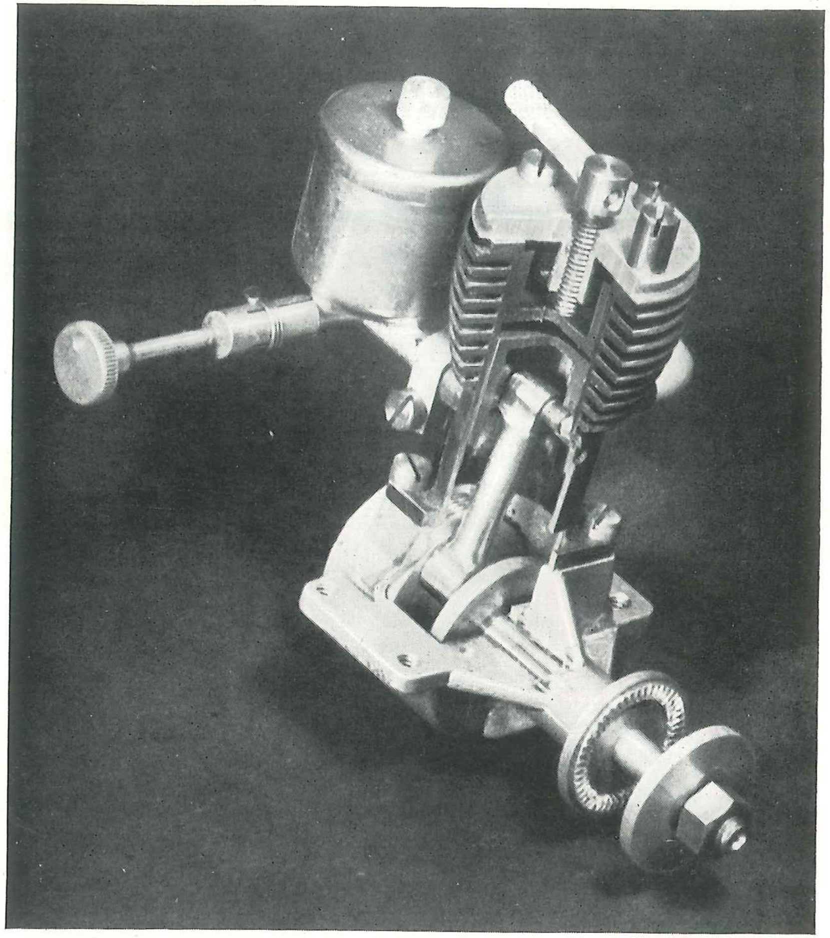


Micron cut-away—but a pity to spoil a good engine like this many may think. There is little to beat such a practical aid to instruction however, as many readers who have taken engineering courses will remember.

CHAPTER V

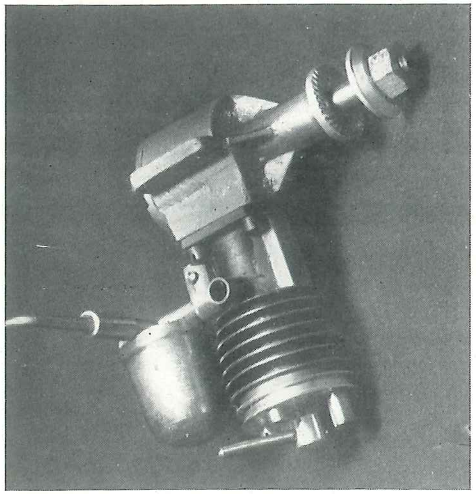
SOME CONSIDERATIONS OF DESIGN

ASSUMING that the reader has developed sufficient interest in the diesel engine to consider making or acquiring one of his own, it is appropriate to discuss the characteristics of a good engine. With the wide range available —or potentially available, if one remembers that holidays abroad are now nearly as simple as ever they were—it is mainly a question of deciding beforehand exactly what is wanted, and then seeing which group of engines most nearly supplies that need. It is a hopeless task to enter into the matter with a completely open mind, and no thoughts beyond securing a diesel—just any sort of diesel. Anyone who does set out to get an engine thus unprepared will suffer from a surfeit of good things, and almost inevitably decide on the very one that more leisured choice would have ruled out.

The first consideration is just what sort of a model or models are to be built. If the reader is comparatively new to powered flying, then he is advised not to decide on anything too large or too small. There is a certain fascination about the real miniatures of under 1 c.c. that will ensnare many an unwary enthusiast. But be warned in time—these engines are for the expert and the specialist. In their hands they perform miracles and make the whole things seem ridiculously easy—just as a professional billiards player makes cannons and potting look child's play. Equally the larger sizes—that is over say, 6 c.c.—are approaching a difficult area. Bearing in mind that these are equivalent to petrol engines of over 10 c.c., as we shall shortly demonstrate, consider carefully before deciding. This leaves the intermediate class of from, say, 1.5 to 5 c.c. In this range will be found the most useful general-purpose motors that can be fitted into all kinds of models from contest duration machines to scale designs and flying boats.

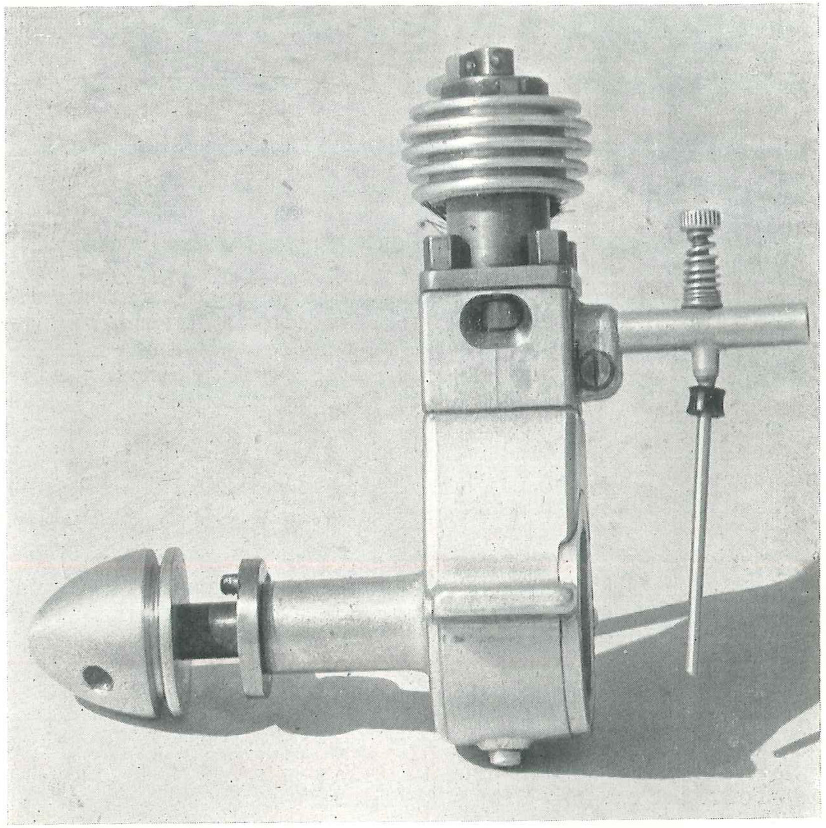
Having decided on the approximate range of size to consider, it is possible to select a number of various makes and compare their points. To do this a few simple characteristics are necessary. Briefly the following information should be collated:—

(1). Capacity in c.c.
(2). Weight ready to fly (without airscrew and with empty tank).
(3). Power.
(4). Weight per c.c.
(5). Weight per h.p.
(6). Power per c.c.



Inverted version of the Micron 0.8 c.c. This little engine gives no trouble and can be handled efficiently by the comparative novice.

The Dyno again — this illustration shows its austere lines. Note the spinner grooved for a starting cord.



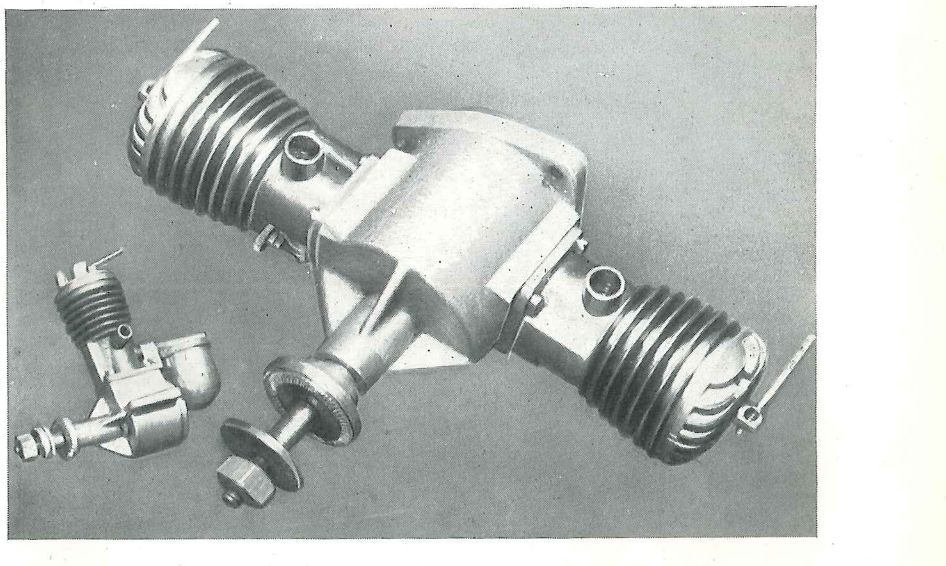
Items 1 and 2 can be obtained from the makers' catalogues. In comparing diesel engines with the conventional petrol engine it is as well to remember that to the all-up weight of the latter must be added weights of coil, condenser, batteries and wiring, to arrive at a fair comparison. Item 3 will also, usually, be given on the makers' lists, and figures can be accepted as fairly accurate, though it should be appreciated that different makers will have arrived at their figures with varying degrees of precision—and some may have given the nearest figure with a somewhat optimistic fraction in mind.

Weight per c.c. is obtained by dividing weight in ounces by capacity in c.c. This figure is an indication of lightness of construction. An engine that seems to give an exceptionally low figure should be viewed with a certain amount of suspicion. It may indicate that here is a nice blend of light metals with the minimum necessary strength; on the other hand, it is rather more likely to indicate that the manufacturer in his search for lightness at all costs has left too little metal in vital places, and the general construction may not be sufficiently robust to stand up to hard wear.

Weight per h.p. is obtained by dividing weight in ounces by power in h.p. This is the important characteristic to note when selecting a motor for contest work. As most continental power competitions are based on the ratio of glide to motor run, this aspect of design has been given very careful consideration. A limited number of engines have occupied the leading positions in contests over the past year or two abroad, and in every case it will be seen that their weight per h.p. is ahead of less successful rivals.

Power per c.c. is obtained by dividing capacity in c.c. into power in h.p. This is an indication of performance quality, and is probably the most

David and Goliath of diesels—the Micron 14 c.c. and 0.8 c.c. compared.

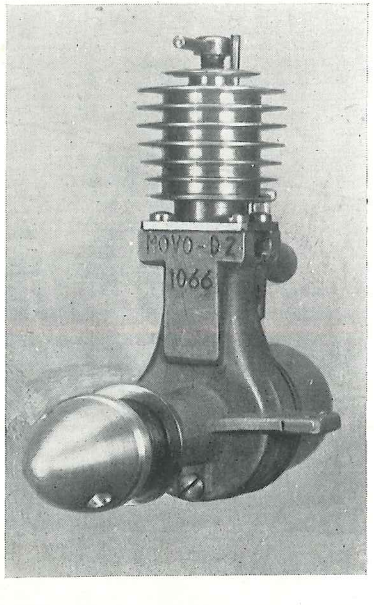


important item on the list. However, it is necessary to consider all the qualities in due relation to one another, and the purpose for which the engine is required, before making any decision. It is well worth while to settle down with a few makers' lists, or the tables given in this book, and work out comparative data for a few engines—the results are most illuminating, as often the engine that appears best from a superficial glance may have hidden weaknesses revealed on analysis.

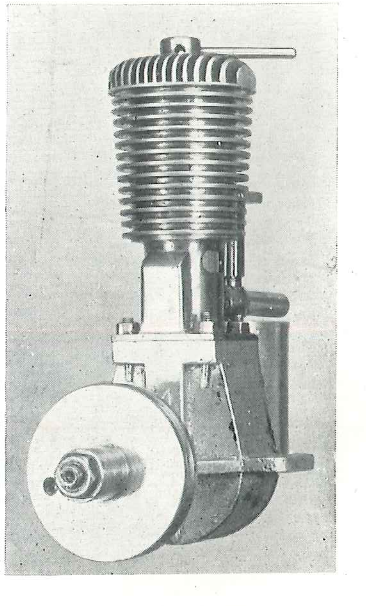
As many will be graduating from internal-combustion engines it may be as well to compare these with diesels from a performance angle.

First it must be borne in mind that to function efficiently the diesel must be made to a finer degree of accuracy, and that a petrol engine made to the same limits would be immensely improved in performance. Such improvement cannot, however, compensate for the weight of electrical paraphernalia that must inevitably accompany it, and this is the damning thing that may well cause the petrol engine in all but the largest sizes to become as obsolete as the compressed-air motor for aeromodellers during the next few years. Take any average petrol engine of, say, 10 c.c., add in weight of electrics, and then divide that figure by its capacity. Comparisons are odious, so the make selected will not be given, but readers may choose one for themselves and have the satisfaction of knowing that figures were not rigged for their benefit. Anyway, our selected example is one of the *best* petrol engines. All-up flying weight with batteries, coil, condenser, but excluding wiring and making, the minimum battery capacity that will give an efficient

Movo 2 c.c. a simple Italian copy of the Dyno that has proved a popular favourite.



Experimental model developed in the Aeromodeller Research Department at Eaton Bray.



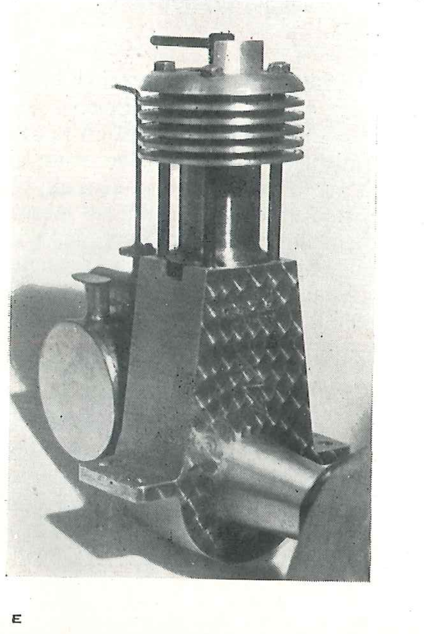
spark of petrol engine X is 20 ozs. Divided by capacity in c.c. gives a weight per c.c. of 2 ozs. Rated h.p. is $\frac{1}{4}$, and this divided into weight gives 80. Power per c.c. amounts to .025. Now take an *average* diesel—again no names . . . .—of 10 c.c. Here all-up flying weight is 13.4 ozs. divided by capacity gives 1.34 ozs. as weight per c.c. Rated h.p. is again $\frac{1}{4}$, and this divided into weight gives 53.6. Power per c.c. again amounts to .025 These figures are the most unfavourable possible for the diesel, as it is least effective at capacities of 10 c.c. and over; nevertheless, there is a $33\frac{1}{3}$ saving in weight alone.

A further example, this time taking a couple of engines of about 2 c.c. are given. Here are the results:—

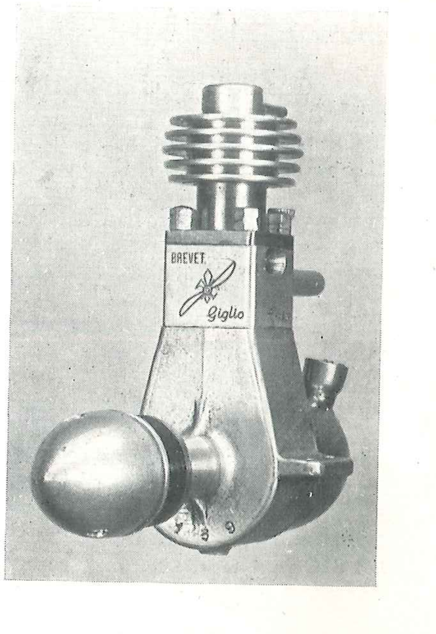
	Weight	H.P.	Power/c.c.	Power/weight	Weight/c.c.
2 c.c. Petrol	9 oz.	.125	.062	64	4.5 ozs.
2 c.c. Diesel	6 oz.	.09	.045	66	3 ozs.

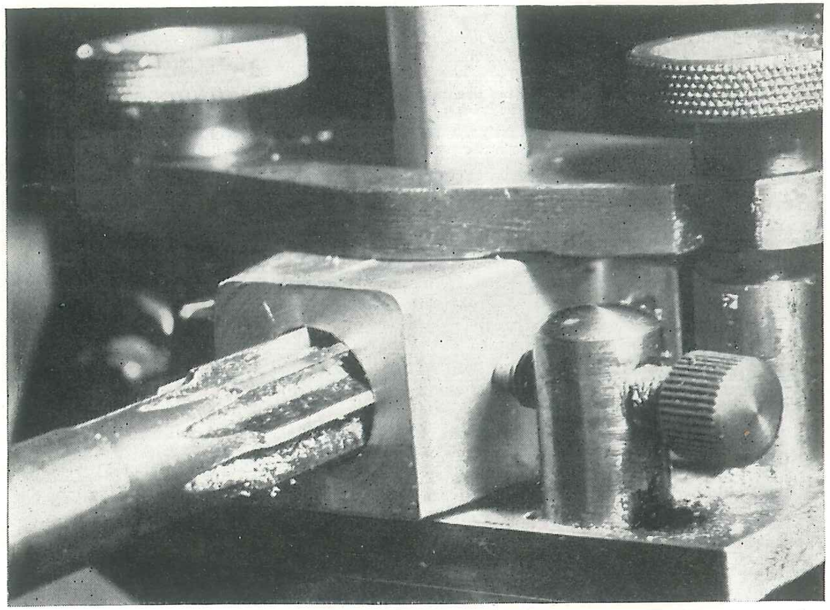
This shows the diesel to be two-thirds the weight of an equivalent petrol engine, to have slightly less rated h.p.; to have almost the same power/weight figure, though the petrol engine includes weight of electrics, thus showing that the whole of the actual strength weight for the diesel goes into making a good stout engine; and a substantially lower weight per c.c. Let us consider what these figures mean in terms of building a model. Assume that our all-up weight of engine and model is to be $1\frac{1}{2}$ lbs.—an acceptable figure for this capacity. In the first instance 9 ounces must be taken up with the motor—leaving 15 oz. for the airframe—in the latter, 18 oz. are

Allouchery 1.25 c.c.—it will be noted that a larger tank is fitted than shown in the drawing.



Giglio 2 c.c. an example of the Dyno influence on Italian diesel design.





Reaming a Dyno crankcase—a process that does not materially differ from that employed by any amateur making his own engine.

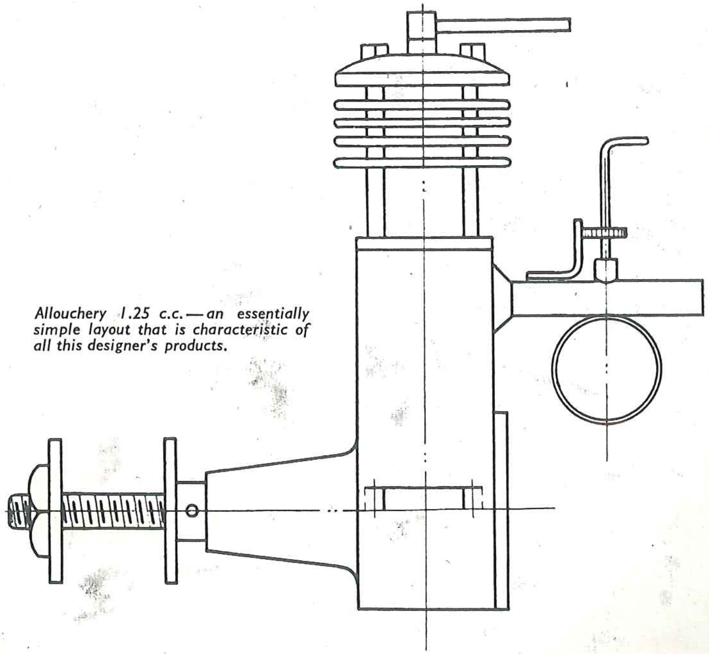
available for airframe, permitting a correspondingly stouter structure—or, and this is quite important, a substantially lighter model of equal strength, with its attendant advantages of slower flying, flatter glide and lower damage potential on landing. These same figures can be used to illustrate a variety of points on these lines, and, however they are taken, cannot be twisted to disadvantage the diesel.

One little point in passing may be of interest to the growing band of flying boat addicts—that is, the immunity of the diesel to involuntary duckings. Recently a flying boat was demonstrated and, as so often is the case when best behaviour is demanded, it finished its flight upside down in the water, and there it lay until the launch came up with it—a soaking of nearly 10 minutes—it had been a good flight. Activities were by no means over for the day, for after shaking out the surplus water from engine, and draining the wings, a few flips on the propeller brought out a wheezy cough, a few more got it started. It was then refilled and gave performances as good as ever. That is something that even Dr. Forster cannot do with a petrol-engined flying boat.

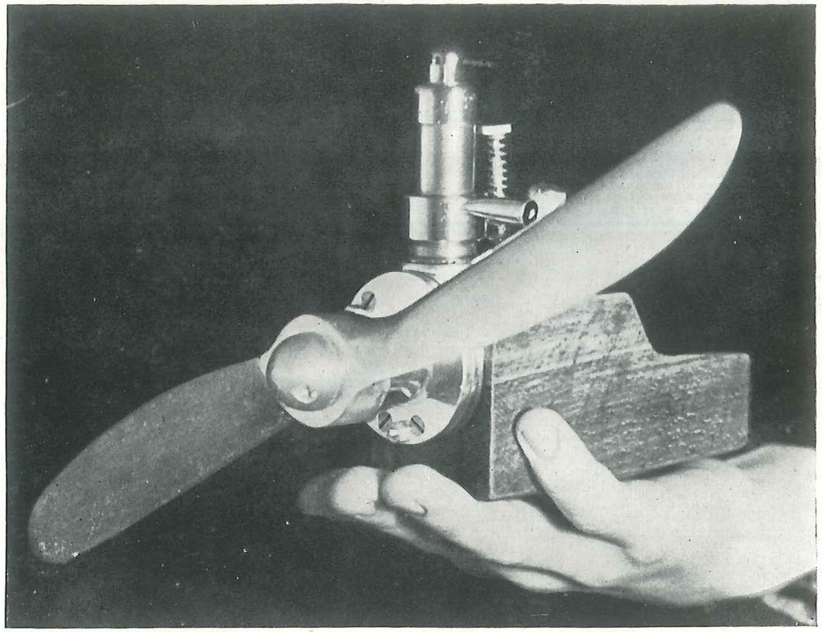
Continuing our search for the diesel of our choice, another query arises—fixed or variable compression. In the larger sizes—that is, above 3—4 c.c.—variable compression is an unnecessary complication and adds to the weight. For those building their own engines it has something to recommend it, as it does give an opportunity to make changes in compression and mixtures, that in the commercial model have been made in the experimental stage and the finished product offered with all the "bugs" removed.

Recent research does, however, show that all the adjustments essential to the correct functioning of a well-designed engine can be carried out by means of the needle mixture control alone. The engine can be started from cold with ease, and equally easily re-started when warm without any need to have that extra lever to fiddle with. For small engines of under 3 c.c. it is more than a luxury; it is essential—as the babies are most sensitive to variants in compression, and need really tickling to get under way. If it could be avoided, be sure the designers would have found the way—especially where here, more than ever, the weight bugbear looms up. There is just one other point in favour of the variable piston—which practical readers will be quick to appreciate—it does allow compression to be increased as old age and growing sloppiness render it necessary. Without it there is nothing for it but to scrap the engine or make a new piston to finer limits.

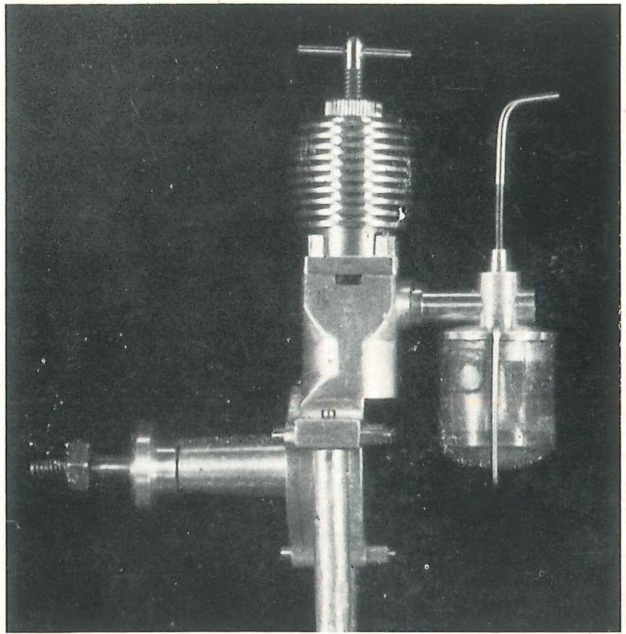
Those who are fortunate enough to possess the necessary tools will not long be content to buy their engines, but will proceed to make their own from one or other of the tried designs available. Several hundreds of the 5 c.c. engine described elsewhere in this book have been made with varying degrees of success all over the country, and, naturally, as the brain-child of our own research department, it is strongly recommended. It should be added that this is not really a case of the cook praising the meal, but is borne out by the long life enjoyed by the prototype, which in spite of literally hundreds of hours of running, and the most unspeakable indignities thrust upon in the shape of harsh treatment and strange mixtures, will still start like a dream and run sweetly in the hands of both skilled and novice operators. The size of 5 c.c. is just right—being neither too large nor



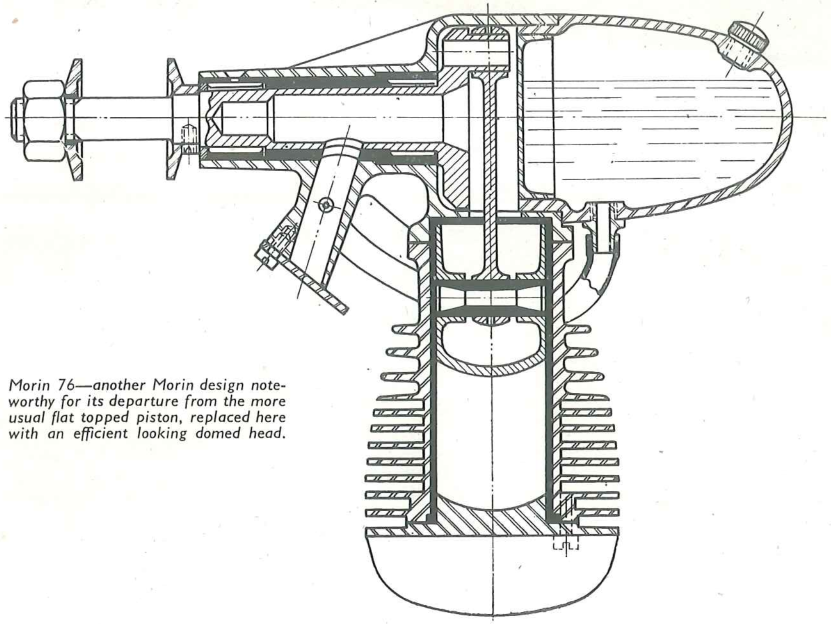
Allouchery 1.25 c.c.—an essentially simple layout that is characteristic of all this designer's products.



Etha II — a rather heavy 6 c.c. Swiss engine that had only a short commercial life.



Atom prototype—comparison with the final product will demonstrate how the production model was refined from this already pleasing design.

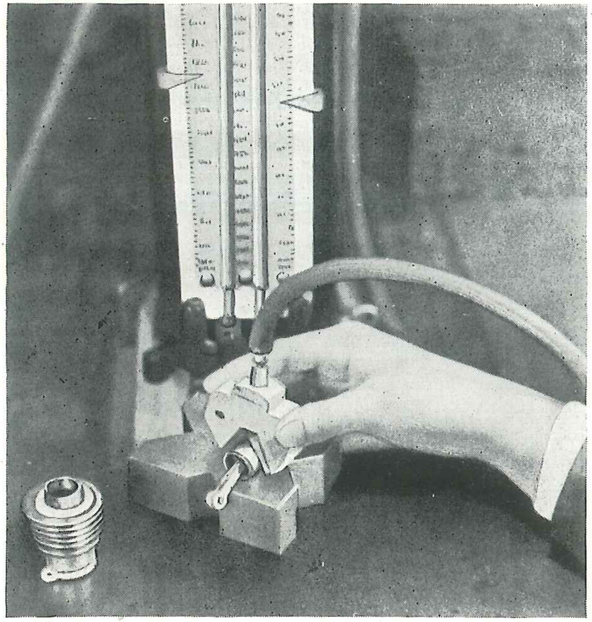


Morin 76—another Morin design noteworthy for its departure from the more usual flat topped piston, replaced here with an efficient looking domed head.

too small for the skill of the average amateur mechanic, and suitable for either model plane, miniature race car or power boat—where once again the remarks regarding flying boats apply in equal measure. But this is by no means the only prototype available; many commercial engines may be secured in casting form, and can afford infinite pleasure for the long evenings.

This will not satisfy the really keen amateur, who is determined to be more than the hand holding the tool, and always likes to design everything that he turns out. A few remarks on the trend of diesel design may not come amiss—though it is not expected that these views on design will necessarily be accepted by everyone. It would be a bad thing for progress if they were.

Some critic of the diesel said quite a long time ago that there was really nothing in it. It was only necessary to take an ordinary internal-combustion engine, stop up the plug-hole, throw away the electrics and fill up the tank with a mixture containing ether, and there you were. He was quite right—as far as he went. Had he added the saving proviso to make sure it was an exceptionally good petrol engine with heaps of compression—about 14 or 16 to 1 in fact—no one could possibly quarrel with his description. It is, in fact, nearly as easy as that. Indeed, a number of enterprising French firms sell so-called "conversion plans" at about 2s. a time, whereby owners can convert their old petrol engines to the new style. How many of them succeed in getting a pop out of their conversions is not known—probably precious few if the truth were told.



Fluid micrometer in use to check tolerances. This useful instrument enables selective grading to be quickly and accurately done in mass production plants.

Running in diesels on special workshop rig.

However, the similarity is so great that it is possible to consider the problems of the diesel along much the same lines as any really high-compression two-stroke engine such as, for example, a racing motor cycle, or, nearer the model maker's heart, one of those zippy little model speedboat engines such as the renowned Gems Suzor still manages to turn out.

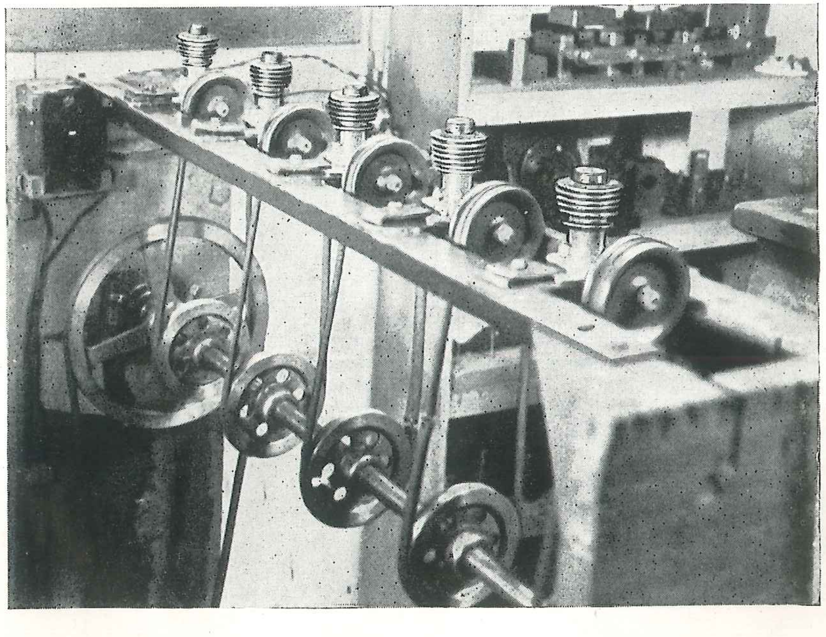
The two-stroke principle is so well established that nothing revolutionary can be hoped for along unorthodox lines—refinement of the structure seems the best approach. Of course, the real enemy of efficiency is inefficient scavenging. There is always that dead area which cannot be swept clean. Equally there is the consequence of ill-advised improvements which result in a large part of the gases being swept out before they have done their bit by detonating. Because of this, the theoretical power output of any two-stroke is much below its actual power delivered. Not that this really matters all that, as the amount given—poor though it may be—is more than enough to fulfil the purpose of the engine. There is a lot of waste, and fuel consumption to power is extremely high, but then there is a lot of running in a pint of fuel! In the model world, fuel consumption can happily be ignored. The newcomer to diesels may be shocked by their apparent inefficiency, as they usually blow out a moist mist of what looks like unexploded mixture.

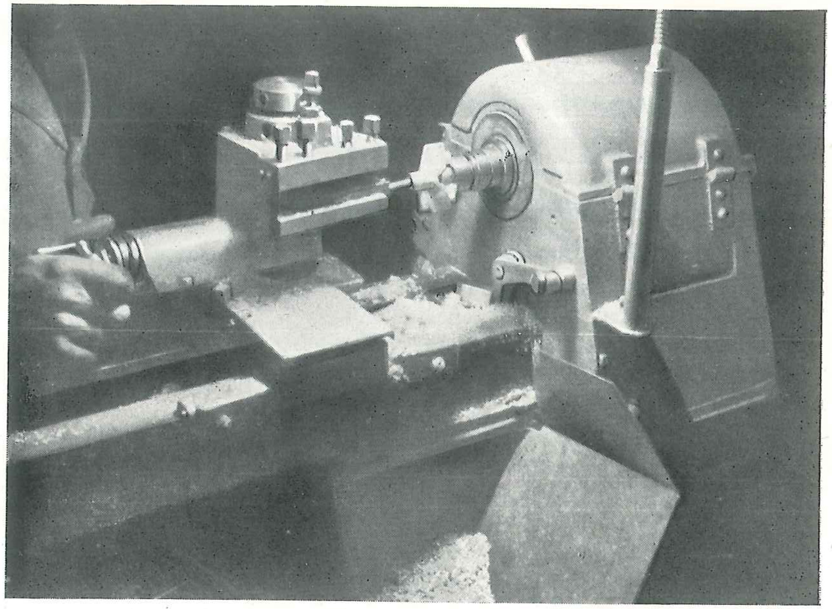
What design can be adopted to get the most out of the mixture, things being as they are? The obvious answer would appear to be a shorter stroke and a larger bore, that will retain the desired capacity, but provide it in a different fashion. This flattens the curve of inrushing gas and reduces the stagnant unswept area to a minimum. It is a truism to say that the power of an engine is proportionate only to cubic capacity. It is erroneous to say that a short-stroke engine revolves more strongly than a long stroke. The factor regulating the speed is the maximum speed at which the airscrew can be persuaded to turn, and this can be adjusted by the pitch. Even so, the finding of pitch will not get more out of the engine than its potential output. Above this figure increased speeds result only in blade slip, and the only consequence is shorter life for the engine!

Having decided on a prototype for consideration of ways and means there are three simple courses of action:

(1) To leave the bore unchanged.
(2) To leave the cubic capacity unchanged.
(3) To leave the stroke unchanged.

Take first considerations of weight. The cylinder will vary in proportion to the piston stroke and perimeter, and consequently in proportion to the bore. The weight of the crankcase will vary only according to the variation of the stroke in its lower part; the upper part (about one third of total weight) will vary in relation to stroke and perimeter of the piston. The weight of the piston should vary in proportion to the third power of the diameter, but in practice the weight of a small piston will be proportionately greater. The same holds good for the contra-piston. The weight of the head varies as the square of the diameter, while weights of connecting rod and crankshaft remain in proportion to cubic capacity. Carburettor and tank weights will not tend to vary much.





At work on a crankcase, helped by magnificent workshop equipment beyond the reach of the average amateur.

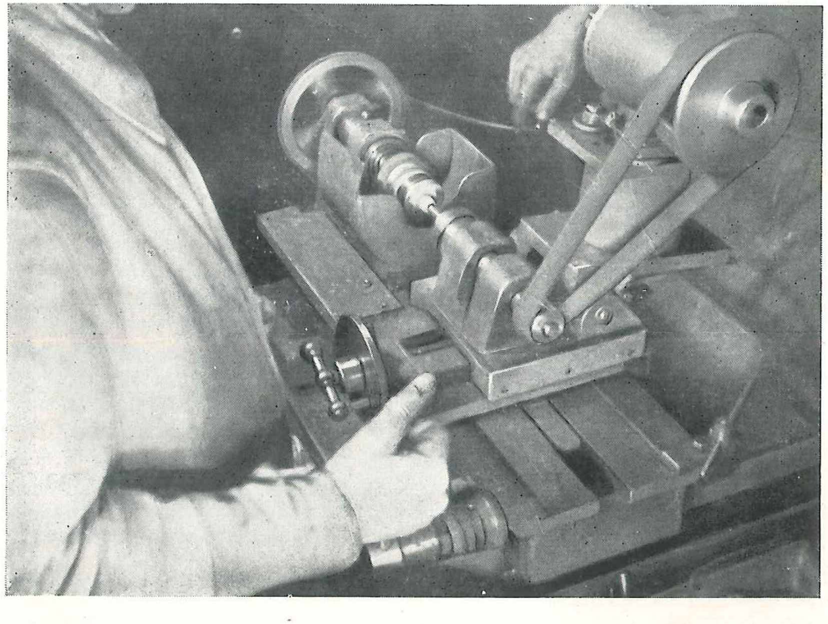
By reducing the stroke bore ratio we get a corresponding reduction in power, but the smaller engine will weight proportionately less than the larger. From a compactness point of view there is something to be said for it. Many authorities contend that the accepted ratios, as tabulated elsewhere, are somewhat high, and there is a case for the approach to the so-called square engine with equal stroke and bore, and relatively lower piston speed, which, of course, would be quite advantageous from the mechanical point of view.

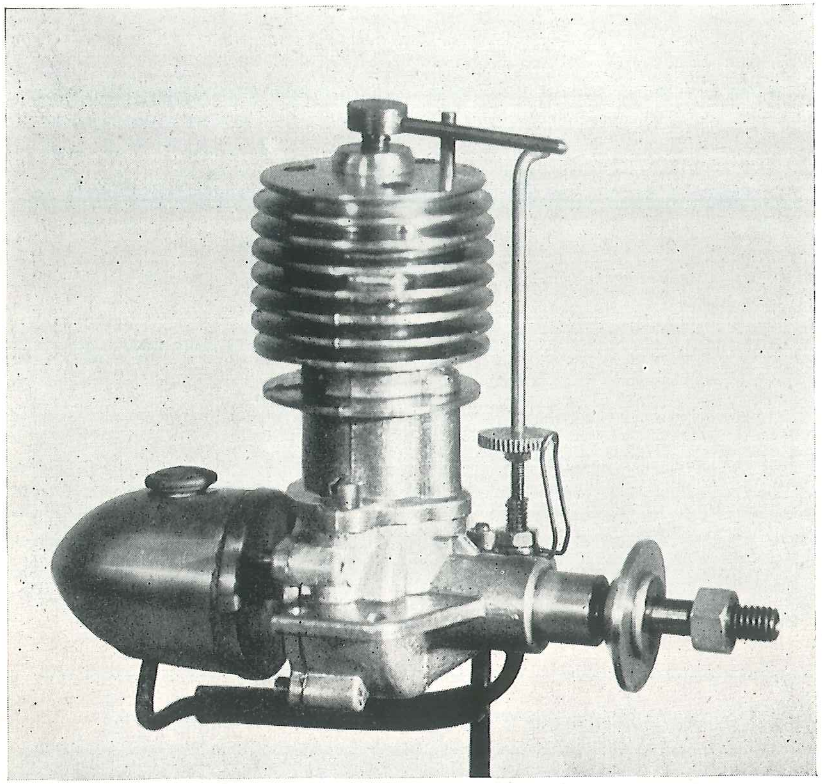
Other advantages of the short-stroke engine are improvements to the feed as the integral surface stroke is increased and the lower inertia of the connecting rod. It may be asserted that the square short-stroke engine presents difficulties of compression regulation, because a movement of the contra-piston brings about a greater variation of compression. This can be compensated by making the pitch of the regulating screw correspondingly finer, and is not a serious disadvantage. Gas losses will also be in proportion to the piston perimeter; that is to say, greater in the case of larger bores, but on the other hand operational troubles decrease when large pistons are used. Again it must be pointed out that thermal losses increase in proportion to the size of the contact surfaces between the combustion chamber and the head. But it can be argued that the greater the surface contact between gas and head, the more gradual will be the increase of gas pressure—hence smoother running. The pros and cons of long and short-stroke will always be debated, and it is no part of this commentary to force a decision.

Heads of compression-ignition engines should be anti-turbulent; that is to say, they should not tend to divide up the mixture or encourage vortices of gas during the compression period. The ideal, of course, is for the mixture to ignite simultaneously at all points, or at least that the ignition spreads with a minimum time lag from its point of initial combustion to all the remaining parts. The ordinary flat head is not the ideal shape to induce this state of affairs. Some form of head with separate compartments, similar to that employed in the true diesel cycle accumulation type of motor, may be indicated. Such a small chamber inaccessible to the washing gas may retain a quantity of combustion gas. Equally it is desirable to establish a cold point in the lower part of the contra-piston to aid the starting of self ignition.

To sum up, it has been suggested that the most practical lines of improvement in model diesel engines is to be found in a short stroke, medium cubic capacity of, say, 4-6 c.c., short connecting rods, separate compartments and pre-established ignition points. Perhaps readers may feel that the present state of development of these engines is quite good enough for them, and we hasten to assure them that any of the better commercial products will give them a great amount of excellent running, and that published designs will provide reliable outlets for their skill, Nevertheless, all those interested in the continual improvement of the breed will, we are sure, be ready to consider our design suggestions impartially, and, we trust, make the results of their own experiments available in due course.

Final lapping of the cylinder with the aid of a specially adapted machine revving at up to 8,000 r.p.m.





Comete Junior 5 c.c.—one of the few makes where the designer recommends a two part mixture, though in point of fact it runs on most of the more normal fuels.

CHAPTER VI

DIESEL FUELS DISCUSSED

BEFORE discussing diesel fuels it is as well to be quite certain exactly what produces self ignition in the compression-ignition engine. It is a basic fact of physics that a gas is raised in temperature when compressed. A simple analogy will prove the point to those not familiar with this physical law, who are reminded that when pumping up a bicycle tyre the body of the pump gets quite warm. This warmth is produced by compressing the air in the pump. It is easy to understand that if, in place of air alone, a suitable mixture of air and some combustible liquid or gas could be compressed, it should be possible to raise the temperature to a degree sufficient to ignite the mixture. Provided the combustible addition has the necessary properties, such ignition will result in an explosion. This in effect is the principle behind all compression-ignition motors. Theoretically, this would appear to be a simple matter to achieve, but to get a motor to function properly it must be arranged under carefully controlled conditions. First a suitable carburant must be chosen, brought to a state of mist with some other agent that promotes combustion, and introduced into the engine where the explosion can exert a driving force.

Contrary to the belief held by the uninitiated, the highly volatile substances are not necessarily suited to this sort of firing, as their spontaneous combustion temperatures are too high. But before making a selection of a suitable agent some of their important characteristics must be considered. There are seven factors governing the choice; viscosity, ignition quality, pour-point, impurity content, volatility, gravity, and flash-point. The last two named can be ignored in the case of engines for models, as gravity relates only to weight, and in the small quantity carried in an average fuel tank will have little bearing on our choice if otherwise suitable. In the same way flash-point can be ignored as when flying out of doors there is nothing to fear from fire hazards brought about by a low flash-point. Pour-point, which is the lowest temperature at which a liquid will flow freely without pressure is another that will hardly have bearing in model practice, unless the optimistic aeromodeller envisages flights to such altitudes as will effect his running temperatures. Which leaves only four characteristics to consider. Viscosity can be briefly defined as the degree of resistance to flow in a substance. Water, for example, is less viscous than treacle. This is affected by heat—treacle when warmed becomes more like water: water on the other hand does not change its degree of viscosity when heated until at boiling point it becomes steam. This question of viscosity is important, for it may be possible to find some agent that combines lubricating qualities with combustible characteristics, as will be discussed later.

Ignition quality is the prime factor to be considered. Points to bear in mind when considering likely substances are the auto-ignition temperature—a low figure is better, so that there will not be too great an amount of fuel in the chamber before ignition—the delay period, or lag, in ignition, which sets up problems of its own—whether combustion is complete or nearly so, incomplete combustion is accompanied by roughness in running and smoky exhausts.

Nor must impurity content be ignored. Minute quantities of impurities are always present in mineral oils and, indeed, in most substances, even if care is taken to buy only the best. In passing it may be mentioned that on the continent many of these engines are run on commercial ether, which contains acid impurities with consequent disastrous effects on their engines unless special precautions are taken. It is worth while to filter all fuels before use, as impurities may be turned into abrasive metal oxides, which will remain after organic substances have been burnt.

Volatility is the remaining point to consider. The liquid fuel has to be converted into vapour, and the vapour has to be heated to auto-ignition temperature in a fraction of a second. Clearly, therefore, rapid vapourisation aided by careful design of the induction is a very necessary feature.

It must be assumed, however, that the experimenter in fuels is not starting absolutely from scratch. He has the previously published facts before him, and will probably have a recommended fuel for his own engine. This can be regarded as the basic or standard fuel, and all subsequent mixtures regarded as better or worse than the accepted standard. In the case of the *Aeromodeller* Research Department's experiments a standard fuel was selected consisting of 45 per cent di-ethyl ether, 45 per cent ordinary petrol, 10 per cent lubricating oil. This had already proved a sound all-round mixture on which most diesels would run, while lacking any super performance that might suggest it could not be bettered.

A short analysis of running conditions on this fuel mixture led to the following brief summary :

(1) Very pungent exhaust fumes with a sickly odour. *Conclusion:* Incomplete combustion taking place.
(2) Constant knocking or pinking. *Conclusion:* Detonation taking place, and (typically) the products of preliminary combustion are running the engine, as is normal with an engine that is knocking continuously.
(3) Coolness in running. *Conclusion:* Latent heat of vapourisation of unburnt petrol and ether was rapidly cooling the engine—thus confirming conclusion to (1).
(4) Quantity of unburnt fuel thrown out of exhaust. *Conclusion:* Further confirmation of (1) and (2).

As the choice of fuel hinges mainly on octane and cetane values, a brief explanation of these terms is offered, but it must be pointed out that this explanation is by no means complete, and, indeed, is totally inadequate for a *thorough* study of the subject. However, it is sufficient to serve its purpose on the present occasion. Those who intend to make a more exhaustive study of fuel problems will, no doubt, take an early opportunity of reading all that they can obtain on the subject, so that the point will in time answer itself.

Certain fuels, notably the ethers and paraffins (both terms embracing literally hundreds of substances), have, as a rule, low or negative octane values. The only ether exception which comes to mind is di-iso propyl ether which has an octane value of well over 100. Now low-octane fuels, due mainly to their molecular construction, will cause detonation, and when used will cause an engine to pink or knock. High-octane fuels do not detonate, but burn smoothly under pressure; again, mainly due to their molecular construction. The addition of a suitable dope may improve fuels by increasing their ignition quality. An example of this is the addition of lead-tetra-ethyl chloride to petrol to increase the anti-knock or octane value. Equally many of the curiously named fluids on the market for improving petrol consumption perform similar functions. Cetane value for the purpose of this chapter can be interpreted as low or negative octane value.

As high-octane fuels are quite clearly ruled out for compression-ignition engines, the choice is really limited to the many and variegated fuels of low or negative octane value with high cetane values. Further, the fuel must be liquid, volatile, with a short ignition lag, and a low inflammation point. Fuels with extremes of long or short ignition lag can damage an engine badly, as the first explosion, or rather detonation, forces down the piston, and then as it comes up again, delivers the full force of the same explosion now at maximum. Such distressing results as ruined connecting rods and big ends hammered oval are among the penalties exacted from the experimenter in unsuitable fuels.

Typical fuels can be most readily found in the homologous paraffin series and the simple and mixed ethers. To digress for the benefit of those unacquainted with organic chemistry—homologous means a series of substances of uniform chemical type capable of being described by a general molecular formula, and each one showing a regular gradation in physical properties. Simple ethers are those containing only one alcohol; mixed ethers those to which a second has been added. Continuing the digression, the usual ether used in diesel mixtures is di-ethyl ether or sulphuric ether, named after its method of preparation from sulphuric acid. An impure commercial ether is made from methylated spirit and produces methylated ether, which should be avoided in model diesels unless special precautions, described in the chapter on maintenance, are taken. To avoid obtaining the wrong kind in all good faith from the chemist, it is as well to specify anæsthetic ether which is always of the purest variety.

Among the commoner of this family of paraffins and ethers—possessing some of the required values—are normal hexadecane, heptane of the paraffins, and di-ethyl ether, di-methyl ether, methyl propyl ether and many others of the ethers. A number of these are ruled out as they are solids or gases, but, luckily, we are not confined to the series mentioned, but can turn, as necessary to many other substances and blend them together to add or subtract from their own individual properties.

At first sight, the action of the ether mixture can be apparently explained quite simply. The ether is ignited by compression, fires the petrol, and the resulting expansion of gas drives the piston down, whilst the lubricating oil merely lubricates, and as may be expected is slightly oxidised in the process. However, the process is not quite so simple as this. The ether is ignited by the compression and begins to burn, but, owing to its low octane value detonates, and virtually prevents the petrol from igniting fully. To say that the detonation of the ether, which causes the knocking, "blows out" any combustion that begins to take place, is both making and stretching a point, but it does serve to illustrate the sort of processes that take place in the engine. The lubricating oil serves another and even more important part in the mixture. It increases the ignition lag of the ether, and by so doing takes some of the violence out of the detonation.

If the engine is run on a mixture of five parts pure ether and one part lubricating oil, the detonation that occurs is really alarming, and quickly ruins both big and little ends of the connecting rod, as well as straining the crankshaft. The ether can, of course, be toned down by mixing it in equal parts with the oil, but the resultant fuel is unsatisfactory as it is too oily and messy generally. Nevertheless one of the more successful French diesels—the Delmo—recommends this mixture, and the engine certainly runs on it quite well. It is essential, however, thoroughly to clean out the engine after use with petrol, otherwise the oil gums up and renders it impossible to start on the next occasion it is used.

A better plan is to mix a high-octane fuel ("good" petrol) with the ether and to adjust the oil content to control the ignition lag of the ether. This is the method adopted in developing the standard fuel described in earlier tests—and produces a good average mixture, if nothing revolutionary.

There are many fuels which can be mixed with the ether, and amongst those tried are ordinary paraffin, petrol ether, petrol, naphthalene—a popular favourite with the Italians—benzene, ethyl, methyl, propyl and alkyl alcohols, acetone and amyl acetate. All these substances serve to help run the engines when used as deadeners for the ether, but fuels which tend to have additive values, of course, cause more severe knocking.

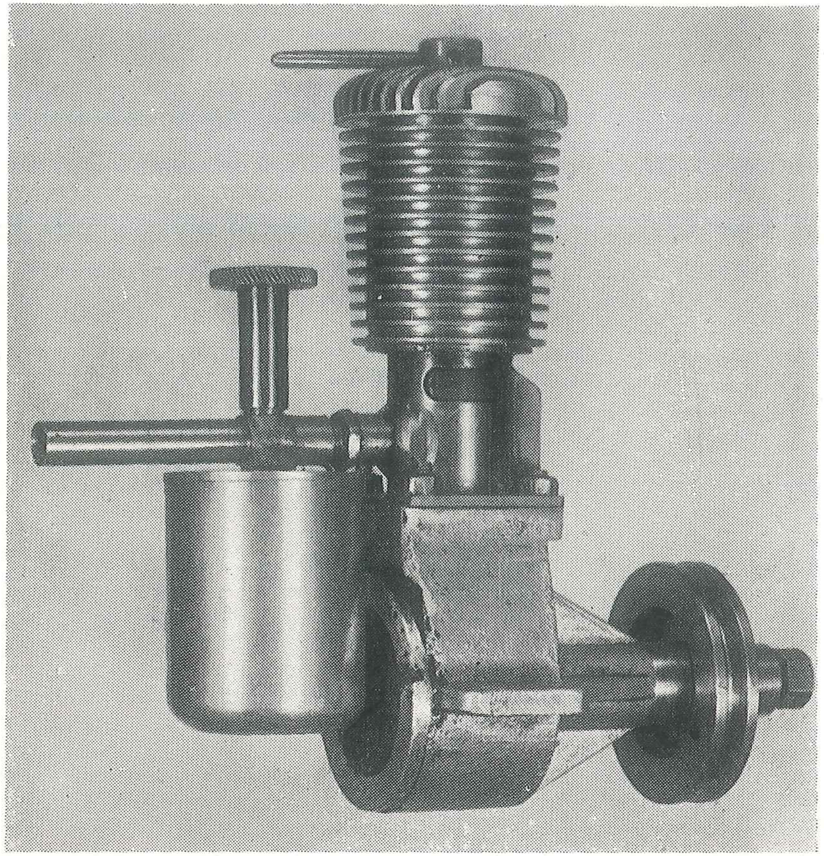
So far one method of approaching the fuel problem has been discussed. Di-ethyl ether is a violent fuel with a negative octane value, and using it as the basis of a diesel fuel it must be toned down by the addition of deadening agents. Another approach is to use a stable and rather "inert" fuel which has some of the ideal properties, and to adjust any deficiencies by the addition of accelerators. It remains to find an accelerator which, unaffected by the presence of lubricating oil—which lengthens ignition lag—will cut down the main fuel ignition lag, and, so far, additions of benzene and inorganic acid esters have shown a certain amount of promise in the blending of a comparatively "safe" fuel.

It may be that the ultimate fuel will be found by considering the fuel used in the true diesel engine, either on commercial vehicles or in full-size aircraft. This suggests Pool Burning Oil, and experiments have been carried out, though not to finality, using this as the basis of a fuel. It is necessary to add suitable accelerating dope to improve ignition quality, and of those tried, ethyl nitrate is the most promising, as it shortens ignition lag considerably. Another promising accelerator is tetraline, while tetralin peroxide and sulphurized terpene can also be tried.

It may be argued that all this search for another fuel is rather pointless, as the little engines go quite well with the ether mixtures used at present. There are, however, many objections to the ether mixture. The ether evaporates very rapidly, and so the fuel proportions are easily upset. Luckily they are not critical, as 20 per cent by volume of ether is adequate, but the larger proportion in the standard mixture recommended does allow for evaporation. The vapour from ether, apart from its anæsthetic, is very heavy compared with air, and, mixed with it, forms a violently explosive mixture, so that care is needed both for storing and handling the substance. A naked flame should never be brought near any open ether vessel, and neither should rags saturated with it be left lying about on bench or table, as the heavy vapour can creep considerable distances, and, if ignited, will flash back to its source. To carry out thermal efficiency tests on these engines necessitates, amongst other things, the use of carefully measured volumes of fuel, and if ether is the basic fuel, evaporation greatly increases the problem.

There definitely is a great need for research on the fuel question. Unfortunately this has been neglected in the drive towards better engines by designers abroad, and engine design has perhaps raced several steps ahead of appropriate fuel advances. Our colleagues overseas have suffered even more than we have in Great Britain from a shortage of nearly every chemical they might have tried, hence their contentment with a mixture that does at any rate work. However, though it must be frankly admitted we are several years behind the continent in actual diesel design, there is no reason to suppose we are lagging in the matter of fuels. Chemicals of all sorts are freely obtainable, and in this field there is a grand opportunity of leaping ahead.

In conclusion, may we give a word of friendly advice. This business of getting a suitable mixture is a scientific study; it is sheer waste of time to approach it on the lines of the popular "lab. mixture" with which our science lessons were enlivened at school. There is not a chance in a million that anyone will just hit on the ideal mixture, without a vast amount of careful thought and quite a lot of time. Equally, there is no need to be frightened of the whole thing by the rather fearsome names of many of the substances mentioned. There is nothing basically difficult in the study of fuels, and no special knowledge required that cannot be learned in a week-end with a judicious selection of books from the local public library.



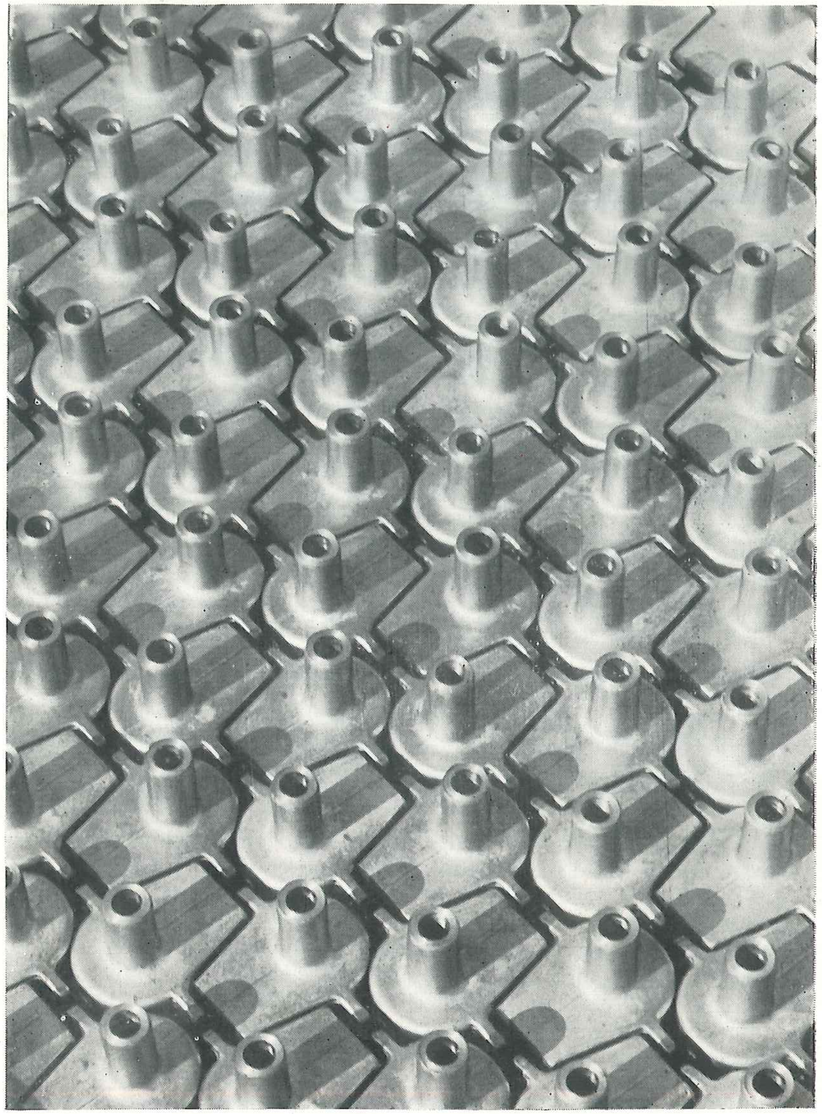
Aeromodeller 5 c.c. diesel designed by L. H. Sparey, whose research work in this field is well known. This reliable engine has been made in workshops all over the country—as well as many odd corners of the world where facilities are available.

CHAPTER VII

MAKING A 5 c.c. DIESEL ENGINE

IN offering building instructions for this 5 c.c. diesel engine it is appreciated that, in effect, we are contradicting our frequent stern warnings that the diesel is beyond the scope of the amateur mechanic. We will go even further, and commence these instructions with a similar grim warning of the "abandon hope all ye who enter here" variety, we still say that this engine is beyond the skill of the average amateur mechanic. But that does not mean we do not wish to encourage all and sundry to try it. "Where there's a will there's a way", and we shall feel more than satisfied if one out of ten of those who start it produce a sweet-running model engine for their pains. The other nine will have learned quite a lot in the process, and we beg them to continue the good work; if they do—and a large number will, we are sure—then, according to the native skill that lies dormant within them, at the second or third attempt they, too, will produce a diesel that really goes. And, rest assured, they will have earned the right to call themselves model *engineers* in so doing. Now for a more cheerful aspect of the business, before you set to work. This design has been available as plans and castings for some months, during which time several hundreds of plans have gone to all parts of Great Britain, to Sumatra and the Far East, to occupation troops in Germany and, in fact, to all places where there are enthusiasts and facilities for turning. Of that number we have had reports at all stages of the work, asking for advice, reporting progress, or forwarding tips to help in its construction. Some have sent photographs, one or two have passed along their actual engines, and, frankly, we are delighted with the skill shown. At the present time upwards of 50 successful engines have been completed—which is well above the depressing average we have suggested. So, good luck and go to it!

It is interesting to know that the prototype of this engine has done several hundred hours of running, and has been demonstrated before many of the best-known Model Engineering Societies in the country. It has always performed with unfailing satisfaction; has always started with ease and regularity, and does, at the moment, show no signs of its strenuous life. Thus, one of the chief "arm-chair" criticisms of this type of engine, namely, the possibility of a short running life, has been disposed of, and it has been demonstrated that, provided the correct materials are used in its manufacture, the miniature "diesel" engine can be as long-lived as its "petrol" counterpart.



Crankcase collection—a picture reminiscent of the "what is it" series illustrating some of the pocket monthlies.

Before launching into a general description, it may be as well to state that, although the parts are relatively few and simple, a high degree of engineering skill will be necessary before a successful replica can be made. This is particularly so in reference to the cylinder bore, and to the fit of the piston within it. The fit and finish of these components *must be beyond reproach*; yet, lest it be imagined that extensive and complicated machinery is needed, it can be said that the original was made solely by the aid of a $3\frac{1}{2}$ in. lathe and a drilling-machine. Care is certainly necessary, but we emphasise this not in order to make the job appear unduly difficult, but to put the would-be constructor on his mettle from the start.

GENERAL DESCRIPTION.

COMPONENT NO. 1: CRANKCASE.

This is machined from an aluminium casting—the only casting required in the engine. The wooden pattern for this is quite a simple affair, as there is no need to core the pattern in this small size. Dimensions may be taken from the drawing, allowing a few "thous." all over for shrinkage.

Machining is mostly plain boring and screwcutting, and the only dimension requiring particular care is that from the centre line to the cylinder seating, and marked as $1\frac{1}{16}$ in. on the drawing. It is also necessary to ensure that the seating for the cylinder is truly at a right angle with the main-bearing housing.

The best method of approach is, I think, to grip the bearing housing in the three-jaw chuck, and bore and screwcut the crankcase portion; also, at the same setting, face the seating for the crankcase cover, and drill and reamer the housing for the bearings. Now remove from the chuck, and mount on an angle-plate on the face plate of the lathe, locating on the cover seating just machined. A long bolt through the bearing-hole and angle-plate will secure the job. Now bore and recess, as shown, and face off the cylinder seating.

The clearance for the connecting rod may be put in by hand with a small round file, or the job may be mounted on the vertical slide and the clearance milled in with a $\frac{1}{4}$ in. endmill. While thus set-up, mill out the transfer passage as shown. It is advisable not to drill and tap for the studs at this stage, but to wait until the cylinder liner is made, and mark off from this when in position.

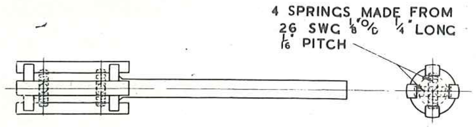
COMPONENT NO. 2: CRANKSHAFT WEB.

This is really part of the crankshaft (No. 11) which will be dealt with later. Attention is drawn to it here to point out the method of shaping the web, as this is necessary to the correct balance of the engine.

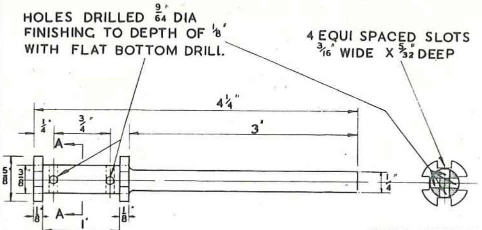
COMPONENT NO. 3: CONNECTING ROD.

This is of 3 per cent nickel-chrome steel, hardened and tempered, or any high-grade steel of similar properties may be used. The original connecting rod was made from a piece of old motor car half-axle shaft,

LAPPING HEAD FOR 5 C.C. DIESEL ENGINE

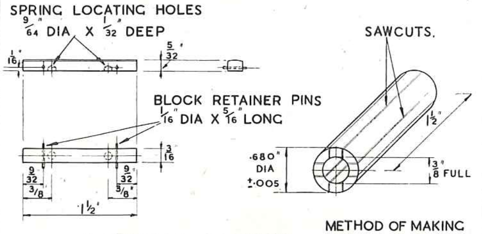


GENERAL ASSEMBLY.



BODY.

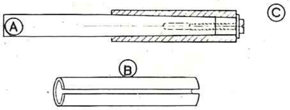
MATERIAL MILD STEEL



METHOD OF MAKING LAPPING BLOCKS

LAPPING BLOCKS.

MATERIAL CAST IRON
No OFF.- 4



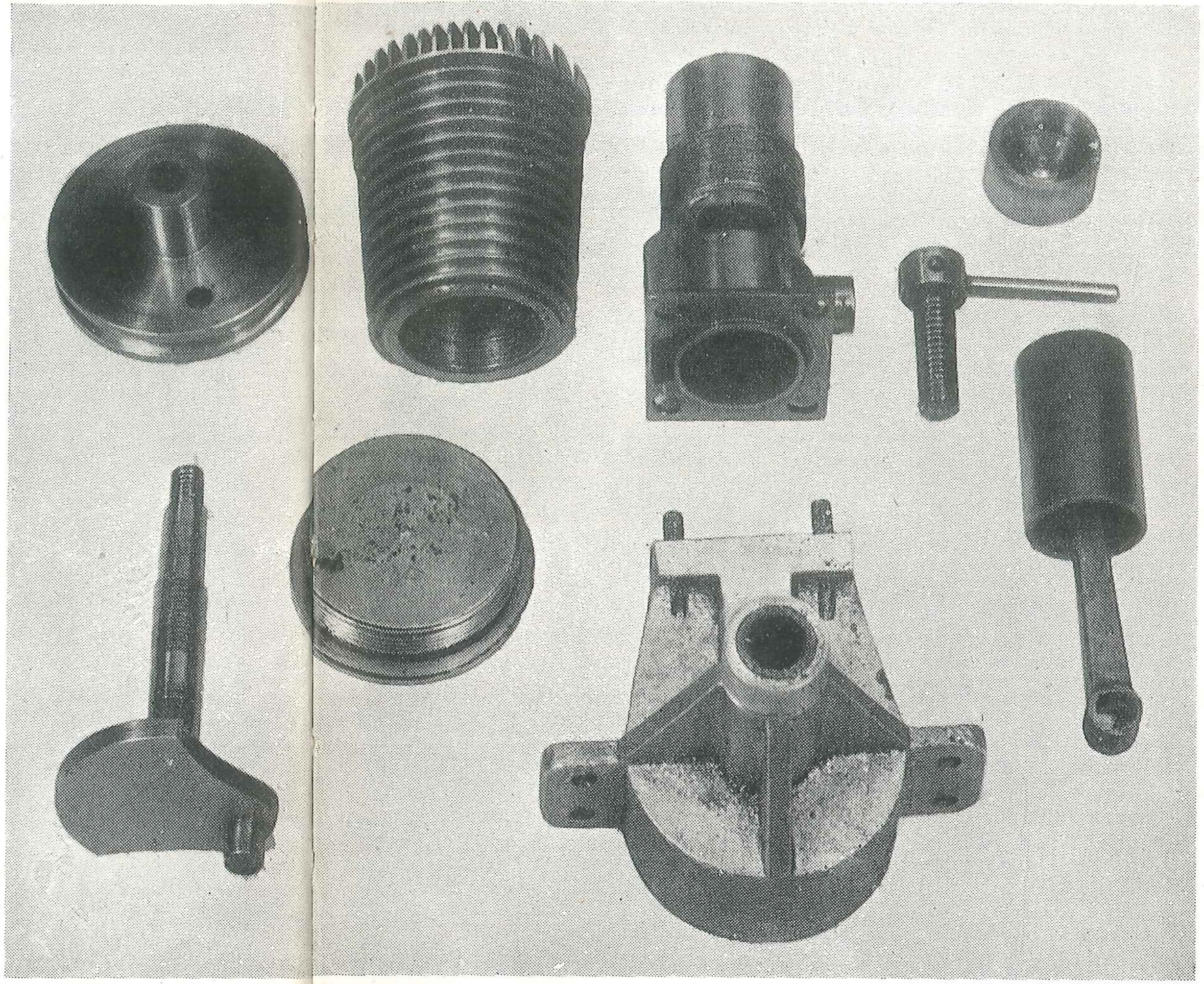
ADJUSTABLE PARALLEL LAP.

ROUGH SKETCH OF LAP WHICH REMAINS PARALLEL WHEN ADJUSTED

Ⓐ STEEL SPINDLE ONE END OF WHICH IS TAPERED & A 4-BA HOLE AT SMALL END.

Ⓑ SLOTTED COPPER TUBE MORSE TAPERED INSIDE TO FIT SPINDLE TUBE TURNED PARALLEL ON OUTSIDE TO DIA REQUIRED.

Ⓒ WASHER & SCREW WHEN SCREWED UP COPPER TUBE SLIDES UP TAPER & DIA IS INCREASED WHILE REMAINING PARALLEL.



Set of parts required for the Aeromodeller Research Department 5 c.c. diesel, finished ready for assembly. As may be seen, this engine embodies many of the best features of continental designs while preserving its own individuality.

obtained from a breaker's yard. Apart from the drilling and reamering of the bearing holes, this con-rod is mostly hand work with saw and files. It is not bushed in any way, but runs on the hardened bearings.

Components Nos. 4 and 5: Piston and Cylinder Liner.

These are the most important components of the engine, and on their accuracy and finish the whole running depends. Except for the lapping there is only plain turning required on the liner. The thread, of course, will be screwcut, but the ports are best filed out by hand. As to the lapping process, readers are referred to the sketches on page 84 which should be self-explanatory.

It is one of the characteristics of small diesel engines that they run extremely cool, so that both the transfer-passage and the carburettor-boss are soft soldered on! This is quite satisfactory, as the cylinder never gets hotter than is just bearable by the hand. The parts should, however, be well sweated on with a blowpipe, and, of course, this should be done before any lapping is attempted. Both cylinder-liner and piston are of 3 per cent nickel-chrome steel, but neither of these components is hardened, owing to the difficulty the average amateur encounters in finishing hardened parts. Provided that a mirror-like finish is obtained in lapping, unhardened parts will be found very satisfactory.

The piston, which is deflectorless, calls for little comment, beyond suggesting that it should be made from a piece of steel about 3 in. long. The piston should be roughed out, and the remainder of the steel reduced in diameter so as to leave a shank by which the work may be held. This will be found to be most useful for both turning and lapping, and also for holding the work in the toolpost (packed up to a suitable height) for the internal milling operation. Do not forget that lapping is the *very last* operation on both liner and cylinder, so that all work—such as the filing of ports, soldering, and the drilling of the gudgeon-pin holes in the piston must be done first. An advantage of leaving a shank on the work is that it can be finished, lapped and fitted, and then carefully parted off in the lathe, removing the small parting-off burr with a fine Swiss file.

Component No. 6: Contra-piston.

This is turned and lapped on a shank as was done for the piston, and here again a very fine fit must be ensured. However, as the contra-piston has but a very slight adjustment movement, a sliding fit is not required, and it is advised that the contra-piston be made an easy tap-fit within the liner bore. Leave the floor of the contra-piston $\frac{1}{8}$ in. thick as shown, and do not attempt to thin it down for the sake of lightness. When the engine is running considerable pressure is exerted on the floor of this piston against the bottom of the adjusting screw.

Component No. 7: Cylinder.

This is a plain aluminium turning from a piece of $1\frac{1}{2}$ in. diameter stock, and calls for little comment. No difficulty should be encountered anywhere, as it is not necessary for the cylinder to form a gas-tight joint

with the liner. In the drawing a finned head is shown, and the photographs will demonstrate that a nice appearance is thus given to the finished engine. The fins were milled in the lathe, using a $\frac{1}{16}$in. slitting-saw, with the job rigged on the vertical slide. However, should the builder not wish to go to this trouble, a cylinder head with plain, turned fins will serve. Finning on these small diesels seems to be more a concession to appearance than efficiency.

Component No. 8: Compression Adjustment Screw.

Turned and screwed 1 B.A. from mild steel rod. The thread should be a good fit in the cylinder head. The lever is a piece of $\frac{1}{16}$ in. silver steel tapped into the screwhead.

Component No. 9: Gudgeon Pin.

This is of silver steel, hardened and tempered to a dark straw colour. End pads of brass should be fitted tightly into the gudgeon-pin holes in the piston.

Component No. 10: Propeller Boss and Pulley.

The most convenient and safe method of starting small diesel engines is by means of a cord and starting-pulley. This pulley is of mild steel, and must be a very secure fit on the crankshaft. To this end, a taper is provided, and locked up by means of a nut. It is advisable to make the crankshaft first, so that a suitable flat reamer may be made to the identical taper after turning the shaft. This will be enlarged upon in the next paragraph.

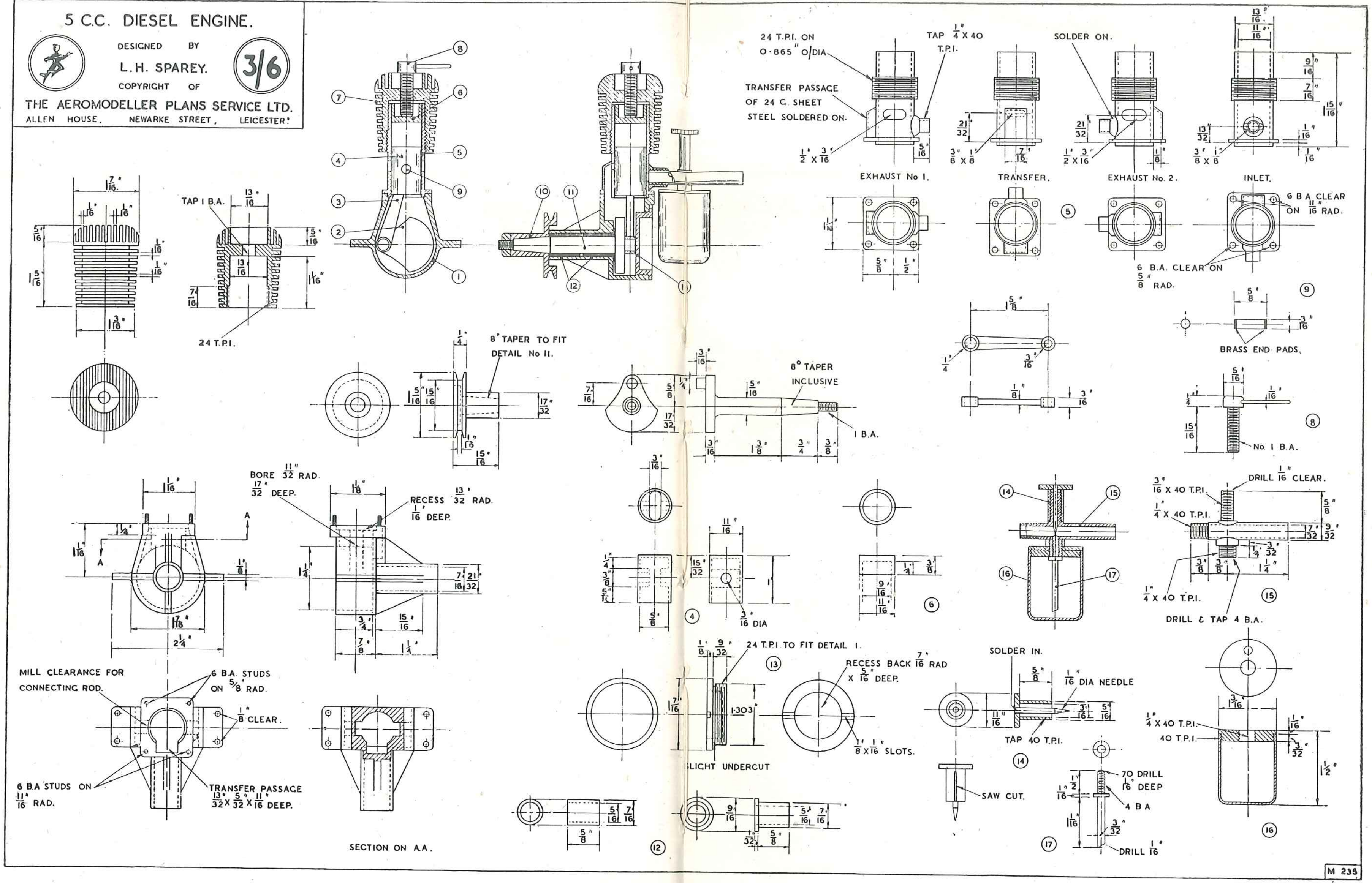
Component No. 11: Crankshaft.

This is of 3 per cent chrome-nickel steel, and is unhardened. The diameter of the shaft is given as $\frac{5}{16}$ in., but as the bearings (No. 12) have to be lapped, it is advisable to make these first, and to turn the crankshaft to fit, as lapping may increase the bores a slight amount. The whole crankshaft is turned from the solid bar by the usual method of offsetting on centres. The shaft must be parallel, and bear a very high finish, as this influences the wearing qualities greatly.

The taper for the starting pulley should be turned off the top slide which is set to the correct angle. Make this the last job on the shaft, so that the work can be removed without interfering with the setting of the tool. Remove the centres from the lathe, fit the three-jaw chuck, and grip a piece of $\frac{5}{16}$ in. silver steel. Now, with the same tool setting turn a taper on the silver steel. This will correspond exactly with the taper just turned on the shaft. On removing the silver steel, file it for the length of the taper to exactly half its diameter; harden and temper light straw. This will form a perfect reamer with which to make the taper in the starting pulley.

Component No. 12: Main Bearings.

These are of *Cast-iron*, and are lapped to a fine finish with metal polish, finishing with white lead and oil. Turn the outside diameters, drill and ream in one setting. It will be noted that double bearings are used rather



Plan of the Aeromodeller 5 c.c. diesel, full-size drawings of which may be obtained, price 3/6 post free, from Aeromodeller Plans Service, Allen House, Newarke Street, Leicester. This engine may be attempted with confidence provided it is remembered that "tool-room" limits are the order of the day—it is definitely not intended for beginners or the incurable "bodger".

than one long, single bearing. This is done to avoid the possibility of the drill "running off", as it so often does when drilling long holes in cast-iron.

Component No. 13: Crankcase Cover.

Plain turning and screwcutting in aluminium. The only precaution necessary is to ensure that the inside of the flange is flat and square with the thread.

Component No. 14: Carburettor Screw and Needle.

It will be noted that the needle of the carburettor is not threaded, but that it is soldered into an internally screwed cap which carried the adjusting knob. This system prevents excessive screwing of the needle into the jet. The needle is of $\frac{1}{16}$ in. silver steel, and the cap is of brass.

Component No. 15: Carburettor Body.

This is of mild steel, and is of fabricated construction. Take a piece of $\frac{9}{32}$ in. mild steel rod, 2 in. long, and at a distance of $\frac{3}{4}$ in. from one end, drill a $\frac{3}{16}$ in. hole clean through. Taking another piece of the $\frac{9}{32}$ in. rod, shoulder this down for about $1\frac{1}{4}$ in., and insert into the hole just drilled. Now silver solder the whole lot together, making sure that the solder runs completely into and around the joint. This gives the foundation for the carburettor body, which now requires only to be cleaned-up, drilled, tapped and threaded as shown.

Component No. 16: Tank.

In the prototype this was turned from the solid aluminium, but any suitable pressing which may be obtained would do. This is screwed to a circular top, which, in turn, screws on to the bottom of the carburettor body. Do not overlook the hole for the filler cap.

Component No. 17: Jet.

This is made from a piece of $\frac{1}{4}$ in. brass rod, turned down to leave a flange as shown, and screwcut at one end to fit into the body of the carburettor. The jet is drilled with a number 70 drill for a depth of about $\frac{1}{8}$ in., then, from the other end, the stem is drilled with a $\frac{1}{16}$ in. drill until the hole just breaks into the jet hole.

OPERATION OF THE ENGINE.

The fuel used in the prototype is one which has given extreme satisfaction, and with which the engine seems to yield its greatest power. The mixture consists of 50 parts of di-ethyl ether, 50 parts of pure benzene, and 30 parts of a good quality, medium grade lubricating oil. Mix small quantities as required, owing to the rapid evaporation of the ether.

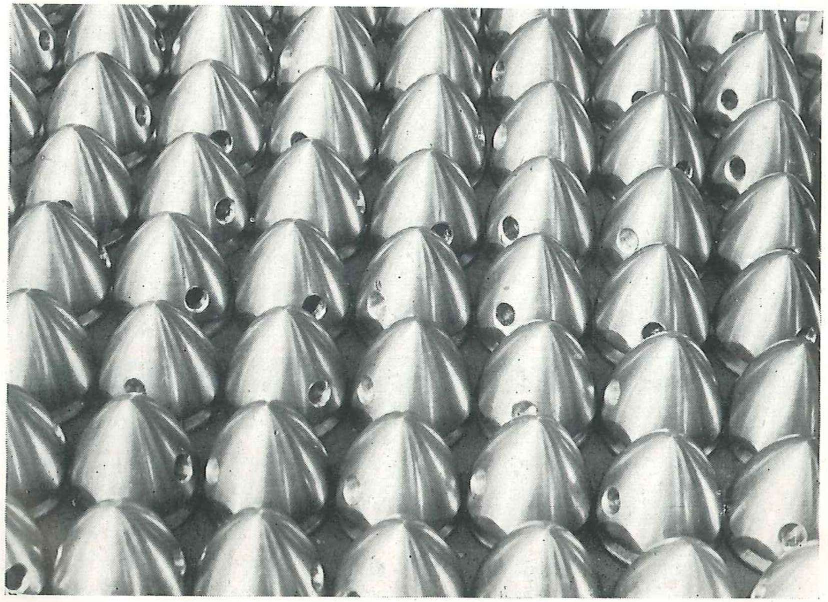
After filling the tank, and opening the jet needle about one complete turn, spin the engine over by means of the cord, several times to warm it. This will also suck fuel into the crankcase. Now screw down the compression adjusting lever until the engine fires, at the same time adjusting the throttle setting in an endeavour to obtain even running. Should the engine misfire in spite of throttle adjustment, it is a sign that the compression should be increased, so screw down the adjusting lever about a quarter of a turn and repeat the processes.

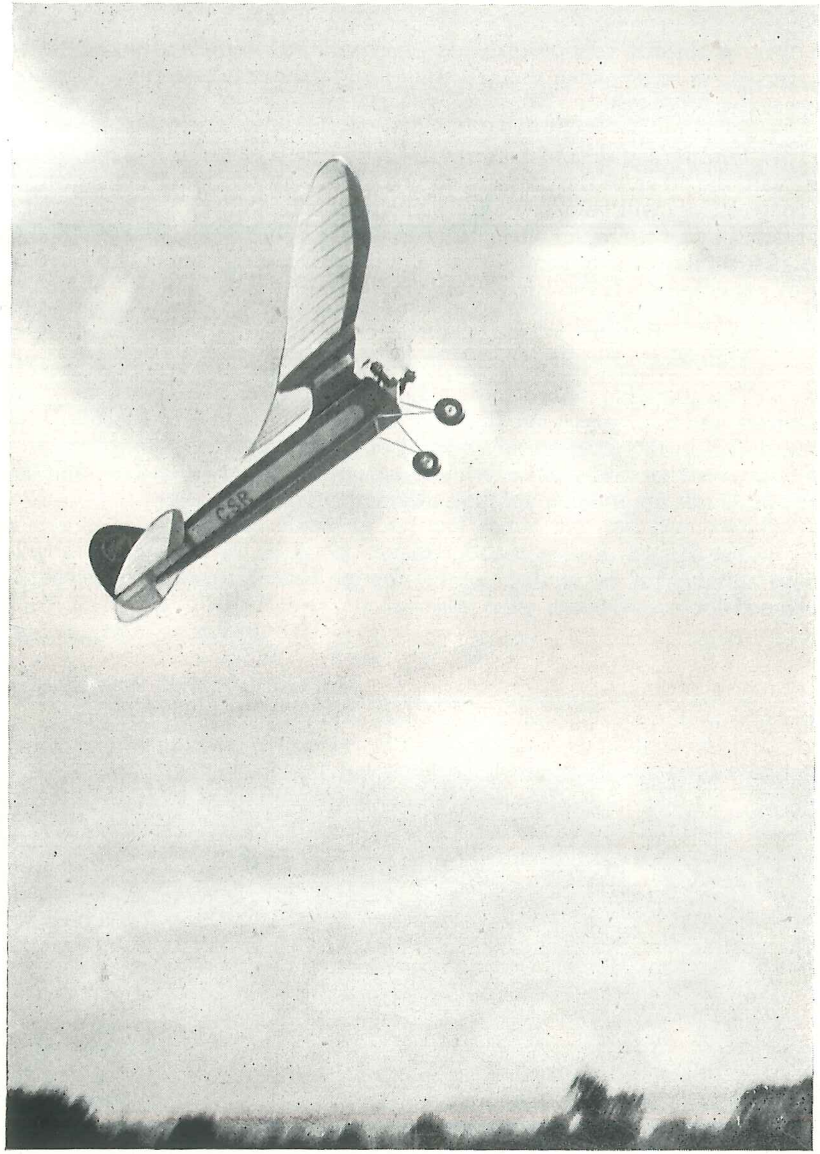
Throttle setting and compression ratio have a very marked connection one with the other, as the pressure needed to fire any given mixture is critical. Wrong settings will be denoted by a harsh, metallic "knock", which may be corrected by an alteration of the throttle setting. Once the engine is running the best combination of compression and throttle settings can only be arrived at by experiment. If the engine runs with a pronounced "knock" no matter what setting is given to the throttle, it is a sign that the compression ration is too high.

The propellor found most suitable for this engine is one of 13 in. diameter and 6 in. pitch, but this may vary according to the efficiency (due to variation in the precision of making) of the particular engine. Propellers of large diameter and relatively fine pitches have proved the most efficient for miniature compression ignition engines.

The largest of the propeller blanks (4) given in Chapter IV should prove suitable for an average engine, though that illustrated is, of course, designed for use with the 5 c.c. Micron.

Spinners galore—finished parts ready for assembly.





Winning Czech model in flight—with such an angle of climb care in checking fuel level is always necessary.

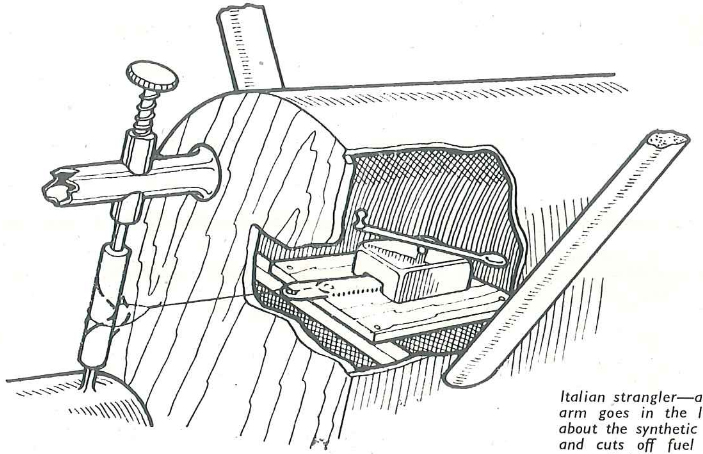
CHAPTER VIII

TIMING & FLIGHT LIMITATION DEVICES

THE thought that what goes up must come down has impressed itself rather forcibly upon many during the past few years, and there is, accordingly, a greater sense of responsibility in respect of wandering model aircraft. Primarily the idea of so limiting a flight that the model lands within reasonable time, and at no great distance, would seem to be the ordinary prudence of a sensible person. Yet there are a number of enthusiastic aeromodellers, who would hotly deny any lack of care, who still send their often heavy and potentially dangerous power-driven aircraft without any form of timing device whatsoever. Apart from being directly contrary to Air Ministry Orders on the flying of powered model aircraft, apart from danger to others not aware of, or remotely interested in, the flight, and apart from the risk of damage to unseen property that may lie over the hedge, there is the risk of losing a model costing many hours of work and a not inconsiderable sum of money. However little the foregoing reasons may effect the careless, surely the thought of personal loss is enough to convince the most anti-social flyer.

Ever since first powered model aircraft were flown successfully the need for some means of limiting the duration of flights has been recognised. The early pioneers were so glad to get their models airborne at all that they relied solely on the consumption of fuel in the tank to terminate the flight. But as soon as a degree of skill developed, this meant that models went out of sight every time, leading to long and tedious chases, and frequent damage on unexpected obstacles. Mechanical devices employing parts of clock mechanisms were then fitted, such as the timer devised by Mr. Allman, and popular in the middle thirties, followed by adaptions of the delayed-action device sold by camera concerns as "Photograph Yourself" gadgets. These latter were usually worked on an airleak principle, and accurate timing was impossible, within seconds. As the hobby developed and a measure of control was exercised, fitting of these timers became compulsory for competition work, and it was not possible to get insurance cover without them. Enterprising firms marketed improved and lighter timers, and they were accepted as a part of the complete petrol model as an essential.

That was the position before the model diesel came into the picture. Immediately its detractors seized on the absence of electrical equipment,



Italian strangler—as the timer arm goes in the loop tightens about the synthetic rubber tube and cuts off fuel supply—not very reliable.

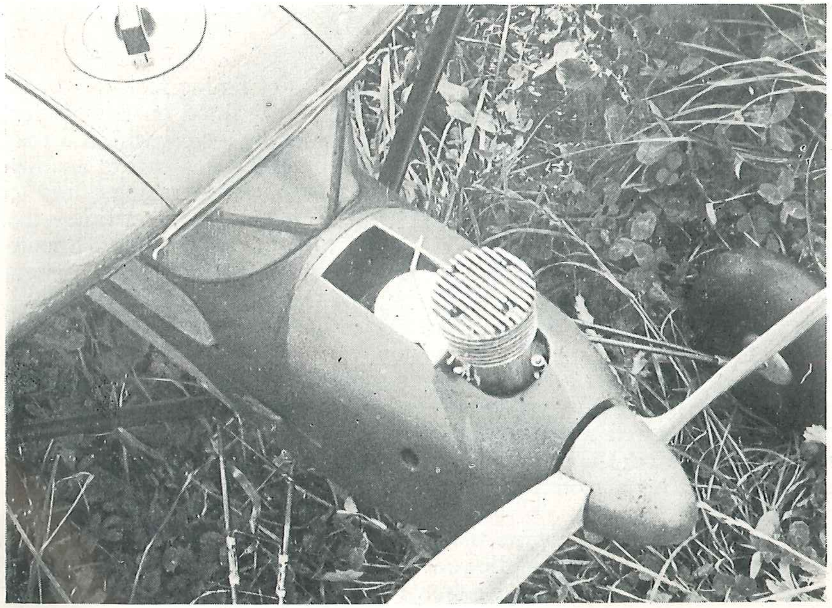
and declared in triumph that such an unreliable machine could not have a timer fitted, as there was no ignition circuit to cut, for this was the invariable procedure in the case of the now fast-growing-obsolete petrol model. Which, of course, is really a point in favour of the diesel when its detractors could only advance the value of ignition as something to cut for flight regulation! Nor is there any particular problem in terminating the flight of a model diesel. Lacking electrical equipment it is obvious that some means must be found of "spoiling" the running. One way is to cut off the fuel supply, so that the engine stops for lack of fuel; the other is to cut off *part* of the supply, so that the mixture is altered sufficiently to stop the engine functioning. This end can be achieved by choking the air intake, and thereby causing an over rich mixture that fails to detonate on account of air starvation.

Before discussing the means to these ends, let us see just what happens when the power is cut in a conventional petrol-engined model. The timer arm moves over after a set period and breaks the electrical circuit. Immediately, without any preliminary slowing down, the engine stops and the model becomes, in effect, a glider. But, just as unskilled or premature release of a model glider on the line may spoil its flight until it recovers from a stalled launch, so the timer takes no thought as to the moment for its cut-out. The plane may be still climbing furiously at a steep angle, it may be banked over in a tight turn, or, by good fortune alone, it may be nicely placed to begin a smooth glide. Whichever way it is caught at cut-out, there is neither blame nor praise to be attached to the flyer, he cannot exactly gauge what his model will be doing in, say, 20 seconds' time, beyond perhaps the comforting knowledge that, all being well, it will be high enough up to come out of the expected stall without structural damage. Now, let us consider the diesel-engined model in like case. Never mind what form of timer has been fitted—this will be considered shortly—after a due period it operates. What happens? Let us suppose a spring-loaded plunger cuts off the fuel instantly. Does this mean that the engine will come to an abrupt halt? By no means—there is still enough petrol already past the needle to suffice for a few more turns. The rate of revolutions will die down and slowly stop over a period of several seconds, thus enabling the model to assume a level flying angle ready for a smooth glide, no matter how steep has been its rate of climb before. But perhaps we wish to use the choking method. Exactly the same applies, as the richer mixture, with its smaller air content, passes into gas with less and less power, until finally it can fire no more, there is again that slowing down to a stop, and its consequent flattening of the flight path. This may seem to be seeking to make capital out of an unconsidered aspect of the diesel, but no fair-minded person who has seen a model so-powered in the air can deny that this is a true and accurate description of its behaviour.

Naturally, as with the petrol model, there is always the risk of the timer not operating, or jamming, or acting inefficiently, but with the absence of electrics that risk is sensibly reduced. Provided the method of flight determination is sound, the only thing that can go awry is the actual mechanical device itself—and this, if well made or purchased from a reliable firm, will be very seldom.

There are four main methods of timing employed on model diesels. In the case of very small engines of up to 1 c.c. capacity, weight is of such importance that no actual mechanical device is usually fitted. Their tiny tanks hold only a thimbleful of fuel, and this, the oldest timing method,

Close-up of engine and timing dial on Varache's record breaking model.

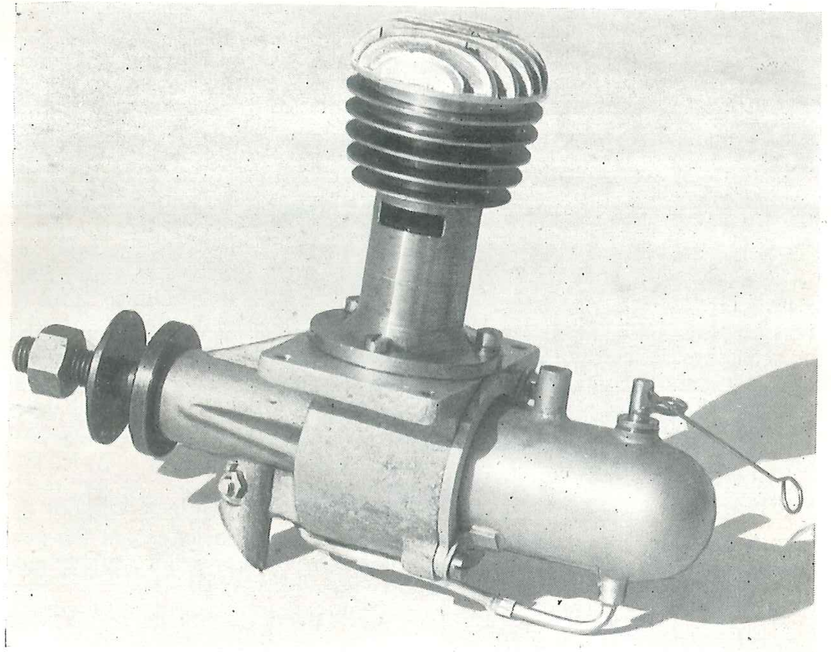


is quite practical and safe. The flyer usually fills the tank, starts his engine and warms it up with the initial tank load, keeping a careful eye on running time, then, when the tank is nearly empty adds a carefully measured quantity of mixture from a graduated hypodermic, and away the model goes. It is possible to be accurate to within 2 seconds in 20, or an error of 10 per cent, which is adequate for safety purposes and for all contests where a fixed engine run is in the rules. Some flyers have developed their "doping" skill to such an extent that their error is reduced to less than one second in 20 or under 5 per cent—few petrol-engine timers are much more accurate! For those not in possession of a hypodermic, or scorning the use of such an aid, a simple tube, such as those which aspirins are bought in, can be pressed into service. Fitted with a short length of brass tubing in a cork, with an ink mark on the tube at the critical line, this can be filled from the main bottle, and will be just as accurate as a more fanciful gadget. Simpler still is to know the exact running time of a full tank, including starting, and to run the engine on the ground until exactly the limit time is left. This is less accurate than measurement, but for those who cannot be bothered with "fiddling" it is the easy way out.

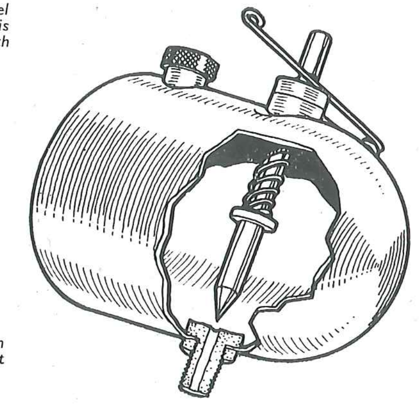
A clever variant of this device was seen recently fitted to a model. The builder had soldered a small supplementary tank below the main container from which it was fed. The fuel line went down to the needle. through the supplementary tank. Above was a small cock which could turn off the main supply. The method of running was to start the engine, switch off the main tank, and let the model go. The small tank held exactly enough for 20 seconds' power flight. Thus the flyer was saved any of the bother of measuring fuel, yet nevertheless had accurately timed power runs without the added weight of a mechanical device. Incidently, the engine was of 1 c.c., and the extra weight involved by the supplementary tank $\frac{1}{20}$ of an ounce!

On larger engines there is often some form of timing regulator fitted that will end the flight. The most practical is that fitted on the Micron engine. Here a spring loaded plunger is kept out by a steel wire rod that engages in a slit in the plunger. This steel wire rod forms part of another spring of the safety pin variety and ends in a loop. By attaching a lead to the loop a suitable mechanical device gives it a pull after the set time—the plunger is free to plunge and effectively seals off the fuel supply. Should the model crash under power the force of impact will have the same effect of jerking out the plunger retaining wire, and the engine cuts before doing any additional damage. No identical device has been noted on any other continental engine, though several employ devices calculated to achieve the same end. Without necessarily holding any brief for a particular engine—and certainly not advising anyone to buy any engine solely for the sake of a gadget—it is as well to learn what all the bits and pieces are when in the market, as, all other things being equal, the possession of an efficient stopping device is certainly something worthwhile.

Another French engine the Delmo embodies a device to admit air on the intake side of the throttle needle; the idea being, presumably to alter the amount of air and prevent a suitable mist forming. In practice the small



Micron 5 c.c. showing location of fuel cut-out device. An identical method is employed on the British Owat which closely resembles this engine.



Cut away drawing to explain the action of the Micron and Owat fuel cut-out system.

hole is liable to become clogged and inoperative, or the engine thrives on the change of mixture. At all events from our experiments we have come to the conclusion that it is a thoroughly unreliable form of timing. Generally it will only operate when the fuel tank is nearly empty. Apart from this failing, the Delmo—the first engine to be produced commercially in France, by the way—is amongst the best. In all fairness we must add that we have seen a number of them in action where their owners were able to make the timing device work. In any event, we must repeat—never select your engine on the gadgets alone—if it is good have it, gadgets or not.

Perhaps the most unusual fitting is that on the Italian Super Tigre G.14. Here there is a spring-loaded trigger that holds a plunger from the transfer port. On being released it closes that port and effectively causes the cease-fire. Whether such a method is deleterious to the life of the engine cannot be said with any certainty. At all events the Super Tigre bears up very happily to this particular burden. For the owner who does not like it there is a simple remedy—just unscrew the whole affair and employ some other means of flight limitation.

By far the greater number of engines are entirely without any form of built-in timing device. This is only to be expected, as, at the price most of them are sold, there would seem little margin for profit, and certainly none for any non-essential fitting. For this reason the most popular stopping method is that which chokes the mixture at the air intake. The fitting of such a device is easy and sure. A small spring-loaded button is mounted on a bearing in close proximity to the air intake. As soon as the full of a lever is removed the spring forces the button over the intake hole. The face of the button is covered with leather, cork or rubber and makes a most effective seal. Sometimes the whole device is clamped to the air intake and forms an integral part of the engine. Occasionally it is mounted on the forward bulkhead separately from the engine. The former method seems preferable, as it enables the engine and flight cut-out to be removed *en bloc* to another model as and when desired. From the point of view of efficiency there is nothing to be said for one method in preference to another.

Super Tigre G.14 a sturdy 5.65 c.c. engine from Italy. Note the unusual cut-out to the left of exhaust port.

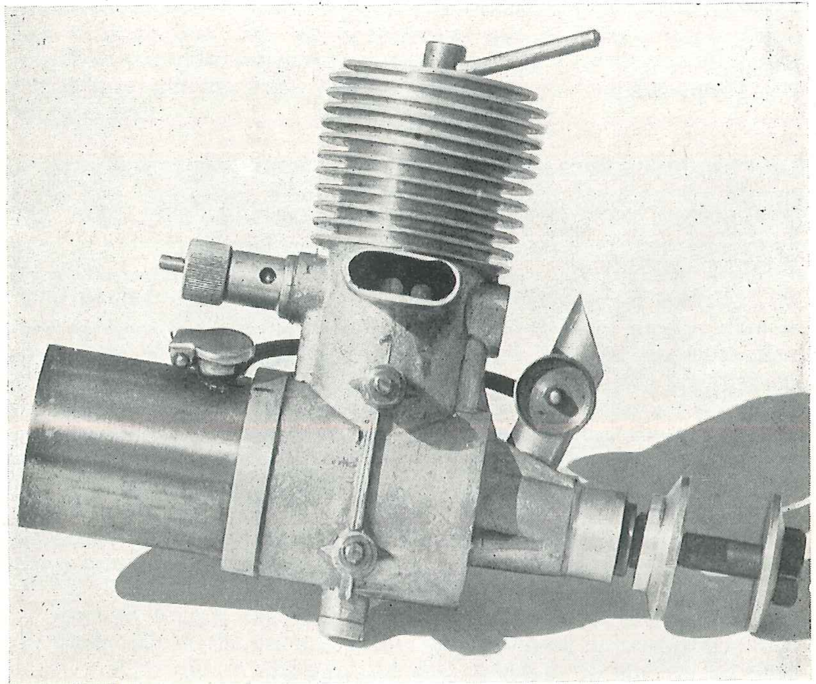
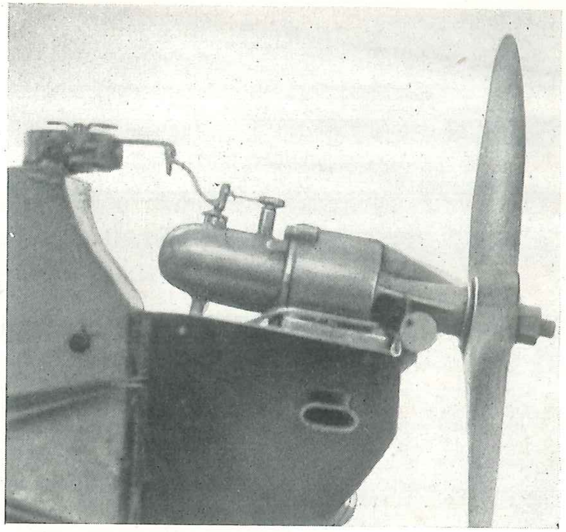
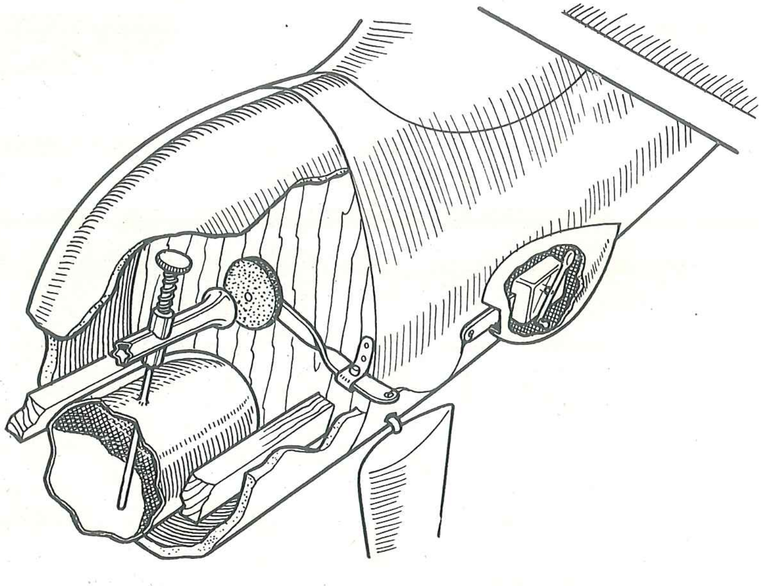


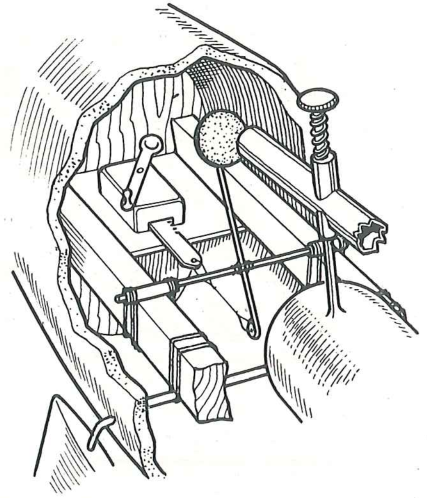
Photo-timer in position. Not exactly how we should like to see it placed for beauty, but few can quarrel with the practical nature of this simple layout.



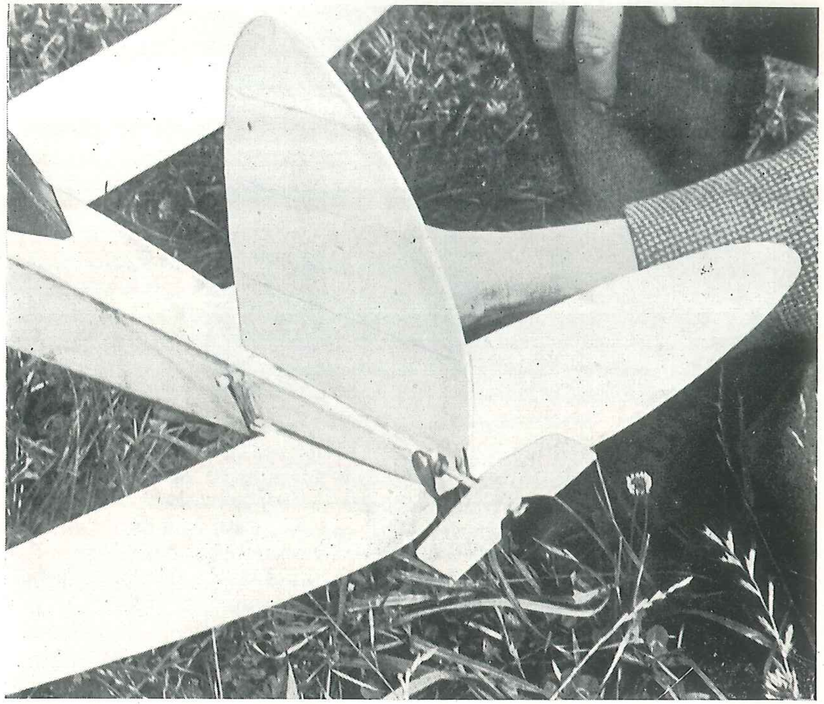
A simple method used by some Italian modellers is to have the connection between the tank and the needle valve of synthetic rubber, round which is looped a thread. This is duly pulled, thus squeezing the fuel pipe and cutting off supplies. Like most simple devices it looks too good to be true—and from a purely practical aspect it is suggested that the thread would in a short time tend to cut through the tube, and that its pressure would only partially cut off the motor—which might well continue to burble along, knocking badly for some time.

That disposes of the general methods of cutting the motor, it only remains to consider the means used to put them into action. Here all the types of timer beloved of petroleers are in favour. The traditional auto-knips seems to be unobtainable these days, but clockwork timers of the photo-clip variety are just as good. The pull exerted as these close is truly surprising—quite sufficient to pinch the finger sharply. The smaller varieties of these usually run for about 15 to 25 seconds, and require to be graduated





Practical engine cut-outs. Two varieties of the clapper system which shuts off the air intake, and is the nearest thing to a fool-proof system yet devised. Upper illustration uses a slack thread, while the lower picture shows the recommended piano wire device which renders spring loading unnecessary.



Wind-vane timer—a simple and fool-proof arrangement

against a stop-watch. When once this has been done they are just as reliable as the best of the special aeromodellers' timers. As there is no question of breaking an electric contact, but only allowing a spring-loaded element to operate, there are two methods of going to work. If the Micron type of plunger is in use, then the moving arm of the timer must be connected by a flexible lead that remains slack until the actual moment when the timer is due to cut out the fuel. Thread or string is useless for this purpose, as it stretches, and it is suggested that a short length of rubber-covered flex is soldered to the arm and hooked into the plunger retaining spring loop, after being well stretched in a vice beforehand to take out any incipient kinks. Where the clapper type of button that closes over the air intake is being used, this method can also be employed, in this case pulling out a pin that allows the spring-loaded cap to shut. For those who like something simpler, the slack-loop type can be used again, this time drawing a simple hinged clapper into position without any spring-loading device. The only disadvantage here is that in the absence of spring-loading the clapper may shift about in flight, perhaps to the detriment of engine running.

Another variant of the clapper has been noted where a clockwork photo-clip style of timer is fitted directly beneath the engine. A rigid extension from the clapper button hinges about a point midway between the timer and the air intake. As the timer lever gradually goes in the button

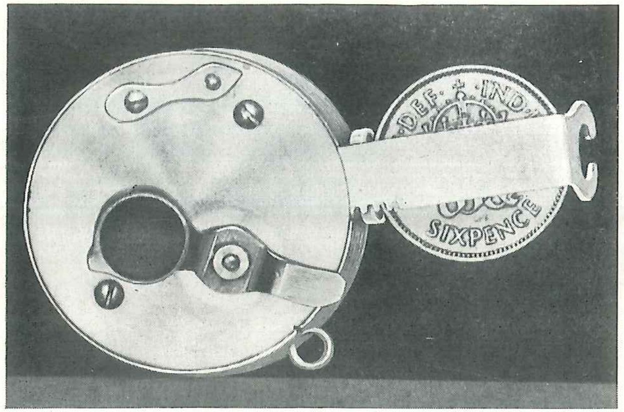


Photo-clip timer which is the almost universal method employed abroad, where these efficient little clockwork devices cost only a few shillings.

is pulled in towards the air intake hole. This has the advantage of more positive action, and does not require any adjustment of the thread for different engine runs. A disadvantage is that the timer is placed dangerously near the airscrew, where an unwary hand can easily be caught.

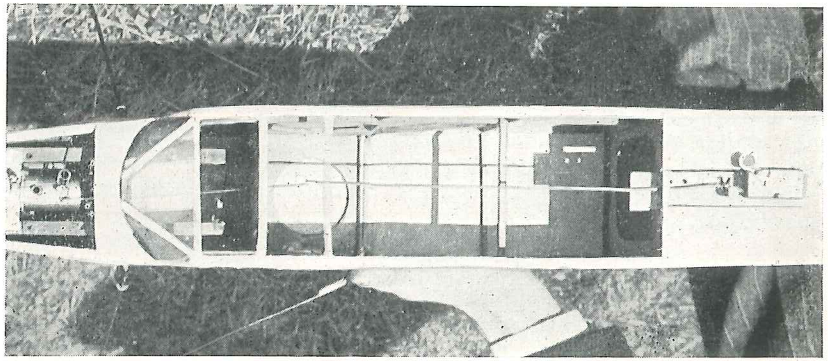
Before leaving the subject of timers they have one other use that may have been forgotten. In petrol-engined models batteries are moved about to effect changes in trim—here the timer can be utilised for the same purpose, particularly if a grooved runway is arranged for it, giving a movement roughly over the C.G. of about one inch either way. It may then be permanently fastened in place or held with locking screws. As the diesel-engined model—power for power—is usually lighter than a petrol model, this will give adequate trimming.

Many British builders will, however, for lack of anything else or on account of its simplicity, be making use of an air-leak timer. The disadvantages of this type are well known in that they cannot be relied upon to deliver exactly the same time for each stroke, and the considerably weaker pull exercised by the closing valve. Nevertheless, if their limitations are appreciated, they can perform excellent service. In all cases they must act against a spring-loaded cut-out—or either variety—but, as they will usually lack strength to hold the spring, they must be attached to a release that will pull out a pin after the due time, thus enabling a spring-loaded cover or other device to come into operation. It is useless to endeavour to operate the stopping mechanism direct; they may have strength enough to break an electrical circuit, but they certainly have not enough to shut an engine off mechanically. However, they are now available of such lightness that it seems a pity not to use them somehow, especially when extra weight is a consideration. A number of home-made airleak timers of more substantial calibre with adjusting valve and other fitments have been seen, and this perhaps is worth consideration. They are made up on the pattern of the old Kodak Self Timer, which could be adjusted with reasonable accuracy, and do exert quite a pull. This strength is at the expense of weight, so that we are back where we started.

But we are not confined to the conventional methods. A popular French method is an adaption of the wind-vane principle. Here a small airscrew is fitted at the rear of the model, which revolves in the slip stream of the model as it flies, and in its turn winds up a single loop of elastic. When this elastic is sufficiently taut, it pulls against a thread and operates the engine-stopping mechanism—which may be any of the varieties described. Adjustment is made by lengthening or shortening the rubber loop, or fitted rubber of a different cross section. That we saw had one loop the full length of the fuselage of $\frac{1}{4}$ in. flat. This operated the timer after 30 seconds, and could be accurately adjusted down to 10 seconds in a few moments. It is only necessary to test the model with engine running while held on the ground to see when the engine cuts, after which it can be easily worked out how many inches of rubber are required for a given power run. It has the advantages that it costs practically nothing, is easy to install, and has little or nothing to go wrong. Readers may remember a somewhat similar device introduced by Dr. Forster on his flying boats as a supplementary timer in case the salt water put the ordinary one out of action. Here a small wind-vane operated an ordinary wood screw, whose helical threads were utilised to start off a gear train. This the doctor set to operate after two minutes, and claimed excellent results from it.

Problems of flight termination can be summed up under two headings: (1) The actual method employed to terminate flight, (2) the mechanical device, clockwork, airleak, windvane or simply fuel rationing fitted to put it into effect. Between the two methods outlined to terminate flight—fuel stoppage or choking—there is little to choose. Provided that a sound method is chosen we would admit to a slight preference for fuel stoppage, but on the other hand less than a hundred per cent efficient choking will stop the engine, while any inefficiency in fuel stoppage may enable the model to fly on, as it is surprising how little fuel is needed to maintain it in level flight. This question has by no means been explored to finality, and we hope to see many other devices in operation, and be offered a variety of best-ever methods all claimed to be the perfect answer.

Clockwork operated photo-timer in place, showing use of lighting flex as a connection to the cut-out.



Varache with his record breaker—a model that has held French and world altitude records. This is probably one of the most elegant diesel powered models yet produced. Power unit, as may be seen, is the famous Micron 5 c.c.

CHAPTER IX

SOME NOTABLE DIESEL MODELS

Now that model compression-ignition engines have been discussed, it is as well to consider the type of model aircraft into which they may best be installed. We have already shown that, except in the absence of electrical equipment, the diesel is very much the same as a normal petrol engine. Nevertheless, there are certain aspects of models powered with such engines that take them out of the normal run. Briefly, all that can be done with a petrol engine can be done with a diesel, plus a number of other models not possible until it arrived on the scene. As we have so small a number of original models designed expressly for diesel power, it is necessary to see what the principal countries using this type of power have done for themselves.

One fact will immediately strike the investigator—the universal fondness for the high-pylon type of wing mounting, which dominates the contest field. This may be claimed as an invasion of the American idea, but it has developed during the war years when opportunities for infiltration of New World notions were somewhat limited, so the cause must lie deeper than that. We in this country have failed to be impressed, but it is likely to be forced upon us if we are to take our place on equal terms in the international competition field. The fact remains that, for certain purposes, the high-pylon wing mounting *is* undoubtedly the best. When Goldberg first fitted such a mounting to his Zipper he can little have realised just how good it was. Now that two widely separated groups of thought have developed it independently over a period of years, we feel, little as we personally like it, that even the conservative British mind must accept it. As may be seen from examples such as Maraget's tiny models, when fitted with a small engine, and carrying a wingspread of perhaps 30 inches only, it makes a simple yet stable machine. The French approach has been fairly rational, and even in super-contest models retains a degree of restraint so that the height of pylon is generally less than one wingchord above the level of the fuselage upper surface. The pylon itself is supported by braces, and takes a streamlined shape when covered with silk, which is the more usual approach rather than sheeting in.

However, in the very small models a still simpler method is employed. The pylon and side elevation of the fuselage is built up in one piece, flat on the building board, and then half-formers are added to complete the fuselage, leaving the pylon sticking up as a single thickness of wood—probably balsa reinforced with thin ply. Such a model can be built, if necessary, between week-ends—in other words it has achieved the ubiquity of the paper-bag duration model, regularly rebuilt by its devotees between week-ends meetings! This is not such a bad thing as it might seem. The weeks of hard work that formerly went to the making of a powered model are cut out, and the builder can afford to experiment, knowing that if he is wrong, then in a few days he can build another. The main snag is that these little models fly so remarkably well, and while anyone can rebuild the air frame, there are none prepared to buy a new diesel as frequently as a new rubber motor. From the fly-away angle then builders must beware of losing their models. Even a power run of 20 seconds is often enough to lose a model of this nature powered with an engine of under 1 c.c. It is better to risk wrecking the air frame with an exceptionally short power run than lose the engine as well as the model in one brief burst of glorious flight.

Italian builders on the other hand have treated the formula with a complete lack of control. They argue, perhaps, that if one chord above the datum line gives good results, if they make it two or three, then results will be outstanding. Some of their efforts look so ungainly that one wonders how they manage to balance on their wheels. Against this there is the story of their flights, they have in fact achieved durations. It must be remembered that continental flying rules for powered flight are different from our own. We in this country have never gone for out-and out duration, but for controlled flight. The results are not particularly flattering, as at few power model meetings is any measure of control seen even when the model is on the ground, but rather time-wasting minutes of inability to get the motor even running! Our continental friends on the other hand comes to the take-off area with complete mastery of the mechanical side of their model as well as the trimming angle. Most of their events are worked out on the relationship of motor run to glide. Motor run divided into glide gives a factor determining the winner. Thus a motor run of 20 seconds followed by a glide of 60, gives a figure of 3. This will beat a motor run of say 40 seconds followed by an 80 second glide when the figure will be only 2.

French diesel line-up during their Nationals. Significant feature of this picture is the almost universal adoption of tapered or elliptical wings.

Danish contest model in the hands of its builder Tage Hansen who has proved a regular winner.

But for every builder who has the contest urge there must be half a dozen who are content to build their models for the sheer pleasure of seeing them fly, without a thought as to whether they can fly better than the next fellow. They have the true spirit of aviation, the same sort of spirit as the Arab chieftain—born and bred amongst horses—who declined when invited to the races, saying: "Who but a fool would deny that some horses travel faster than others!"

Let us therefore look at progress outside the strict competition field. Here the diesel comes into its own. The cool running nature of the formula renders it possible to cowl in the engine without any overheating complications. The light weight of the ensemble enables small models to be built without any of those high flying speed bugbears that usually attend the petrol model when much under four feet in wingspan. In the larger sizes elegant monocoque fuselages can be built without fear of adding disastrously to the weight, while even three-foot span models with 1.5 c.c. engines can be of similar construction without risking a total write-off in the event of heavy landings.

The absence of batteries to be used for altering trim may perhaps worry some builders, and make them hesitate to build a fixed-wing design. They need not be afraid. There are two possible approaches—one is to fit a small lead adjusting weight sliding on a thread fixed to the under-belly of the fuselage, a method popularised on streamline Wakefield models; the second method, which is better as it adds no weight, is to use the timer for this purpose, either by fitting it as a detachable unit and sliding it back and forth as done by Col. Bowden with his dummy "radiator", or by fitting the timer inside the fuselage and sliding along a runway to which it can be suitably strapped. All that it is necessary to do then is to alter the length of thread connecting the timer arm to the cut-out. This works very well with the clockwork type of timer, which has an appreciable weight, but will hardly do for the tiny aluminium-cased dashpot timers that are more easily procurable these days. A third method that is neat and practical is to have the actual bearers holding the engine adjustable within limits. A series of holes at $\frac{1}{4}$ inch intervals would enable say, a travel of 1 to $1\frac{1}{2}$ inches, which would be more than enough to trim the most curiously balanced model.

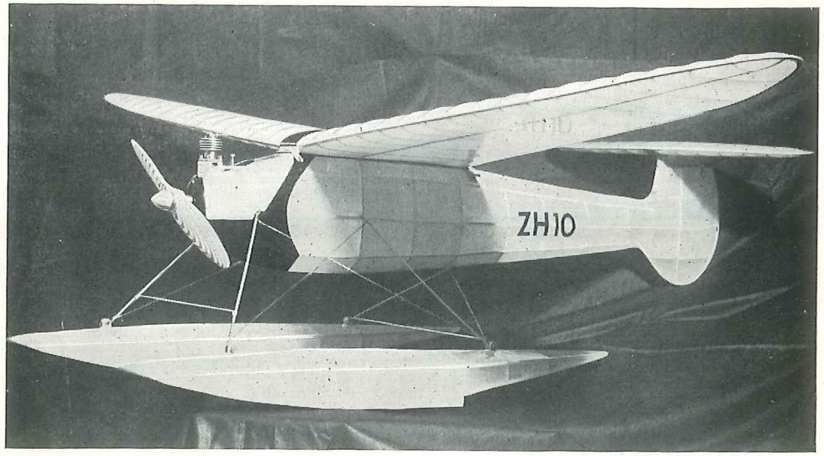
French low-wing model built by Vincre during his stay at Eaton Bray for the first International Week.

Flying "beer-barrel" a peculiar looking model that flies well in the hands of its Czech designer Jindra.

A Swiss flying-boat embodying twin hulls and "power-egg". This type of experimental model is particularly suited to diesel power for no matter how many duckings it receives it will go on flying until the covering is soaked off by constant immersion!

Knock-off engine mountings, by the way, do not seem at all popular. This is another of those controversial matters which can never be argued to finality. However, in spite of really severe head-on crashes, we have yet to see a model diesel seriously damaged in landing with fixed mounting. It must be remembered that, owing to their higher compression ratio, they are made more substantially then petrol engines of similar power output, and as such can take a lot more savage treatment without harmful results.

Another feature that will be noted in all but the smallest continental diesel-powered models is the fitting of flying wires. These seem to be necessary to take the strains of the terrific climbs most of them are trimmed to do. One model seen, in spite of its flying wires, would gradually fold up its wings on nearly every flight until it came to earth very like a butterfly alighting on a twig. Strangely enough it never crashed, though the dihedral must have reached about 70 degrees!



Dyno-powered seaplane from Zurich. This pleasing model has flown long distances over the lovely Zurichsee. There is little that can equal the fascination of an inland lake, fine weather, a comfortable motorboat, and a well-trimmed waterplane, not forgetting, of course a well stocked hamper and suitable liquid refreshment.

Fixing of wings to pylons is a feature that offers a wide range of choice. Some wings are in one piece and held down on a platform with elastic bands passed over the top of the wing. Others are in two halves—plugging in—which gives a somewhat weak fixing though not always so. Another method favoured by the Czechs is to slip a tongue vertically into the pylon, and hold this in place with shear pins of hard balsa, a satisfactory engineering method that does away with elastic bands.

The ordinary slabsider, too, has had a new lease of life with diesel motors. The common or garden duration-type model of elastic days can be modified to take a small engine and give any amount of useful flying. A point to watch in this respect, however, is the increased vibration of a diesel against the smoother running of a petrol engine. One model which started life as petrol-engine and was modified for a 5 c.c. diesel shook the whole of its rear spacers out when first run. This curious trouble was cured by the addition of strengthening gussets at each joint, an addition which took a little time but amply repaid the trouble in increased strength.

As the power unit for a scale model the diesel is unsurpassed. Practically any civil aircraft of reasonable flying speed can be used as the prototype of a one or two inch to the foot model, and can be flown with a minimum of modifications. Such aircraft as the Auster, Piper Cub, Widgeon make models that can compete on equal terms with so-called contest designs. Old timers of the Gladiator type, or, going still further back, the Bulldogs, Camels and Spads can all be diesel powered, and made manageable models without undue trouble. The saving of batteries and ignition, and the weight forward makes a scale disposition of weight so simple that the battle is won at the very start.

Nor must its value for flying boats and seaplanes be ignored. Crowning glory in this sphere is its immunity from the effects of water, which is so disastrous to electrics. A good shaking and a few swings, and the diesel starts again after quite a lengthy submersion. If flying from salt water, however, remember that some of the light metal alloys can quickly be corroded by it and, after flying, the engine should be carefully cleaned with petrol and a little thin oil injected through the exhaust ports before putting away. Equally valuable is the diesel for experimental and multi-engined aircraft, owing to its compactness. Push-pull designs, with an engine at front and rear, have been successfully engined with Dynos; and for canard flying with a pusher arrangement it has proved its worth.

In any discussion of notable types, some mention must be made of what we are pleased to call freaks—though they may, of course, prove to be the accepted aircraft of to-morrow. A fine bag of models in this category was recently shown by the Czechoslovak visitors to Eaton Bray, who exhibited a "flying pencil", a "flying beer-barrel" and a "flying triangle". The pencil was simply a hollow dural tube with engine bolted to the front, empennage to the rear and with a further length of dural tube extending upwards to support a platform on which reposed normal polyhedral wings. A single-leg undercart completed the picture. Of course its performance was magnificent, drag was reduced to a minimum—apart from the uncowled engine there could hardly have been any—and weight was insignificant; building time, including the normal wings, probably a short week-end. But was it a model aeroplane? We know the answer that if it flies and complies with the rules of a given contest then it must take credit. We venture to hope, however, that we shall not see any more quite like it. The beer-barrel was an almost identical model, but in this case the front part of the "fuselage" was swollen to barrel-like proportions to house part of the engine, the cylinder of which protruded through the top. Had it been intended to streamline the engine, the barrel could have been excused, but as it failed to do this the only reason for its presence was obviously to comply with a normal fuselage ruling. Once again we deplore it. The flying triangle was an ugly

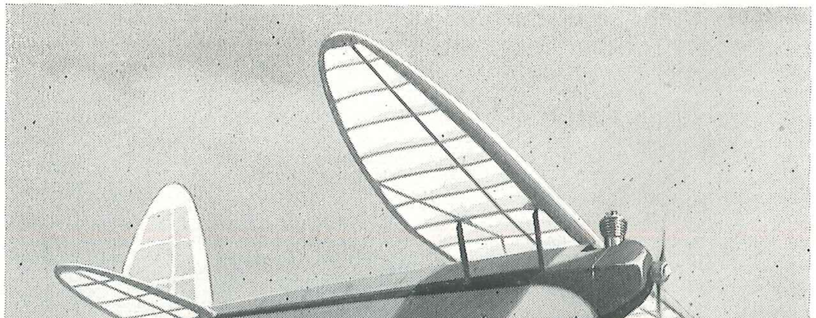
Piper Cub in the hands of its Belgian designer Maurice Ferber. This little model is quite capable of tackling the average contest model for duration and precision flying.

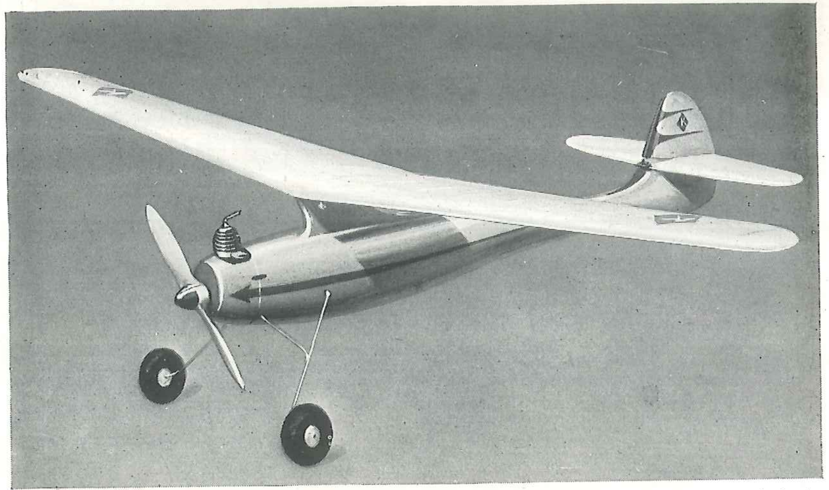
duckling of another sort—here the side elevation of the fuselage was a right-angled triangle, with the hypoteneuse forming the underbelly. The larger angle housed the single wheel of the undercart, and the smaller angle was at the tail end. This model, too, gave an excellent account of itself. Apart from its ugliness there is nothing against this layout, which is obviously simple to construct and enables accurate trimming to be quickly made, using the flat top of the fuselage as the datum line. In all fairness to the Czechoslovak visitors, we must add that they produced the international winner on that occasion with a perfectly normal, semistreamlined model that was a fine example of elegant construction allied to first rate performance.

While on the subject of oddities, there is one form of fuselage building that seems to have found little support in this country as yet. We refer to the American "crutch" system, by which the plan of the fuselage is laid down on the building board first, and the sides built up over it, rather than our own more usual method of making a pair of flat sides and then inserting spacers. The crutch method has a great deal in its favour, as it enables a positive datum line to be accurately built in, and helps to ensure that the completed fuselage is perfectly true. For diesel-powered models of all kinds it appears the ideal method of starting work on any sort of fuselage, and might well enjoy a more general popularity.

Covering of diesel-powered models is nothing like the problem usually associated with petrol-engined models. The light weight of most of them makes tissue, as used for rubber-driven jobs, a quite satisfactory material. Many examples up to six feet in span were seen with a single covering of ordinary jap tissue—and many of these hailed from France, where silk can be obtained far more cheaply and easily than here. Other examples of covering were to sheet in the whole of the upper surface of the mainplane, and then cover that with thin tissue. Where silk was used the model was generally of really substantial structure and good for several seasons' hard flying. But out of nearly a hundred continental models inspected hardly a dozen had utilised silk. Incidentally, the quality of foreign covering papers seems below that of even the English tissues we are now using, so modellers should have no cause for complaint on that score. The new British "blotting paper" tissue, which is apparently made for duplicator stencils, thus accounting for the absence of colours other than white, is a great find, and can be confidently recommended to anyone wanting strength combined with cheapness. Double covered, it is quite as strong as if not stronger than silk, and will shrink drum tight; single covering gives a finish equal to bamboo paper. It can, however, be pierced comparatively easily by stubble and the like, so that too great a reliance should not be placed where such hazards are to be found.

Czech Kolibrik—the aptly named Humming Bird—plans of which are available in this country from A.P.S., Leicester.





Another Czech winner—Kapitan, reduced scale plans of which appear overleaf; full-size plans can be obtained at 2/6 post free from A.P.S., Allen House, Newarke Street, Leicester.

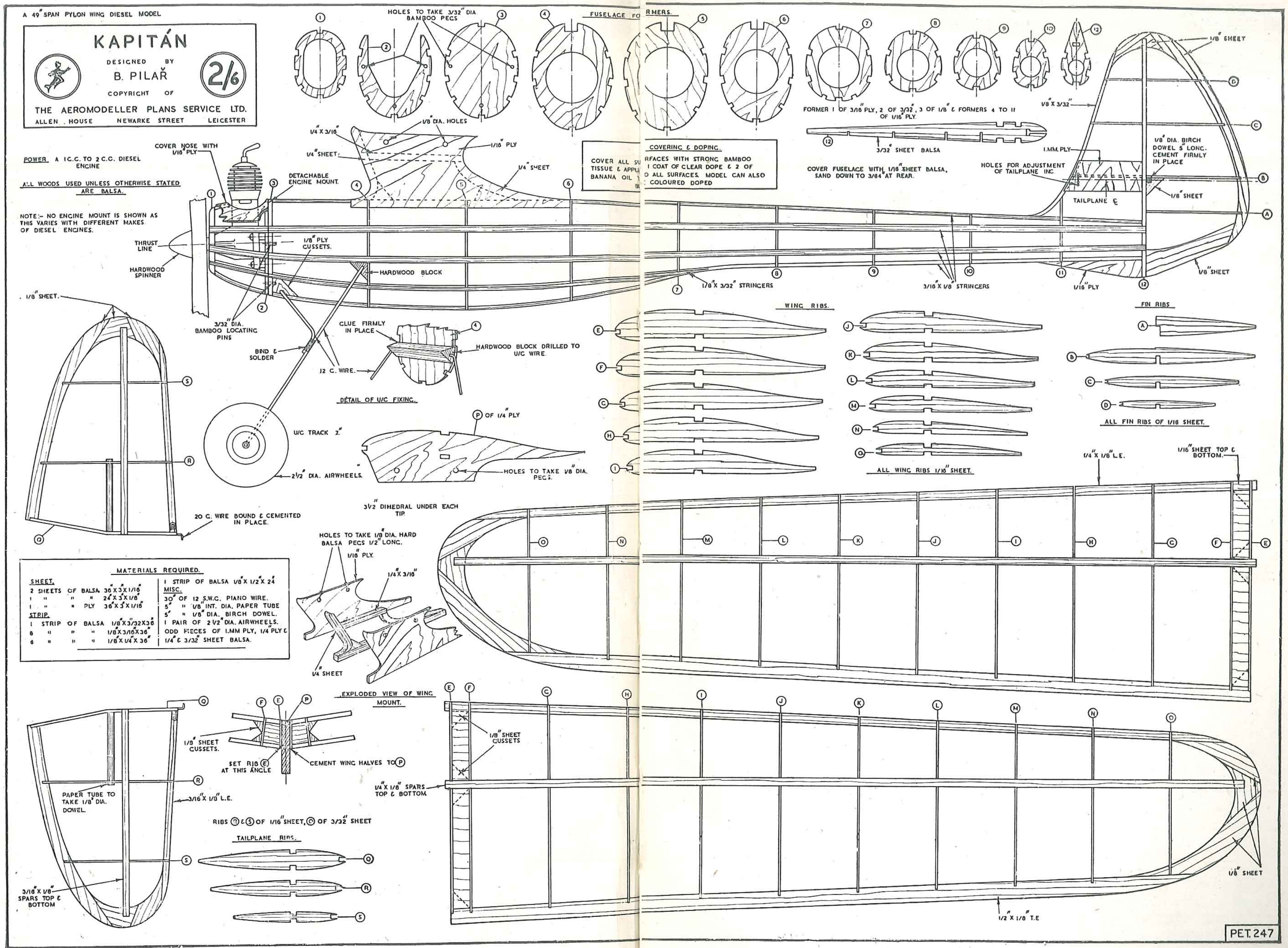
These pages have necessarily been somewhat disjointed and do not pretend to be more than a mere lightning tour of the principal types of model aircraft to which the diesel is applicable, while the points on building give only a few tips acquired from a study of these models. As a final word on the subject, the average diesel-engined model can easily be built by anyone who has ever made a four-foot sailplane, and good results will follow similar building methods. For models intended for diesels of 5 c.c. and over the average petrol model technique may be employed, bearing in mind that butt joints should, where possible, be gussetted. In most cases there will be anything from two to ten ozs. spare weight, which may be utilised in making the model crashproof, or, in the case of the contest minded, in letting it have just that much more ceiling! Whichever sort of enthusiast you are, take up the cult of the diesel with confidence; it will never let you down.

A 49" SPAN PYLON WING DIESEL MODEL

KAPITÁN

DESIGNED BY
B. PILAŘ
COPYRIGHT OF
THE AEROMODELLER PLANS SERVICE LTD.
ALLEN HOUSE NEWARKE STREET LEICESTER

2/6



POWER A 1C.C. TO 2 C.C. DIESEL ENGINE

ALL WOODS USED UNLESS OTHERWISE STATED ARE BALSA.

NOTE:- NO ENGINE MOUNT IS SHOWN AS THIS VARIES WITH DIFFERENT MAKES OF DIESEL ENGINES.

COVER FUSELAGE WITH 1/16" SHEET BALSA, SAND DOWN TO 3/64" AT REAR.

COVERING & DOPING.

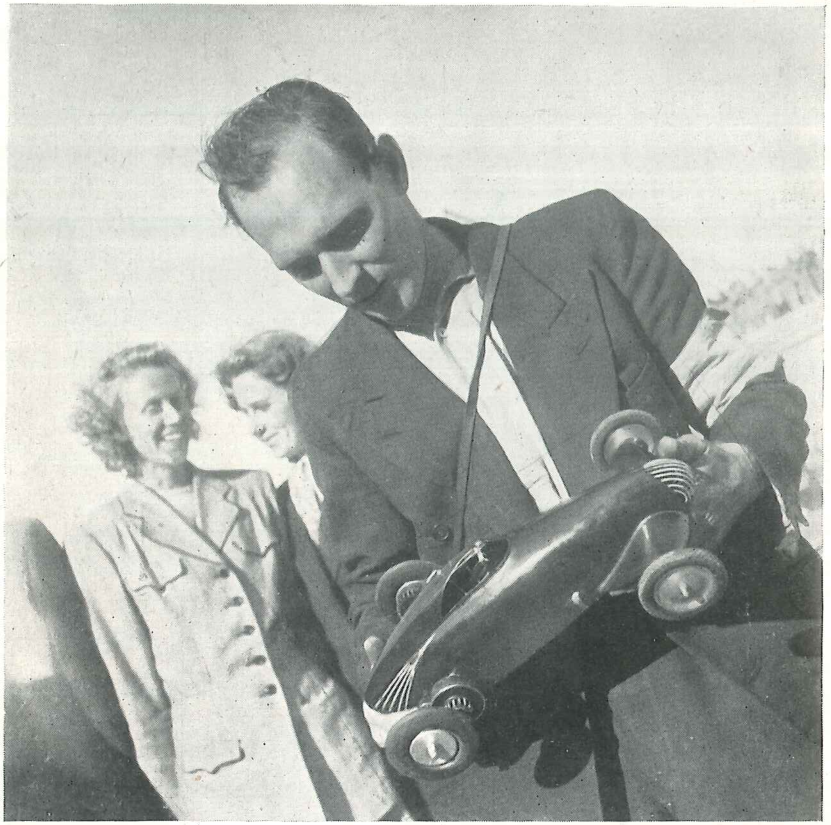
COVER ALL SU RFACES WITH STRONG BAMBOO
TISSUE & APPL 1 COAT OF CLEAR DOPE & 2 OF
BANANA OIL O ALL SURFACES. MODEL CAN ALSO
B COLOURED DOPED

MATERIALS REQUIRED.

SHEET.
2 SHEETS OF BALSA 36" X 3" X 1/16"
1 " " " 24" X 3" X 1/8"
1 " " PLY 36" X 3" X 1/16"
STRIP.
1 STRIP OF BALSA 1/8" X 3/32" X 36"
8 " " " 1/8" X 3/16" X 36"
6 " " " 1/8" X 1/4" X 36"

1 STRIP OF BALSA 1/8" X 1/2" X 24"
MISC.
30" OF 12 S.W.G. PIANO WIRE.
5" " 1/8" INT. DIA. PAPER TUBE
5" " 1/8" DIA. BIRCH DOWEL.
1 PAIR OF 2 1/2" DIA. AIRWHEELS.
ODD PIECES OF 1.MM PLY, 1/4" PLY & 1/4" & 3/32" SHEET BALSA.

PET. 247



Red Devil in the hands of its designer, Rudolf Tegstrom. This twin Dyno engined race car is probably the best Swedish example and is capable of nearly 50 m.p.h.—no mean speed for a total capacity of 4.08 c.c.

CHAPTER X

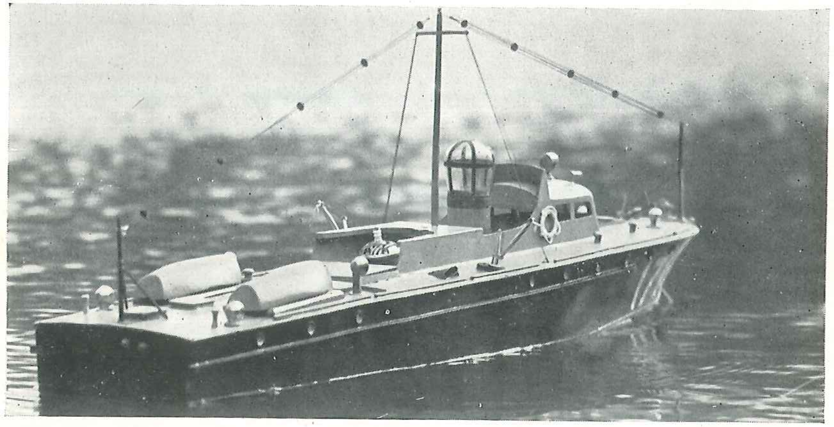
SUGGESTED FURTHER USES FOR DIESELS

WHILE the model diesel engine was introduced primarily for the benefit of model aeroplane enthusiasts, and this aspect of its use has occupied the major part of this volume, there are equally a vast number of model builders who will immediately seek to exploit it as a motive power for their own particular branch of miniature transport. In the same way, European modellers have adapted it to every conceivable sort of model.

First in popularity is probably the model power-boat. The remarks applied to it for use in flying boats and seaplanes have an even more potent value when housed in the hull of an air/sea rescue launch for example. The introduction of miniature accumulators has helped the problem of dry-running quite a lot, but still many a model is laid up after a few runs only because water has got in somewhere. The saving in weight is of great value to those who are always on the look out for a little extra speed. The old belief that a power-boat had to be heavy to hold it down on the water has long been exploded—here is the best chance for years to make a really light craft that can simply eat up the knots. To achieve this end, model aeroplane fuselage construction of balsa formers and a thin ply skin will prove amply strong enough for the little diesel. Many continental manufacturers offer a choice of propeller or fly wheel with their engines so that the hold these have already got for general use can be appreciated.

Another branch of model watercraft that has a big overseas following is the hydroplane. Not the outboard variety, which is properly included in the power-boat group, but the type where an airscrew is mounted on a pylon and drives the model over the surface of the water at quite remarkable speeds. These are available in most European countries in the form of kits, and may be seen on lakes and inland waterways in nearly every part. A 5 c.c. engine will power such a boat of up to 2½ feet overall length and 15 inches beam, and produce speeds of up to 15 or 20 miles an hour without special tuning or cunningly contrived underwater lines.

Other outlets include the use of diesel for scale-type models of the destroyer or pleasure yacht type, where there is a lot of detail work on the upper decks. A single hatch is all that is necessary to work the diesel, and no space must be painfully contrived for coil and batteries. Whether, when fitted to speed designs of power-boat, the diesel can equal the already high



Air/Sea Rescue Launch—suitable medium for diesel power.

speeds put up by such experts as Gems Suzor remains to be seen. These little engines are still in their infancy, and five years may produce a crop of amateur-built specials that will displace petrol engines in popularity as surely as the petrol engine has seized the initiative from steam.

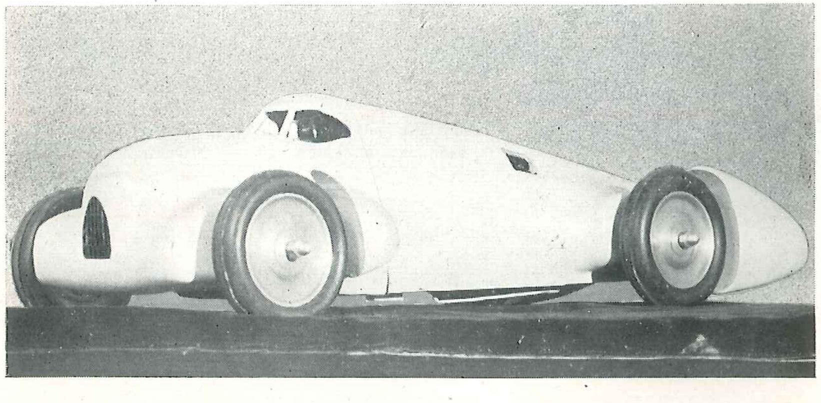
Next in line of popularity comes the growing body of model race car enthusiasts. This sport is as yet almost unknown in France, except for a few primitive designs that have appeared. We understand, however, that at least one manufacturer is now putting car kits on the French market, while Maurice Bayet, editor of the leading French aeromodelling magazine (History repeats itself!), is shortly producing the first race car book—so British enthusiasts must look to their laurels! In Scandinavia the race car movement has found a really receptive response. The race car clubs organise meetings in towns all over the country and turn up with their own portable wood tracks which can be bolted down in an hour or two in the local market place where they have been dumped from a lorry which also contains the models and their owners. American influence has played a considerable part in their designs, but, with the exception of one or two monstrosities, they have developed along the same lines as British model race enthusiasts; that is, with a leaning towards models that look like cars. In the matter of power-units, however, they have branched out entirely on their own. The diesel has naturally played a major part in this development, if only for lack of petrol engines, though, as least so far as Sweden is concerned, it should not have been impossible to get them in small numbers throughout the best part of the war from America if they had so desired.

The leading Swedish race car designer, Rudolf Tegstrom, has produced a particularly pleasing model which he calls "Red Devil". It is powered with *two* Dyno diesels placed side by side, and each driving one of the rear wheels by a spur gear. The engines are inclined so as to interfere as little as possible with the streamlined, fully enclosed body that completes the model. The drive is quite open, and must presumably be lubricated by a liberal application of thick grease before each run, and there are no complications so that the design is, indeed, within the power of any model enthusiast, who would not need a lathe or any great variety of tools, provided he could get the gears made up for him. Speeds are quite modest as yet; the best that "Red Devil" has clocked is 84 k.p.h. or a fraction over 50 m.p.h. But when it is realised that this speed comes from a total capacity of 4.08 c.c. there is every reason for congratulation.

British efforts with diesel-engined model cars are still much more in the experimental stage. A 5 c.c. *Aeromodeller* diesel was fitted to the Russell Auto Union by the Research Department a month or two ago and tried out on the track at Eaton Bray with most disappointing results. It would chug round quite happily at about 20 m.p.h., but showed no inclination whatsoever to give of its best. No matter what was done, it continued to chug soberly until the fuel was exhausted. The only explanation for this conduct is that it is obviously necessary to run the engine under load, and by increasing the weight of the flywheel satisfactory performances can be obtained. Lack of time has prevented further steps being taken in this direction, but, as a guide to would-be experimenters, a flywheel approximately twice as heavy as that used for normal petrol models is suggested as a starting-off point. The diesel will not give of its best except when working at full revolutions, so it must be loaded up until it is screaming. With fixed drive this will lead to wheel slip, so a centrifugal clutch should certainly be fitted. This, incidently, is not fitted to Swedish diesel-engined race cars, but initial low speed obtained by over-rich mixture which works right after a circuit or two.

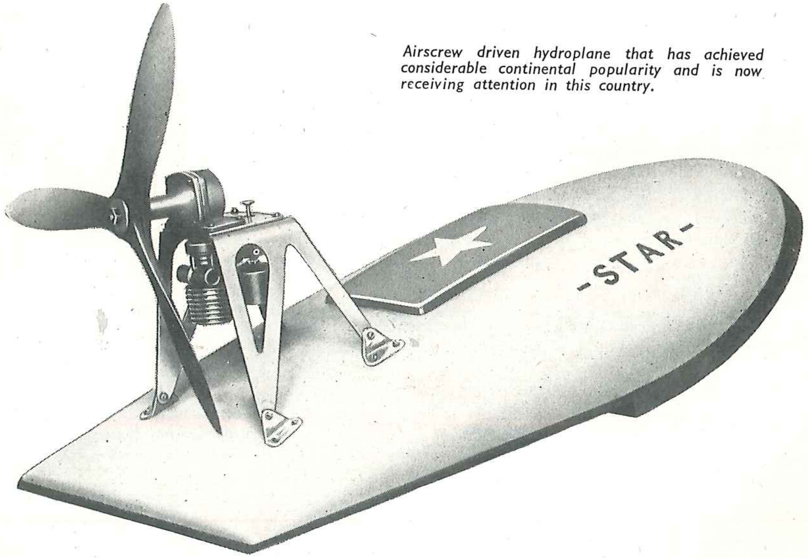
One field of research will be to devise a suitable method of stopping these cars, as there is no ignition circuit to break. The normal swivel arm extending above the car might be retained, attached to a spring-loaded cut-out mechanism which would be released on movement of the swivel. It would have to be of a rather firmer nature than the usual aircraft cut-out owing to possibility of vibration or track unevenness setting it out when not required. Equally it may be possible to work out an entirely new stopping gear without any relation to existing methods.

The Russell Auto Union. This well-tried veteran of the model race track has been used as a test-bed for diesel research.



Another popular air/sea rescue launch that simply cries for a diesel

Airscrew driven hydroplane that has achieved considerable continental popularity and is now receiving attention in this country.



Hook hydrofin—a power model that follows a new technique evolved for full-size craft by Christopher Hook of Egypt Hill, Cowes, I.O.W.

Other models recommend themselves immediately to diesel operation. The locomotive enthusiasts might consider using the really small engines of under 1 c.c. to power 0 gauge designs. It is not beyond the bounds of possibility to fit, say, a 0.7 c.c. engine into a 00 or h0 locomotive—though admittedly a tricky problem. Unfortunately, our continental friends appear to have a very limited interest in model locomotives, and as far as can be ascertained no existing literature on the subject at any rate in the French-speaking countries. In Germany before the war there was a keen circle of locomotive enthusiasts, and many of the finest commercial models came from there, but to-day they have no time or opportunity for such things—apart from the general suspicion attached to modelling as a state sponsored group under the old regime. It is not possible, therefore, to instance any successful locos. powered with diesels—but offer it as food for thought.

We have had information, though, of a diesel model designed to power a stationary plant that actually had true diesel injection. This was built by a Dutchman, forced to work in Berlin, and the original model was destroyed during the blitz. However, the designer is happily now back in Rotterdam and hard at work again, so that we can hope to have more news shortly. Fitted to other forms of transport than cars, such as articulated lorries or farm tractors, the diesel could make another niche for itself. We are firmly of the opinion that it can do all that the miniature petrol engine has done in the past with greater ease and reliability, and may even be developed to oust steam, which still plays a large part as the motive power of heavier models.

In these pages we have endeavoured to give a picture both of the model compression-ignition engine as it is to-day, and to make practical suggestions for its improvement in the future. We hope our readers will enjoy reading it as much as we have its preparation. There will certainly be errors and omissions, and for these the indulgence of all is craved. If they can be amended with the help of the public we shall be duly grateful, in the same way notes on any models not described, and more particularly the loan of such a model for testing purposes, will be extremely welcome. We hope that we have confirmed enthusiasts in their appreciation of this new medium, and won many more converts to the diesel cause.

APPENDIX I

Principal Characteristics of Leading Diesel Engines

SWITZERLAND

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Dyno I	2·04	12	18	190	6¾	7500	·09	10¾/7⅛
Etha I	2·5	13	19	270	9⅝	6000	·08	12/7⅛
Etha II	6	20	25	500	17⅝	5000	·3	16/8
Buchmann	0·6	8	12	45	1⅜	6000	·03	7⅛/2¾

ITALY

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Alfa I	1·8	12	16·5	135	4¾	4500	·1	–
Antares 4	4	–	–	330	11⅝	5000	·2	14/7¾
Atomatic 1	1	10	15	80	3¾	7500	–	10¼/7½
Atomatic 4	4	15	22	260	9⅛	6000	–	8/6
Delta 2	2·1	12·2	18	130	4½	7000	–	11⅛/8
Elia	4·2	–	–	230	8⅛	5500	·2	–
Folgore L.N. 2	1·99	12	18	160	5⅝	6500	·12	–
Giglio	2	–	–	180	6⅜	5500	·1	11/4¾
Helium MB6	6	16	30	430	15⅛	7000	·2	–
Helium C6	6·3	–	–	300	10⅝	7000	·25	18½
Movo D. 2	2	12	18	170	6	5500	·12	7/5½
Super Tigre G13	5	–	–	290	10¼	7000	–	–
Super Tigre G14	5·65	20	18	300	10⅝	7000	·25	–

FRANCE

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Allouchery Eclair	0·16	5	8	15	½	12000	–	4½
Allouchery Eclair	0·7	9	15	60	2⅛	7000	–	8
Allouchery Eclair	1·25	10	16	104	3⅝	6100	·035	9½
Comete Junior 5A	5	18	20	220	7¾	5000	·17	13¼/8½
Delmo	2·65	13	20	235	8¼	5500	·11	12
Jide 8	1·7	12	15	105	3⅝	5500	–	10
Jide 12	3	16	15	135	4¾	4500	–	14½
Maraget	·9	10	12	50	1¾	5500	–	9¼
Marquet	5	17	22	250	8¾	4200	·12	13¼
Micron	5	17	22	280	9⅞	4800	·18	14
Micron	2·8	16	14	135	4¾	4700	·1	12
Micron	0·8	–	–	42	1¼	–	–	–
Morin 76	10	21·5	27	350	12⅜	5700	·25	18
Morin 47	4	16	20	280	9⅞	5000	·2	16
Morin 81	5	16·5	23	290	10¼	5500	·2	16
Morin 70	10	21	28	380	12⅜	5500	·25	18
Ouragan	3·36	13	15	180	6⅜	6600	·25	10⅞/7⅛

FRANCE

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Stab	1·25	10	16	170	6	4500	·08	9¼
Stab	3·52	15	20	295	10½	4500	·14	12
Sirocco	2	12	18	130	4½	6000	–	11⅛

CZECHOSLOVAKIA

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Atom	1·8	12	16	100	3½	6000	–	10¾/5½
Super Atom	1·8	12	16	95	3⅜	6000	–	10¾/5½
Super Atom Major	3·5	–	–	165	5¼	–	–	–

SCANDINAVIA

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
Diesella	2·4	12	18	200	7	4500	·17	–
Johanson	2·5	12	18	180	6⅜	7000	·1	–
Mikro	2	12	17·5	220	7¾	7500	·1	10¼
Monsun	2·4	18	·457	180	6⅜	5000	·1	12¾/7
Pinotti (C.P.)	1·5	11	16	135	4¾	4000	·1	8¾
Rogstadius	2·04	12	18	250	8¾	7500	·1	–

GT. BRITAIN

Type	C.C.	Bore in mm.	Stroke in mm.	Weight		R.P.M.	H.P.	Prop.
				Gms.	Ozs.			
*AM	5	17·5	22	310	11	5000	·25	13/6
Frog "100"	1	9·5	14	100	3½	6000	–	9/5
Leesil 24	2·4	12·7	18	200	7	5000	–	9/7
Mills	1·3	–	–	130	4½	7000	–	9
Owat	5	17	21·75	310	11	5000	–	14/9

*Plans only available.

Other projected British Diesels include Clan 1 c.c., Clansman 5 c.c., Atlas 3 c.c., Electra 2 c.c., of which details have not yet been released. All British makes of which brief specifications are given are either already available or will be in quantity production in 1947.

NOTE.—Bore and stroke dimensions are given in millimetres to conform with conventional capacity in cubic centimetres. Weights are given in both grammes and ozs. to enable quick comparisons to be made. Propeller particulars give first diameter and then pitch where known or calculated, both dimensions in inches. Metric measurements have been given to the nearest simple fraction.

APPENDIX II

Experimental and Recommended Fuel Mixtures

(1) TWO-PART MIXTURES

Recommended by	Ether %	Lubricating Oil %	Medicated Paraffin Oil %
AEROMODELLER Research Department ..	60	—	40
Delmo	50	50	—
Micron	75	25	—
	or 80	20	—
Comete Junior	50	50	—
Stab	85	15	—
	or 75	25	—

(2) THREE-PART MIXTURES

Recommended by	Ether %	Naphthalene %	Lubricating Oil %	Petrol %	Medicated Paraffin Oil %	Castor Oil %
AEROMODELLER Research Department Standard	45	—	10	45	—	—
Allouchery ..	33⅓	—	—	33⅓	—	33⅓
Atomatic ..	20	—	40	40	—	—
Jide	45	—	10	45	—	—
Morin	40	—	20	40	—	—
Micron ..	80	—	5	—	15	—
	or 75	—	5	—	20	—
Mikro	40	—	20	40	—	—
	or 40	—	25	35	—	—
Monsun ..	60	—	20	20	—	—
Movo	37½	37½	25	—	—	—
	or 37½	—	25	37½	—	—
Helium ..	45	—	10	45	—	—
	or 45	45	10	—	—	—
Stab	75	—	5	—	20	—
	or 37½	—	25	37½	—	—
Comete Junior	50	—	30	—	20	—
	or 40	—	40	20	—	—
Ouragan ..	45	—	40	15	—	—
Delta	40	45	15	—	—	—
Buchmann ..	40	—	40	20	—	—
Owat	70	—	10	20	—	—

(3) FOUR-PART MIXTURES

Recommended by	Ether %	Turpentine %	Lubricating Oil %	Petrol %	Medicated Paraffin Oil %	Castor Oil %
Atom	20	—	20	45	—	15
Pinotti ..	15	—	—	65	5	15
Etha	40	25	10	—	25	—

(4) FIVE-PART MIXTURES

Recommended by	Ether %	Turpentine %	Lubricating Oil %	Petrol %	Medicated Paraffin Oil %	Castor Oil %
Dyno	16	25	9	25	25	—

EXPERIMENTAL MIXTURE

AEROMODELLER Research Department	Make up a mixture of 98 per cent Pool Burning Oil and 2 per cent Ethyl Nitrate. Fuel is comprised of 90 per cent of this mixture and 10 per cent XL Lubricating Oil. Note: Under no circumstances should the proportion of ethyl nitrate be increased. This mixture is not recommended for use except by those with an adequate knowledge of model diesels.

Notes: Where Petrol is specified ordinary Pool Petrol is intended. In the absence of this, a *good* lighter fuel may be substituted. Medicinal Paraffin Oil is always specified rather than ordinary burning paraffin.

Ether is Sulphuric Ether or Anæsthetic Ether. Always secure the purest obtainable.

Where makers recommend a variety of fuels, this is intended to assist in case some constituents are not easily obtainable.

APPENDIX III

Names and Addresses of Model Diesel Engine Manufacturers

* Plans only

GREAT BRITAIN

AM .. .. .. *AEROMODELLER PLANS SERVICE, Allen House, Newarke Street, Leicester.

Atlas .. .. .. ATLAS MOTORS, Studham, near Dunstable, Beds.

Clan .. .. CLAN MODELS LTD., 24 First Avenue, Glasgow, S. 4.

Frog .. .. .. INTERNATIONAL MODEL AIRCRAFT LTD., Merton, London, S.W. 19.

Mills	Mills Bros. (Model Engineers) Ltd., 2 Victoria Colonnade, Southampton Row, London, W.C. 1.
Myers & Young	Myers & Young, 46 Stanley Street, Queens Park, Brighton.
Owat	Modella Engines (Bradford) Ltd., 44, Bridge Street, Bradford, Yorks.
Leesil	Leesil Ltd., 1 Arthington Street, Bradford, Yorks.

CZECHOSLOVAKIA

Atom	*Designers :* Hruska a Choc, Vodickova 18, Prague II. *Distributors :* M. K. Moucka, Vinohrady, Prague XII.

DENMARK

Mikro	Kai Nielsen, Copenhagen.
Monsun	Leo Jeppesen, Snekkersten, near Elsinore.

FRANCE

Allouchery Eclair	P. Allouchery, 15 Rue R. Giraudineau, Vincennes.
Comete Junior	Societe Jesco, 48 Rue Chapon, Paris III.
Delmo	J. Debrel, 29 Rue Feray, Corbeil.
Jide	*Designer :* J. Durand, 8-15 Villa Maurice, Antony (Seine). *Distributors :* A. Paillard, 52 Rue Battant, Besancon (Doubs).
Maraget	*Designer :* J. Maraget, 92 Rue Jean Jaures, Puteaux (Seine). *Distributors :* Aviaplane, 10 Rue Leon Bourgeois, Colombes (Seine).
Marquet	G. Marquet, Lyon (Rhone).
Micron	*Designer :* A. Gladieux, 8 Rue Victor Gelez, Paris XI. *Distributors :* S. A. des Etab. Claude Bonnier, 35 Rue Marengo, Courbevoie (Seine).
Morin	*A. Morin, 7 Rue des Gardes, Paris XVIII.
Ouragan	R. Chatet, 61 Rue Damremont, Paris XVIII.
Stab	Stab, 35 Rue des Petits-Champs, Paris I.

ITALY

Atomatic	Aviominima, 50a Via S. Basilio, Rome.
Delta	Fram, 60 Via Carlo Farini, Milan.
Elia	Aeropiccola, 252 Corso Peschiera, Turin.
Folgore	Aviomodelli, 25 Via G. Grandi, Cremona.
Helium	Aeropiccola, 252 Corso Peschiera, Turin.
Movo	Movo, 14 Via S. Spirito, Milan.
Supertigre	Aviomodelli, 25 Via G. Grandi, Cremona.

SWITZERLAND

Dyno I	*Designer :* Klemenz-Schenk, Alfligen. *Distributors :* G. Feught, 48 Bahnhofstrasse, Zurich.
Buchmann	E. Buchmann, 317 Hardsturmstrasse, Zurich.

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