to use upholstery solution, which has more " body " in it.

Rubber solution is not usually successful with other materials, and for joining rubber to other materials or for joints in other materials, there are many better adhesives.

Bostik is probably the best-known general adhesive, but there has been much misunderstanding about it and some users have been disappointed. The name is given to a series of adhesives and sealing compounds of various sorts produced mainly for industry by B.B. Chemical Co. Ltd., Ulverscroft Road, Leicester. Obviously, unsatisfactory joints will result if the wrong compound is used. For joining rubber, linoleum, felt, leather, etc., to themselves or to metal, plastics, wood or any porous or non-porous surface, the grade to use is Bostik C, which may also be called Bostik 252, the difference being in the method of packing.

Bostik C, and other similar adhesives, should be applied with a brush, squeegee, or piece of wood to both surfaces. If there is any doubt about the cleanliness of the surfaces, they should be wiped over with petrol first. The film of Bostik should be thin but even. Leave to dry. This is most important, and may take about 30 minutes in normal temperatures. It should be possible to touch the surfaces without any adhesive sticking to the hands. When all the solvent has evaporated, bring the surfaces together in such a way that no air is trapped—usually by rolling one on to the other. Use as much pressure as the materials will allow.

Where a quicker setting time is desired, there is Bostik 89/AA, which has otherwise similar properties to Bostik C. If the black colour of the other Bostik adhesives is objectionable, there is Bostik D (Bostik 299, in a different packing) which is off-white in colour and not quite as strong as Bostik C. Bostik 321 is off-white and intended for sealing between riveted joints, but it will also stick leather and leather cloth to metal.

Messrs. Surridge's Patents Ltd., New Works, Croydon Road, Elmers End, Beckenham, Kent, make a large range of adhesives for use in the motor industry. Besides a series of rubber solutions, they produce cements with similar applications to the Bostik types mentioned above. Their Black G.P. Cement, Ref. No. 11, will stick all the common flexible materials to themselves and to solid materials. This cement may be obtained in varying speeds of setting. Where the black colour is objected to, there is White G.P. Cement, Ref. No. 11A.

Surridges make an exceptionally powerful adhesive called Bondtite " A," which is also proof against dilute acids and alkalis, oils and greases, and petrol. Most of the other adhesives break down when in contact with these liquids. Bondtite " A " may be diluted with acetone. Where both materials being joined are porous this adhesive may be applied to both surfaces, left for five minutes, then pressed together.

If one material is non-porous—as in joining wood to fabric—the adhesive need only be applied to the non-porous surface, and the other piece pressed to it after five minutes.

For joining two non-porous surfaces Bondtite " A " is applied and allowed to dry completely. They are then pressed together and held under heavy pressure for about three minutes. This gives a very strong joint between metals or plastics, as well as the flexible materials.

Messrs. Newman, Staff & Co. Ltd., Dome Buildings, Richmond, Surrey, make two general-purpose flexible adhesives—G 11, which is dark grey, and G 10 which is cream. G 11 is the stronger, but G 10 is the more flexible. They also make X 59 Lastoid Cement which is exceptionally powerful, with applications similar to Bondtite " A."

Bostik and Surridge's cements are obtainable from motor sundries firms, Newman, Staff's products can be bought from the makers or from yacht chandlers. All are supplied in various size containers. Keeping qualities are good, but a partly-used tin may harden or become lumpy. For occasional use, tubes are preferable to tins.

" Copydex " is a general-purpose flexible adhesive, made by Copydex Ltd., 242, Harrow Road, London, W.2, and supplied by stationers and upholstery sundries firms at 3s. 11d. for a 4 oz. jar or 12s. 6d. for a one-pint tin. The jar has a brush attached to the lid. " Copydex " is a white rubber-like paste with an ammonia solvent. It will stick paper and most flexible materials, and makes an exceptionally strong joint in open weave cloths and canvases, such as sacking or coconut matting. Joints are made by spreading " Copydex " on one surface, then pressing the parts together and hammering if practicable.

IN THE WORKSHOP

by "Duplex"

No. 107.—*Making a Twist Drill Grinding Jig

NOW that the grinding head itself has been finished, the next step is to make the saddle and holding-down bolt for fixing the head to its small baseplate.

The Saddle—Part 5, Figs. 45 and 54

This part can quite well be made of brass and is either built up by hard-soldering a short length of tubing into a turned collar, or the plumber may be able to supply a suitable machined casting like that forming part of the waste-pipe joint of a wash basin. In either case, it will be necessary to form the hollow in which the body of the grinding head rests. This is, perhaps, best done by a machining operation in the lathe, and in THE MODEL ENGINEER of October 25th, 1951, a simple and accurate method is described in the "Novices' Corner."

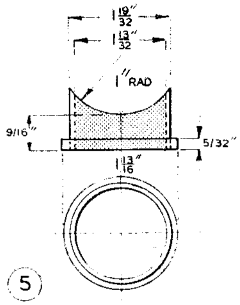


Fig. 54. The saddle supporting the grinding head body

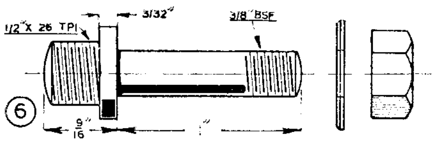


Fig. 55. The holding-down bolt

The Holding-down Bolt—Part 6, Figs. 45 and 55

This is a straightfroward turning and threading job; but, as there is no need for the two threaded portions to be exactly concentric, the work can be gripped in the self-centring chuck for machining one end and then reversed in the chuck for turning and threading the other. As the height of the saddle may vary somewhat, it is as well at this stage to make sure that the bolt is turned to the right length and will not stand proud of the surface on the under side of the baseplate.

The Baseplate—Part 7, Figs. 45 and 56

A length of flat mild-steel is used for the base, and the surfaces should be either filed flat or machined in the lathe or shaping machine.

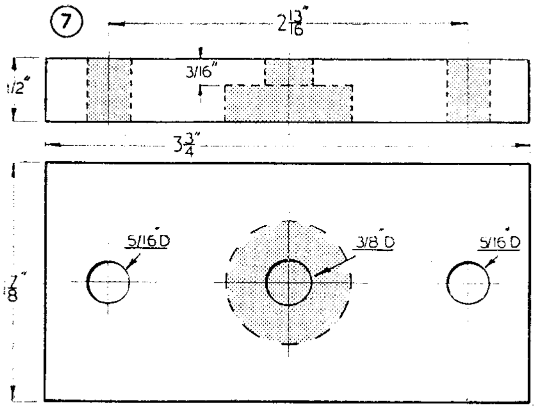


Fig. 56. The grinding head baseplate

The clearance-size holes for the two hexagon-headed fixing screws are spaced to correspond with the holes already drilled and tapped in the baseplate of the jig itself. As will be seen, the nut of the holding-down bolt (part 6) lies in a recess formed in the under side of the baseplate, and the diameter of this counterbore should be large enough to allow a $\frac{5}{16}$ in. Whitworth box spanner to engage the $\frac{3}{8}$-in. B.S.F. nut. The easiest way, perhaps, to form this recess is to mount the work in the four-jaw chuck with the $\frac{3}{8}$ in. dia. hole set to run truly; the recess can then be readily machined to a good finish with a small boring tool. The grinding head can now be assembled on its baseplate, and the baseplate, in turn, secured to the baseplate of the jig; it should then be found that the drill slide of the jig comes into the correct position in relation to the grinding wheel.

The Grinding Wheel

The form of grinding wheel used is shown in Fig. 57 and is known as a cup-wheel. A wheel of this shape has the advantage that the working face is narrow and can easily be kept flat when trued or dressed with a special tool. The wheel fitted is 3 in. in diameter, $\frac{1}{2}$ in. wide on the

*Continued from page 62, "M.E.," January 10, 1952.

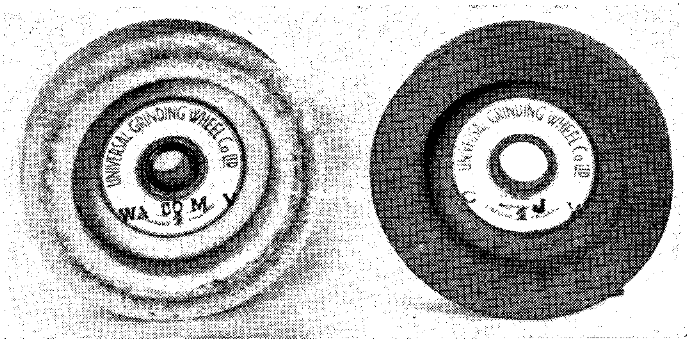


Fig. 57. Course and fine cup-wheels

working face and $\frac{7}{8}$ in. in total thickness ; the central recess is $\frac{1}{2}$ in. in depth, leaving a backing of $\frac{3}{8}$ in. The coarser wheel, of 80 grit size, is made of white Bauxilite which is a refined form of aluminium oxide ; this substance cuts freely and, owing to its fr ability, has but little tendency

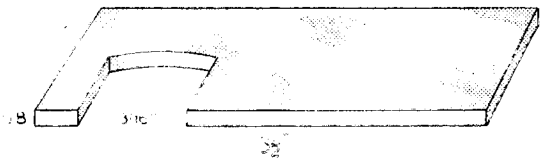


Fig. 58. The special adjusting spanner

to become glazed. The fine wheel has a grit size of 220 and is kept in reserve for grinding batches of very small drills, but so far the coarser wheel has proved quite satisfactory for grinding drills down to No. 60.

The Universal Grinding Wheel Co., who are the manufacturers of these wheels, recommend that they should be run at from 6,300 to 7,600 r.p.m.

It is important to mount the wheel rigidly so that it abuts against a fixed flange of about half the diameter of the wheel itself. The clamp-nut should be tightened just enough to give a secure frictional drive, and this will be helped by inserting blotting-paper washers between the wheel driving flanges.

It will be noted that a lock-nut has been fitted on the spindle, although this may seem unnecessary, as the drive tends to tighten the clamp-nut. However, we remember seeing a grinding head driven by a converted motor of the surplus variety ; here, the wiring connections were so arranged that a back-E.M.F. was generated when the motor was switched off, and as a result, the motor pulled up with a jerk, but the heavy grinding wheel continued to revolve and was liable to spin off the end of the spindle.

The Adjusting Spanner

The small spanner illustrated is made to engage the flats formed on the adjusting and locking collars fitted to the spindle of the grinding head. The material used should be rather tougher than ordinary mild-steel, and ground, flat, carbon-steel strip was found to be satisfactory for this purpose. When applying the spanner, in conjunction with an ordinary open-ended spanner, the spindle can be held by the two flats formed at its right-hand end.

Finish

The steel parts of the grinding head and the jig may be left bright and unpainted if they have been given a good finish ; but the bronze and brass components, that is to say the body of the grinding head and the saddle, will look more in keeping with the rest of the work if they are painted. For this purpose, it will be found that treatment with optical black will give a pleasing, dull, ebony finish that is remarkably resistant to wear or accidental damage.

The Grinding Jig with Self-contained Motor Drive

Rather than drive the grinding head from a lineshaft or from a motor already serving another purposes, many workers will, no doubt, prefer to have the grinding jig as a separate unit with a self-contained drive. For if the jig has to be specially rigged, it may mean that drill grinding

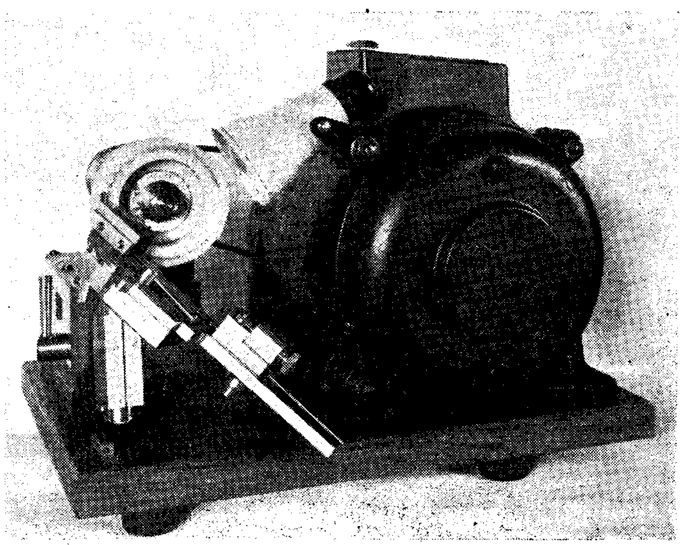


Fig. 59. The self-contained drill grinder

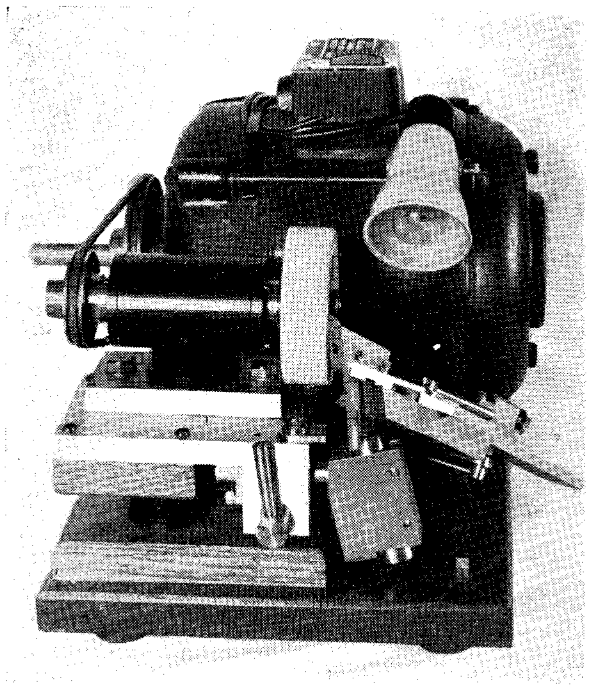


Fig. 60. Another view of the grinder

is postponed until the drill has long ceased to cut efficiently ; whereas, with the grinder ready for immediate use, few will grudge the few seconds spent in restoring the sharpness of the drill point. In the photographs of the machine it will be seen that the components are mounted on an oak base supported on rubber feet. The motor shown is a $\frac{1}{4}$ h.p. d.c. machine driven from the workshop rectifier. This motor is unnecessarily large for the power developed, but it was used, as it was the only spare machine available at the time. An a.c. motor of 1/6 h.p. should, however, serve quite well for driving the grinding head. The motor is controlled by means of a sliding thumb-switch of Arcolectric make, and this has been fitted in a convenient operating position on the box-casting covering the motor connections. As it is a great help to have the machine well-lighted when a drill is being set up in the jig, a small spotlight has been fitted to thow a beam on to the drill rest ; this fitting consists of the 15 W bulb, the lamp-holder, and the shade removed from a surplus Anglepoise lamp designed for use in aircraft. In this way, excellent lighting is obtained, and the lamp is controlled by a second small switch of the push-on and push-off type made for switching table lamps ; but as shown in the drawing, a miniature tumbler switch can be used instead.

The most convenient way of carrying out the wiring is to attach a small junction box to the wooden base, and from this the supply current is distributed to the motor and lamp circuits with their control switches ; in addition, an earthing wire should be connected to the earth terminal of the motor.

Wheel Guard

The substantial guard usually fitted to grinding wheels, to protect the operator in the event of the wheel breaking, is not illustrated, for when using a cup-wheel the operator stands facing the wheel and is hardly in the direct line of danger ; moreover, the wheel is of small diameter and the grinding pressure applied to the amply thick wheel face is very small. Nevertheless, for safe working, and in accordance with factory regulations, a guard can be easily fitted by bending a length of flat mild-steel, say, $1\frac{1}{2}$ in. × $\frac{3}{16}$ in., to shape and securing the ends to the steel baseplate of the jig.

Dressing the Grinding Wheel

After the wheel has been in use for some time, it may become glazed and, in part, lose its cutting properties ; this is owing to the sharp abrasive grains becoming blunted and not being shed so as to expose fresh grains. When this happens, the wheel is liable to heat the work and the temper of the drill may be drawn. To restore the cutting efficiency of the wheel, the surface must be broken up and new, sharp grains brought into use. For this work a star-wheel dresser is commonly used, but the ordinary commercial pattern of this tool is rather too large for the present purpose. However, a description of a small wheel dresser was given in THE MODEL ENGINEER of June 21st, 1951, in "Novices'

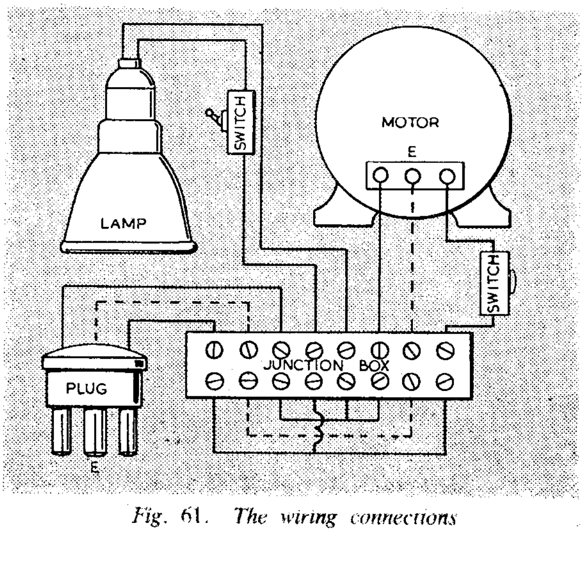


Fig. 61. The wiring connections

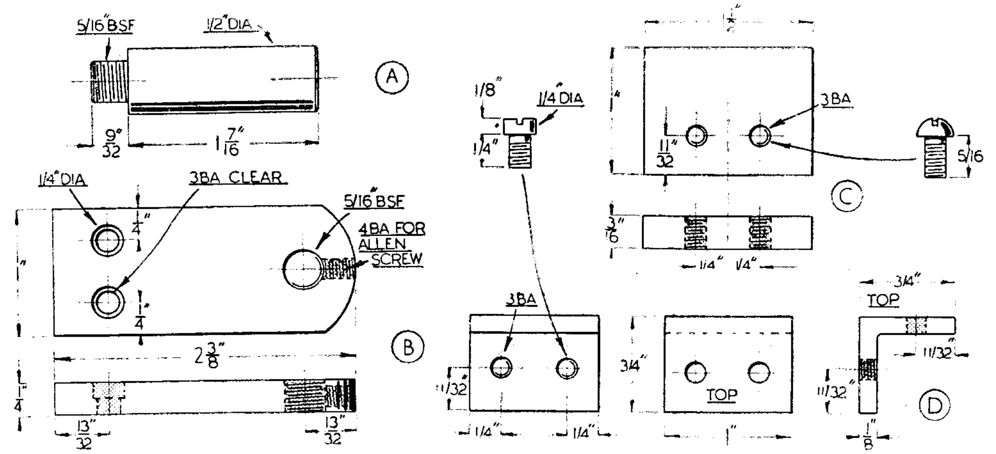


Fig. 63. Details of the rest. "A"—the shank; "B"—the upright; "C"—the table; "D"—the angle bracket

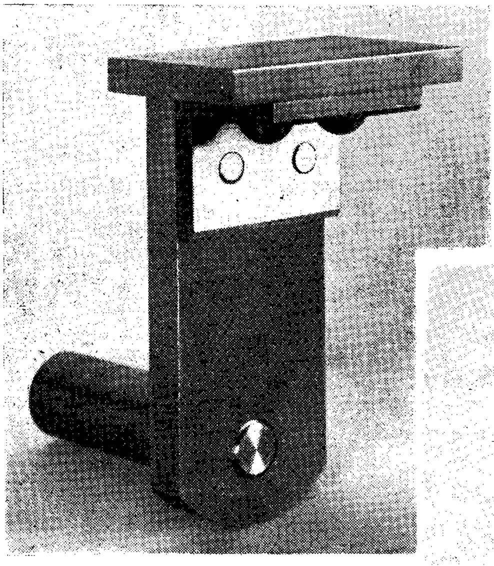


Fig. 62. The special dressing rest

Corner," and a tool made on these lines would be suitable for dressing the cup-wheel. When applying the dresser to the wheel it is essential to have a rigid grinding rest.

The rest illustrated is made as an attachment for use with the jig, and the shank portion (*A*) is clamped in the base bracket after the jig itself has been withdrawn. A vertical bar (*B*) is attached to the threaded end of the shank and is secured with an Allen grub-screw. The grinding table (*C*) is attached to the upper end of this bar by means of a short length of steel angle (*D*).

Just as the stop-plate fitted to the jig baseplate limits the forward travel of the drill slide and prevents its coming into contact with the wheel, so this stop also sets the position of the grinding rest and keeps it just clear of the wheel.

It should be noted that the shank of the rest has no keyway, and that it does not enter the base bracket as far as the key fitted to the pivot guide, part (*F*) shown in the earlier drawings. With this equipment there whould be no excuse

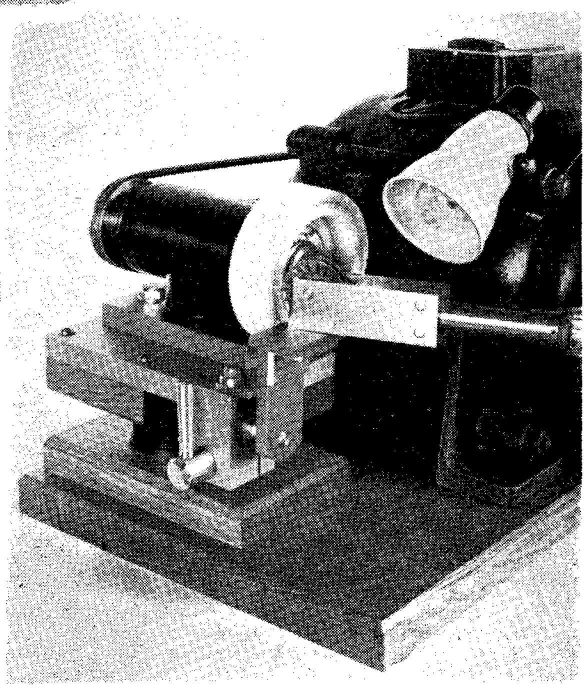


Fig. 64. Showing the attachment and the wheel dresser in use

for not keeping the wheel in good order so that the jig can be operated to the best advantage.

Finally, keep the jig clean so that it works freely, and, after use, dust off any abrasive that may have collected on the working parts with a small brush kept specially for the purpose.

PRACTICAL LETTERS

Man or Horse?

DEAR SIR,—My copy of THE MODEL ENGINEER dated December 6th, 1951, reached me recently from my home in Normandy, Surrey, and by a coincidence the article "Round Town in the 'Nineties," by "B.C.J." contains details of the Bisschop gas engine.

Quite recently I was chinwagging with a member of the Manchester Society in our meeting room and discussion was upon horse-power and I mentioned that I had one of Paul N. Hasluck's books at home entitled, if memory serves me correct, *The Metal Workers' Handbook*, wherein it describes the Bisschop engine briefly as a motive power for driving light machinery, but the strange part is that instead of horse-power rating it is quoted as ½ man-power, 1 man-power, etc.

It is the first instance I have ever read of engines being so rated and has for some time past excited my curiosity as to how this is calculated. Perhaps some reader may explain.

Thanks "B.C.J."; apart from Hasluck's book, your article has given me a great deal of pleasure, relating as it does, details of this engine.

Yours faithfully,

Manchester. J. DAVIES.

Old Gas Engines

DEAR SIR,—I have just read the article by "B.C.J." in THE MODEL ENGINEER, December 6th issue and I would like to extend to him my compliments for one of the most interesting seven pages I have read in "Ours" for many a day.

I, too, am one of those "types" who delight in a slow-running engine which can be *seen* and heard, and may I add, smelt, and although I am only a young man I regret the disappearance of these fine old engines, therefore "B.C.J.'s" delve into the past must be appreciated by many young engineers like myself.

It may interest "B.C.J." to know that I have two gas engines in my home workshop, one, a ¼-h.p. Tangye is now on the retired list having given way to a more powerful engine built by James Taylor of Bradford and reputed—by the gentleman I bought it from—to have first been used by your old advertiser, Mr. Tom Senior.

I do not know the age of this engine, but it is running perfectly; better, perhaps, as it has been converted to magneto ignition in place of tube ignition and is veritably the basis of my workshop, being used mainly for dynamo driving and power for my lathe.

It may be interesting to add that I have also pressed it into service for sawing wood with a home-made power hacksaw contrivance made from a bow-saw, and also for making butter with a "churn" arrangement bolted to the lathe-bed and driven by a crank held in the chuck! This will shock many model engineers I am sure, but home-made butter (with a variety of churning speeds) has been most acceptable to the domestic side of our house!

However, enough of my own engine, perhaps "B.C.J." could let us have another of these most interesting and enlightening articles on old gas engines which, in his humorous way, has revealed to many of us some of the old engines which, unfortunately, will never be used again. I for one would dearly have liked to have stood in his shoes and watched those "old masters" of sixty years ago.

Yours faithfully,

Alton. H. J. GATES.

"New Engines for Old!"

DEAR SIR,—Though for years a warm admirer of Mr. E. T. Westbury, I cannot share his enthusiasm for the rebuilding of the old gas engine. As originally found, the engine was something of a period piece; an example of a commercial production turned out for a very low price, admittedly scamped in design, workmanship and material. As rebuilt, the engine will be soundly built, but still no more than an amusing toy. To me the original had a certain charm which will be quite lost after rebuilding, and in that state could stand by the vertical Crossley shown on the cover of THE MODEL ENGINEER for December 6th. In the present case the engine should have been restored like an antique clock, using the minimum amount of new material. It would then have been in fit state to putter away as required in a most attractive way.

Yours faithfully,

Sheffield. J. BLACKBURN.

Scraping

DEAR SIR,—I would like to endorse the sentiments of Mr. Banyard, whose letter on "scraping" was published by you in the December 13th issue.

I cannot recollect an article on this subject within the last ten years, and I think that one by Mr. Westbury who is particularly gifted in explaining how things should be done, or by "Duplex" who are constantly publishing photographs of the beautiful mottled surfaces which they produce in the workshop, would be very well received.

Yours faithfully,

Edinburgh. J. IRVINE CARSWELL.