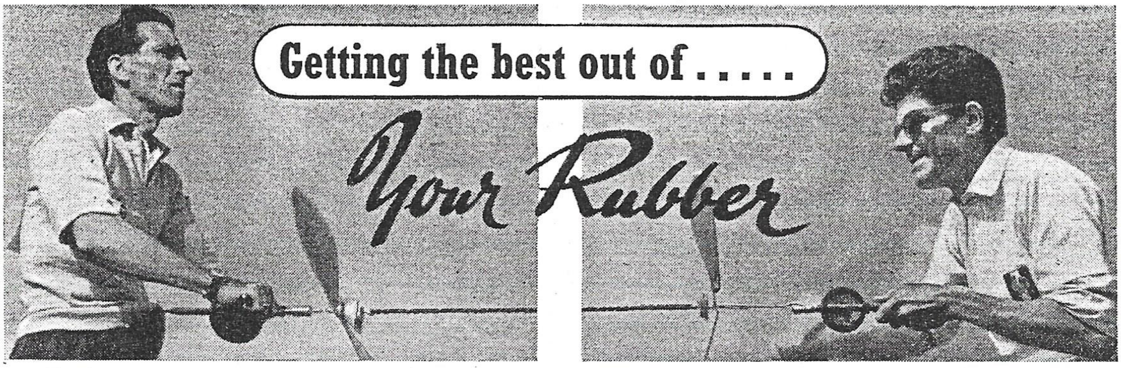
Getting the best out of..... Your Rubber



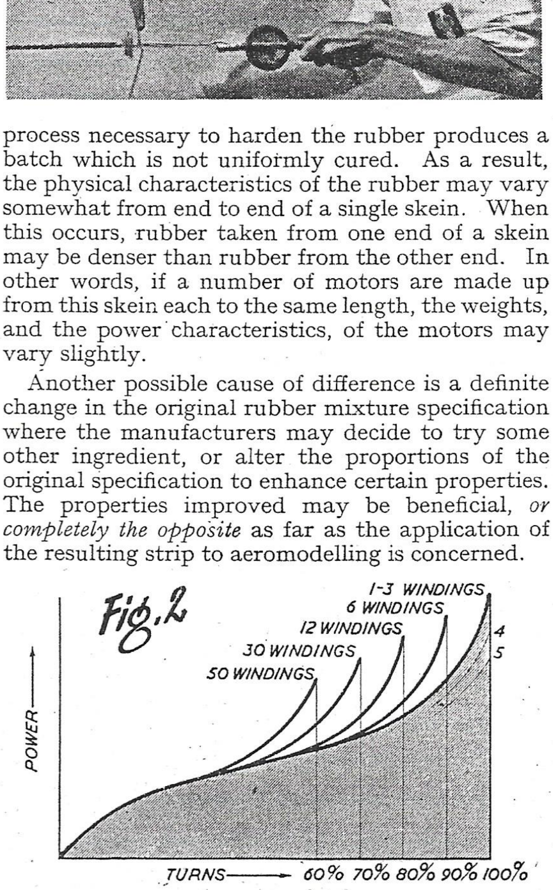
THE rubber-driven model is still the best introduction to " power " flying, relatively cheap, simple to construct and amazingly consistent, once properly trimmed and given the right care and attention. Once trimmed, a well constructed good design should *stay* trimmed. The one factor which may remain variable, however, is the rubber motor.

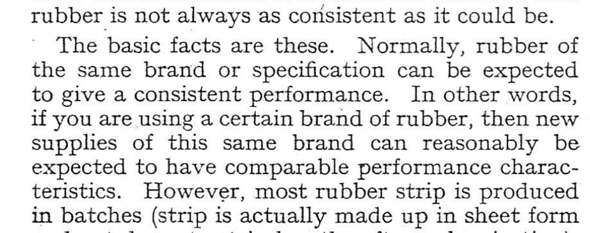
A lot of nonsense has been written about rubber motors, tending to over-emphasise the failures which may occur if elaborate care and attention is not given to the motor. At the same time there is more than a modicum of truth in the assertion that rubber is not always as consistent as it could be.

The basic facts are these. Normally, rubber of the same brand or specification can be expected to give a consistent performance. In other words, if you are using a certain brand of rubber, then new supplies of this same brand can reasonably be expected to have comparable performance characteristics. However, most rubber strip is produced in batches (strip is actually made up in sheet form and cut down to strip lengths after vulcanisation). If the specification or make-up of the original rubber mixture is not carefully controlled from batch to batch, some difference may be experienced from skeins of different age. These small variations in the composition may be within limits accepted by the manufacturers as normal to their production methods. Absolutely *fresh* rubber, too (i.e., straight from the manufacturer) is seldom as consistent as aged rubber. After manufacture, rubber characteristics generally tend to improve with storing—up to a period of six to twelve months.

Sometimes, variations in the heat-treatment process necessary to harden the rubber produces a batch which is not uniformly cured. As a result, the physical characteristics of the rubber may vary somewhat from end to end of a single skein. When this occurs, rubber taken from one end of a skein may be denser than rubber from the other end. In other words, if a number of motors are made up from this skein each to the same length, the weights, and the power characteristics, of the motors may vary slightly.

Another possible cause of difference is a definite change in the original rubber mixture specification where the manufacturers may decide to try some other ingredient, or alter the proportions of the original specification to enhance certain properties. The properties improved may be beneficial, *or completely the opposite* as far as the application of the resulting strip to aeromodelling is concerned.





These possible variations concern the contest modeller principally, since he is always seeking rubber strip which gives the greatest possible power output for a given weight as a primary characteristic ; and rubber which has a good physical strength as a secondary characteristic. We put performance before durability of the rubber for contest work, since it is not uncommon for modellers to adopt a principle of " one motor—one flight " in important contests.

The main advantage of changing a motor each flight would appear to be a psychological one—a fresh motor *should* give peak performance whereas a used motor *may* have fatigued and will consequently give less power. Usually, however, the rubber motor is far more blameless than even expert modellers give it credit for. A bad flight with a poor climb from an otherwise high-performance model may well be due to adverse weather conditions prevailing at the time, rather than the rubber motor "tiring", or a broken strand. As a point of interest here, static torque tests *have failed to detect any difference in power output* from a wound motor with up to four of its 16 strands broken, provided the loose ends are "caught up" and thus bound in with the bulk of the wound motor.

Running-in

Ultimate performance of the rubber motor will, almost entirely, depend on the way in which it is run-in. Like an internal combustion engine, a rubber motor cannot be expected to develop full power from its initial winding up. Unlike an engine, however, a "fresh" motor develops *more* power until run-in. It cannot be wound up to anything like its potential maximum turns without breaking.

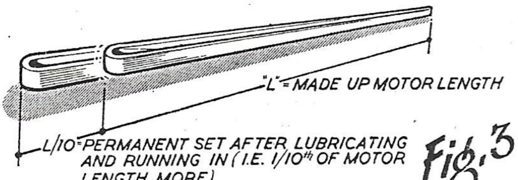


Fig. 3

If the motor is simply made up to length and installed in the model it cannot initially be wound up to, say, about half *potential* maximum turns without fear of breaking. Its corresponding power output will be high, but its duration of run short. For the second winding, the turns that can be put on are some 20 per cent. higher, and so on, stage by stage, until the potential maximum is reached.

In other words, if we had some sort of device which would indicate when the motor was about to break, turns and power output corresponding to successive initial windings, would take a pattern similar to those shown in Fig. 1. Continue with more windings and the maximum turns possible would now *no longer increase.* During this series of windings, too, the power output curve would be identical for each winding. After a certain number of windings, again, maximum turns would still stop at the same level, but the power output curves would gradually get lower and lower. The rubber motor has now become fatigued and its useful life is over.

A proper run-in period is essential with all new rubber made up into motors, first to develop its capabilities to take a maximum number of turns and second to bring it to the state where it will give a constant power output. The "constant power" stage corresponds to the normal useful life of that motor.

It is also interesting to note how the number of "useful life" windings varies with the number of turns applied to the motor. Properly run-in and

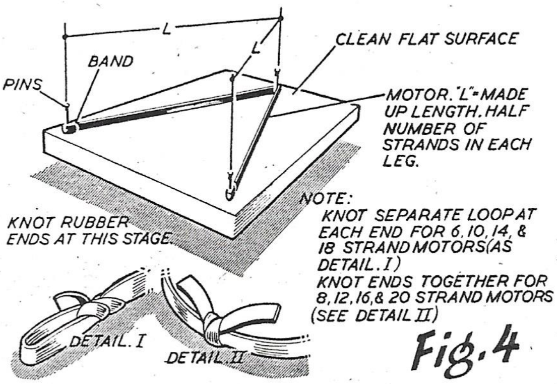


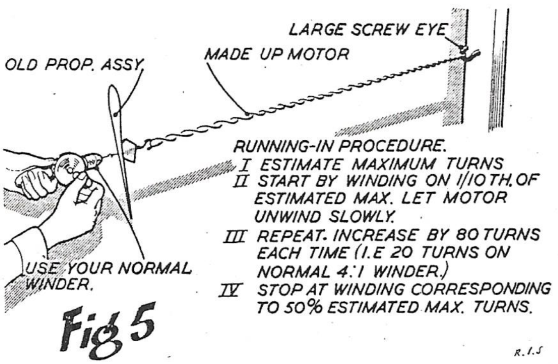
Fig. 4

then wound to maximum turns each time, motors may show signs of fatigue after only three windings—Fig. 2. Wound to 90 per cent. turns each time, "useful life" winding may be double that number, or more. Wound to only 80 per cent. maximum turns each time, "useful life" is doubled again. These are only rough figures, but indicate that "full turns" windings do drastically reduce the useful life of a rubber motor.

What the graph does not show is the mechanical failure of the motor on repeated high-turn windings. Individual strands are more prone to break, calling for constant repairs. Normally this does not affect the "useful life" figure, but it is annoying to find strands breaking during winding up, generally calling for a change of motor to be on the safe side. When one strand "pops", quite likely others are beginning to part and the whole motor may break suddenly if winding is proceeded with.

Dealing now with the practical side of making up and running a new motor, there are two main factors to be considered—the number of stages in which the motor should be run-in and the increase in length or permanent stretch the rubber will have after running in. Fresh rubber, properly run-in, has a permanent deformation equivalent to about 10 per cent. of its original fresh length—Fig. 3. In other words, if you made up a 30-in. motor from fresh rubber, ran it in stages and then re-measured its length, this final length would be about 30+3=33 ins. It should remain at that normal length for the rest of its useful life. The amount of permanent stretch is independent of the number of strands. The permanent stretch must be taken into account in making up the motor length.

The best way to make up a new motor is to lay it out in two "legs" over any *clean*, flat surface, as shown in Fig. 4, having calculated the normal length of motor required. Each "leg" comprises one half of the required number of strands in the finished motor. If the motor has to be made up to a definite *weight*, the resulting length can be calculated from Table I, noting that lubricant increases rubber weight by about 1/12th. Rubber ends should be knotted permanently at this stage and the motor ends bound with a rubber band.



The motor should now be removed from the layout board and lubricated. Ordinary castor oil is satisfactory, if messy, lubricant. Proprietary lubricants based on a soft-soap-glycerine mixture are normally regarded with more favour. The latter do provide slightly better lubricating action, as exemplified by the fact that knots can be tied to hold in rubber lubricated with castor oil, but the same knots will not hold on soap-lubricated rubber. With soap lubricant, any knots which may be necessary in the lubricated strip must be bound, preferably with wool.

The motor is now ready for running in. An old propeller assembly should be used for this, the rear end of the motor being looped over any suitable fitting. A door knob is widely favoured for the latter, although a large screw eye fitted to the workshop door frame is generally better—Fig. 5.

The optimum number of strands for running-in fresh rubber is a matter of controversy. If the stages are few in number (which gets the job over quicker !) there is more danger of the rubber breaking up. A particularly safe process seems to be to start with only *ten per cent.* estimated maximum turns and then work up, increasing the number of turns by a maximum of 80 each time (i.e., 20 turns on a 4 : 1 winder) up to some 80 per cent. of the estimated maximum. There is no real need to go beyond this point, unless the motor is intended for a short contest life on " near-maximum " turns, when a final winding to 90 per cent. maximum turns should be done, after an accurate determination of the *actual* breaking turns on a spare motor.

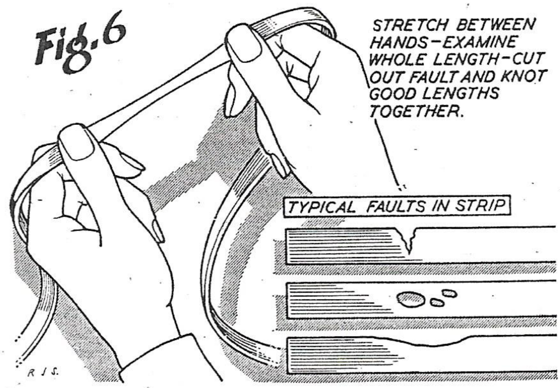
TABLE 1

AVERAGE WEIGHT OF GREY RUBBER STRIP (Unlubricated) (Ounces)

	$\frac{1}{8} \times 1/30$	$\frac{3}{16} \times 1/30$	$\frac{3}{16} \times 1/24$	$\frac{1}{4} \times 1/30$	$\frac{1}{4} \times 1/24$
Per Inch	·0023	·0035	·0093	·0046	·0058
Per Foot	·0278	·0918	·0520	·0556	·0695
Per Yard	1/12	$\frac{1}{8}$	5/32	1/6	5/24
Per 10 yds.	$\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{9}{16}$	$1\frac{2}{3}$	2
Per 12 yds.	1	$1\frac{1}{2}$	$1\frac{7}{8}$	2	$2\frac{1}{2}$
Feet per 1 lb. weight	576	384	306	288	230

It is quite possible that a strand or two may be broken during the running-in process. This does not necessarily mean that the rubber has inferior mechanical properties. The broken strands can be re-tied and the motor will be quite satisfactory, although it would be commonsense precaution to reject the motor if more than, say, one quarter of the total number of strands broke during running-in.

There is also the chance that the whole motor will break during the process. This happens with the best of rubber strip. Sometimes with three or four motors made up from the same skein one will break completely during pre-winding, another will break



a strand or two and the others will show no signs of breakage. The danger point for complete breakage appears to be when running-in reaches the stage 50 to 60 per cent. full turns. Provided the motor takes up to 80 per cent. maximum turns during the running-in it can be relied upon to take at least these turns on the field and considerably more, provided it is not completely over-wound.

Examination

After running-in, the motor should be inspected carefully along its entire length, pulling a single strand stretched between finger and thumb of one hand, well stretched, as in Fig. 6. This will indicate points of potential failure—nicks started in the edges or imperfections in the strip itself. The rubber must be cut at this point and re-knotted. If made up for use without such a check, strands are almost certain to break at these points on an early winding. Some rubbers are particularly prone to faults of this nature—others are remarkably free of mechanical imperfections.

The run-in, checked motor is then laid out over the marking board again—Fig. 7—re-adjusting the length of the " legs " to account for the permanent stretch achieved during running-in. With a " taut " motor the two ends are brought together and bound, the other end likewise bound with a small rubber band. Corded motors are dealt with as shown in Fig. 8.

Washing of the new rubber strip before lubricating has not been mentioned—simply because it is not necessary. It is sufficient to shake off any chalk adhering to the rubber. Nor is washing off the lubricant necessary after the motor has been used. Lubricant can stop on for a whole season, re-lubricating at intervals as required. Motors can also be left corded for weeks at a time without suffering any apparent ill effect, although the areas covered by the rubber band (end) binding should be re-lubricated before use. Normally, however, corded motors are unwound after a day's flying and re-corded again the evening before the next flying session.

Storing the Motor

Sensible care of the made-up, run-in motor consists of keeping it free from grit and dirt and storing it in a clean container (e.g., a plastic or glass jar) between flying sessions. Motors should not be left in a model from one week to another as this tends to dry out the lubricant. Good rubber, properly run-in, however, is surprisingly resistant to abuse and will seldom let you down if treated with *adequate* care. However, never take risks with unknown motors.

Comparative Tests

For simple " static " comparison of new motors, simply timing the power run on a given number of

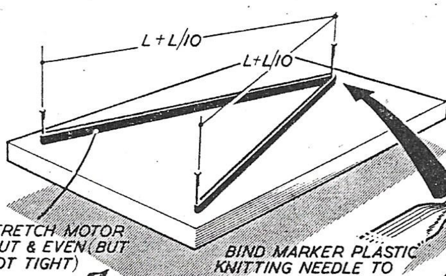


Fig. 7

turns and comparing with the length of run on the same propeller and a proven motor with the same number of turns is a useful check. If the new motor gives a longer run, then almost certainly it is weaker than the original motor. If a shorter power run, a more powerful motor. This test, of course, must be applied *after* the new motor has been run-in.

Another practical check is the " feel " of the motor during the winding stages associated with running-in. With enough experience this becomes a most valuable guide. During the running-in windings, though, a motor always feels more powerful than when wound on the field, partly because it *is* more powerful at this stage and successive windings, increasing the number of turns each time, is more tiring than a single winding. The " feel " check is most likely to detect a weak motor.

TABLE 2
NOMINAL " SAFE " MAXIMUM TURNS
(Based on motor length before running-in)

No. of Strands	Turns per inch Motor Length				
	⅛×1/30	3/16×1/30	3/16×1/24	¼×1/30	¼×1/24
6	53	44	42	40	37
8	42	38	36	34	31
10	38	34	32	30	26
12	36	31	30	28	24
14	33	30	27	26	21
16	31	28	26	25	20

The best check of all, of course, is a flight test on the model on each new motor. This need not be carried out on high turns. Most rubbers of the same brand, good or bad, follow a similar power output curve. Knowing the still air flight time on, say, half turns will soon indicate whether they are " up " or " down " on the original. Once again, of course, the new motors must be adequately run-in for this check to have a real signficance.

The danger associated with running-in a new motor in the model, during actual flights, is that you *may* break the rubber at some stage. The destructive characteristics of a broken motor are too great to court lightly. For the same reason, high-turn flying in contests should be restricted to a *working maximum* which has been checked as on the safe side by a destruction test on a similar motor, preferably under similar conditions. Extreme cold tends to harden rubber and reduces the maximum turns possible. Extreme humid heat can also lead to premature breakage and, more likely loss of power. Modellers in tropical areas are well aware of the short expectancy of life for their rubber motors ; but similar humid conditions, though to much less a degree, can prevail in Europe, and must be guarded against with the use of reduced max. turns.

Fig. 8