MODEL DIESELS

MODEL DIESELS – Laidlaw-Dickson

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A complete description of the model compression-ignition engine in theory, practice and construction, compiled from exclusive sources; together with the results of over four years' exhaustive experiments by the *AEROMODELLER* RESEARCH STAFF

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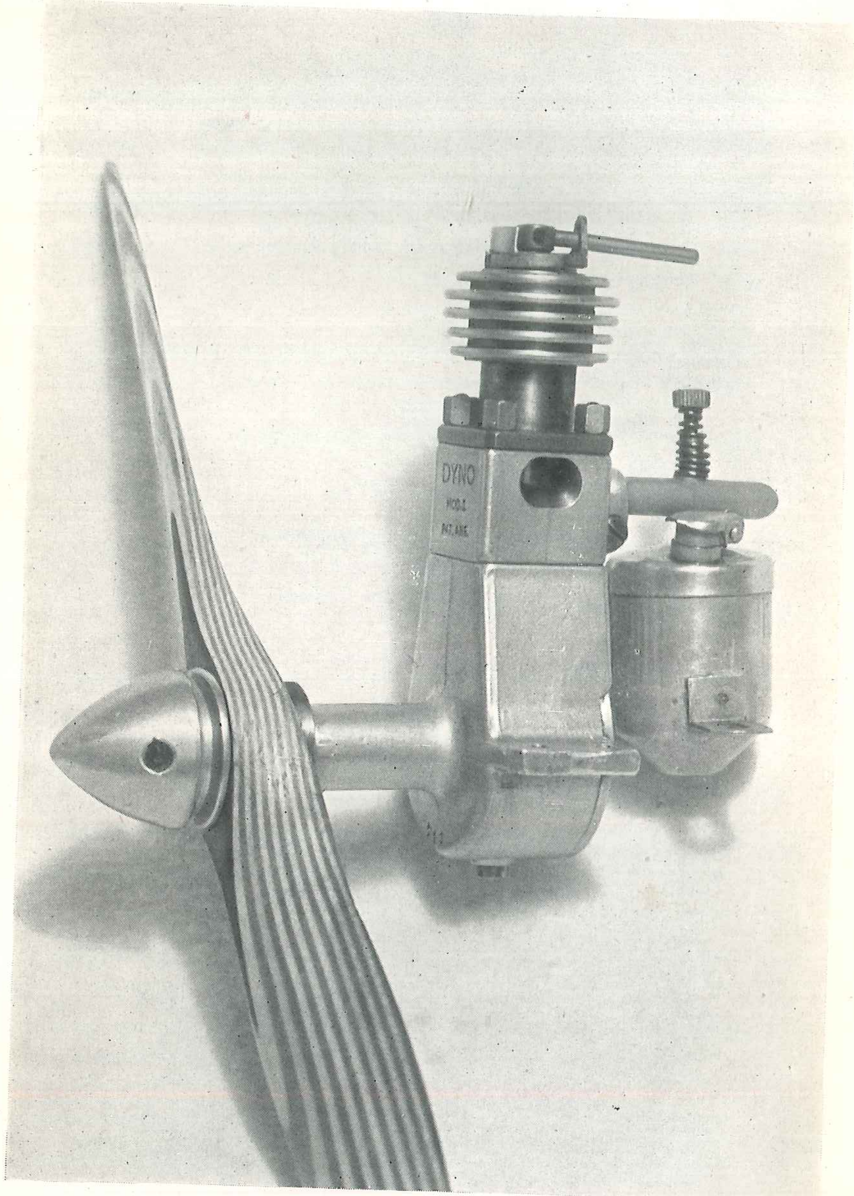
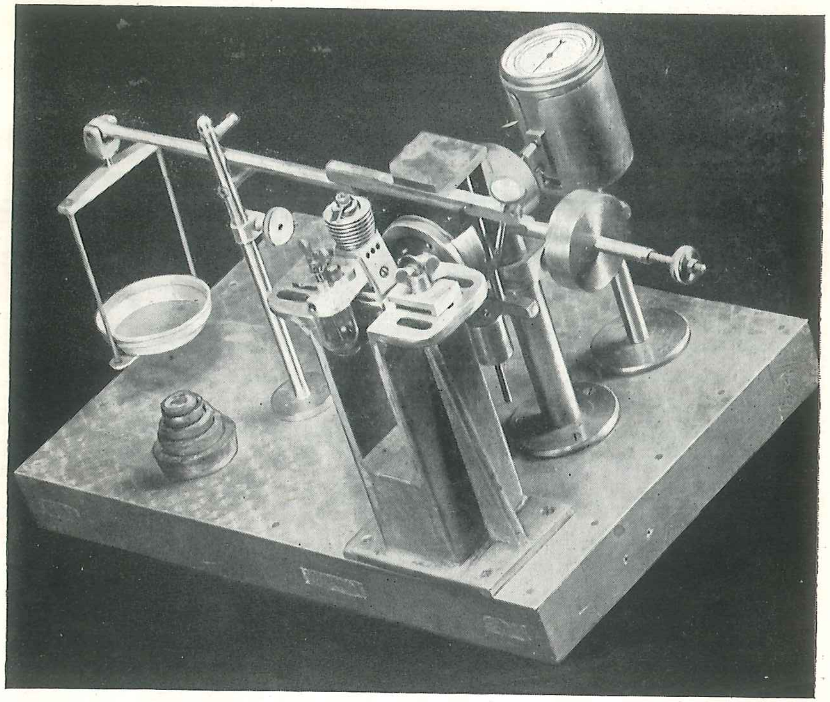


The father of all diesels—the Dyno I first practical model diesel engine to be offered commercially, and still an outstanding example of expert mass production methods.

LIST OF ILLUSTRATIONS



Dynamometer designed and constructed by Aeromodeller Research Department to carry out tests on model diesel engines. With its aid it is possible to arrive at comparative figures as between different engines obtained under identical conditions—an important matter when manufacturers' own figures cannot so be given, for obvious reasons.

CHAPTER I

FIRST LIGHT ON THE DIESEL

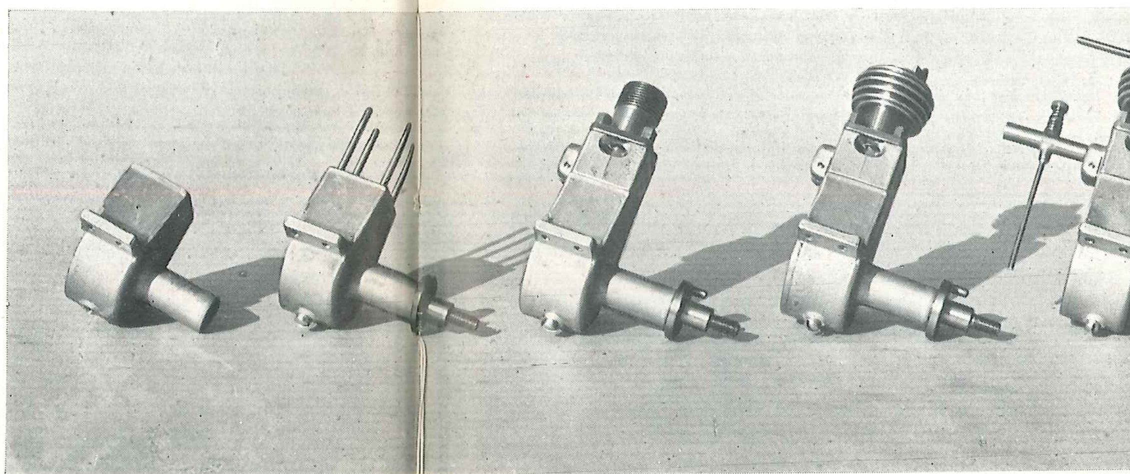
In the history of research and development are recorded many instances where work has followed similar lines during concurrent periods, but in places spaced many miles apart. The story of the model "Diesel" engine is yet another example of this, and accordingly it is not possible to name any one person as its "inventor". During the past five or six years development work has been going on in Switzerland, Italy, France, Germany and the Scandinavian countries, while in England the *Aeromodeller* Research Department has patiently been adapting, improving and inventing. Almost alone, it may be said, has America stood out as the one country where experiments were *not* proceeding—whether from ignorance, disinclination, or the power of vested interests to keep competitive and revolutionary designs from the market is not known. Sufficient to say, that now, when the "diesel" is an accepted part of European aeromodelling, a number of American business firms are displaying a lively interest. We can only hope they will take them up with the same enthusiasm displayed in the marketing of petrol engines, and offer some of their super-finished designs in due course. However, this may be one of the few occasions when they have missed the boat and given the Old World a chance to show their mettle. Be that as it may, there seems no real answer to the question "Who invented the diesel engine?" We can only say, with due modesty: "We do not know—certainly *we* did not!" But we *were* the first in this country to carry out considerable research and development work, which at least enables us to publish the first authoritative survey on this type of engine based on our own original, practical work, and the co-operation of over 40 British and Continental firms producing commercial model diesel engines.

It is possible to give some glimmering of the chain of circumstances which led to model diesels sweeping from Switzerland over the whole of aeromodelling Europe. It was in Switzerland that the first experiments appear to have been made on semi-diesel or hot bulb engines. Ignition for the first power stroke in this type is produced by an electrically heated copper block in the cylinder head, which retains its heat for the ensuing strokes. About the same time Vantini was conducting experiments in Padua, where the plug was replaced by a coil of platinum wire, with promising results. The high cost of the wire and the general structural weaknesses of the modification prevented its commercial exploitation. It was not until a firm of bicycle accessory manufacturers discovered a 20 year-old British patent—impractical when first patented—that the diesel as it is known today was evolved. This old patent covered the employment of a movable head that enables the compression ratio to be varied by means of a cam or screw. With this as the basis of his engine, the firm of Klemenz-Schenk produced model diesel No. 1—still claimed to be the most efficient in its class—the Dyno I. News of this development, coinciding with the exit of France from the late war, was received by Monsieur Debrel, a French engineer and aeromodeller, who soon produced a successful 1 c.c. engine. Emboldened by his success he marketed the 2.65 c.c. Delmo, which became France's first mass-produced model, and is still today in the front rank. Italian enthusiasts, facing a shortage of electrical equipment, leaped on the new design, and by the time Italy abandoned Facism was among the leading continental exponents, with Giglio, Antares and Movo as the outstanding makes. So the news spread ever northwards, until stolid German scientists took time off from more destructive labours to produce Aryan imitations, while in Denmark and the Scandinavian lands similar engines made their appearance. In spite of wartime censorship of trivial as well as important happenings, news trickled through to Great Britain, where the *Aeromodeller* Research Staff were already exploring possibilities of some method to divorce electrics from the petrol engine.

Whether a British diesel was running before a French, or whether Italian scientists beat them both to it, cannot be stated with any certainty, but there is no doubt that the fall of Italy gave the first avenue of approach to compare our efforts with those of other countries. Correspondents abroad sent home a wealth of literature and a number of engines, which enabled experiments to race on, where before they had, of necessity, been rather slow and groping. Although these engines are commonly called "Diesels" they are not, in fact, true diesel types. Rather should they be known as compression ignition engines. In the diesel engine proper a charge of air

is first drawn into the cylinder of the engine, and compressed by the up-stroke of the piston. This compression heats up the air to a considerable temperature, and into this hot mass a tiny charge of fuel is injected from a fuel pump at the peak of the compression stroke. The fuel thereupon explodes, thus providing the power stroke, and it is upon the precise timing of the injection of the fuel that the power depends. Severe mechanical difficulties had to be overcome before the full-sized diesel was brought to its present state of perfection; not the least of which was the making of a suitable injection pump capable of delivering the precise tiny quantity of fuel against the enormous pressures in the cylinder head. In the large sizes of engines this was found possible, but when applied to such small engines as are required for model work it was not practicable to construct pumps nor jets with the requisite precision. This statement is not entirely correct, for cases have been brought to our notice where model engineers have, in fact, built true diesel down to capacities of 6 c.c., but these are isolated instances of extreme skill, and not to be repeated by the average amateur with the usual amateur's workshop equipment—nor are they such as could be reproduced commercially at reasonable prices. Beyond a bare mention therefore, to uphold the enthusiast's boast that there is literally nothing the aeromodeller cannot make if he sets out to do it, they must be dismissed as beyond the realms of *practical* development.

In view of these difficulties the orthodox diesel principle was abandoned, and, seeking solution along a different road, the compression ignition engine with which we are concerned was evolved. The solution was found by combining with the fuel of an ordinary two-stroke *type* of engine a substance known as an accelerator, such as ethyl ether. An "accelerator" is a substance which, when added to any normal engine fuel, lowers the octane number of the fuel, and imparts to it the property of detonating under high compression. This detonation provides the power stroke. Such is the principle of the model diesel engine, although a considerable modifi-



Progress of a Dyno—a picture story that portrays the assembly of the now world famous Swiss model diesel from its basic parts to the complete engine.

cation in the actual mechanical design becomes necessary. In spite of the disclaimer, however, the name diesel seems likely to stick as its designation in this country. Compression ignition is rather a mouthful, and when given the abbreviated title of C.I. is apt to be confused with the longer established I.C. or internal combustion engine, which in model circles it aims to supplant.

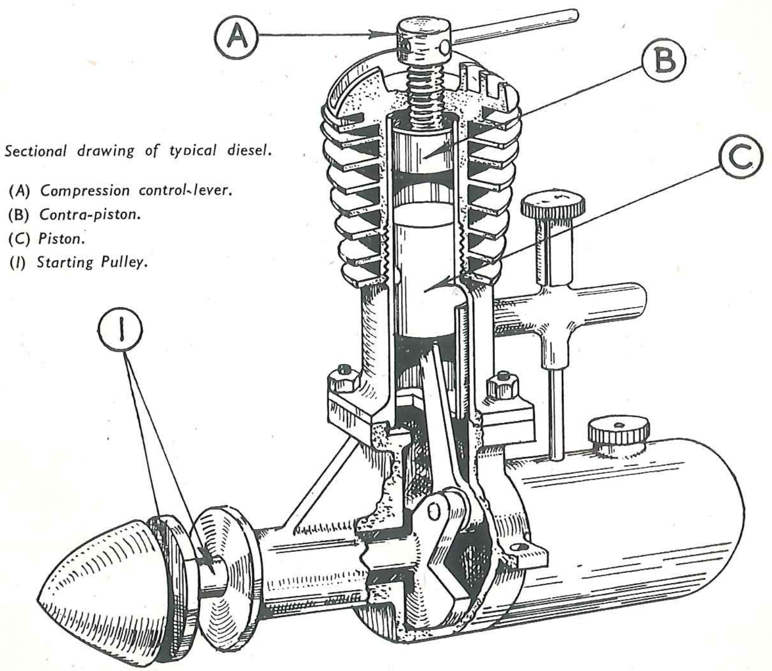
From the sectional drawing given here of a typical diesel type, two features will be evident. First we note that the engine is of extremely long stroke. More striking, however, is the small piston at the top of the cylinder, having provision for adjustment of position by means of a screw protruding from the top of the cylinder head, and acting in opposition to the piston proper. This component is called the "contra-piston", and its function is to provide an adjustment of the compression ratio of the engine. Usually the compression is adjustable between ratios of 10 to 1 and 20 to 1, which is a much greater range than is required, as the compression ratio for correct running is rather critical. In some engines, in fact, this contra-piston is omitted altogether, the correct compression ratio being obtained by grinding away the seating of the cylinder barrel, or by some other such permanent adjustment. The gain lies in the fact that the overall height of the engine may be made less, and that the operation of the engine is confined to one control only. Against this may be offset the disadvantages that extreme precision is required in the design and manufacture; that no compensation may be made for minute leakage due to piston and cylinder wear; and, more serious still, an absolute uniform standard of fuel mixture must be maintained for perfect performance.

The long stroke, which is advantageous in obtaining high compression—and which also makes possible a long piston-seal to prevent leakage—makes the model diesel slightly taller than a petrol engine of equivalent capacity. The space occupied by the contra-piston also adds to the height. Similarly, the long stroke makes a larger crankcase necessary, so as to accommodate the increased swing of the crankpin. Thus, the diesel is apt to be of larger overall size than a normal engine of like capacity. Now that we have made this point, we would draw attention to contrary advice in a subsequent chapter where builders are advised of all the advantages of a large bore and a short stroke. We make no apology for this contrariness—the fact remains that the greater number of successful diesels *are* long-stroke engines, equally this does not prevent the opinion that a well-designed and equally well-built short-stroke engine would not be superior. Unfortunately we have not yet had an opportunity of putting this into practice.

The usual compression ratio of small *petrol* engines is between 4 and 6 to 1, while that of the diesel is around 16 to 1. As may be expected with these high compressions, internal strains are much greater in the diesel requiring very sturdy construction. Crankshafts and bearings of truly massive proportions are desirable, whilst the most satisfactory connecting rods are those of solid steel with hardened and lapped bearings. These necessities make the small diesel heavier than its petrol counterpart, but this is of little importance considering the absence of any ignition accessories, and the fact that the power developed per c.c. by the diesel is very much greater than that developed by the normal petrol-engine type.

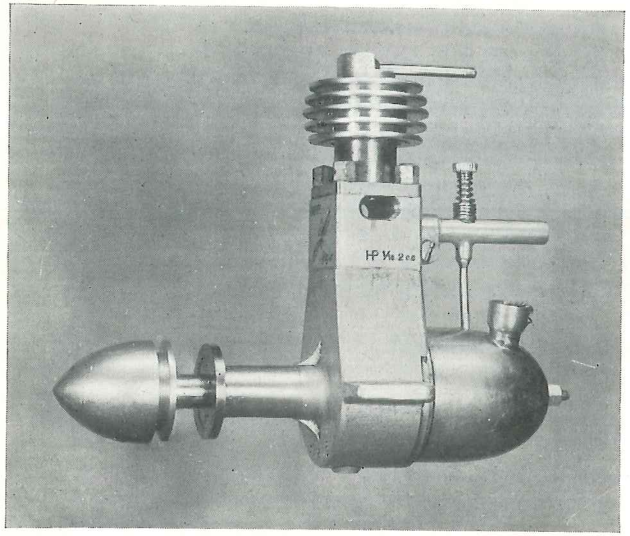
Generally speaking, the wear and tear on the small diesel is greater than that on orthodox units, making necessary the use of special steels for certain parts. Cylinders, crankshafts and connecting rods may well be made from nickel-steels and hardened. Lapped cast-iron bearings will be found to stand up to the job in preference to the more usual bronze. If, however, due regard is given to these points there is no reason why the small diesel should not live as long as the normal petrol type. As the great majority will be buying rather than making their diesel, due attention to the specification should be paid at the time of purchase: an extra pound spent then may well make the difference between long life and satisfaction, or early disappointment and a further hand in the pocket.

Owing to the need for a small compression space, the usual deflector on the piston head is not often used on the diesel engine. The piston top is usually flat, and this seems to have no adverse effect on the simple operation of the engine. Some sort of deflector is, however, sometimes used, and this takes the form of a small step milled into the side of the piston so as to register with the transfer port in the cylinder. Nevertheless, there seems no reason why a normal deflector piston should not be used, provided that the cylinder head or contra-piston is profiled to register exactly with the piston top. Irrespective of the difficulty in machining which this entails, our experiments tend to show that some advantage in speed and power may be obtained by the use of a deflector of some sort.



Sectional drawing of typical diesel.

(A) Compression control-lever.
(B) Contra-piston.
(C) Piston.
(I) Starting Pulley.



An Italian engine—the 2 c.c. Giglio—with flat top piston and twin exhausts—one of the best Italian designs, though its imitation of the Dyno layout suggests a certain lack of originality.

Linked with the problem of high compression is the matter of starting the engine. It is not easy, against the high compression to flick the propeller by hand with the requisite smartness for a start. For this reason a small pulley is often provided on the propeller mounting, so that the engine may be smartly turned over by means of a cord. The starting of these small diesels is invariably extremely easy, as both starting and running are—apart from the simple compression and throttle controls—purely dependent upon the mechanical efficiency of the engine itself, and are not subject to that bugbear of model engines—ignition troubles. This freedom from ignition faults must be experienced to be appreciated, as, once the correct starting and running positions of the controls have been determined these engines perform with unfailing regularity. Another reason why starting by cord is advisable is that hand-flicking of the propeller, especially when the engine is hot, is apt to be dangerous, and although it may not continue to run at incorrect settings, the danger to the fingers from a sudden spin of the propeller is considerable. Familiarity having bred contempt, if not immunity, a French visitor attended our First Aid Station four times in one afternoon, until, having only his thumb unbandaged, he learnt a little wisdom!

Altogether it may be stated that small diesels must be made with an accuracy and precision much greater than that required for ordinary petrol engines, and that special attention must be given to the design of ports, transfer passages, and the choice of materials.

Miniature compression-ignition engines have definite running peculiarities of their own, which differ from those of orthodox petrol types. In the first place, there is a definite relationship between the compression ratio and the throttle setting. It is possible to start and run the engine at a great variety of settings, none of which may be the correct one for maximum efficiency. Preliminary trial-and-error tests will, however, give the correct

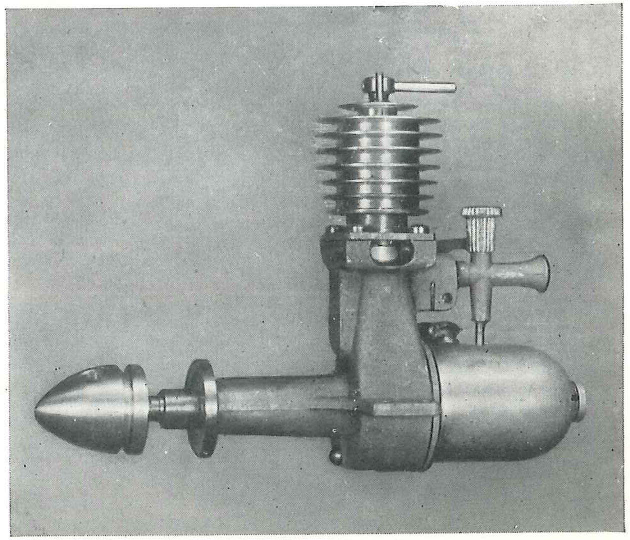
settings, when the control lever of the compression adjustment may be anchored between stops so as to provide a range of adjustments between small limits. These will of course only apply while the mixture is unchanged in proportions.

In making these trial-and-error tests it is, at first, advisable to run the engine at the *lowest* compression ratio consistent with regular firing. Should the compression be too low this will show itself in mis-firing, and the compression lever should be adjusted slightly until regularity is maintained. The throttle needle should then be adjusted. By *shutting* the throttle too much the engine will be made to pink badly, and this will be evidenced by a series of loud metallic knocks. Similarly, should the throttle be *opened* too much the same symptons will be manifest; the engine will be found to knock badly at the limits of about one-third of a turn of the needle valve. The correct needle setting for that particular compression ratio will lie midway between the limits of knock.

Now the compression may be increased slightly, when the engine will again knock badly. A readjustment of the throttle needle, as before, will again correct this. Continue this series of adjustments until the engine is running evenly and at its maximum speed, but without knocking. When the compression ratio has been raised too high this will be indicated by the engine slowing down and knocking, no matter how the throttle needle is manipulated. It is important that the engine should not be left to run for long periods when knocking, as this will have a disastrous effect upon the bearings.

When starting the engine the throttle needle should be shut down, and the engine given a few sharp turns with a cord to warm it up. Then

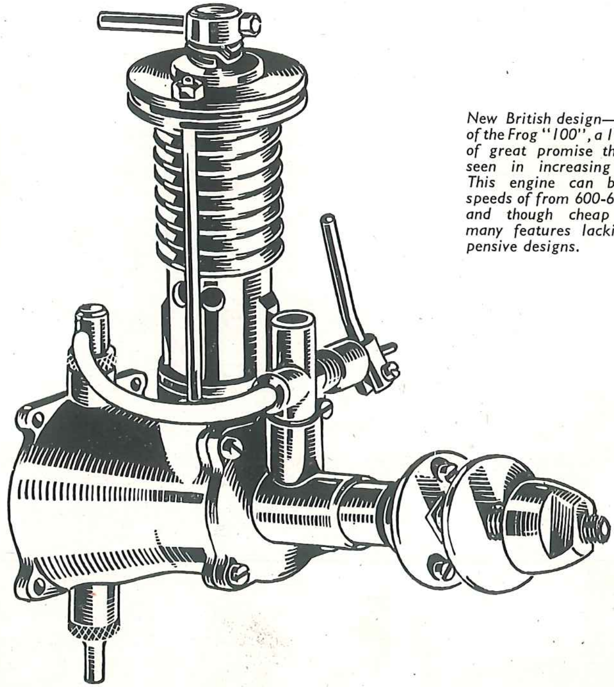
Another Italian engine—the Movo 2 c.c. Here an attempt has been made to get away from the standard layout. This engine is also available as a "sports" type with a longer crankshaft, thus enabling complete cowling-in—a useful feature when building scale models.



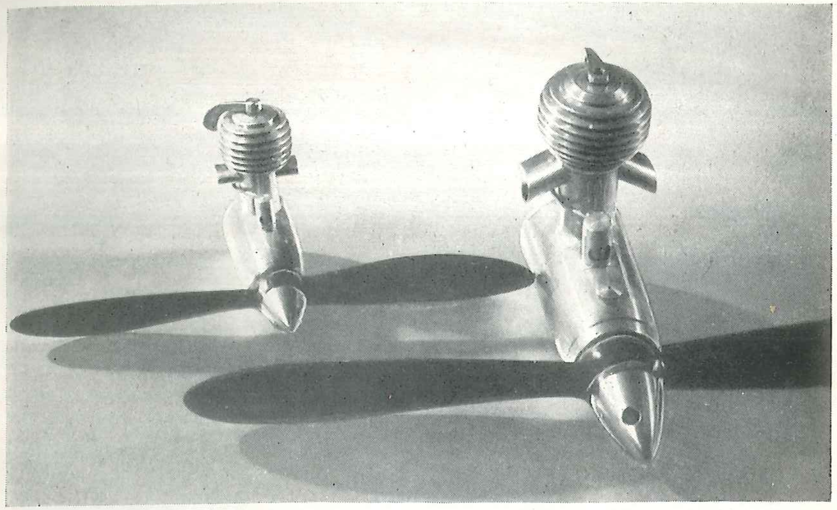
open the throttle to its known setting, choke the air intake with the finger, and turn the propeller twice by hand to draw up the fuel. Now increase the compression slightly beyond the correct running position, and start the engine with the cord. As the engine picks up speed reduce the compression to its running position, and adjust the needle valve in the manner stated, so that maximum revolutions are attained.

Miniature diesels will not run slowly under load, but require maximum revolutions to run efficiently. So much is this so that they will refuse to run at all if the diameter or pitch of the propeller is too great. For this reason airscrews must be accurately matched to the engine, and it will be found that the best results will be had by keeping the propeller at its maximum possible diameter and reducing the pitch until the greatest revolutions are obtained. When running correctly, however, the small diesel will produce considerably more power than a petrol engine of equivalent capacity. Maximum revolutions seem to be about 5-6,000 r.p.m. under suitable load for a 5 c.c. engine. Figures up to 12,000 have been obtained from a 1.8 c.c. engine on test, while Allouchery's 0.16 c.c. engine habitually runs at this terrific speed, though only for short bursts of up to 10 seconds.

One curious feature of the small diesel is that it runs extremely cool, so that it is quite possible to grasp the cylinder with the hand even after a protracted spell of running. This is principally due to the extremely rapid evaporation of the ether fuel. At the present state of development the fuel



New British design—a drawing of the Frog "100", a 1 c.c. engine of great promise that will be seen in increasing numbers. This engine can be run at speeds of from 600-6000 r.p.m. and though cheap embodies many features lacking in expensive designs.

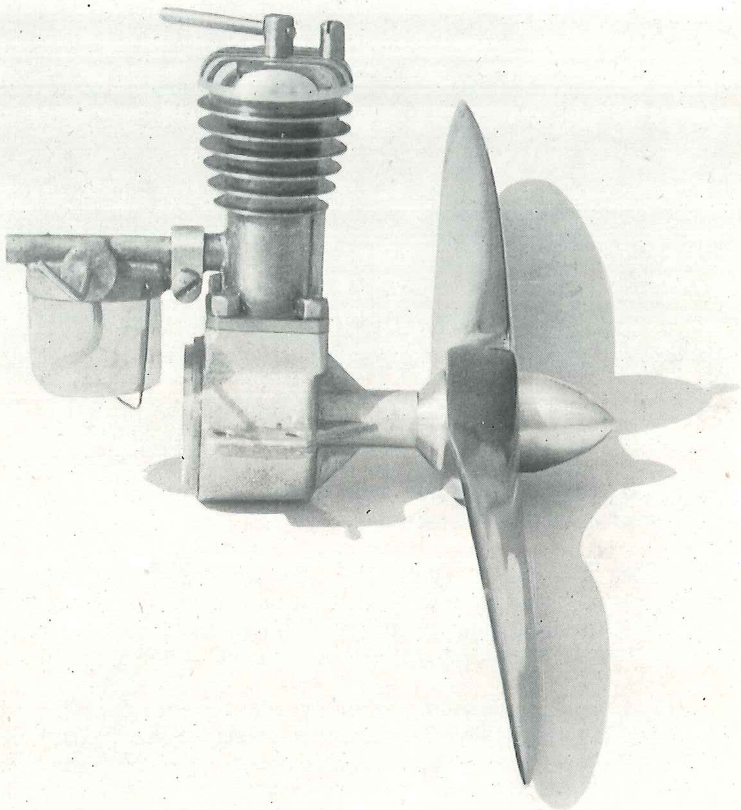


Atomatic 1 c.c. & 4 c.c. engines—a new Italian make that should prove popular.

does not seem to be completely burnt, and there is always a dribble of liquid from the exhausts, which makes these engines rather dirty in use.

There can be no doubt that the miniature compression-ignition engine opens up a new phase in model aeronautics if only because the weight of any electrical equipment is absent. This means that model aeroplanes of rubber-driven size and weight may be designed as power machines!

In spite of its apparent simplicity, the diesel engine does not seem suitable for general amateur construction owing to the extreme precision required and the necessity for hardened parts. Cylinder bores must be honed or lapped to a glass-like finish, and must be dead parallel and circular. Pistons must be similarly accurate, and must fit the bores to within microscopic limits. Even the different expansion factors of a cast-iron piston and a steel cylinder may cause sufficient leakage to stop the engine. But do not let this solemn warning prevent those who possess the necessary patience and skill from trying their hands at a diesel of their own. We are sufficiently confident that there *are* a reasonable number of enthusiastic model engineers so equipped that we have included a design from the *Aeromodeller* Research Department as well as a chapter on considerations of design. We shall be delighted to correspond with those making their own, and pass on the benefit of any advice that we can offer, but, before sending your engine to us with that sad little query—"Please, it won't go!"—do satisfy yourself that you have indeed built it to the fine limits specified. Provided you are sufficiently self-critical to scrap ruthlessly any parts not absolutely up to standard, then you are half-way there to making a satisfactory engine. Remember, there is no room for the "bodger"—when making a diesel you are working to tool-room limits! We can only add—good luck!



Meteore-Maraget 0.9 c.c. an outstanding miniature that its designer Gustave Maraget demonstrated most ably at the Eaton Bray International Week.

CHAPTER II

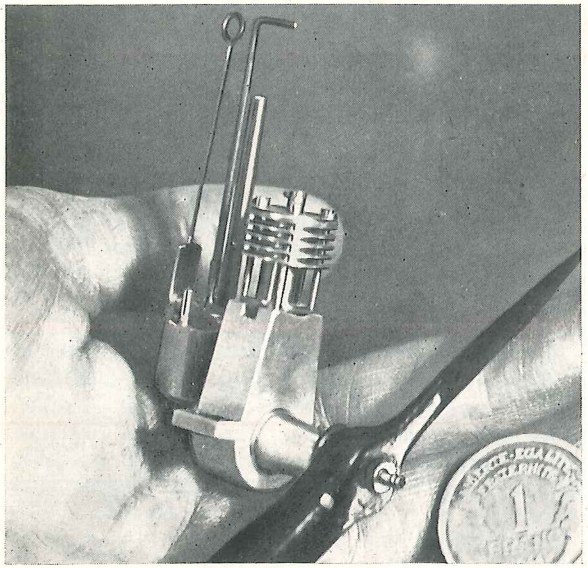
DIESEL ENGINES UP TO 2½ c.c. DESCRIBED

IN describing the various makes of model diesel engine at present on the market every effort has been made to present an impartial picture. It would be impossible to pass by a particularly desirable engine without commenting on its advantages, and seeking as far as possible to lead the would-be purchaser from any pitfalls that might engulf him from a too hasty selection. This has been done in an entirely unbiased fashion, and we would ask readers not to interpret any of our comments as expressing a bias in favour of any particular design. Naturally, where manufacturers have co-operated to the extent of submitting engines for test or sending voluminous literature, we are able to give a more detailed account of their products, but this should not suggest that a short description necessarily implies lack of first-hand knowledge. In the case of British engines, where a degree of partisanship might have been forgiven, we are unfortunately not able to give much data, as in the majority of cases they have been so recently marketed as to still be little advanced from the experimental stage. Furthermore, other manufacturers have announced models which they have not yet marketed, and do not propose so to do until all problems of mass production have been solved. These latter firms are naturally unwilling to give more than a brief outline of their forthcoming engines lest the ultimate product should so differ from the proposed type as to create dissatisfaction.

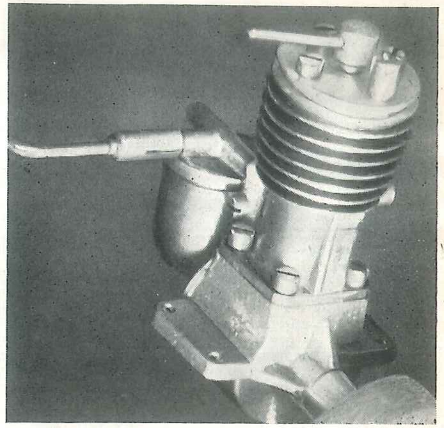
On the score of novelty alone the group of engines below 1 c.c. evokes immediate interest. Smallest of all engines is the 0.16 c.c. model designed by Allouchery. This is not strictly speaking a production engine, as a large part of the work entails hand finishing. Nevertheless specimens have been exhibited at trade shows in France as indicative of what can be done with ordinary mass-production plant. The prototype which runs at 12,000 r.p.m. can fly a model of under 4 ozs. all-up weight in any hall of fair size. It can never, however, get beyond the stage of an interesting curiosity—and if sold at all must be at a price far beyond its intrinsic value. To Allouchery belongs the honour of marketing the smallest *practical* engine—the 0.7 c.c. This is in production, and deliveries can be made usually in about a fortnight. Again, a proportion of the final work is hand finished, and this is reflected in the clean nature of the castings. Two versions of the engine are available ; one the normal type for duration models, the other a special design with lengthened crankshaft for use in flying scale models. Either variety may be flown upright or inverted. The main design is followed in all Allouchery models, including the larger sizes of 1.25 c.c. and 3 c.c., but the flying scale version is available only in the 0.7 c.c. size. One-piece cylinder block is of aluminium alloy, cylinder and crankshaft of special steel, con-rod of toughened steel and piston of cast-iron. Although a comparatively small manufacturer, this company has secured a very fair share of competition honours.

Next in size comes the 0.8 c.c. Micron, designed by the well-known French engineer, Andre Gladieux, who is also responsible for other engines in the Micron range. Messrs. Claude Bonnier and Co., who are the distributors, have been selling these engines for over three years, and they have built up a splendid reputation for reliability and, equally important, after-sales service. All parts are detachable, and individual replacements can be supplied from stock, until ultimately a completely new engine may have been assembled piecemeal. Materials used are similar to those employed on the Allouchery engine, except that con-rod is of bronze. This engine, too, can be run upright or inverted ; it is only necessary to unscrew two bolts and reverse the fuel tank.

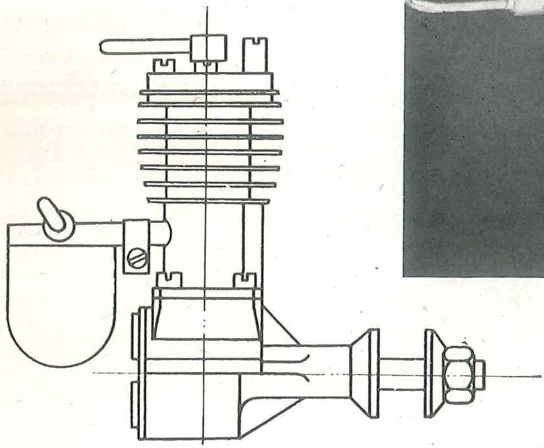
Next in size comes the 0.9 c.c. Meteore-Maraget, made by Monsieur Gustave Maraget at Puteaux, and distributed by Aviaplane of Colombes. Although larger in capacity than the previous models described, it looks equally small on account of the large bore in relation to stroke. In fact, it nearly reaches the theoretical ideal of a "square" engine, being 10 mm. in bore and 12 mm. stroke. Again, the materials used do not differ from other small engines, from which it can be inferred that these have proved to be the most practical. Con-rod here is of steel. Generally, the Maraget



Smallest in the world—Allouchery 0.16 c.c. shown approximately full size. This little engine runs at 12,000 r.p.m. and can conveniently be flown in a small hall, powering a 4 oz. model.



Micron 0.8 c.c. a very satisfactory miniature engine, that in spite of its small size is not unduly hard to start, and sturdy enough to take some hard knocks.



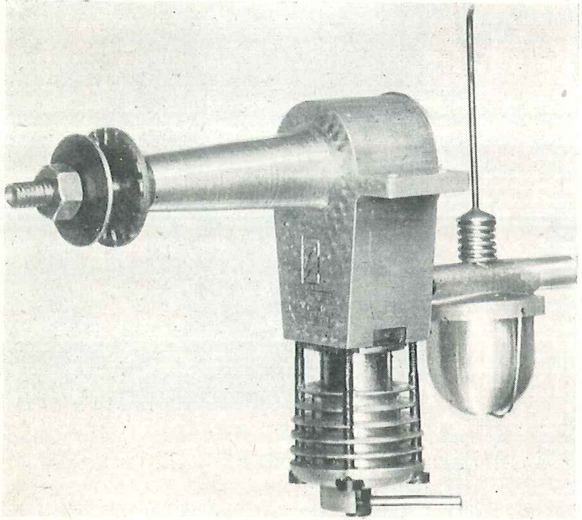
Comparison of this drawing with others of the Micron range will show quite a family likeness—though superficially very different.

is supplied only to order, but delays are not likely to be more than a week or two.

Many may hesitate to go in for such miniatures for fear of difficulty in starting. This cannot be entirely ignored. They are temperamental, but once the knack has been acquired take no longer to start than engines four and five times their capacities. Added to which they are suitable for powering models in the neighbourhood of 30 inch span, which is a great consideration in these days of crowded buses and trains.

The Allouchery 1.25 c.c. possesses all the virtues of its smaller brother with that little extra size and power that permits a small monocoque model to be built round it. Particularly pleasing to those who enjoy a nice-looking engine is the detail work that goes into all models from this factory. It not only runs well but looks well, which may always be considered a formidable pair of reasons for popularity.

The 1.25 c.c. Stab, produced in Paris, is a good general-purpose engine with several unusual features. The contra-piston lever has a further lever affixed to enable it to be locked in position. The fuel tank is attached to the engine by a circular clip extending right round the cylinder block, and fastened by a locking screw. This makes a very firm fixing, unlikely to be damaged in the event of a bad landing. Also welcome to cowling enthusiasts is the extension fitted to the throttle needle turnscrew. The makers offer five different fuel formulæ for the engines, graded from "very good" down to "less certain". Specification follows the usual lines, with the addition of phosphor bronze bearings, a somewhat controversial point amongst designers.



Allouchery 0.7 c.c., smallest commercial engine on the market. This shows the long crankcase model specially designed for use in flying scale models. An excellent power unit for a one inch to the foot Tiger Moth or Widgeon or any of the slow flying old-timers.

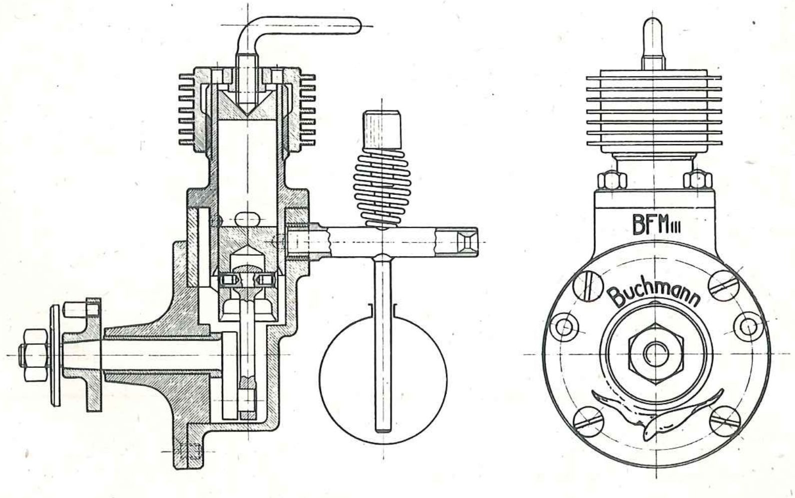
The Jide 8 has a capacity of 1.7 c.c., and presents a thoroughly practical engineer-made job for the connoisseur. Feed is by rotating valve, and there are twin inlet and exhaust ports. Materials introduce no new factors ; cylinder, con-rod and crankshaft being of steel, piston of cast-iron, crankcase, finning and fuel tank of duralumin. There are no soldered connections, and by undoing four bolts the whole engine may be taken down for inspection. The designer is J. Durand of Antony, while the engines are distributed from Besancon, so that this may be claimed as Southern enterprise. While the majority of French engines come from within 50 miles of Paris, and achieve a greater fame from their proximity to the capital, a limited number of provincial factories are turning out excellent engines for the benefit of local enthusiasts.

One of the first of the Central European countries to get into its stride again was Czechoslovakia, and they claim our attention for the 1.8 c.c. Atom and Super Atom diesels. These are fundamentally the same design, the Super Atom being a de-luxe edition. As might be expected from a country somewhat detached from the rest of Europe for so many years, a number of novel, and it must be added, praiseworthy features are incorporated. The cylinder head and finning is cast in one piece, which screws down onto the crankcase, and at the same time forms a support for the cylinder liner. Equally ingenious is the moulded plastic fuel tank which fits in a hollow round the crankcase extension, completely encircling it. By this means, fuel pipes are reduced to a minimum and a singularly neat and compact engine results. In the normal version a metal tank is employed, with the fuel inlet pipe and mixture control in the top. The only criticism is the fragile nature of the plastic tank which disintegrates in time, and also requires the filling hole to be enlarged for easy replenishment. Once this

tank has broken up it is quite tricky to make another. If, however, the engine comes on the British market in numbers, a spares service will overcome this small objection.

A number of Italian engines have been produced, and as they seem to have been amongst the early experimenters their commercial designs merit careful consideration. Amongst their latest models is the Alfa I of 1.8 c.c. capacity, developed by Mancini. The specification includes cylinder of heat-treated steel, crankshaft and piston of nickel chrome steel and con-rod of toughened steel. Cylinder is lined, and a higher power output claimed than that of any other engine of its displacement. In spite of its excellent materials on first sight it fails to impress, by reason of its abnormally long stroke, which makes the engine tall and spindly. Added to which the manufacturers have seen fit to paint the fins in black cellulose paint and the tank in red. Cleaned up and regarded simply as a piece of machinery it will satisfy. Nevertheless, the height of the cylinder will, in common with many Italian models, hardly commend it to those who like some form of engine cowling.

The Movo D-2 of 2 c.c. capacity avoids many of the faults of the Alfa I and is of a shape more pleasing to British taste. Its competition successes are a recommendation, and it can be relied upon to start with a minimum of trouble. Specification follows the lines of the Alfa, with the exception of the con-rod, which is of stamped alloy and perhaps a trifle light for hard use. When it is considered that its optimum revs. are 1,000 per minute higher than the former engine, it would seem to be rather asking for trouble. In spite of this, however, our test engine has stood up to a remarkable degree of maltreatment, so must, in fact, be quite sound.

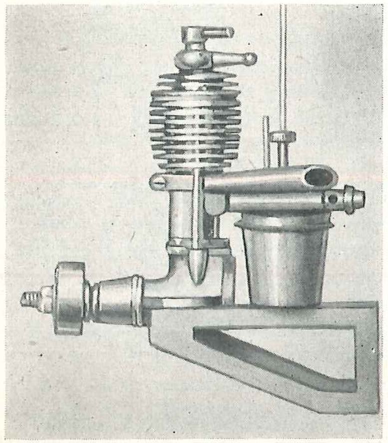


Buchmann Mk. III 0.6 c.c. a delightful miniature that displays a wealth of original thought in its conception.

Another 2 c.c. engine—the Giglio—has proved a favourite with enthusiasts on essential business in Italy during the past year or two. The exhaust ports are at right angles to each other, and the piston is without deflector. The head, as in the Atom, screws down onto the crankcase block. Specification departs from the usual in that bearings are of Liase bronze, and the crankshaft is made in three pieces and welded. Piston is of steel, crankcase of duralumin, cylinder and crankshaft of nickel chrome steel, while toughened steel is used for the con-rod. The engine can be run for long periods without overheating, and generally bears every evidence of being a well-thought-out production. Grazzini of Florence is the designer responsible for this, one of the oldest engines on the market.

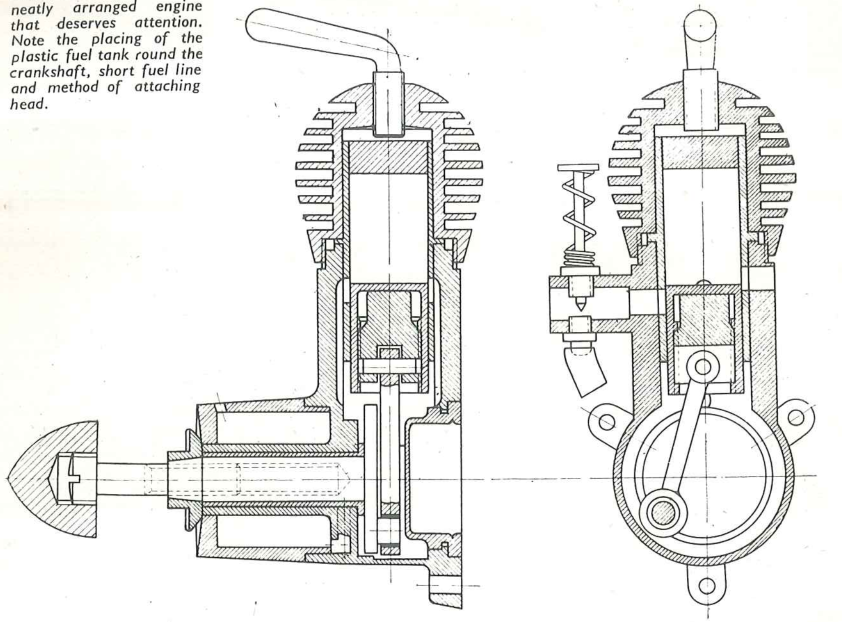
A small engine that is highly regarded in Italy is the Folgore LN 2 which with a capacity of 1.99 c.c. turns at 6,500 r.p.m. Here again, however, the long stroke rather spoils its appearance, which is otherwise inoffensive, if without any particularly attractive features. Most of the smaller Italian designs seem to conform to a style peculiar to themselves. In the main it fails to appeal to those as yet unbroken to fully exposed engines and high pylon mountings. On the other hand, in spite of æsthetic failings, they all seem to possess an adequate power output, reasonable ease of manipulation and every prospect of a long life.

The father of all diesels—the famous Swiss Dyno I—must be considered, not only for itself, but as a basis of comparison with all the engines that have followed—many slavishly—its design features. After five years of testing it is significant that the makers have introduced no major alterations in the specification and have failed to introduce a successor. Well may it be called the Ford of diesels, not in any disparagement of that household name, but as a tribute to the production genius who got the Dyno right, and was content to turn out more and more to the same pattern. On taking the engine to pieces its simplicity is shown to be the result of careful non-essential eliminations rather than any niggardly ideas on the costing side.

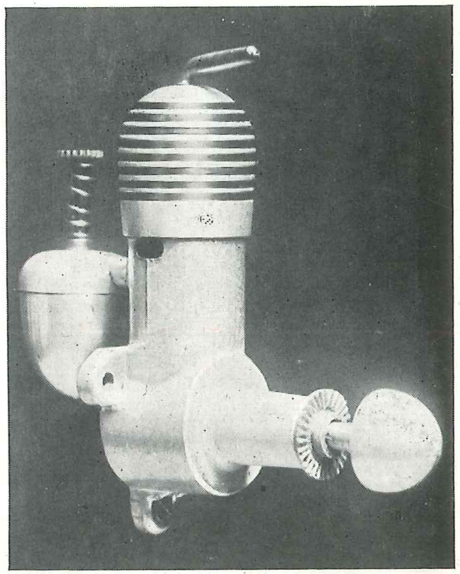


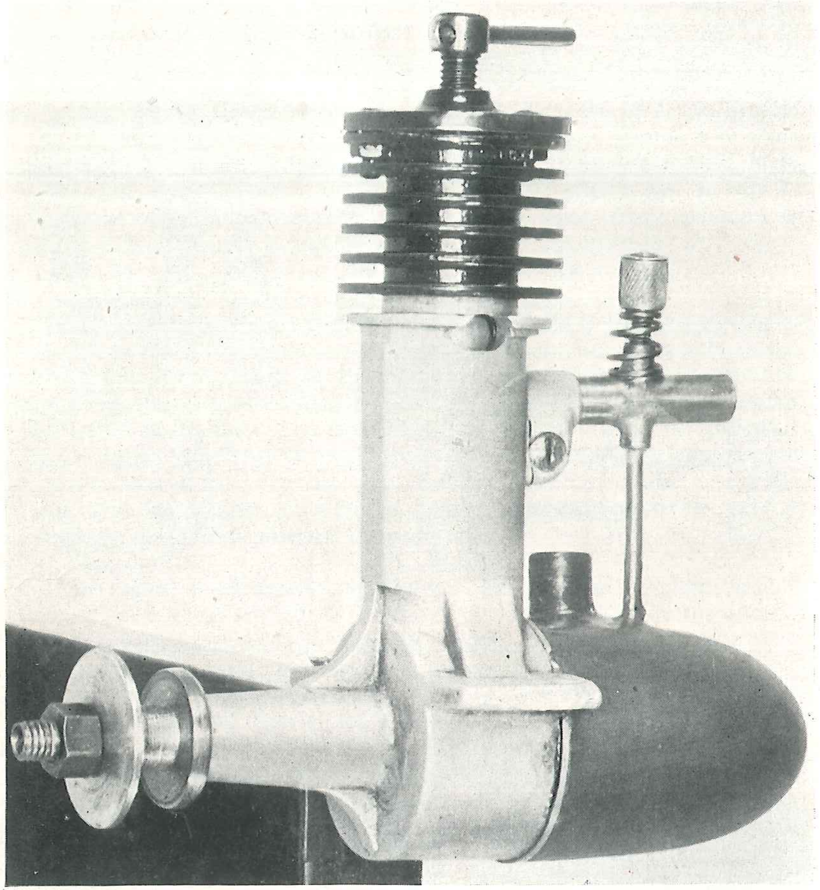
Stab 1.25 c.c. a French engine that enjoys a certain vogue in the Paris district—remarkable for the vast variety of possible fuel mixtures offered by the manufacturers.

Czech Atom 1.8 c.c. a very neatly arranged engine that deserves attention. Note the placing of the plastic fuel tank round the crankshaft, short fuel line and method of attaching head.



Czech Super Atom 1.8 c.c. with plastic tank, and right the standard model with conventional light alloy tank, which is slightly heavier than the Super.



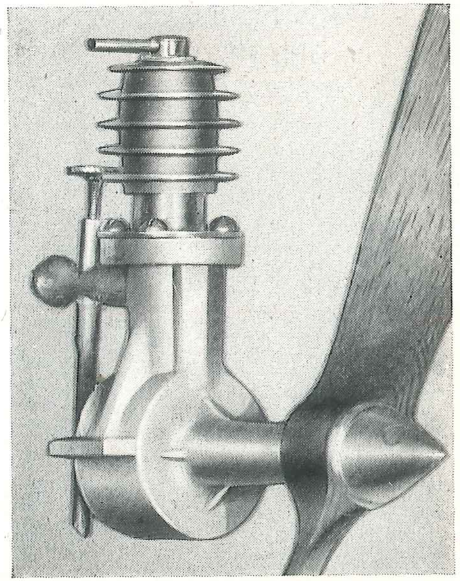


The head and liner forms one piece, with fins shrunk on, this is separated from the crankcase by a small square block which houses the transfer passages and fuel inlet sleeve. The inlet pipe and needle assembly pushes into this sleeve, and is held in place with a single screw which tightens the collar. The fuel tank is entirely separate with its own fixing lugs, and would seem to be the only weakness in design, if such may be admitted. An excellent turned spinner, with a tommy-bar hole drilled through for tightening, completes an altogether praiseworthy job. Imitation is the sincerest form of flattery, and the Dyno has been universally flattered by makers in nearly every diesel-producing country. It is heavier than many, less beautiful than most, but has so imposing a record of constant reliability that no criticism is really justified. Capacity is 2.04 c.c. ; it employs the long stroke so favoured by Italian imitators, and turns at 7,500 r.p.m.

Another Swiss maker produced a small number of Etha engines of which the Mark I was of 2.5 c.c. This followed the same general lines of the Dyno, and sold at a lower price. Little success seems to have attended production, for it is no longer available, though a number have been made privately to Etha I drawings. The Buchmann 0.6 c.c. is the only other Swiss engine that remains on the market. It is most attractive in appearance, the ingenious design giving an impression of a short stroke. It is a reliable example of its capacity group. Altogether the excellence of the Dyno seems to have deterred any wholehearted effort to cut in on its established market in Switzerland.

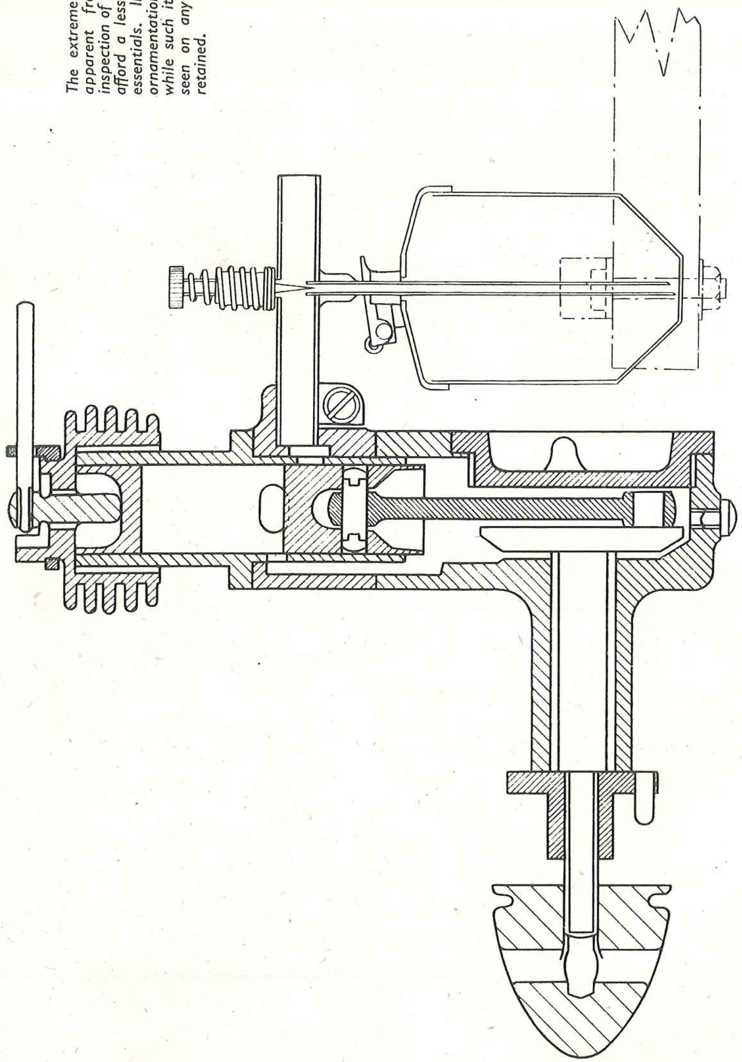
A number of excellent engines were developed in Scandinavia during the war years. Nearly all of them followed the Dyno pattern and were of 2 c.c. capacity or thereabouts. Denmark was responsible for the Mikro—not to be confused with the French Micron—which is an almost exact copy of the Swiss engine, featuring the square block between head and crankcase block in which machining of transfer ports is carried out. A transparent tank is fitted as part of the assembly. The only addition of note is the installation of lubricating cups to the crankshaft bearing, though this would seem to be an unnecessary addition, and can hardly argue confidence in self-lubricating action when running. The spinner has two flats cut in it to enable it to be suitably tightened on the airscrew. For those who like the Dyno pattern with some of the embellishments found on less matter-of-fact engines then the Mikro is your choice. Tank, by the way, is reversible so that the engine can be run inverted if desired. Maker is Kai Nielsen of Copenhagen, who gives members of the Danish Model Flying Clubs 15 per cent discount—whether this would apply to British clubmen we cannot say !

Alfa I a fairly clean engine that demonstrates the Italian fondness for long strokes. In spite of its ugly appearance however it is considered efficient.



Folgore L.N.2, another Italian engine that achieves a certain grace of outline combined with good performance.

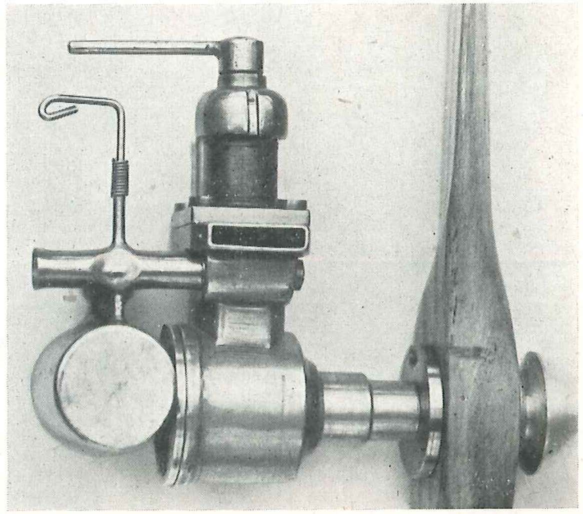
The extreme simplicity of the Dyno I is apparent from this drawing. Careful inspection of the various points in the design afford a lesson in the elimination of non-essentials. In spite of its apparent lack of ornamentation the aesthetic whole is pleasing, while such items as a drain plug—seldom seen on any of its imitators—are rightly retained.



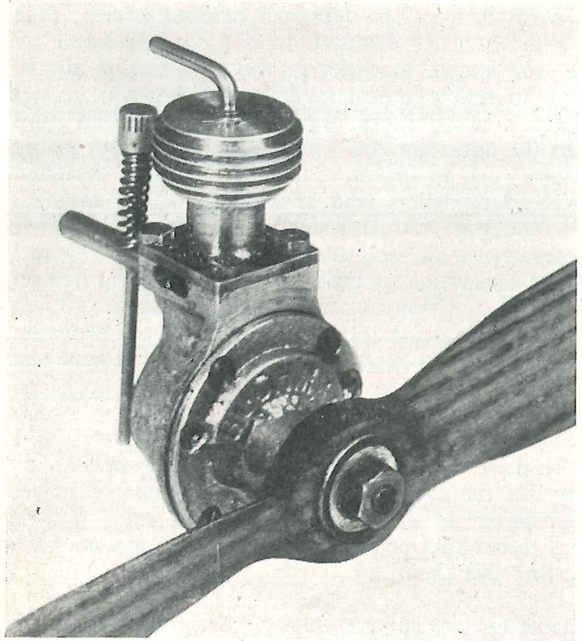
Most go-ahead Danish firm is Leo Jeppesen of Snekkersten, near Elsinore, who produce the Monsum Standard of 2.4 c.c., designed by Jorgen Dommergaard, a well-known modeller in those parts. It always seems to us a good thing to find practical modellers at work on model aircraft engines, they have a much more practical approach than pure engineers, however skilled the latter may be. This, in passing, is probably why the French diesels make such an appeal, as they are nearly all designed and produced by practical æromodellers who know most of the answers. The cooling fins on this model are few and small ; in fact, the designer declares they are not necessary at all, but that the customers like them ! He has recently backed that declaration by producing the Thorning Bensen IA, which is a development of the Monsun, and this model has no ribs at all. Presumably he has talked the customers round. Anyway, the Monsum Standard is a good-looking job with a reputation. The prototype was test run for more than one hundred hours without ill effects, on several occasions for eight hours non-stop.

Oldest of the Danish diesels is the Diesella with a capacity of 2.4 c.c., of streamlined shape very like the Monsun. The makers claimed a power output of one-sixth horse-power at 4,500 r.p.m. but this seems a little optimistic. Of late it has rather dropped out of the picture and we have had no opportunity of testing this claim.

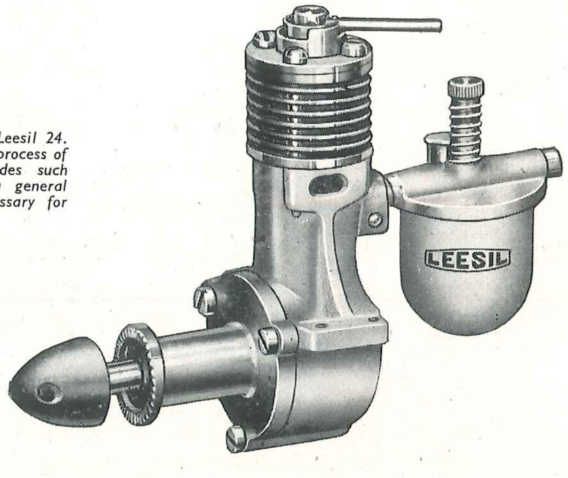
Sweden is responsible for two engines—the CP designed by Pinotti, an Italian who emigrated to Sweden, and the Rogstadius. Little is known of the CP, except that it follows the general Dyno lines, while the Rogstadius is virtually a replica down to the precise capacity of 2.04 c.c. Its weight of nearly 9 ozs., however, places it unfavourably when compared with other engines of like capacity which can get under the 7 oz. mark without sacrifice of necessary strength.



Swiss Etha I 2.5 c.c. which made an appearance on the market but was unable to compete against the established Dyno. Nevertheless those who possess examples have every reason to be satisfied with their purchase.



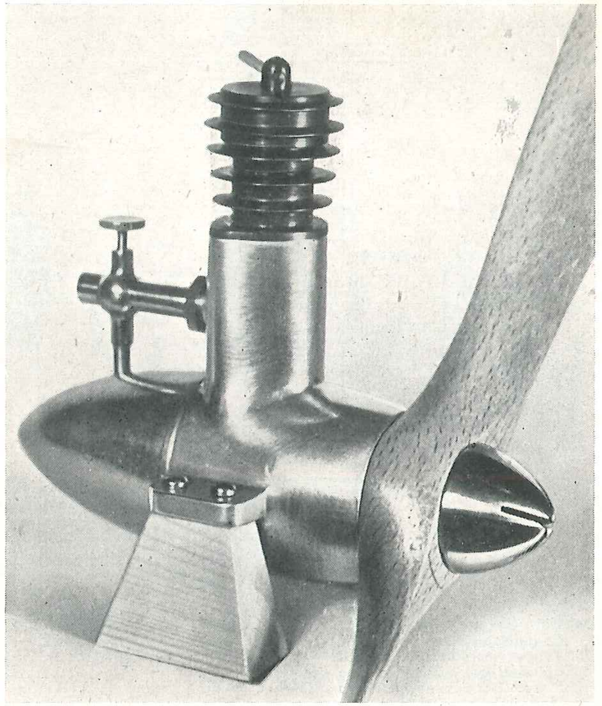
Buchmann 0.6 c.c. the only Swiss competitor to the Dyno which remains on the market. Clever design gives it a short appearance though in fact stroke is of conventional length.



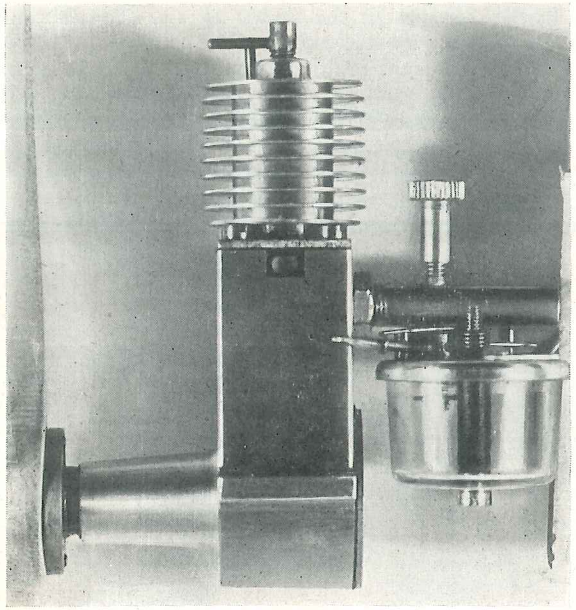
An early example of the British Leesil 24. This 2.4 c.c. engine is now in the process of revision; the new version includes such refinements as die-casting and a general cleaning-up of the exterior necessary for quantity production.

This leaves only British engines in the under $2\frac{1}{2}$ c.c. class, about which a considerable degree of mystery still exists. The Mills 1.3 c.c. is now coming on the market in small numbers, and from what we have seen of it definitely impresses. Flying a standard kit model, usually powered with a 2.5 c.c. diesel, such an engine recently flew o.o.s. on its maiden flight, afterwards being recovered over five miles away. A cut-out for connection to the flight-timer is fitted, a refinement not usually seen in engines of this size. What is more, this cut-out really works, operating at about three-quarters of its travel, when positive stoppage occurs within two seconds. It is the first British make to get over its teething troubles, and the advice to "Buy British" is more than a slogan ; in this case it is sound commonsense.

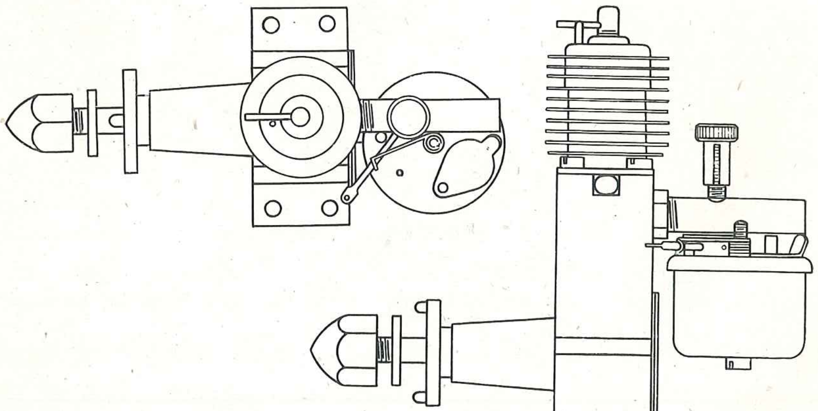
Other British firms with small diesels on the stocks include International Model Aircraft—the "Frog" people—who can be relied upon to produce nothing at all until they can be sure they have a troublefree product ; advance information suggests that this will be a real "best-seller." Type designation is Frog "100", and price will be something under £4, when in full production. Capacity is 1 c.c., and remarkable speed control is claimed, with a range of from 600-6,000 r.p.m. If this claim is substantiated the



Monsun Standard—a very attractive design from Scandinavia. Note particularly the excellent streamlining from airscrew to cylinder block. This is perhaps an argument against cowling—at any rate in this particular case!



Mills's 1.3 c.c. engine—the first of the many. Mills can justly claim the lead in British diesels as the first firm to get down to quantity production of a really trouble-free engine.



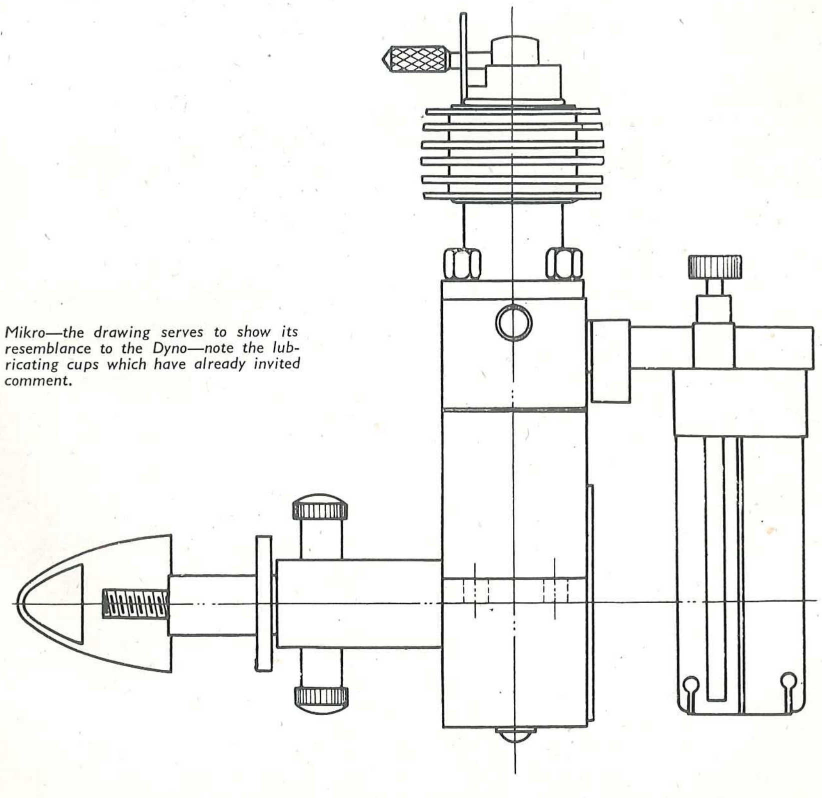
General arrangement drawing of the Mills 1.3 c.c. The operation of the cut-out, which unlike many is efficient, can clearly be seen. Its neat features and easy starting will no doubt establish this engine in a formidable position.

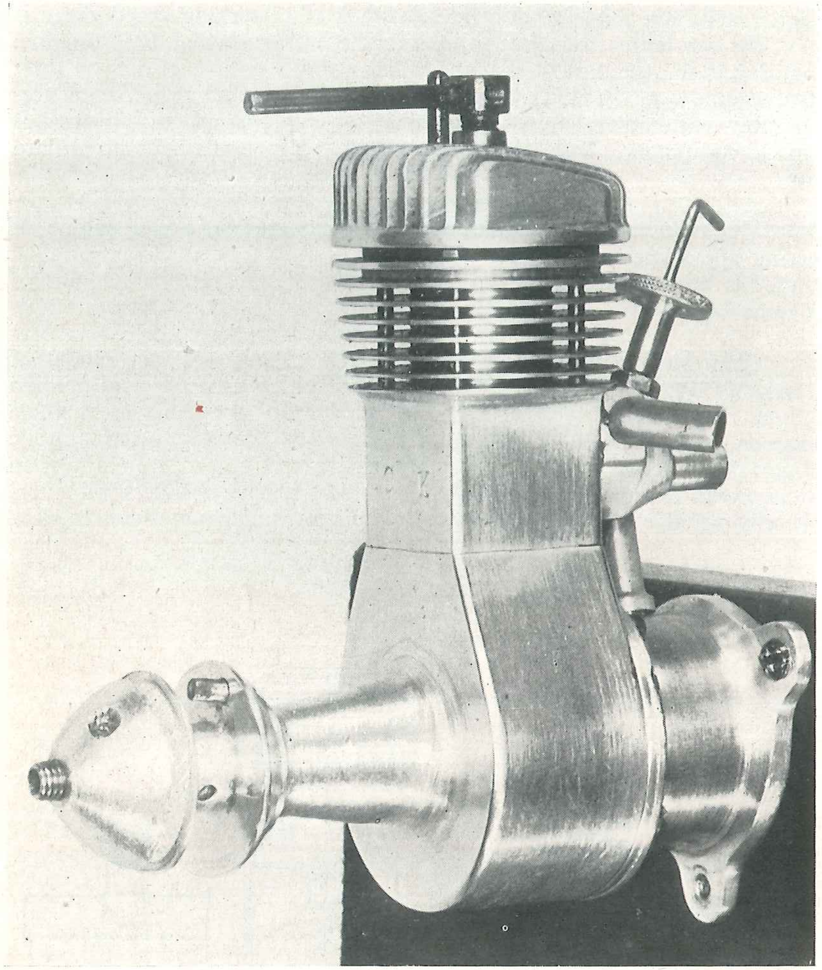
designer will have made great strides, as lack of a working speed range is one of the few faults that can be found in the average model diesel engine. Mounting is the standard four point radial fitting identical to that on their petrol engine type "175". Weight without airscrew of $3\frac{1}{2}$ oz. compares favourably with other engines of similar capacity. A plastic airscrew is standard equipment. We shall be interested to see how it stands up to hard wear.

Messrs. Leesil, who produce the Leesil 24—a 2.4 c.c. engine of pleasing appearance—have been dogged with ill-fortune. Their original design has been withdrawn and replaced with a cleaner die cast engine of the same capacity.

Clan Models of Glasgow are also advertising a 1 c.c. model of remarkably light weight. It is singularly difficult to give any real opinion of these new makes, as, apart from the difficulty of reporting on a single specimen, which may be extra good or extra bad, there is no general public opinion developed as yet. This may often be wrong but, in the main, if an article proves popular there is something to be said for it—unless, of course it is only popular because trade competition is lacking.

Mikro—the drawing serves to show its resemblance to the Dyno—note the lubricating cups which have already invited comment.





The magnificent Constant Kemmerling 5 c.c. engine, made in Germany—the only post-war example yet seen. A criticism, perhaps unfounded, is that the small diameter of the radial mounting may tend to tear away from the plane in a hard landing.

CHAPTER III

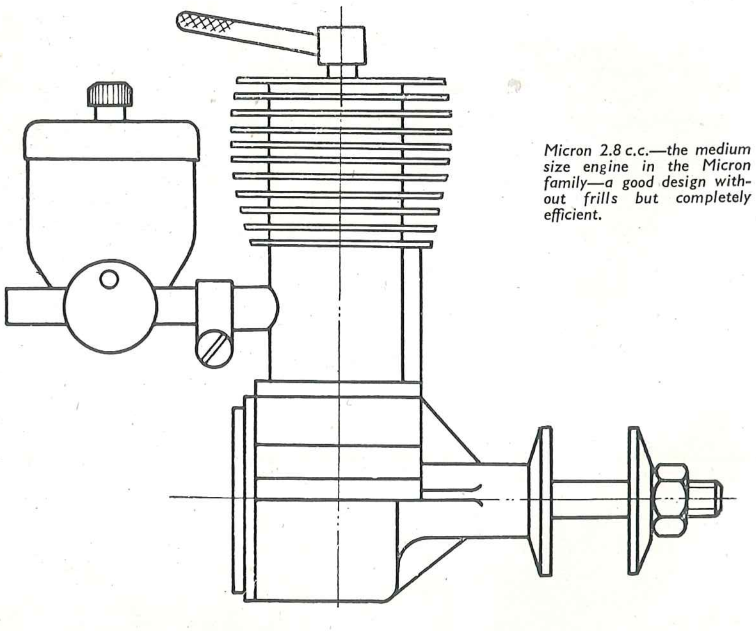
ENGINES OVER $2\frac{1}{2}$ c.c. in CAPACITY

So far in discussing the smaller compression-ignition engines, simplicity has been the keynote; only those fittings and that degree of finish necessary for efficient running have been found. Moreover, to ensure ease of starting every engine has been fitted with variable compression. In the larger sizes this will not always be part of the specification; whether this is good or bad is argued elsewhere without coming to a definite decision for or against. It will always remain a matter of personal opinion whether the more pleasing shape of a fixed-compression engine outweighs the possible advantages of the variable type. Here, too, in the larger sizes will be found assorted methods of cutting out the engine for flight limitation. Need we emphasize that very few of them are particularly efficient, and should certainly not be the deciding factor in selecting an engine.

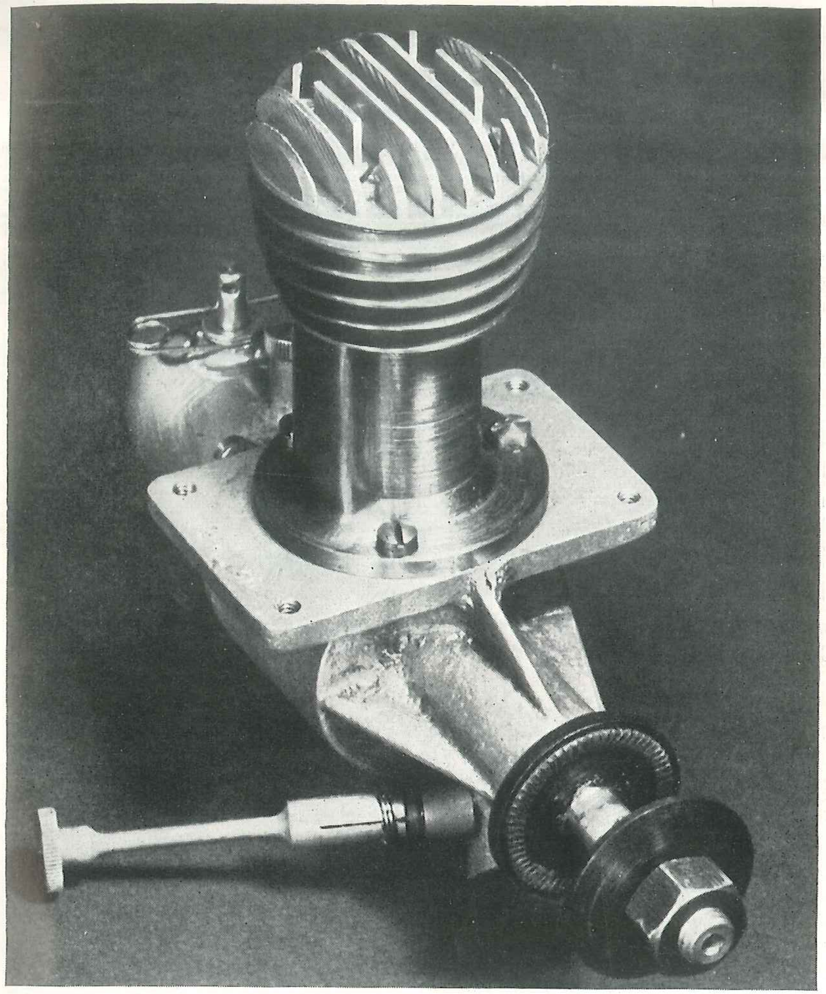
As several manufacturers market a variety of engines over 2.5 c.c. we shall take no fixed order of presentation, but discuss each make in turn rather than each size. As the most successful contest diesel, Micron comes up for discussion first. The 5 c.c. is probably the best seller in France to-day, and certainly merits very careful attention. Fixed compression is embodied, in spite of which starting is simple and easy—and leads one to approval of this variety. The cylinder head is of pleasing proportions, and generally the whole ensemble recommends itself to British eyes. Specification is sound with cylinder and crankshaft of specially treated steel, cast-iron piston and a stamped con-rod. Cylinder head is of aluminium, and crankcase of light alloy. Altogether a sound selection of metals, apart from the con-rod, where stampings make no personal appeal. Admission is via the crankshaft and power output claimed by the manufacturer is equal to a petrol engine of 7 c.c. This is a most modest estimate as a number have been fitted to airframes originally flown by 9 and 10 c.c. engines with *marked improvement* in their flying characteristics. This engine also possesses the only certain form of flight control yet seen, where a spring-loaded plunger cuts off the fuel when operated by a timer. Both flat and deflector type heads to the piston have been seen. Fuel feed is by gravity, as opposed to the majority of engines where it must be sucked up. The 2.8 c.c. follows the same lines, except that compression is variable and the con-rod of bronze. No fuel cut-out is fitted.

Probably the most interesting of all foreign diesels is the Ouragan 3.36 c.c., produced by Chatet in Paris. Again this is an aeromodeller's design and, as may be expected, offers practical advantages. Here are to be found the advantages of fixed compression combined with those of variable compression. This is achieved by an eccentric mounting to the crankshaft bearing, which is operated by an extension arm. Thus, in effect, the whole engine is pushed up or lowered down the cylinder to achieve compression variations. The head is therefore without the excrescence of a contra-piston lever and is correspondingly shorter, whilst a considerable saving in weight is achieved without loss of a valuable movement. All parts except the crankcase and cylinder head which are of light alloy, are of specially hardened steel. In operating this engine the compression lever is used as if it were the ignition control, and advanced or retarded. Coming in much the same position it will not seem out of place to ex-petroleers. The engine runs equally well upright or inverted.

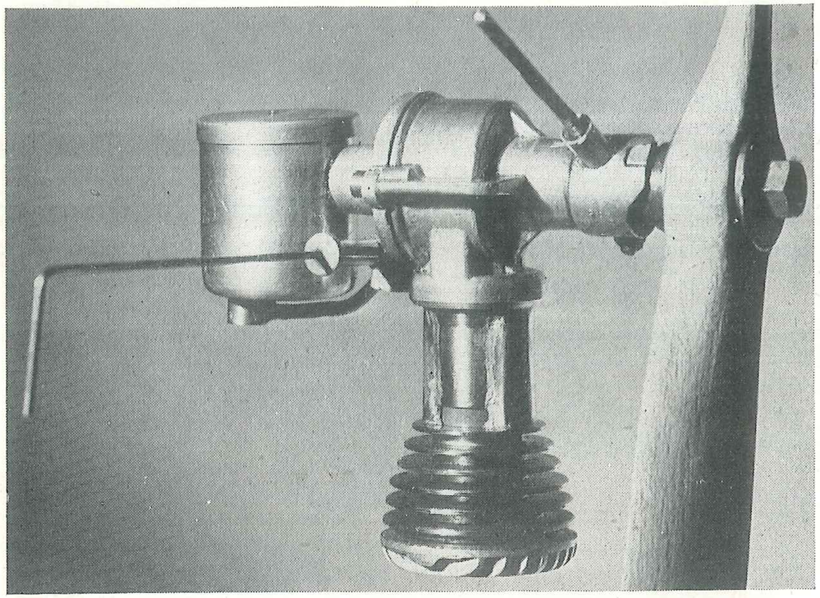
The Comete Junior 5 c.c. is interesting as the cheapest engine of its size on the French market, being approximately 20 per cent. lower in price than its nearest rival. Such being the case, a high-class outside finish is not to be expected. In fact, the original castings are not touched on the outside at all, but within they are given very careful attention. We recently had an opportunity of visiting Societe Jesco's factory, where the Comete is made, and saw some of the processes in operation. A fluid micrometer is employed to gauge limits, and various degrees of tolerance are graded as in the best American mass-production practice, thus ensuring the closest possible fits. There are special buffing machines, and a long bench where



Micron 2.8 c.c.—the medium size engine in the Micron family—a good design without frills but completely efficient.



One of France's best—the 5 c.c. Micron that has an unequalled list of contest honours since its inception. The British Owat of similar capacity ia almost identical in appearance—though yet to achieve equal fame.



The unusual Ouragan, Compression is varied by the lever on crankshaft casing, which houses an eccentrically located crankshaft—probably the most ingenious solution of the variable compression problem.

each engine is test-run before delivery. The only fault we must mention is a certain weakness in the gaskets. It was necessary to replace these on the test engine we have been running after a short run, since when it has been functioning well. Variable compression is a feature which will recommend it to many. An extension to the needle adjustment screw enables full cowling to be employed without gadgets. The fuel tank and fuel pipe is flimsy, and many owners will probably replace them with something stouter, but at its equivalent English price of under 70s. a de-luxe finish is hardly to be expected.

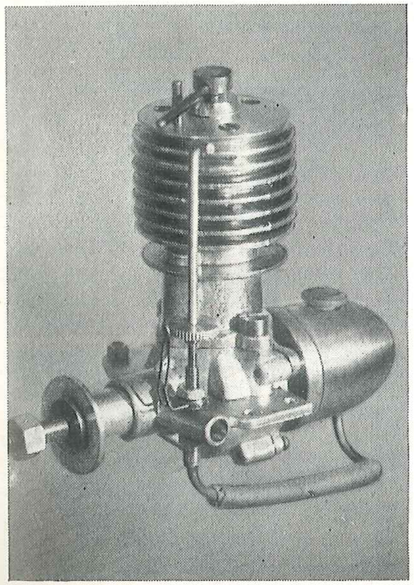
Whether, strictly speaking, the publications of A. Morin should be included as "engines" is a moot point, but they have so much to recommend them that it would be a pity to omit them. Morin offers a really remarkable range of plans for no less than four standard diesel engines which are all worthy of examination for their carefully thought-out design features. Complete engines are not available, but sets of castings may be obtained from the publisher. In addition to issuing really detailed plans he also offers a little booklet that leads the novice step by step through the various operations necessary on the lathe to complete the job. There is no editorial matter in the booklet, but a series of pictures of each part, with the necessary tool about to make a cut. Each cut is numbered and the appropriate shape of tool indicated, so that a comparative beginner could start with confidence as soon as he had mastered the actual mechanical operation of using his tools. Sizes range from 5 to 10 c.c., with both fixed and variable compression.

A medium-sized engine that attracted a degree of interest both in France and Belgium is the Delmo 2.65 c.c. Monsieur Debrel the designer was responsible for the very first French diesel—a now discontinued 1 c.c. job which was the original prototype for the present engine. Installed in a model flown by Guillemard, noted French designer author and model trader, it attained the official altitude record of that country at 1,410 metres or nearly 4,500 feet. Specification is worthy of note, including special steel crankshaft cut from the solid, tempered steel con-rod, centrifugally cast-iron piston, aluminium alloy crankcase. The engine is beautifully finished and is a joy to handle. Although the makers offer a recommended mixture, this is one engine that will literally start on practically any combination of ether and any one of the usual additions. It runs on old fuel that other engines scorn, and behaves like a perfect lady always. The cut-out fitted, however, like most of the others, is not reliable—in fact, it seems to improve the engine when operated—but perhaps we are unlucky in this respect.

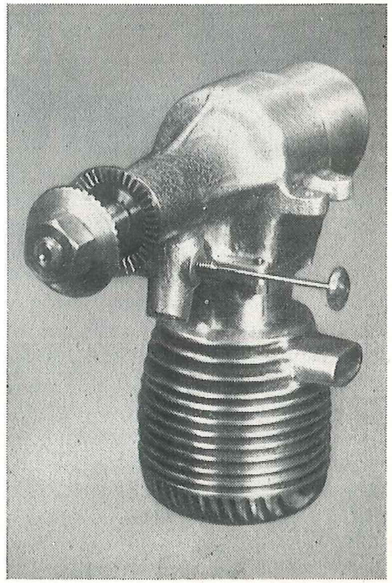
Stab have also produced a 3.52 c.c. engine with fixed compression, which otherwise follows the specification and general appearance of their 1.25 c.c. model. It is not unlike the Micron in appearance, though lacking in some of the refinements.

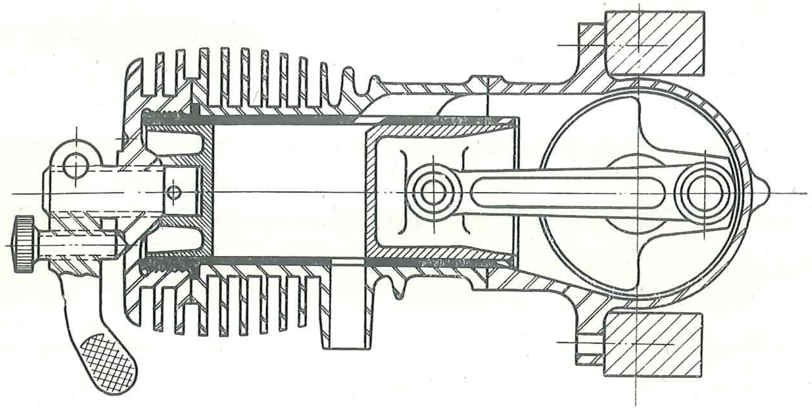
In the same way, Allouchery appear again with a 3 c.c. design that again follows the lines of their smaller models. This firm are concentrating on output of the two smaller models in which they undoubtedly have a good

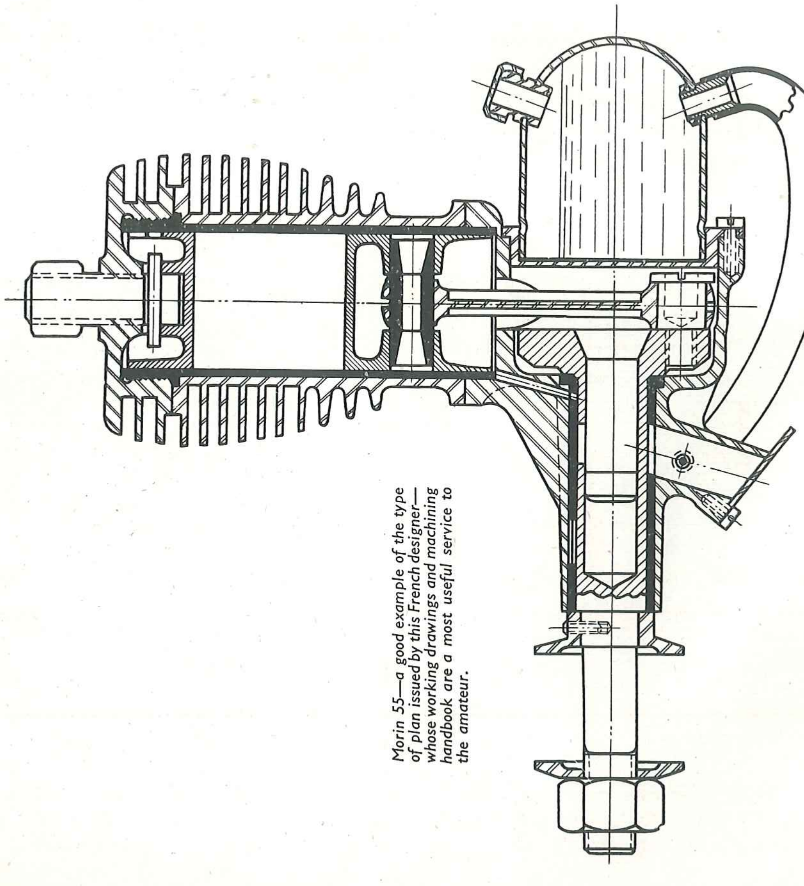
Comete Junior 5 c.c.—the cheapest model on the French market, selling at under £4.



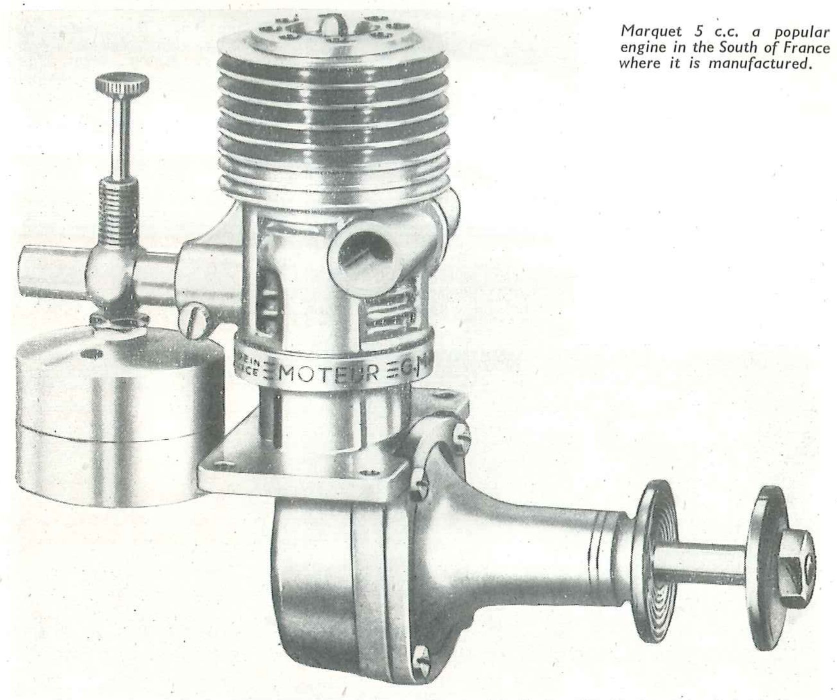
Morin 10 c.c. built from commercial plans and castings by a French amateur.







Morin 55—a good example of the type of plan issued by this French designer—whose working drawings and machining handbook are a most useful service to the amateur.

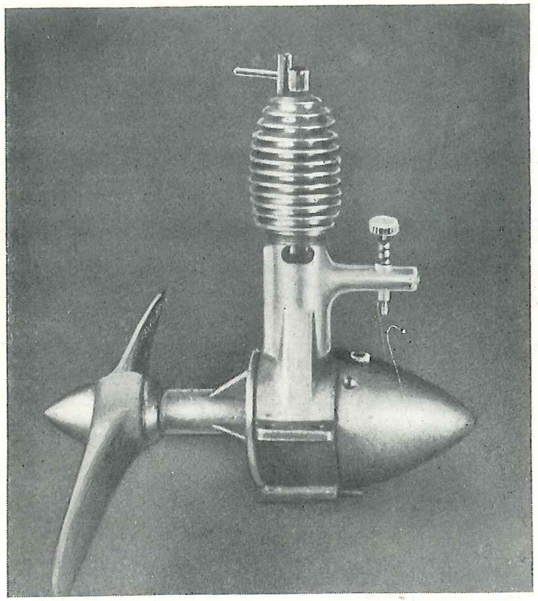


Marquet 5 c.c. a popular engine in the South of France where it is manufactured.

market, whereas competition is considerably fiercer around this size. However, for those to whom the fine Allouchery finish appeals, their 3 c.c. is definitely the model.

Jide produce another model—the Jide 12 of 3 c.c.—which again follows the design of the Jide 8 of 1.7 c.c.

From the South of France comes the Marquet 5 c.c. Mons. Marquet is also a manufacturer of ultra-lightweight motor cycles and outboard motor boat engines, so may be expected to have a sound knowledge of the two-stroke principle. The Marquet is deservedly popular in the Lyon region where it is made—and here modellers tend to ignore the Paris firms and concentrate on local industry, not only on account of spares which are easier to get, but because in their opinion they are just as good. And we have no reason to doubt their belief. Here the specification includes a light alloy sleeve containing admission transfer and exhaust ports, which fits in very like that on the Dyno. The crankshaft sleeve is detachable, being held in place with four screws, and generally the whole engine is rapidly demountable for inspection and cleaning out as necessary. Compression is variable. The throttle needle is itself threaded to within a quarter-inch of the tip which seems an undesirable feature in view of the difficulty of emergency replacement. Most needles are sweated into larger diameter sleeves, of course, and can easily be replaced in event of damage. However, this is a trifling disparagement of an otherwise most elegant and efficient little engine.

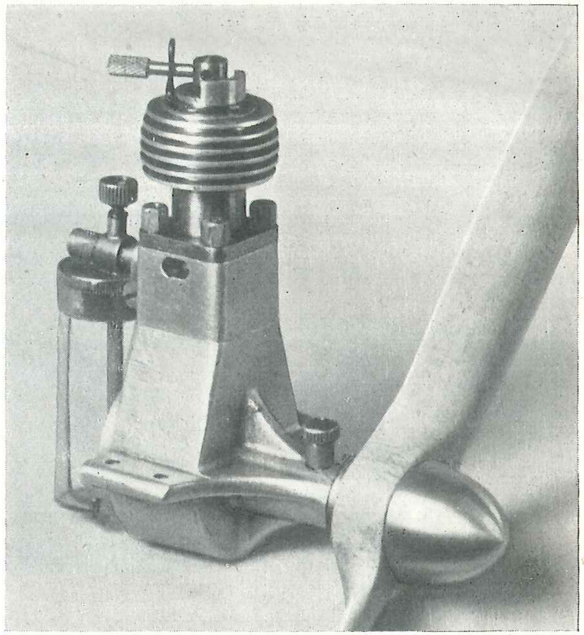


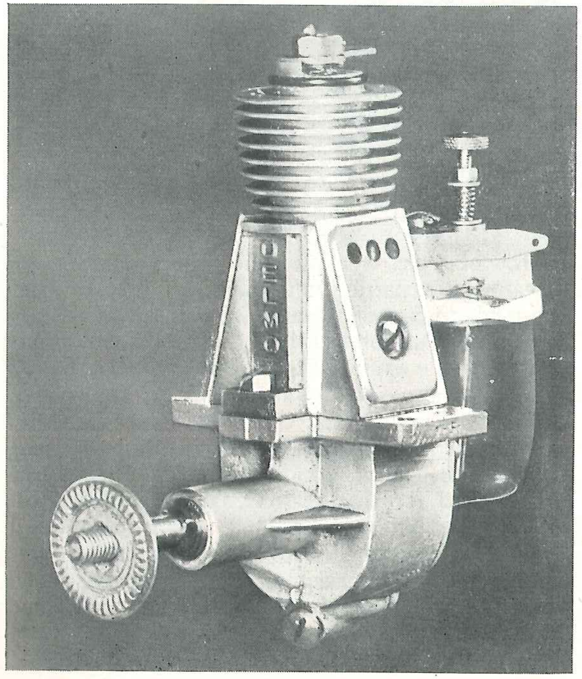
Helium B.6. The prototype from which the curious looking C.6 was developed. In this earlier form it enjoyed quite a degree of popularity.

Czechoslovakia provides one example in the Super Atom Major, which possesses all the neat features of the Atoms previously mentioned. The fuel tank is, however, conventionally placed. Only point of note is location of throttle control, which is situated immediately above the tank. This does away with any fuel lines and makes the whole engine exceptionally compact. Czech engines have already demonstrated their ability on occasion to beat the best of French designs, and, while credit must be given to the individual for his model, it does at any rate show that they are capable of holding their own in international competition. As a thoroughly neat engine, without a surplus excrescence to mar its simple lines, this Atom too is recommended along with its stable companions.

Quite a number of Italian designers have entered the over $2\frac{1}{2}$ c.c. field. To start with the most recent addition to the range, and almost the latest engine we have had through our hands, we will introduce the Super Tigre of 5.65 c.c. This massive engine is considerably heavier than the average of this capacity, but begins to have the appearance of a real engine rather than a motor for gentle use only. The capacious fuel tank forms part of the engine, and is bolted firmly to the rear of the crankcase, which is substantially constructed of dural. Mixture is adjusted by a thumbwheel type turnscrew located immediately between the airscrew and the cylinder block. Admission is therefore via the crankcase. In so substantial a model it is a pity to see fuel lines soft-soldered into place, as apart from the probability of fracture on the first heavy landing it makes dismantling a workshop rather than a field job, unless one possesses one of these handy pocket blowlamps. This model is described as particularly suitable for control line models; fitted with their special U-control propeller 10,500 r.p.m. are claimed. An ingenious cut-out is fitted that may be completely unscrewed and removed

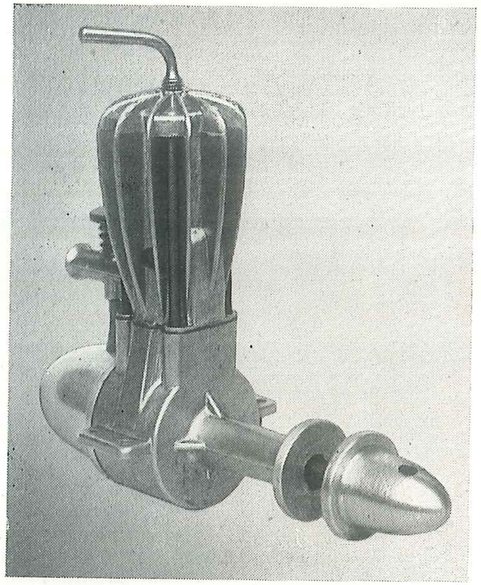
Danish Mikro—a pleasant little engine that follows the Dyno layout with the addition of a fixed transparent fuel tank. Note the curious lubricating (?) cup on the crankshaft sleev

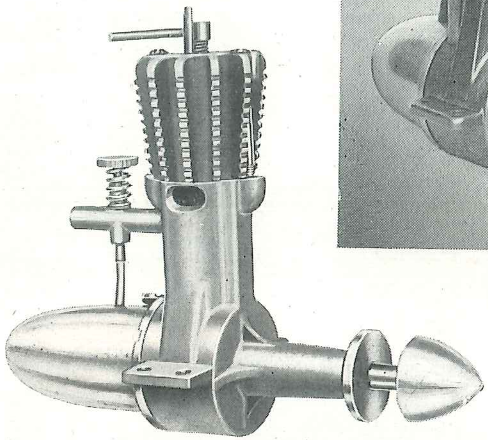




Delmo 2.65 c.c. an excellent example of a reliable French make, that is particularly recommended to newcomers for its ease of starting under practically any conditions.

Helium C.6 a neat engine with vertical finning that gets it out of the rut.

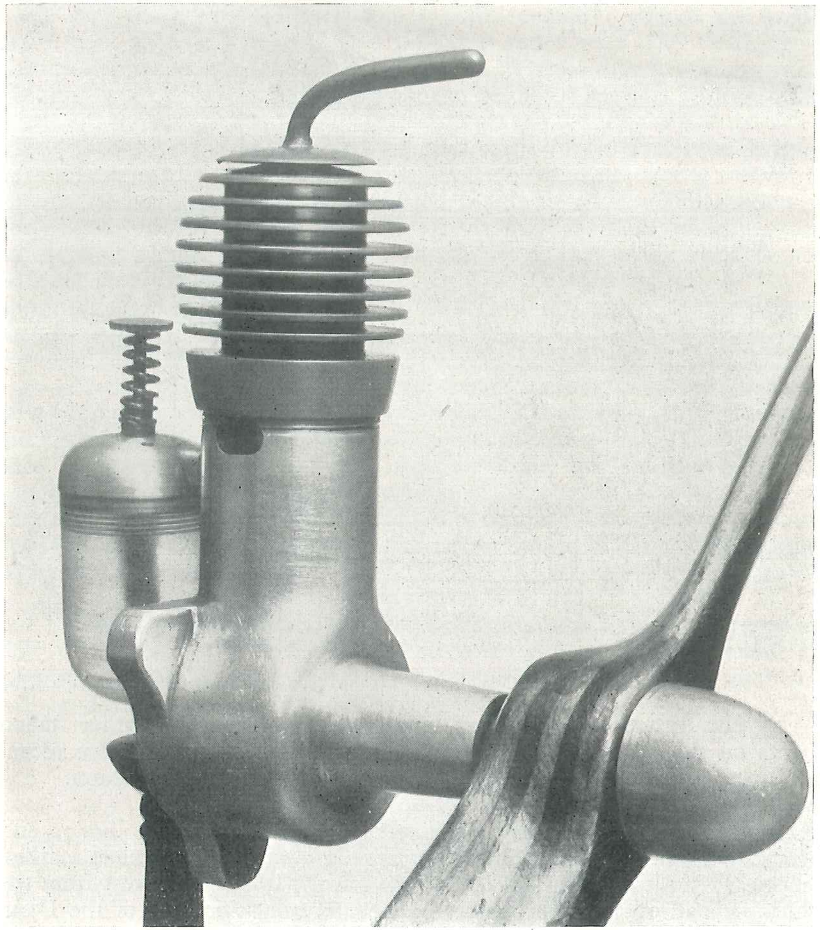




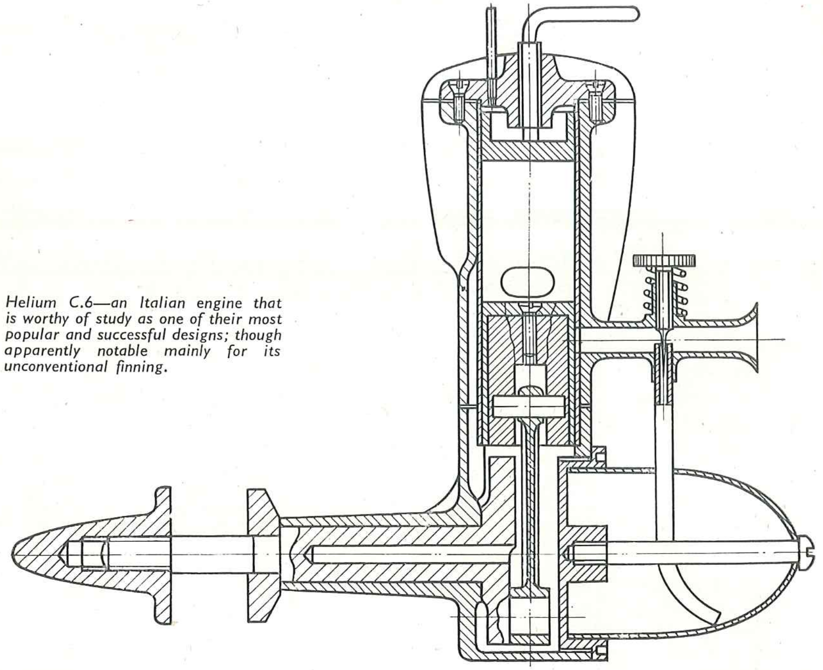
Prototype of the C.6, which appears to have started life with conventional fins and been altered to the present specification.

if desired. A drain plug to the base of the crankcase is a welcome refinement. Compression is variable, as is usual with most Italian designs, irrespective of size. The prototype G.13 of 5 c.c. and 7,000 r.p.m. is entirely conventional though offered at the same price as the G.14, which apparently supersedes it.

The Helium motor B.6 of 6 c.c. is a pleasant little Italian design without vices or, for that matter, any particular advantages. The cylinder head is beehive shape which tends to conceal the usual Italian height. Tank is of streamlined shape—the usual spun job that holds little fuel and makes no particular gain by streamlining as it is almost invariably concealed within the fuselage. In effect it is a scaled up version of any 2 or 3 c.c. Italian job. The same company have now brought out the C.6 model, another 6 c.c. It follows the lines of the earlier model, except that for some obscure reason the cooling fins run up and down instead of round and round. It gives the engine an unusual appearance, and for that reason may be commended. Probably the makers had this in mind when marketing it. From a theoretical point of view nothing is gained as cooling fins are little more than a concession to custom anyway, but from a structural angle this change may make for strength. For those who like the conventional, yet wish to have some small feature out of the ordinary, the C.6 may appeal—it certainly has little to go wrong.



The business-like Atom Major 3.5 c.c. which hails from Czechoslovakia. Apart from being a clean and efficient design a number of novel features are embodied. Illustration is about full-size.



Helium C.6—an Italian engine that is worthy of study as one of their most popular and successful designs; though apparently notable mainly for its unconventional finning.

The Antares 4 c.c. is often spoken of as amongst the earlier Italian makes on the market, but has dropped back in the light of more recent additions, which is not surprising in view of its weight of over 11 ozs.

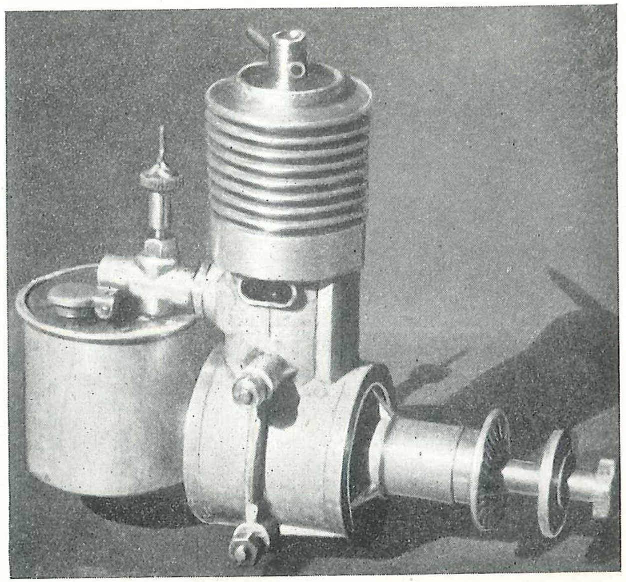
The Elia of 4.2 c.c. on the other hand is nearly one-third lighter, and is claimed to have the best power weight ratio of any on the Italian market. Lines are simple and without any of the frills that divert interest from the main question of how well it goes. There is still something of the Dyno influence to be seen, but not a flagrant copy—it appears only in details such as the tommy-bar hole in the spinner, and the severe lack of ornamentation. A disadvantage seems to be the difficulty of running the model inverted without a certain amount of "homework". Apart from this, the short fuel lines and neat assembly commend it.

A number of German firms followed the elusive quest of a perfect model diesel—some with noteworthy success, others with equally appalling lack of it. Nowadays stocks of diesels in the occupied zones have rather gone to ground so that really first hand knowledge is difficult to acquire. The principal firms concerned were apparently Eisfeld and Kratmo, both well known for their conventional petrol engines. The Kratmo was by all reports a singularly bad example of engineering, and to date no specimens have come our way. Eisfeld, on the other hand, managed a very attractive little engine, one of which sure enough fell into the hands of Lt.-Col. Bowden to whom we are indebted for the following comments :— ". . . has a needle

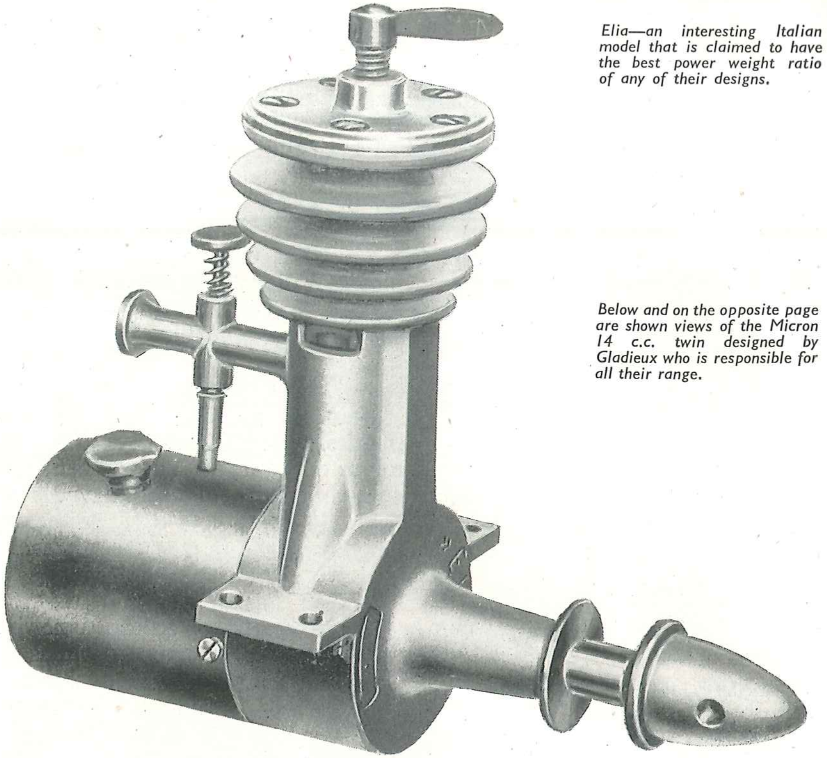
valve very much like a Brown Junior petrol engine. Around the needle valve tube there is a sleeve with a hole in it and a brass tube. This sleeve rotates, and when in a forward position with its brass tube it is kept in that position by a spring catch. This catch can be pulled back by a timer, when it releases the tube attached to the sleeve, and a spiral spring round the sleeve causes the air tube and sleeve to rotate backwards until the air-tube registers with a hole just below the fuel needle valve . . . thus destroying suction in the jet . . . Running can be regulated by an air choke similar again to that fitted on the Brown Junior, this I find is more effective than adjustments of the contra-piston. The model is very easily flooded and will not start on very rich mixture". Lt.-Col. Bowden appears to have a specimen of the DV2 engine of about 6 c.c.—a few other lucky ex-forces men have managed to secure examples and also speak highly of them.

We are lucky to have in our possession the only *post-war* specimen of a German model diesel, made by Constant Kemmerling, who is turning out a strictly limited number of 5 c.c. engines of superb finish and performance. This engine is far and away the best of any that we have seen, and would be welcomed as a form of reparations! Unfortunately a large part of each engine is handmade so that it is hard to describe it as a true commercial engine. However, for the sake of the many interested in fine workmanship, a picture is included.

British manufacturers, again in this size group, have been somewhat slow off the mark. This is understandable with so many demands on engineering skill, and only really skilful handling of production problems will produce trouble-free engines in reasonable quantities.

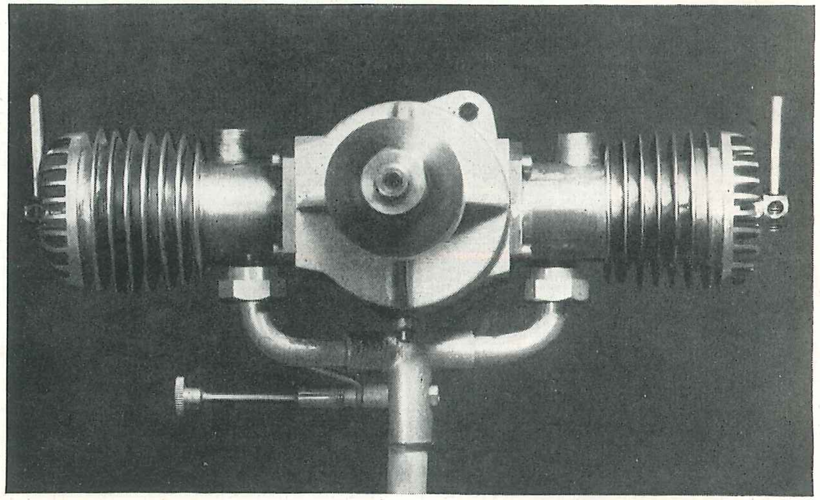


Super Tigre G.13—the prototype of the present G.14. This earlier model bears only a superficial likeness to its successor. Engine mount fixing is novel.



Elia—an interesting Italian model that is claimed to have the best power weight ratio of any of their designs.

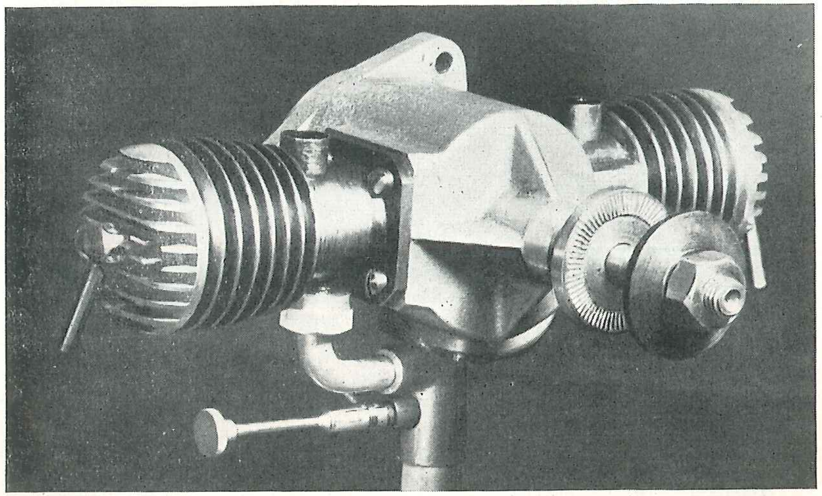
Below and on the opposite page are shown views of the Micron 14 c.c. twin designed by Gladieux who is responsible for all their range.



Modella Engines of Bradford have been offering the Owat 5 c.c. engine, though so far only experimental prototypes have been seen in action. This engine bears a surprising resemblance to the French Micron, both in layout of controls, fixing lugs and the special Micron cut-out device. However, if it flies equally well that is a matter for congratulation. Specification includes special alloy steel cylinder, piston of heat-treated cast-iron with deflector type head, crankshaft machined from solid bar nickel chrome alloy, and crankcase of light alloy. Connecting rod is of duralumin, with reamed and lapped bearings, while gudgeon-pin is of the full floating type, of hardened steel with soft brass end caps. Fuel induction is through a rotary port in the crankshaft, with gravity feed.

Atlas Motors also have plans under way for an engine of around 3 c.c., which will incorporate the best of continental design. At the moment full particulars are not available, but it should be a welcome addition to the growing range of forthcoming attractions. Another firm with a diesel programme is Messrs. Myers and Young of Brighton—they, too, have pulled across the security curtain until ready for general release.

To conclude on a note of novelty there is the 14 c.c. twin—probably the largest practical model compression-ignition engine—designed by Andre Gladieux, the engineer responsible for the Micron engines. This is still in the experimental stage, but should be the ideal power unit for large radio-controlled planes in the near future. Much of the specification is still on the secret list, but it is hoped that it will be added to the Micron range during the next few months. A point of interest is the reversion, in spite of size, to variable-compression control. This is no doubt necessary in view of the difficulty of ensuring that compression was exactly similar in each cylinder. If this is carried any further to, say, a five-cylinder engine, the operator would have to manipulate the contra-piston levers like opening a Chubb safe—unless he knew the combination it would be hopeless!



Easy starting—Emmanuel Fillon shows how simple this can be for a man who really knows his engine.

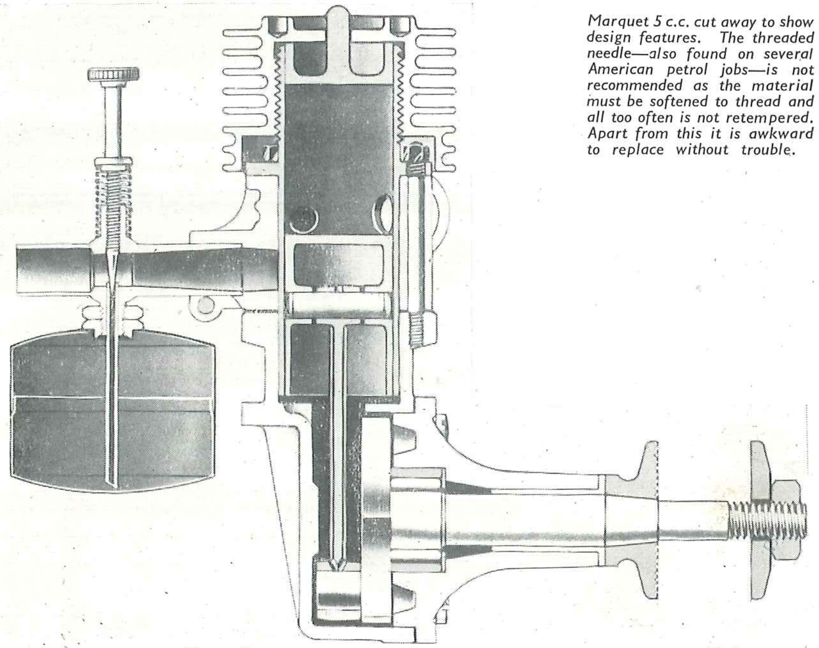
CHAPTER IV

STARTING, MAINTENANCE & TROUBLE FINDING

If flying with a diesel engine is to be the pleasure it should be and not a constant worry, the aeromodeller must bear in mind that old maxim of petrol-engine days—get to know your engine so well that you could start it in the dark without a fumble! That may be a counsel of perfection, but there is a lot of truth in it. If anything is to be done well it entails a degree of practice, and the compression-ignition engine needs to be studied just like any other piece of mechanism. Because it embodies a new principle—or perhaps we should say a new slant on an old principle—that hour or two's preliminary study is going to pay good dividends in a very short time.

The recommendation to rig up the engine on the bench before fitting into a model will hardly be necessary, as we have never yet met an aeromodeller with a new engine who did not start it up long before the model was even built. Whether they all profited by their bench testing is another story. Make certain that the engine *is* fixed in place for its first tests, and that it is possible to swing the airscrew without catching on to any item of workshop equipment. It is easy enough to get a smack on the fingers without additional hazards! Allow plenty of room at each side so that adjustments can be made without instinctively putting the hand through the propeller disc. This sounds very obvious, but many an old hand has been guilty of one or all of these omissions.

Prepare a supply of the maker's recommended fuel mixture and have it handy in a well-corked bottle. This is important, as the rate of evaporation may soon change its nature. Make up only enough at a time for probable needs of the day. It is sound policy to mix up the fuel *without* ether in the proper proportions, and then add the necessary amount at the last possible moment. Corks soon get out of shape, so have a good supply of new ones in the workshop and replace as soon as they work at all loose. A handy pour device as fitted to lighter fuel bottles prevents spilling the mixtures everywhere. Some engines have ridiculously small holes into which the mixture must be poured. If yours has a pinhole like this it will save later annoyance if it is drilled a little larger at the start—from $\frac{1}{16}$ to $\frac{3}{32}$ in. diameter is about right for a filler-hole that is not fitted with a spring cover. Those that have covers are usually anything from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. diameter and can almost be filled straight from the bottle. Fill up the tank.



Marquet 5 c.c. cut away to show design features. The threaded needle—also found on several American petrol jobs—is not recommended as the material must be softened to thread and all too often is not retempered. Apart from this it is awkward to replace without trouble.

There will probably be instructions with the engine as to how to proceed next—in which case advice may be unnecessary, but it is our experience that the maker is usually a little reticent about certain essential parts of the operation. In half a dozen instruction leaflets picked up at random, only one has any reference to the position of the contra-piston; this reference, by the way, is most explicit and recommended to other makers. Here a picture of the head is given with a blue pencil line indicating the starting position, and another giving the best running setting. These had apparently been added as the machine was bench-tested before delivery. Full marks to Messrs. Mills for this customer service! Lacking any precise information on the subject, it is best to start with the compression lever fully open—that is with the lever unscrewed—leaving the contra-piston as far up the head as possible, giving the *lowest* possible compression. It is most unlikely that this will prove to be the correct starting setting, but a methodical approach saves time in the long run.

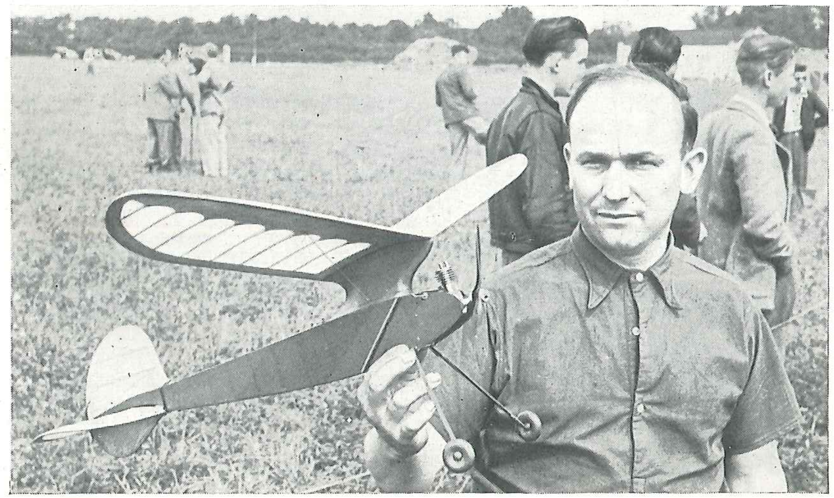
It is assumed, of course, that the operator has fitted an airscrew—preferably that intended to fly the model—or a suitable flywheel. If the engine is above 3 c.c. it is a help to have a small grooved pulley wheel attached, so that it can be flipped over with a cord. This may save sore fingers on the airscrew blade, at any rate until the knack of flicking has been acquired, as quite a powerful twist is needed. The less-energetic members of our research staff have found that grooving the spinner boss of engines as small as 0.7 c.c. is well worth while.

Most tanks are situated below the level of the needle, and it will be necessary to suck up mixture to start. Open the needle control as many turns as the maker recommends—this information is usually given—or failing any precise number, open a half to a quarter turn. Yes, that really is all that will probably be required—these little engines are most sensitive to mixture! Place a finger over the air intake and give the propeller a couple of turns. Take the finger away and give the propeller a flip; if the mixture is coming through you should hear it being sucked up—the motor is slightly flooded and you will not get it to fire yet. Continue to swing the propeller, and after a few turns it should begin to fire and then to run. That is starting in theory.

If after a couple of dozen turns the engine fails to fire then there are three possible things to put right. First, the engine has not been sufficiently choked. Try putting a finger on the air intake again. This time to be quite sure, keep it there until it is wet with the mixture. Next possibility is that the needle is not open sufficiently. Open it up another quarter turn, and try again. Finally, it may be that the compression is too low. Move the contra-piston lever over a fraction. If there is still not a pop, then open the needle yet another quarter turn. Even then, it may not fire, which points to compression, so swing the lever right over to maximum compression, that is over to the other stop.

If this leaves the engine still unresponsive there is happily only one reason left for its behaviour—something is obstructing the passage of the mixture. Such an event will seldom happen, and then only if the mixture is not filtered, but it is a wise precaution always to filter it—it only takes a minute or two, and removes not only the chance of a tricky start, but all fear of damage to piston or liners through scoring. Take down the needle

Gustave Maraget with his highly successful 0.9 c.c. Meteore-Maraget engined contest model.



Swiss unorthodoxy—this unusual model shows a pleasing breakaway from conventional ideas, but as usual the motive problem is solved by the ubiquitous Dyno.

valve and clean it out thoroughly with petrol—this will certainly solve the problem. Then start again at step one, and continue until the engine starts. Do not drown the engine in fuel ; once the mixture is through close down the throttle. Should it become flooded, then shut the needle right down and swing the propeller until the liquid has been cleared out of the crankcase, just as you would a flooded petrol engine.

There are several points to watch when trying out the engine. Probably you will experience horrible knocking and pinking when you do get it going. This must be adjusted to its minimum with the compression lever, then close the throttle until it starts knocking again; follow this with a further change in compression lever setting until the engine is running at its fastest without knocking, and with the throttle screwed down as far as possible, again without recurrence of the knocking. It will be found that there is a point beyond which these adjustments cease to improve running—just a fraction before this point is the optimum running position. Having found it make a careful note of the settings; it will be found that, with the same mixture these settings will always give the best running. Sometimes, for no apparent reason, the engine will knock no matter how the controls are twiddled. In this event stop the motor by cutting the fuel or choking it, and start up again.

Another rather surprising phenomenon may be to see the airscrew first revolve one way then the other. This is caused by pre-ignition of the mixture before the piston reaches top dead centre, followed by the main explosion before the end of the stroke. Actually it is not making complete

revolutions, but only turning part of the way alternatively left and right. De-compress at once, and re-start with a more vigorous spin.

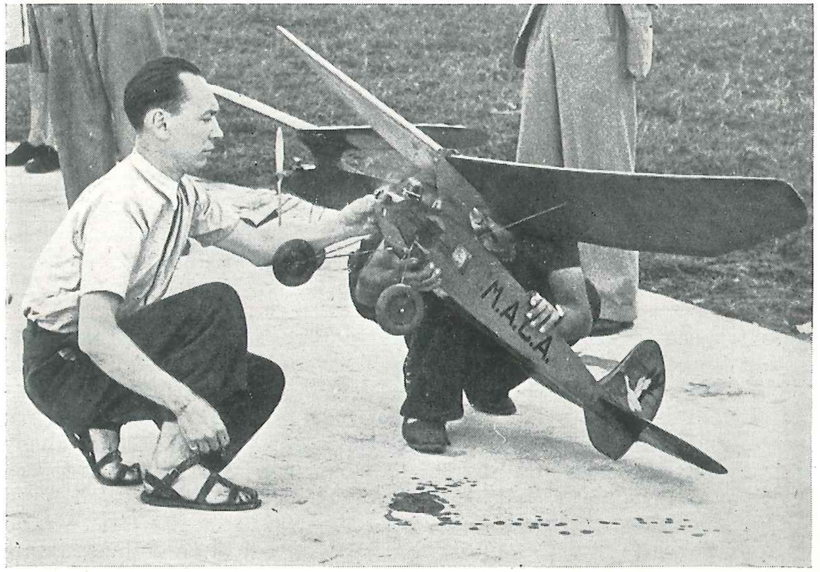
Some engines have their fuel tanks placed above the needle valve, and these do not require choking before the start as the fuel enters the pipe by gravity feed.

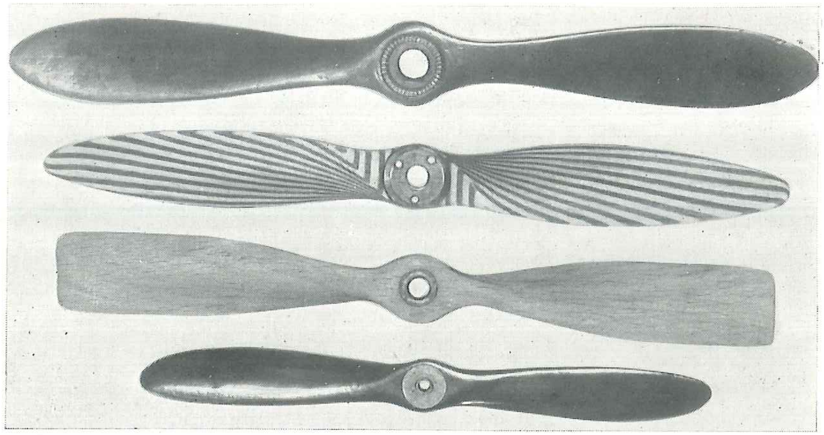
When starting an engine that has been previously run some difficulty may be experienced at first by the presence of oil in the inlet pipe. This is the residue left from its last use, the ether has evaporated leaving the less volatile part of the mixture behind. If this is suspected it can often be cleared without washing out the needle valve assembly, by opening the throttle wide and letting a good flood of liquid come through.

A point to bear in mind when experimenting with a new engine is to make every movement deliberately and slowly, and proceed to each new setting methodically without haphazard changes for which there is little or no justification. If anything untoward appears to have taken place, sit down for a moment and carefully reason out just what and why. In that way everything, good and bad, can be made part of the preliminary testing experience.

When running in a new engine it is as well to inject a drop of oil into each exhaust port before starting to make sure that there is an adequate oil seal. This precaution may save scoring of cylinders. In the same way, to preserve your engine after running, make sure no mixture is left in the

Testing fuel level—the model is inclined at its angle of maximum climb to be sure that adequate fuel still reaches the engine in this position.





Typical airscrews. Top to bottom Delmo 2.65 c.c., Dyno I 2.04 c.c., Czech contest propeller for Atom 1.8 c.c. and finally the delightful little job for the Allouchery long crankshaft 0.7 c.c.

crankcase by closing the needle and giving the propeller a dozen or two swings. Then turn the motor upside down and see if any more mixture can be shaken out, and repeat for another dozen swings. This is a wise precaution, because no matter how pure the ether you have bought, it may be less than the best, and contain acid impurities. Finally, leave the pistons at top dead centre so that any unsuspected residue remains above the stroke path in the compression chamber, and any acid scoring will then have no effect on subsequent running. These are all little points, but may make the difference between a long and merry life for your engine or a short and unhappy one, not to mention an equally unhappy owner, with hardly a good word to say for diesels. Nearly always the grumblers have only their own ignorance to blame.

So far we have considered only the initial running of an engine that is fundamentally in order. There will be cases where the tester is running an engine of which this cannot be truly said. Once again a routine approach must be mapped out and adhered to until it comes as second nature. There is not a great deal of difference in the approach, except that we must be more wary. It must be clear that, in the absence of any ignition, all faults must lie somewhere in the engine.

They can be due to (1) Poor Compression. It is assumed that manipulation of the contra-piston lever is ineffective. This fault will normally be found only in amateur-built engines, as commercial models are bench-tested before delivery. The cure, of course, is to make a new piston, this time to finer limits. With all due apologies to amateur builders, many expert technicians do not realise until they have tried for themselves to just what fine limits these little engines must be made. Once they have learned by experience they are able to turn out what is wanted in no time. Often the trouble will be found in an old engine—like that of an enthusiast who

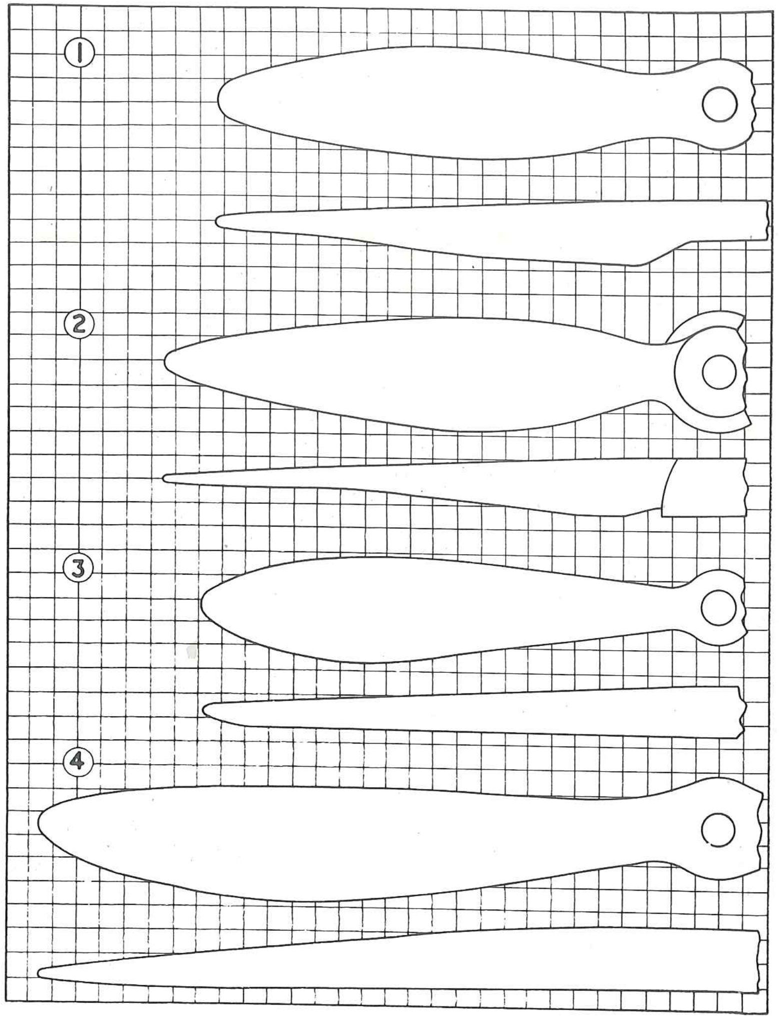
confessed he had obtained it from a foreign visitor in exchange for an old suit : we only hope the suit was in better condition! Be warned—do not buy an engine secondhand unless you are pretty sure of its pedigree, and see it running! As mentioned elsewhere, the fixed-compression motor is at a disadvantage when the bloom of youth has worn off, for wear can only be taken up by making a new piston; within reasonable limits the compression lever can be used to take up wear with the adjustable type. It is hardly necessary to remind readers making new pistons that the cylinder is NOT the proper place in which to lap it in !

The next cause of non-functioning is (2) Incorrect Mixture. If the maker's instructions have been followed this will probably be due to evaporation of the ether. Freshly made mixture and a tightly corked bottle will overcome this. Where the correct mixture is unknown it is rather more of a problem. If there is variable compression then the engine will certainly fire on standard mixture, that is 45 per cent ether, 45 per cent petrol, 10 per cent lubricating oil; or for those who prefer a two-part mixture 60 per cent ether, 40 per cent liquid paraffin (the medicinal sort). Either of these mixtures is a general-purpose fuel suitable for almost every known make of engine. Should a fixed-compression model be on test then the composition of the fuel may be critical. Start with standard mixture, and continue testing with increased parts of ether in 5 per cent additions until the proportions are 80 per cent ether, 10 per cent petrol and 10 per cent lubricating oil. If it has not shown a kick by then it is probably something else wrong, but as a last resort try changing the petrol for paraffin or castor oil.

Continuing our fault routine comes (3) Incorrect Needle Seating. This has doubtless been checked when first giving the engine the once-over —now it must be looked at more carefully, fully unscrewed and examined, if possible, under a magnifying glass to see if the point is truly ground, and of even taper. It may have been broken off, or bent, and if so it is usually possible to get it back into some sort of trim by carefully grinding it by hand on a fine carborundum block or honing stone. Failing anything else an ordinary sewing needle of appropriate size can often be pressed into service and saves a lot of finicking work—medium-sized darning needle will be about right.

But the principal cause of trouble is (4) Oil. Attention has already been drawn to this and a cure suggested by vigorous flooding of the engine, or even washing out the inlet pipe with petrol. In the case of old engines that have been allowed to stand for some time the trouble is probably chronic, and nothing less than an all-night soaking of the complete engine in petrol will effect a cure. We have even had to resort to soaking a hard case in penetrating oil—a cure not to be recommended unless care is taken to wash it out afterwards in petrol.

That exhausts the main causes of non-starting, but there are other little points that may arise. "Tight spots" seem to be a fairly common fault where engines have been neglected, owing to localised oxydation causing rust patches to form. This is the result of unconsumed mixture being left in the cylinder after use; minute impurities get to work and the



Useful propeller blanks shown half-size—Squares render re-drawing quite easy. No. 1 shows typical coarse pitch as used on the Dyno I. No. 2 is a shape from Norway, suitable for 1.5—2 c.c. engines, of medium pitch. No. 3 is Italian as recommended for the Folgore—a fairly fine pitch example. No. 4 is a fine pitch propeller which will serve the 5 c.c. Micron and similar engines.

damage is done. It is usually possible to clean up these patches with a little very fine jeweller's rouge, but care should be taken not to use any rough abrasive, as it will make the trouble infinitely worse. In emergency a piece of very old worn emery, on which no roughness can be felt with the fingers may be employed, or a little graphite made by scraping off lead-pencil and rubbing the effected part. This is comparatively simple when it is on the piston; if on the cylinder walls it is really necessary to rig up a parallel bore—as described in the chapter on building a deisel—and polishing up anew. An unsuitable propeller may be a cause of non-running. If this is suspected, fit a really fine pitch airscrew that has already shown its fitness on another engine, or, if this is your first, buy a good commercial fine pitch petrol-engine propeller—very few firms yet are offering specially designed diesel propellers—and try again.

Just why "special" diesel propellers should be offered to the public is another matter. There is no doubt that, sooner or later, enterprising firms will do so, and probably market very efficient ones at that. There is no need to await that happy day, it is a fairly simple matter to decide what sort of propeller will give the best results. First of all we must kill the bogey of a special diesel propeller. After all, the only thing that makes the diesel any different from a conventional petrol engine is that it is more reliable and does not require electrics; in other respects it is a normal two-stroke high compression engine which will give of its best at certain engine speed to be determined. This speed will be given by the maker of a commercial engine, or calculated by the aeromodeller building his own. Once this figure is known the rest is easy. Calculate the weight of the proposed model, all up, and the speed required for level flight, increase this as necessary to give the desired degree of climb according to the nature of the beast—contest, semi-scale, or whatever you may have in mind. These calculations, by the way, can nearly all be done without trouble by stretching a ruler across appropriate pages of *Nomographs*; and all the design calculations are to be found in Russell's *Design and Construction of Flying Model Aircraft*. Both these works should be on the bookshelf of every aeromodeller who pretends to serious building.

Now that speed required and r.p.m. are known, it is possible to work out the pitch required. It is well known that a pitch of, say, six inches means that the propeller blade travels forward this distance in a complete revolution. Equally well known is the comparative inefficiency of propellers, which may be put at no higher than 67 per cent, which means that, if six inches actual forward travel gives the speed required, then the propeller must be carved to 9-inch pitch to allow for this slip. In other words, it loses a third of its efficiency and is back where it is wanted at 6-inch pitch. Diameter can also be worked out from formulæ, but is often taken empirically at about 15 in. for a motor producing $\frac{1}{5}$ horsepower, and *pro rata*. The old maxim of about $\frac{1}{10}$ diameter as maximum blade width can be followed, though it may be slightly increased to say $\frac{1}{8}$ without ill effects, except with very high-revving miniatures.

As can be seen there is nothing new in this to petrol model enthusiasts, who should be quite at home. One thing must be remembered, that is the

Waterplanes are no trouble with a diesel. Sven Goetze well known Swiss enthusiast drains his water-logged wings before starting up again.

r.p.m. of diesel engines. Generally these will be found to be higher than for petrol engines delivering the same power. For this reason propeller pitch tends to be finer than for equivalent petrol engines—especially when it is remembered that a good 2 c.c. diesel will equal a good 3.5 c.c. petrol engine, and *pro rata* up to about 7.5 c.c., after which the advantage of the diesel is not so manifest. Where manufacturers recommend a propeller diameter and pitch, this is for optimum output of their engine, and may not at all suit the particular model in which it is installed, so that the following random examples, must be accepted as generalities rather than figures to be followed slavishly. The Czech Atom 1.8 c.c. uses a $10\frac{1}{2}$ in. propeller of 5 in. pitch at 6,000 r.p.m.; the 3.36 c.c. Ouragan uses one of the same diameter, but $7\frac{1}{2}$ in. pitch at 6,600 r.p.m.; while the 5 c.c. Comete Junior employs a 12 in. propeller of 8 in. pitch at 5,000 r.p.m. Continuing in generalities, and in order to give rule of thumb as well as theoretical assistance, the pitch can be equal to half the diameter for engines up to 3 c.c. and two-thirds the diameter over that figure. This will not always be right, but it will be right enough to produce results in the majority of cases.

Those who like developing contest models, and seek the almost vertical climb that the other fellow gets, may like to try a tip passed on to us

by our recent foreign visitors. Get your model going as well as you know how, using a normal propeller, then cut half-an inch to an inch off each blade of the propeller, leaving the ends square. Sand down and rebalance, and then try the model—the increase in r.p.m. will give that little extra zip that wins competitions. But do not run your engines too much like this, as it is overloading to an extent and will tear the heart out of the motor if indulged immoderately.

This should not be confused with the recently introduced technique of designing propellers with square ends. This of course is the more expert way of going about it and superior to trimming off the tips. There seem grounds for the belief that square ended props do give better performance and this is being tried out by many of the experts. When designing the blank draw out a shape exactly like an oar blade and you have it. After all that shape has served well in water for long enough—why not for air?

The final word is to propeller twiddlers. When next your model dives into earth and lands in a nice gritty patch, try not to give the propellers those few turns that ninety-nine out of hundred modellers do—if there is grit in the engine it is being ground into beautiful scores as you twiddle. Anyway, watch the other fellows at your next meeting and see how they all twiddle!

Record attempt by Maurice Ferber—not on this occasion crowned with success, when he struggled patiently with a stubborn motor for nearly half-an-hour before getting it to start.