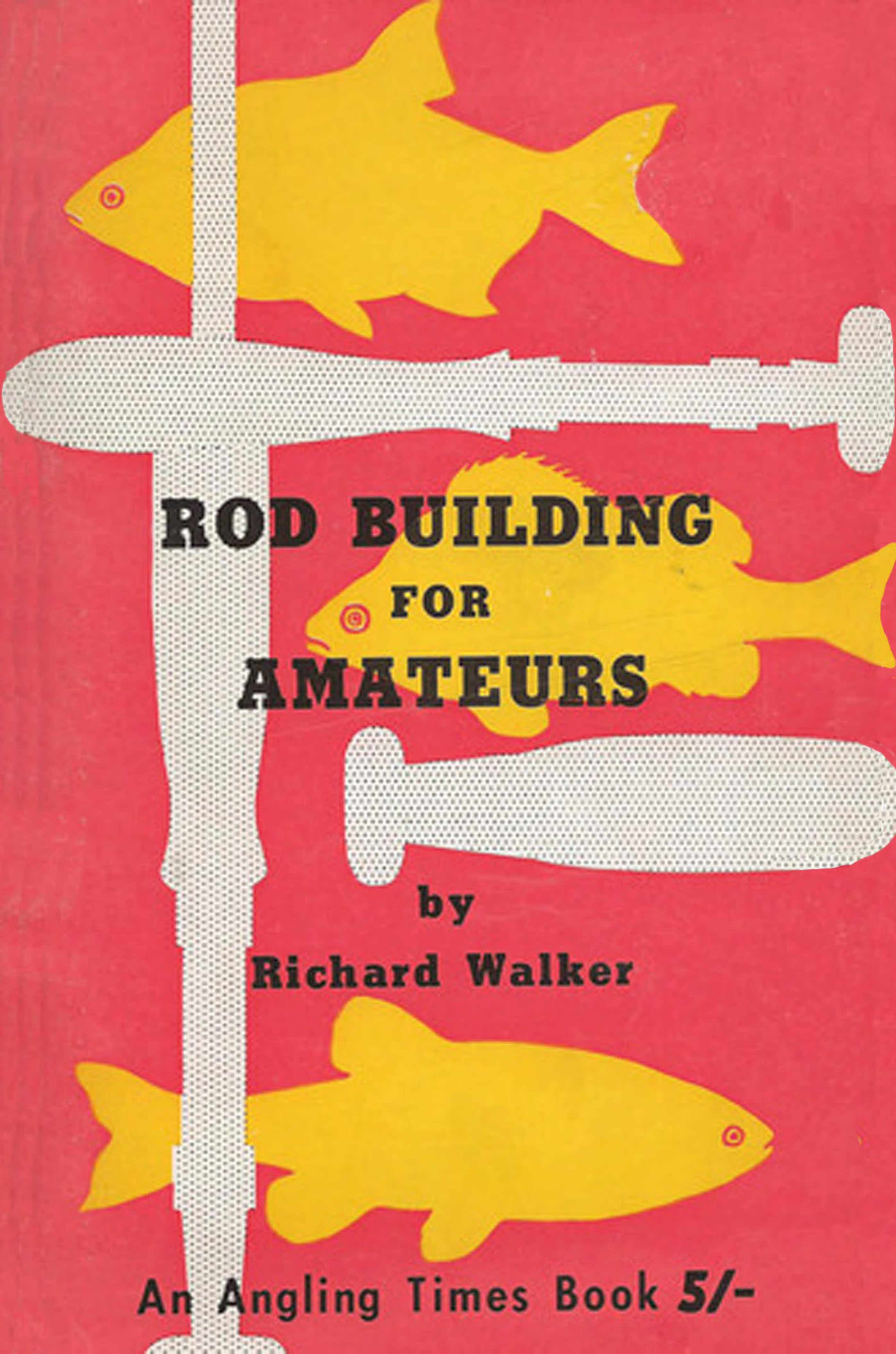


ROD BUILDING FOR AMATEURS

by

Richard Walker

An Angling Times Book 5/-

ROD BUILDING FOR AMATEURS

by

RICHARD WALKER

To

EDWIN HALFORD

who convinced me that an amateur could make a good rod

An Angling Times Publication

Printed by
East Midland Printing Co. Ltd.
Bury St. Edmunds, Suffolk

INTRODUCTION

SINCE 1945, more than one book has been published on the subject of Amateur rod-making. In this, the second edition of mine, I feel I should acknowledge that of them all, Col. Lawton Moss's "How to Build Your own Split-cane Fishing Rod" was undoubtedly the pioneer. It gave a minutely detailed account of what is probably the easiest and most economical method that the angler attempting to make his first rod can adopt. Col. Moss followed this book with another describing the building of a match-fishing rod. Both his books are published by Technical Press Ltd., and I would advise every prospective amateur rod-builder, and especially those whose experience in the use of rods may be limited, to read these books, because they deal with small details of craftsmanship that I have not enlarged upon here.

The result of information on rod-building having been made available to anglers generally, in books of modest price, has been interesting to observe. Accounts of large fish caught and matches won include more and more often the information that the successful angler was using a rod he made himself.

It has also been interesting to note the reactions of the Tackle Trade. The appearance of materials, in the shape of corks, ferrules, rings, lengths of split-cane and greenheart, etc., in the windows of retail shops, showed that a demand had been created. Fears that amateur rod-making would have a damaging effect on the sale of finished rods were expressed in some quarters, and one manufacturer devoted a page of his catalogue to an attempt to convince anglers that making their own rods was not a good idea. These fears proved, in the main, to be groundless, for several reasons. Firstly, amateur rod-building greatly stimulated interest by anglers in the qualities and design of rods, so that many who had neither time nor inclination to build them bought new ones. Secondly, knowledge of how a rod is made has engendered a more real appreciation and admiration of the top-class professionally-built rods for which this country is famous. And while the sales of the lower grade type of rod may have been slightly affected, there can be no doubt at all that the trade has found ample compensation for this in increased sales of auxiliary equipment, such as reels, lines, etc.

In the first edition of this book, I pointed to the saving that an angler could make by building his own rods. Experience since then has taught me that though such a saving is possible, it seldom, if ever, is made in practice. The angler who buys all his tackle is often content with a modest collection. But let him make one rod himself, and he will not stop till he owns a dozen. For each, he will want a reel and lines. Often—very often—he will be led to explore branches of angling he had never previously contemplated; to go to places he might otherwise never have seen; to catch fish, or win matches, far beyond his former dreams. If he saves no money, he is likely to find his horizons broadened to no small degree; and certainly, he will derive much pleasure from craftsmanship for its own sake.

The more thoughtful amateur will inevitably be tempted to explore the intricacies of design. Let me say here that rod-designing is part science and part art. Knowledge of mathematics and physics can carry a designer far, but not all the way. For the rest, he must rely upon his angling knowledge and what can best be described as a sense of proportion.

As an example of what is involved in rod-design, let me tell the story of the evolution of the Mk. IV Carp rod and its brother the Mk. IV Avon. Shortly after the war, "B.B." (Denys Watkins-Pitchford) and I came to the conclusion that no rod was made professionally that had not serious shortcomings for catching big carp. We took our problem to the late A. Courtney Williams, then managing director of Messrs. Allcocks, who pointed out that the market for a carp-rod was too small to justify his firm designing and producing one. He sent me a quantity of choice bamboo and the suggestion that I make my own.

I built in succession four rods, each of which was tested for at least a season by "B.B." and Peter Thomas, and later by Maurice Ingham and other members of the Carpcatchers Club. The fourth attempt was found satisfactory and was called the Mk. IV. It is now used by every member of the club and by a great many other anglers too, many of whom have built their own. It has to its credit the record carp of 44 pounds, as well as nine others upwards of 20lb. in weight, and it has also accounted for salmon and pike over 20lb.

It took six years to get it right, because it was only after making and trying several rods that we knew what we really wanted, and how to produce it. But how different it was with the Mk. IV Avon! This rod was designed to meet requests from friends who wanted a rod with the casting-action and curvature of the Mk. IV, but suitable for lighter tackle used in fishing for big chub, tench and perch; in long-distance ledgering for reservoir roach and in spinning for Thames trout.

Ten minutes of calculation gave the dimensions for the new rod. It was made, and its test-curve proved exactly the figure at which we aimed. That is what happens in designing rods. The more the designer knows about a rod-type, the easier he finds it to use his knowledge of physics to produce variations from that type. But when he is called upon to produce a new type, he may expect it to take him a long time.

In the introduction to the first edition of this book, I had to assure the reader that building a fishing-rod, and making a first-class job of it, is well within the powers of any ordinary man. I need not press the point now because few anglers can have failed to see ample proof of it in the shape of amateur-built rods in the hands of others, if not in their own. It is now only the ignorant who reads or uses the term "home-made rod" as signifying something inferior.

RICHARD WALKER.

CHAPTER ONE

HOW TO BEGIN

ANGLERS who build their own rods do so for a variety of reasons. Some do it because there is a substantial saving in cost; some because they are unable to obtain rods of the kind they require from the tackle-makers except by having them specially built at high cost. Others make their own rods because they are interested in the job for its own sake.

It is difficult to decide, in individual cases, just how a budding amateur rod-maker should begin. My own view is that before he commences building his first rod he should first put in some time in repairing and renovating rods he already has, beginning with the oldest or shabbiest. This will give him practice in putting on whippings, aligning rings and finishing. If his old rod has not a cork handle, he might very well build one up for it; if it has a top of inferior timber or one which is badly bent or strained, he can usefully employ some time in making a new top of greenheart or built cane.

The next step depends on ambition. If an angler is only going to make one or two rods, it is hardly worth his while to build his own split cane. Ready-cemented split cane of high quality can be obtained either in standard sizes and tapers, or made to specification at very reasonable prices, and it is hardly worth the trouble of buying planes, making (or having made) formers, and obtaining bamboo poles, plus measuring instruments, cement, etc., if only a few split cane rods are to be made. Firms which specialise in materials for amateur rod-builders carry large stocks of all the things required and can be depended on to supply exactly what is required to build a rod with the minimum of waste. These firms usually have a selection of rod-building "kits"; a range of rods of known qualities has been designed, and these kits contain all the materials needed to make whichever design is chosen. If an angler cannot find the rod he requires in the lists of kits, the supplier will gladly make up a special kit according to what is required. The man from whom I obtain my bamboo poles, rod fittings, corks, etc., is not only a keen angler and rod-builder himself, but he is in touch with many experienced and well-informed amateur and professional rod-makers up and down the country. As a result, he is always able to recommend rod designs for practically every kind of fishing, and to help his customers to solve any problem they may encounter. The man who only intends to make a couple of rods can do so with the minimum trouble and expense by buying kits of materials ready to assemble.

For those intending to build their own split cane, my advice is to obtain first enough ready-built split cane to make up into a rod. This serves two purposes. It enables the beginner to obtain a good idea of the standard of workmanship required; of the stiffness and texture of the professionally made article, and of the work involved in building a rod after the built cane has been made. His next step should be to make up his own built cane to the same dimensions as the bought set; he can use either the triangular former or the grooved-board methods, the first being perhaps the best to start with, as it involves less skill, both in making and in using the former, than the second. The success achieved at the first attempt depends on the skill of the individual. I have known several men who have made some first-class sections of built cane at their first attempt; others have had to make a dozen triangular strips before they had six sound ones which could be assembled to make a good rod section. The possession of the professionally-built material is a valuable check to over-confidence and its cost is money well spent. Until the amateur can make split cane which is as good as the bought material, he must keep on practising. He ought to be able to make *better* split cane than the professional, because he can afford to select the bamboo more fastidiously; he can heat-treat it with greater care, he can stagger every knot, and he is not pressed for time. This is the field for the amateur who enjoys the work for its own sake and takes pride in the perfection of his design and workmanship. Once he has learned to equal the best he can buy, he is well on the way to becoming a real craftsman.

CHAPTER TWO

MATERIALS

THE chief materials used in modern fishing rods are Tonkin Bamboo, Greenheart and Spanish Reed cane. Tubular steel and Glass Fibre are also used, and are spoken of highly by some anglers, but, with the possible exception of short, American-type bait casting rods, I have yet to handle a rod made of either of the latter materials which could not have been made equally as well, and in most cases better, from split bamboo.

Of all materials used in rods, split bamboo is the most popular. If it is well made, it will outlast most other materials, not excepting steel. The only material, in fact, which may prove to have more durable qualities is glass fibre, and as far as I can judge from samples of glass fibre rod tested, built cane is superior in action and "steeliness". Provided that proper care is exercised in choice of bamboo poles for splitting-up and in carrying out the work of preparing the sections of a built cane rod and cementing them together, built cane provides a first-class material for all kinds of rods, and one which leaves little to be desired.

Nearly all anglers nowadays know how a built cane rod is made up. The commonest type, which is also one of the most efficient, consists of six strips of bamboo, the cross-section of each of which is an equilateral triangle, cemented together to form a hexagonal cross-section, the hard outer skin of the natural bamboo pole being kept on the outside. (FIG. 1.)

"Double-building" consists of using twelve strips, arranged as in FIG. 2. This form of construction tends to be rather overrated; it is hardly necessary on rods where the section does not exceed $\frac{1}{2}$ inch, provided first-class bamboo is used; and even in thicker sections its desirability depends very much on the type of rod; in general, only heavy sea or big game fishing rods gain real benefit from double-building. The only effect of this form of construction on the majority of rods used in lake and river fishing in England is to increase weight without a proportionate advantage in strength and power.

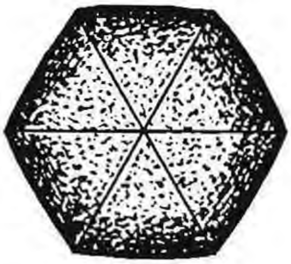


Fig. 1 Single-built hexagonal split bamboo

Fig. 2 Double-built hexagonal split bamboo

Much discussion has taken place from time to time as to the optimum number of sections for a polygonal-section rod; it has been argued that an odd number of sections is preferable, to avoid the reputed tendency of a rod to act in preferred planes, i.e., the bends taking place across the smallest dimension (which is across the flats in the case of a rod with an even number of sections). As there is not, in fact, any such tendency, the conventional six-sided construction has successfully held its own against all other designs.

A little-known, but none the less effective method of building rods, is what is known as the "flat-strip" method. A number of very thin strips, taken from the hard outer part of the bamboo, are glued together in the form shown in FIG. 3. Each strip is made with a proper taper as regards to thickness, but left oversize on width; the desired cross-section is then obtained after the strips have been cemented together by planing the edges of the glued strips. The finished job is usually planed to an octagonal form (FIG. 4), but any shape of cross-section can be produced with this form of construction. The number of strips used will depend on the thickness desired; an effective tip for a roach rod can be made from only two strips of first-class bamboo.

Built bamboo is made by some manufacturers with a tapered and tempered spring-steel wire running down the centre; "steel-centre". This is another example where there is a good deal of argument as to the merits of the design. The Managing Director of a very famous fishing tackle firm once told me that a built cane rod accurately made from high-quality, well seasoned bamboo was incapable of improvement by the addition of a steel centre. My own experience fully bears out that statement. The steel is in the worst possible position for stiffening the rod and adds weight without a corresponding increase in stiffness.

The amateur rod-builder will find that built cane is quite easy to produce. Tackle manufacturers like to create the impression that its production is a highly skilled and difficult process which requires many years of experience to carry out. The truth is that excellent built cane rods can be produced by anyone capable of handling ordinary carpenter's tools; I find that most people who try, succeed in making themselves a first-class built cane fishing rod at their first attempt.

FIG. 3 Flat strip before planing

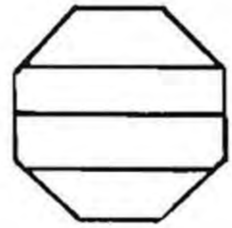


FIG. 4 Flat strip octagonal

Fly and spinning rods can be made of built cane throughout. Rods for roach fishing or general work are often made with the tip only of built cane, the rest of the rod being of whole cane of one kind or another, this form of construction being particularly suitable where a long, light rod is needed. Such rods can also be made of hollow split cane, the inner apex of each triangular section being planed off, resulting in a cross-section as shown in FIG. 5. But equally good results can be obtained by the use of whole Tonkin cane, bored out to leave a thin wall. Spanish Reed cane, which is naturally thin-walled and light, is also used for these bottom-fishing rods, but it is a fragile material and its use involves considerable waste. Where it can be bought in quantity and only the choicest pieces selected, it can be a useful material, with little work required to prepare, but for the amateur who is going to build only a small number of rods and whose time is not a primary consideration, I do not recommend Spanish Reed.

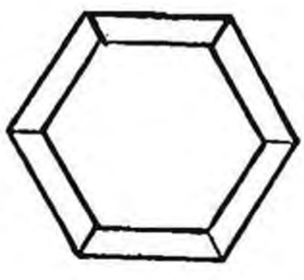


FIG. 5 Hollow built hexagonal

Until the invention of Built cane, Greenheart was the favourite material for Fly and Spinning rods, and for the tops of Roach rods. There are still anglers who prefer Greenheart, claiming that it has an easier action than built cane. This is not necessarily true; built cane can be produced with an easy action if desired, and will greatly excel Greenheart in durability and toughness. Greenheart is much cheaper to buy than ready-made built cane, but the only Greenheart one can trust is that which is split out and not sawn, and which is taken from the proper part of the tree. Greenheart fulfilling these requirements is very difficult to obtain, and even when obtainable, the cost of such fastidious selection is likely to be high, while even the very best quality will not surpass built cane in action, and is not likely to equal it for durability.

It can be seen, then, that the amateur rod-builder really requires nothing but Tonkin Bamboo for all the rod-building he will want to do. Reference will be made in succeeding chapters to the way in which other materials should be treated, but I must emphasise that they are never necessary for the production of a first-class rod for any style of fishing.

Tonkin Bamboos for splitting-up to make built cane should be very carefully selected. The first thing to look for is the diameter; poles should be 1½ inches or larger in diameter, and should be uniformly round in section and as straight as possible. The knots should not be too prominent, and the cane should vary as little as possible in diameter between the knots. Longitudinal splits do not matter, but the outside of the pole must not be marred by scoring or scratches and cuts across the grain. The colour should be a golden buff; avoid bright yellow or greenish poles.

Where only a few poles are to be bought, it is worth paying a little extra for selected poles and to ask that each be split longitudinally into two halves; this will obviate the disappointment of finding, when a pole is split, that the knots have been eaten out from the inside by some kind of woodworm, which renders the pole quite useless.

Poles should be split on receipt in any case and stored in a warm, dry place; the longer they can be kept before use, the better, though reputable suppliers usually provide perfectly seasoned poles ready for immediate use.

Before the halved poles are split down into narrow strips they should be thoroughly heated until the outside just—and only just—shows signs of scorching by changing colour. The amateur can do this easily in front of an electric fire, or over a red-hot plate on a gas-ring or a fire. The bamboo must be constantly moved and turned to ensure even heating all over. This treatment hardens the bamboo and adds materially to the "steeliness" of a finished rod; it will not, however, compensate for the use of poor quality bamboo.

Generally speaking, the effect of heat is to increase both stiffness and brittleness. It is not necessary to heat-treat bamboo in order to produce a good rod, but there is no doubt that judicious baking does enable one to produce a rod having greater power for a given weight of bamboo. Hexagonal split-cane, made from three strips baked and three unbaked, arranged alternately, makes an excellent compromise, resulting in a rod which is both steely and tough.

Before using bamboo for a rod, a sample strip should be tested by breaking it. It should offer considerable resistance before fracturing, and, when it does break, the fibres should break successively from the outside to the inside of the bend. There should be gradual splintering; if there is a clean snap, the material is of poor quality.

Tonkin canes for use whole, should be those which are known as "female" Tonkins; these have very slight knots and are uniform in diameter. Choose only the well-seasoned, straight canes; no splits are permissible in these canes. Try also to select those whose cross-section is circular; some are oval.

In selecting Spanish Reed, look carefully for minute cracks. This material is often badly stained with brown stains, but they do not affect its strength, and after a rod has been whipped and varnished, they are not as unsightly as might be thought. Spanish Reed is not as easy to straighten as Tonkin, being easily split, and it is therefore important to obtain it as straight as possible initially.

Little need be said about the choice of Greenheart; not much choice is available to the amateur who buys only in small quantities, and all he can do is to choose the straightest-grained pieces and those which are closest-grained and stiffest.

In all cases, where only small quantities of material are needed, the amateur rod-builder will find that it pays to obtain them from a reputable dealer in materials who specialises in supplying these small quantities and who can be depended upon to choose only the best for his customers.

In addition to these various rod-timbers, corks, whipping silk or Sylko, and various glues, cements, etc., will be needed. These will be dealt with in their appropriate places.

APPENDIX

Another cane which is undergoing a revival of popularity is Japanese cane. In appearance and action it may be said to be intermediate between Tonkin and Spanish Reed. It is used mainly in match rods, and very successfully. As with all canes, the greater the spacing between knots, the stiffer the cane for a given diameter.

CHAPTER THREE

MAKING BUILT CANE

THERE are three ways in which the amateur can make his own built cane. Each involves the use of wooden jigs or formers and one or two small planes, which must be kept very sharp indeed. The preparation of the bamboo for shaping is similar in each case.

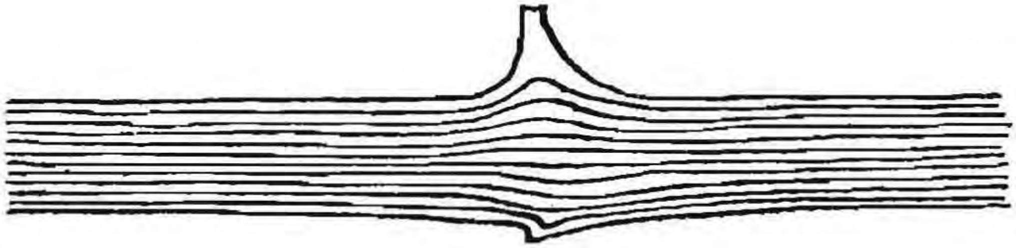
The first thing to do is to cut the bamboo poles (which have been split longitudinally into two halves) to a length approximately 18 inches longer than the length desired for the finished rod-joints. In making these transverse cuts, use a hacksaw or a fine tenon saw, and make the cuts with due regard for the best use of the material in hand; the fewer knots included in a given length, the better, other considerations being equal.

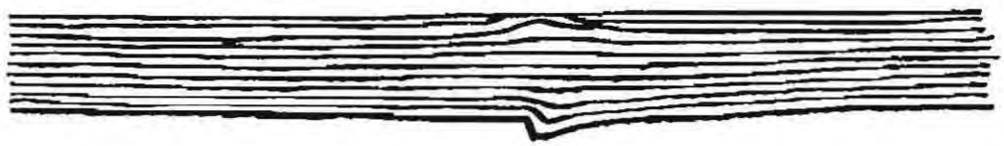
(Each of the six strips for a given rod-joint should have its knots in a different position relative to those on the other strips, so that when the finished sections are assembled, the knots will not coincide. Professionally built rods are often seen in which the knots are allowed to coincide on alternate strips, but I prefer to see the knots staggered so that there is no coincidence at all.)

Using an old table-knife, split the half-sections into half again, and then again halve them, until strips are obtained, which must be at least $\frac{1}{8}$ inch wider than the *width of the flats of the hexagon of the desired rod joint, at the thicker end*. If the splitting jibs when a knot is reached, use a mallet to tap the knife through; but the knife must be blunt and not sharp, so that the action is one of *splitting* and not of cutting. Sometimes a pole will split up without trouble; sometimes the splits will tend to run into one another and a good deal of material will be wasted; in this matter luck is a potent factor, but generally speaking the best and driest poles give the least trouble in splitting.

In splitting the bamboo and in the subsequent handling, it pays to wear stout leather gloves, as bamboo can cut like a razor and inflict serious injury to unfamiliar hands.

Having split out the strips, the knots must be removed, commencing with those on the inner surface. Cut them down with a stout knife—a pruning-knife with a concave, sharp blade is excellent for the purpose. Then finish them flat with a coarse file. Now turn the strip over and file down the knots





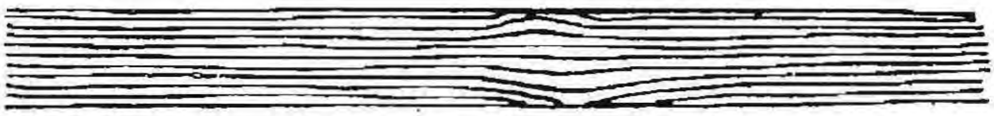


FIG. 6 (Top) Bamboo as split from pole
FIG. 7 (Middle) Inside knot removed and inner surface planed flat
FIG. 8 (Bottom) Outer knot removed

flush with the outer skin, taking off as little as possible consistent with getting the knots flat. (See FIGS. 6, 7 and 8.)

The next step depends on which method will be used to shape the strips. To produce a conventional hexagonal rod, the simplest is the triangular former method. This requires a piece of good wood (beech, oak or ash for preference) with straight grain and as few knots as possible. In length it should be 12 inches longer than the required rod-joint; in section it should be an equilateral triangle; approximately 2 ins. x 2 ins. x 2 ins. Unless one is a skilled carpenter, it is best to have this made by the local joiner; it should be made accurately.

Having obtained it, it should be stained all over, using cotton wool or rag dipped in ordinary writing ink.

A flat is then planed on one edge, as much wood being taken off as is required for each of the six strips which will form the desired rod-joint—i.e., the flat is tapered and of the same dimensions as the flats of the finished hexagon.

For a top joint tapering from $\frac{1}{4}$ in. to 3/32 in., measured across the corners of the hexagon, the flat on the former would taper from $\frac{1}{8}$ in. to 3/64 in. As the former is longer than the finished joint will be, these measurements should be taken at 6 inches from each end—see FIG. 9. This shows a former suitable for making a straight-taper, top joint of a 9 ft. two-piece trout fly rod.

In using this former, the strips are first planed down to a thickness only a fraction greater than the width of the flat on the former, only planing on the soft inner side of the bamboo. Each strip in turn is then glued to the flat on the former, outer skin to former, using a type of glue which will soften with heat, such as "Duroglue" or "Seccotine". Weights are placed on the bamboo to hold it firmly to the former while the glue sets, or the strip can be bound to the former with string. After the glue has set, the bamboo is planed flush with the former, using a fine-set, sharp plane. If the former itself is touched by the plane, the stain will be removed and white wood will show immediately, thus avoiding damage to the former. The strip of bamboo is then removed from the former by warming it, which softens the glue. (See FIGS. 10 and 11.)

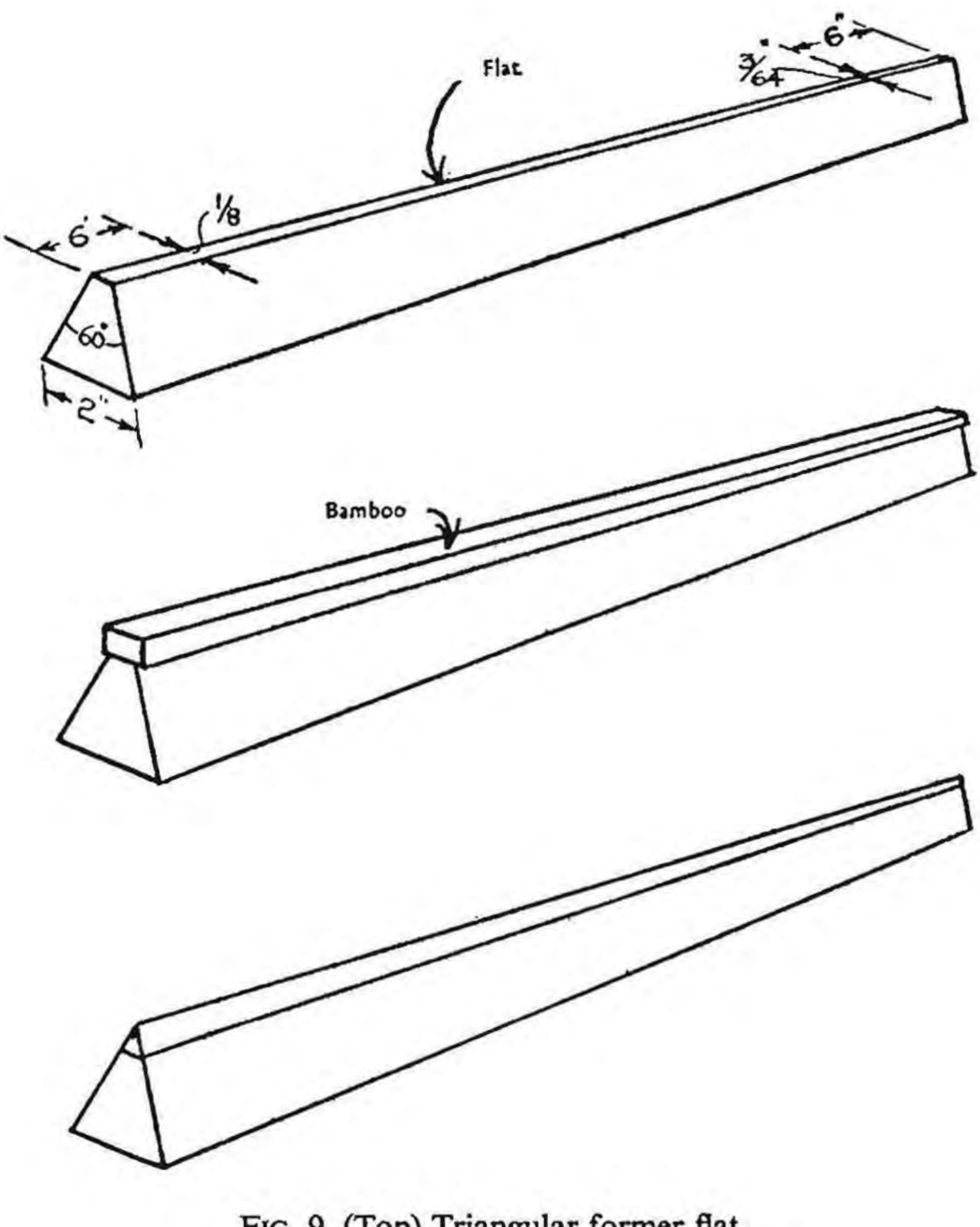


FIG. 9 (Top) Triangular former flat
FIG. 10 (Middle) Bamboo glued to former
FIG. 11 (Bottom) Bamboo planed flush to former

Six strips are made in this way, the former being carefully cleaned down after the removal of each strip. The strips are then assembled and cemented together; the methods used for this will be described later.

The triangular former method is a simple way of making built cane and, provided due care is taken, it is one of the most accurate. It is however, a slow method, though this drawback can be overcome to some extent by using several formers for each joint. One can use up to six and thereby save time, as the glue holding all the strips can set simultaneously. It is, of course, possible to plane a flat on each of the three edges of the former.

I have heard the triangular former method condemned on the grounds that in order to glue the strip to the former it is necessary to plane the outer skin flat. This idea has no doubt arisen through Lt.-Col. G. Lawton Moss's book, *How to Build Your Own Split-cane Fishing Rod,* in which the triangular former method was explained in detail. In this book, Colonel Moss advocated very light planing of the outer enamel, emphasising the importance of removing as little as possible, before glueing the strip to the former. This is not really necessary, as the curvature of the outside of a narrow strip taken from a large diameter pole is so slight as not to matter.

Points to watch with this method are that the strip is in contact with the former throughout its length; that the plane is not canted and that the glue is firmly set before commencing to plane. When planing, always work towards the thin end, commencing near to that end and beginning the planing stroke further back towards the thick end, as the work progresses. *It is essential to*

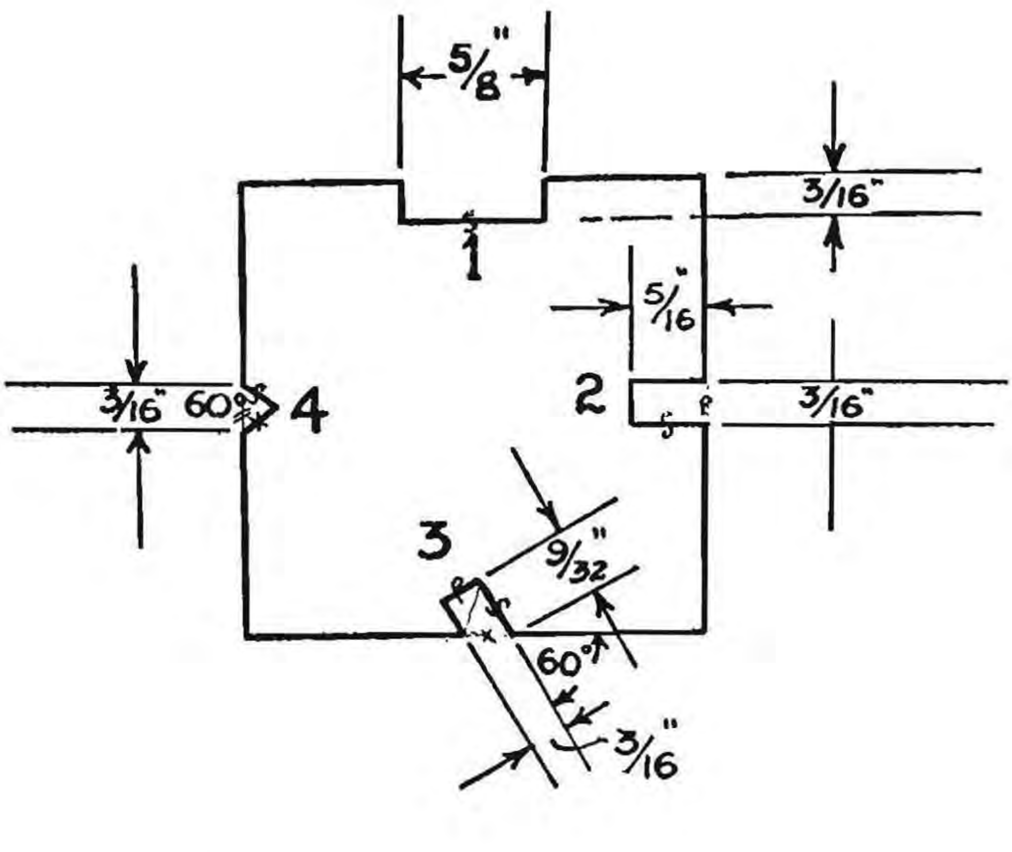


FIG. 12 Preparation board, cross section

keep the plane very sharp indeed. To continue planing after the edge of the plane has become dull is asking for trouble, as sooner or later the bamboo will "pick up" at the knots and the strip will be spoiled. I make it a rule to resharpen my plane blade after finishing each section, and I use a second small plane to take the last few cuts, using a setting which removes a very thin shaving indeed. It is absolutely fatal to try to hurry in this work; any attempt to do so is sure to result in spoiled strips and more time will be lost in the long run than can be saved by hurry.

Another way of making built cane is that known as the groove method. This utilises two boards, one approximately 2 ins. x 2 ins. x 24 ins., known as the preparation board, and one about 2½ ins. x 1 in. in section, and about 12 inches longer than the joint which is going to be made, known as the finishing board. In the preparation board, four grooves are cut so that the board has the cross-section shown in FIG. 12. The dimensions shown are suitable for making light fly-rods and tops for roach rods; where larger sections are required, the size of the grooves must be increased. One can have two or more grooves in each face of the board, but for the sake of simplicity only one is shown in each. These boards should be of good wood, beech, oak or ash being preferable. Unless facilities exist for making these grooves accurately, it is best to have the board made complete by an experienced joiner.

To use this board, first stain it all over so that if it is touched by the plane the fact will at once be apparent. Then place it on the bench with No. 1 groove uppermost. Put the prepared bamboo strip in the groove, skin side down, and plane the strip down until it is flush with the board. This will allow it to go into groove No. 2, and the board should be turned to bring this groove uppermost. Put the strip in the groove and again plane flush.

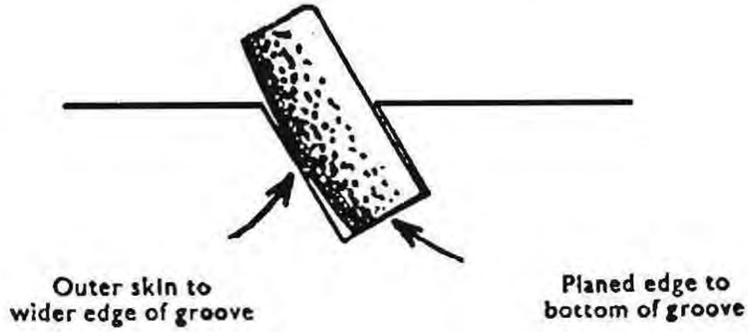


FIG. 13 Placing the strip in No. 3 groove

Now turn the board to bring groove No. 3 to the top. Put the strip in the groove with the planed edge downwards and the outer skin against the longer side of the groove. (See FIG. 13.) Again plane flush to the board. This will give a strip with one edge at 60° to the outer skin.

Turn the board to groove No. 4, put the strip in the groove, 60° edge down, and plane flush. Before removing the strip, mark the last edge planed with a pencil. Get this face smooth because it may not subsequently be planed.

The strips should all be treated as above, after which they are ready for the finishing board, which is 12 inches longer than the joint which it is to be used to make, and is provided with a groove whose taper is that of the triangular section which it is desired to produce. It is, of course, the full length of the board, and its sides form an angle of 60°. Its width varies as in the case of the flat used in the triangular former method. Where triangular strips which are more than ⅛ in. wide at the narrowest are to be made, only one groove is necessary. For finer sections, it is desirable to employ two or even three grooves in the finishing board, all with a taper but of different depths, commencing with one, say, tapering from ¼ in. to ⅛ in., the next from 3/16 in. to 3/32 in., and the final one of the correct taper for the finished top.

The method of using this board will no doubt have been already guessed by the reader. The strip is laid in the groove and planed flush to the board which, like all the others, should be stained. For the thin sections, commence planing in the largest groove, moving to the next as the strip is reduced. It is important to plane the unmarked side of the strip first, that is when only one finishing groove is in use. Where more than one is used, the strip can be turned before moving to the next groove. remembering, of course, never to plane the outer skin.

The reason for marking the side last planed in the preparation board is as follows. When planing in the grooved board method, *the plane should be held at an angle, so that the outer skin of the strip is pressed against the side of the groove*. Since the outer skin is not flat but slightly curved, this will result in the 60° angle produced by groove No. 3 being, in fact, rather less than 60°, if anything. The angle produced in groove No. 4 will be more accurate, because the strip will tend to wedge into the groove and, if it cants, it will be accurate in relation to the skin side rather than the side already planed. When the strip is transferred to the finishing board, any error in the angle produced by groove No. 3 will be corrected, provided the *skin side* and the *side planed in groove No. 4* are against the two sides of the finishing groove.

Because one does not have to wait for glue to dry, the grooved board method is quicker than the triangular former. It also has the advantage that in the event of a strip being oversize in one or more places, it can be returned to the board for rectification. If all the strips are oversize in a particular place, the finishing board can be planed a little to correct this and re-dyed. While most amateur rod-builders will probably have their boards made and grooved for them, they must be prepared to make small adjustments to the finishing board themselves, and for this purpose a small 60° scraper, which can be made from an old hacksaw blade, will be useful. The 60° grooves can be deepened by means of a three-cornered file, but the extreme bottom of the groove will not be reached and the scraper must be used to clear it, as a sharp corner at the bottom of the groove is essential. Care must be taken not to allow shavings to become trapped between groove and strip.

If the rod-builder possesses an electric drill, or can borrow one, he can produce his own grooves by fixing the drill over a guide through which the boards can be slid, using a bit in the drill ground to the right shape to produce the desired grooves, finishing up with file and scraper. Tapered grooves can be easily made by sticking brown paper to the underside of the board, building up in layers to obtain the right taper, but the board must be straight and of uniform thickness.

Some variations in the taper-groove technique are possible. By the use of a series of 60° grooves of varving depth and taper, and by using additional skill, it is possible to dispense with the preparation board, putting the cleaned-up strips straight into the largest 60° groove.

The outer skin is kept pressed against one side of the groove by one's left hand and by inclining the plane in that direction. By turning the strip often, the initial errors are progressively eliminated.

Professionals making high-class, handbuilt, split bamboo rods usually employ this method, their "grooved boards" often being made of steel and having accurately cut grooves which give a number of standard tapers. These tapers are chosen to enable a wide range of sections to be produced, sufficient for most requirements; additional tapers are obtainable by moving the strips up or down a particular groove after some planing has been done. It is also possible to obtain different diameters with a given taper by using removable shims underneath and at the sides of the plane, or by side-plates which are adjustable so as to enable the underside of the plane to be raised by any desired amount from the surface of the board. This could be applied, of course, to planing on a wooden grooved board.

Although the steel "boards" are accurately made, the professional who wishes to produce a series of rods of identical action uses a micrometer to check each strip at predetermined intervals, measuring from the outer skin to the opposite apex. It is usually sufficient to check at six-inch intervals.

Here are the dimensions of a steel "board" available to amateur and professional rod builders in the U.S.A.:—

	1st Groove	2nd Groove	3rd Groove	4th Groove
end	.2261 in.	.1808 in.	.1325 in.	.0858 in.
6 ins.	.2196 in.	.1728 in.	.1260 in.	.0792 in.
12 ins.	.2116 in.	.1648 in.	.1180 in.	.0712 in.
18 ins.	.2036 in.	.1568 in.	.1100 in.	.0632 in.
24 ins.	.1956 in.	.1488 in.	.1020 in.	.0552 in.
30 ins.	.1876 in.	.1408 in.	.0940 in.	.0472 in.
36 ins.	.1796 in.	.1328 in.	.0860 in.	.0392 in.
41 ins.	.1716 in.	.1248 in.	.0780 in.	.0312 in.

These dimensions are the *depths* of the grooves.

Sometimes, when using 60° grooved boards, errors creep in and it is found that, while the angle of the inner apex of a strip is correct, the sides of the triangle of which the skin side is the base, are of unequal length. A careful watch should be kept for this so that the tendency is discovered soon enough for it to be corrected.

Correction can be made by tilting the plane, or by using a correcting board which has four or five grooves at various angles, to enable a compensating cut to be taken before returning the strip to the finishing board. The correcting board need be only about two feet long.

Each strip should be checked with the 60° gauge before assembly. Never use an inaccurate or chipped strip.

Five-strip or pentagonal built cane, which is slightly more rigid for a given cross-sectional area, can be produced on a triangular former in the same manner as 6-strip or hexagonal material, except that the angle of the inner apex of each strip must be 72° instead of 60°. Consequently, only two corners of a triangular former for 5-strip rods can be used. Grooved board construction of 5-strip rods is more complicated, two grooves being required for each taper, one being used to plane one side of a strip and the other to plane the other, the outer skin being kept always against the longer face of each groove. (See FIG. 14)

For rods built up from different numbers of strips, as for examples, four or seven, grooves or formers will naturally be used which will produce the correct apex angles for the strips. Considerations affecting the choice of construction are discussed in the chapter dealing with design.

In making polygonal built cane, always remember that it is much better to err on the side of too great an apex angle than too little. If the apex angles are slightly too great the final result is hardly affected, but should they be too small there will be a gap caused by cumulative error. (FIG. 15)

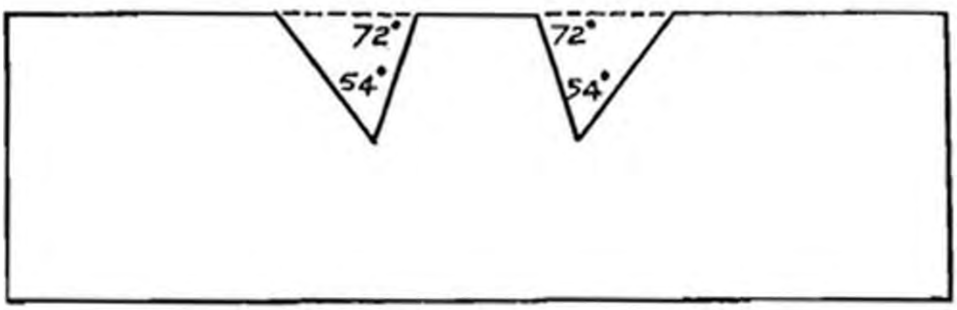


FIG. 14

Having coated each strip with cement, lay them together at the thick end to form the hexagon, keeping the skin side outwards and the strips in their correct order where this is necessary. Only concern yourself initially with about two inches of the thick end of each strip. Bind this part firmly together with stout linen thread, leaving a long length of thread over. Attach the end of this to something solid, then rotate the joint so as to run a spiral binding of the thread along the joint. Persuade each strip to fall into its place as the thread spiral progresses along the joint, still in open spirals, to the original end, where it is secured and the end cut off.

In applying the glue and assembling the strips, care must be taken to see that shavings, sawdust or dirt are not caught on the glued strips; it is preferable to carry out assembly operations well away from the workbench where the strips are prepared.

After the strips have been bound together, first damp the binding thread, then lay the joint on a perfectly flat surface and roll it backwards and forwards, under pressure of the hands to ensure its straightness and to squeeze out surplus cement, checking by looking along it from one end. Damping linen thread causes it to shrink and it will press the sections tightly together. Leave the joint lying flat to dry, or alternatively, a loop can be whipped roughly on each end and the joint hung up with a heavy weight attached, to keep it straight while the glue sets. Always check for straightness and see that the joint is not twisted before leaving the cement to set. You can bend or twist the joint easily before the cement sets, and you should correct any faults before then.

After the glue is firmly set, the bindings are removed and the joint is cleaned down. I find a fine, flat file applied to each flat is best for removing the temporary binding. Each edge of the hexagon—i.e., each corner of the cross-section, should be lightly scraped; then each flat can be finally cleaned with a block to which is affixed fine glasspaper.

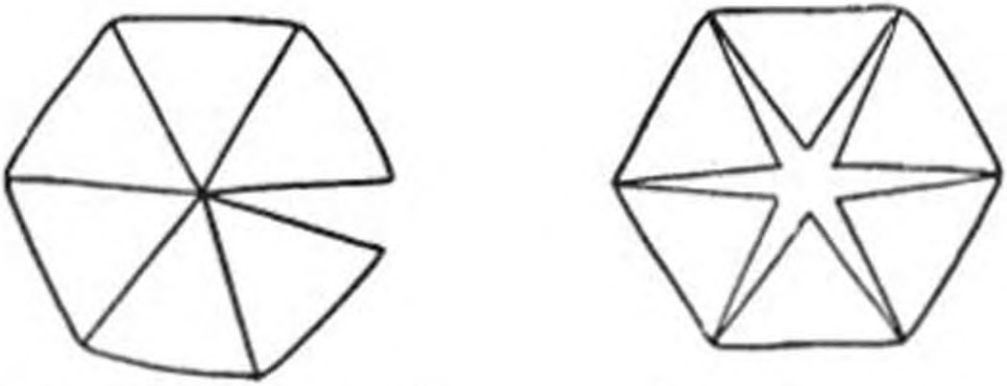


FIG. 15 Apex angles too small — Apex angles too large

A section of built cane has now been produced which is about a foot longer than the desired rod-joint. The purpose of this extra foot is to allow adjustment to be made after glueing-up. The piece of built cane can now be measured and tested, and on the basis of these tests, the piece can be cut to size, cutting more or less off either end as found necessary. Unless this extra foot or so is allowed, the piece is sure to be a little too thick or too thin, too stiff or too flexible, and nothing can be done about it; to add bamboo is impossible and to plane or scrape down removes the outer skin, which spoils the section. It is impossible to separate the sections of a well-glued-up piece, unless "Duroglue" or "Seccotine" have been used, when heat may do the trick. The extra foot allows a joint to be made which tapers from too thick to too thin; the final rod-joint can be cut right.

When the amateur becomes experienced and is using a former which has been modified in the light of experience gained by several rods produced on it, he may dispense with most of the extra foot allowance, provided he is using bamboo of fairly uniform quality; but until that stage is reached he will find that the small additional effort involved in having the extra foot is well repaid.

Double-built cane is made in exactly the same way, except that two strips are glued together before passing through the various grooves, or going on the triangular former. In doing this, the strip which is to be on the outside must be tapered in thickness by the correct amount, otherwise the inner strip may be planed right away at the thin end. The inner strip must have the skin side planed flat, as little as possible of the outside being removed consistent with obtaining a flat surface. In double-building, the outer strips should be kept as thin as reasonably possible throughout, and in general should not exceed $\frac{1}{8}$ in. If very powerful rods are being built it may be desirable to use treble building rather than make the outer strips more than $\frac{1}{8}$ in. thick; this, of course, would only be necessary in the case of very heavy sea or big game fishing rods.

All sorts of modifications and refinements will no doubt suggest themselves to the reader, and he will probably wish to try unconventional combinations of taper, shape and material. I have experimented with rods made with three strips of bamboo and three of greenheart; with five- and seven-sided rods and with various forms of hollow building, with varying degrees of success. I have never found anything to beat the ordinary six-sided construction for solid joints, using bamboo throughout. Hollow-built rods are excellent for long, light roach and general rods, but equally good results can be obtained from bored-out natural cane. Keen amateurs will, however, perhaps enjoy making a really first-class match-fishing rod, entirely built-up and with a stepped top. Stepped tops of wonderful lightness and striking powers can be made by building an ordinary solid hexagonal top, say thirty inches long. A sextet of triangular-section strips is now made, each about 12 inches long, which have no taper and whose dimensions are about 1/16 in. greater than those of the thick end of the solid top. Before assembling, however, each strip has its inner apex planed away, except for about one inch at one end, to leave

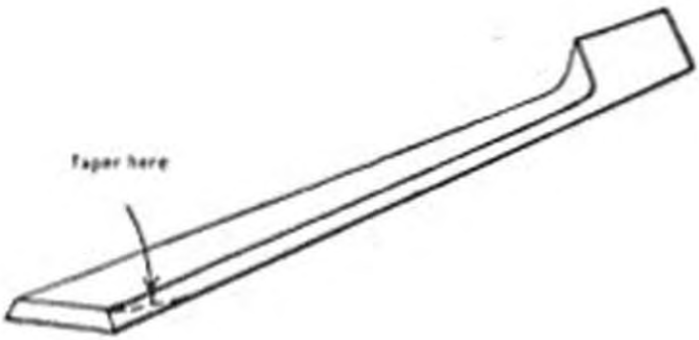


FIG. 16 Section for step taper, hollow built top

the outer part about 1/32 in. thick (see FIG. 16.) The extreme end is then tapered to very thin—just a few thousandths of an inch, working from the outside. These sections are now assembled, the thick end of the solid top being pushed about two inches in the open end of the hollow part, with plenty of glue, during assembly. After the glue has set and the piece has been cleaned down, a whipping is put over the junction of the two sets of strips (see FIG. 17). A second "step" can be added in exactly the same way as the first; the choice of length, number of steps, and diameter must depend on the action required.

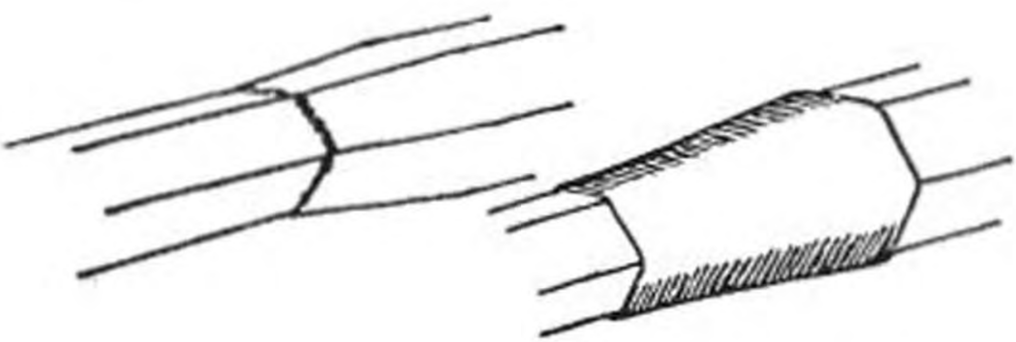
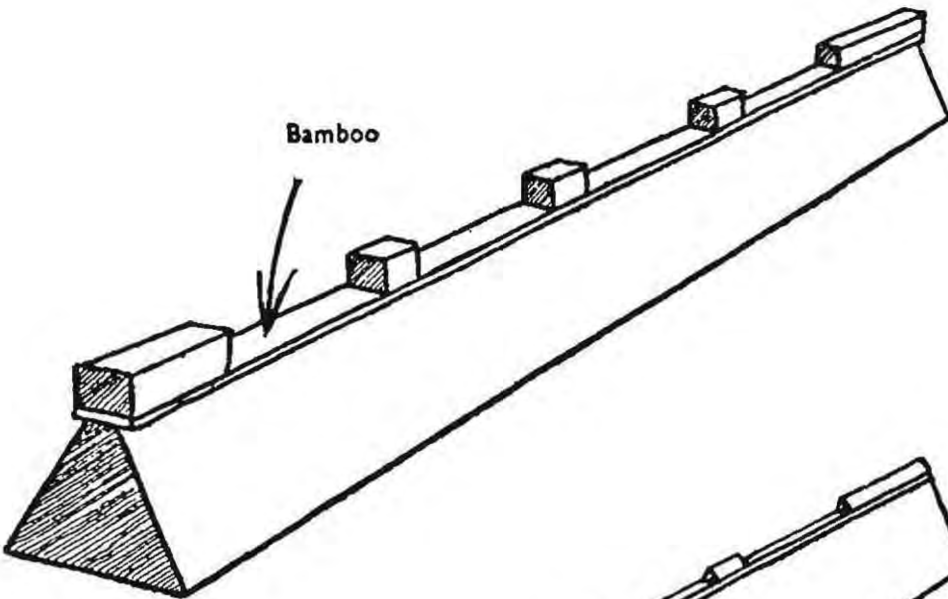


FIG. 17 Part of step taper top before and after whipping join

This applies, of course, only to the top sections of a rod, where the diameter is not very large. For the butt and middle parts of the rod, tapered hollow-built joints are necessary. I think these are more easily produced on a triangular former than by any other method. One first decides what the dimensions of each of the flats of the hollow-built joint are to be, and prepares a triangular former with a suitable flat, to which a strip of bamboo is glued in the ordinary way. Before planing its edges, however, the thickness is reduced to whatever is considered suitable for the wall-thickness of the desired hollow-built joint, something between 3/32 in. and 3/64 in. will probably be satisfactory, the larger dimension being chosen for larger diameters and more powerful rods. Even for very light match rods it is not desirable to go thinner than 3/64 in. in the wall, or difficulty may be encountered in obtaining good adhesion between strips.

If desired, the wall thickness can be tapered as well as the joint itself; the effect of refinements of this kind can only be deduced by trial and the keen amateur will soon obtain the result he requires by experiment.



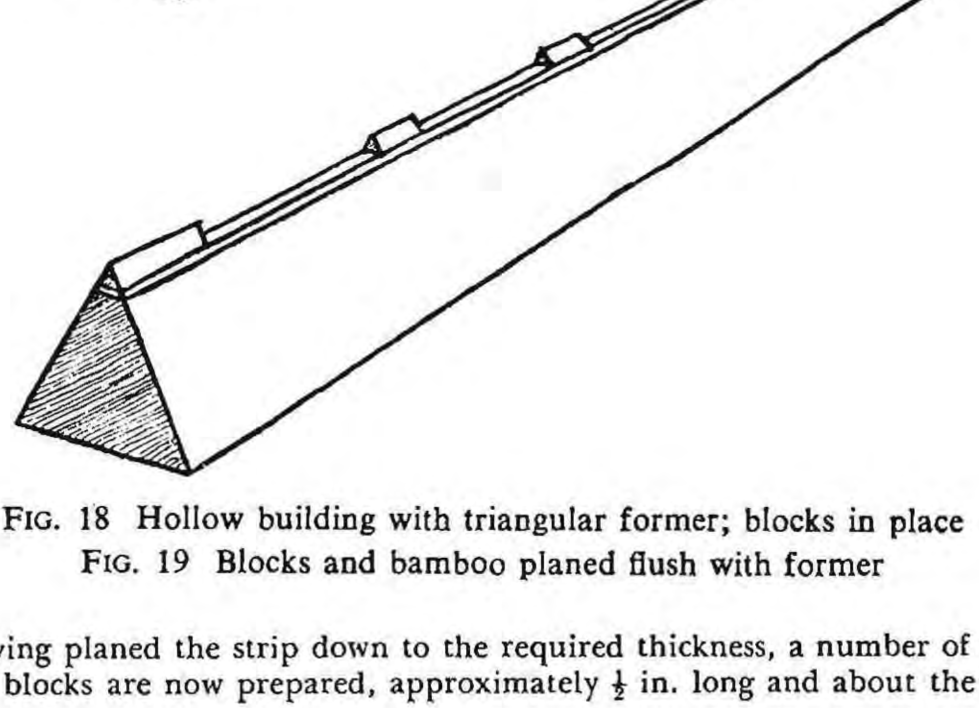


FIG. 18 Hollow building with triangular former; blocks in place

FIG. 19 Blocks and bamboo planed flush with former

Having planed the strip down to the required thickness, a number of small wood blocks are now prepared, approximately ½ in. long and about the same width as the bamboo strip; their cross-section is square. I find beech is as good as anything for the purpose. In addition, two blocks of the same cross-section but about two inches in length are needed. The two latter blocks are glued on to the bamboo, one at each end; the remainder are glued on at regular intervals along the strip. The more blocks that are used, the *stiffer* and *heavier* the joint will be; a block every six inches does well for the average joint. (FIG. 18.)

In glueing on the blocks, a glue which does not soften with heat must be used, or the blocks will come adrift when the former is warmed to allow the strip to be removed. "Durofix" is satisfactory, but urea-formaldehyde cement is better and should be used if possible. The former must now be clearly marked to show where these blocks have been placed, so that they can be similarly placed on subsequent strips which will be shaped on the same former.

Now all that remains is to plane the edges of the strip *and* the sides of the little blocks flush with the former (FIG. 19), heat the latter and remove the strip. Six strips, each with its quota of blocks, are made and assembled, the result being a very light and stiff rod joint, the longer blocks which are set in the ends providing a sound foundation for ferrules.

It is not, of course, necessary to use a long block for the larger end of a butt joint; the long blocks are to provide good support for the ferrules.

Built-cane fly-rods can be lightened considerably without appreciable alteration in their action by using hollow-building methods. Little can be gained by applying the technique to sections under $\frac{1}{4}$ in. in diameter, but in the case of the butt joints and, in the larger three-joint fly rods, the butts and middles, a lot of weight can be eliminated. Such rods can either be built up as already stated, or the strips can be planed as for solid split-cane and the inner apex of each strip partly removed, leaving it intact at regular intervals and for two inches or so at each end. This is effected by using a board with a

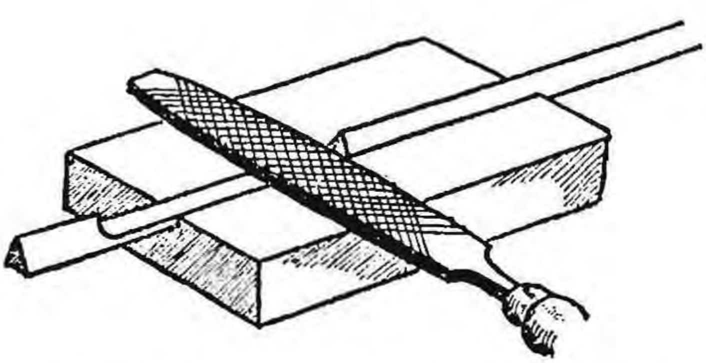


FIG. 20 Filing-block for hollow building

shallow groove, whose depth is equal to the desired wall-thickness, and filing away the bamboo until it is flush with the surface of the board. (See FIG. 20). It is, of course, necessary to mark each strip to ensure that they match up when assembled.

Another method of producing stiff, light rod sections, is to build up sections of thin bamboo round a core made of balsa wood.

Square-section balsa should be chosen, and planed to a size which is less than that of the finished joint required by $\frac{1}{8}$ in.; keep the balsa square-section, but taper it according to what is required. Then prepare four strips of bamboo, 1/16 in. thick, and glue one on each side of the balsa core, to give a section as shown in FIG. 21. Then plane each *edge,* as in FIG. 22. Then glue on four more strips, one on each planed edge (FIG. 23). Finally, plane off the surplus to leave an octagonal cross-section as shown in FIG. 24. This makes a very light and rigid piece, ideally suited to the butts and middles of quick-striking match rods.

The flat-strip method of building a rod requires little explanation. The number of strips must be chosen to suit the diameter of the section to be made; each strip can be planed to the correct taper by using a grooved board having a shallow groove whose depth varies from one end of the board to the other, or by marking off each strip at regular intervals and checking with a micrometer. The outer skin of the two outer strips should, of course, be disturbed as little as possible and should be placed outwards in assembling the piece. The outer skin of inner strips will have to be planed just enough to get it flat. Each strip is left wider than necessary, and the piece is then planed on each edge after glueing, a square section being thus obtained, with the correct taper.

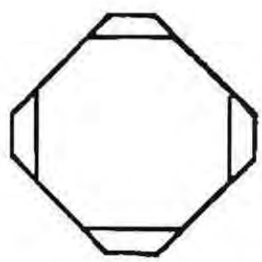


FIG. 21 (left) Building round Balsa core; first four strips in place
FIG. 22 (right) Corners planed

In order to obtain a true square, the section should be held between two boards bolted together while the first edge is being planed, or it can be held in a vice, and filed, working on a short length at a time, until one edge is flat. It is important to obtain a truly square section.

Each corner of the square can then be planed down to produce an octagonal cross-section. This flat-strip construction results in very good and durable rods, and as it is a method which requires very little in the way of jigs and formers, it is well suited to the amateur. Weights can be used to keep the strips pressed together while the glue sets, ensuring firm adhesion. A board with 90° grooves of various depths facilitates planing the corners of the square section.

The important thing to bear in mind in the making of built cane is that the strength of bamboo lies in its outer skin. Every care should be exercised to preserve as much of this as possible; provided this is constantly borne in mind, the amateur rod-maker can confidently hope to produce rods which are quite as efficient as the most expensive professionally-built weapons

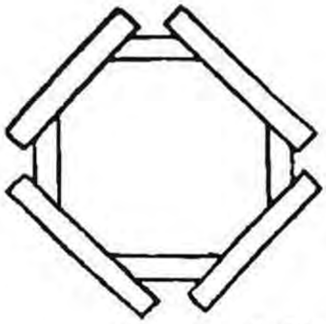
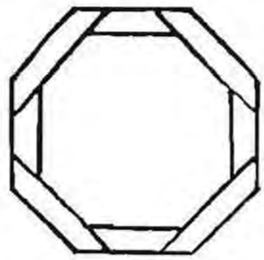
 

FIG. 23 (left) Second set of strips in place
FIG. 24 (right) Finished cross-section

Examination of professionally made rods, even those made by many of our leading firms, will show that in most cases all the outer enamel of the bamboo has been planed away, so that each face of the hexagon is perfectly flat. This is done in preparing the bamboo strip, and a flat surface on the outside greatly facilitates subsequent operations. In some cases I suspect that a fine cut is taken on each face after the sections have been cemented together, as a quick means of cleaning up and to improve the appearance. It is true that excellent rods are produced in spite of such liberties having been taken. Nevertheless, I strongly recommend that the amateur should do his utmost to preserve every bit of outer enamel possible. If he objects to its appearance, he can remove it by very light scraping after the sections have been cemented; but to those who know their rod-building technique, its presence is the mark of a well-made rod.

NOTE.—The following extracts from an account of tests made of bamboo specimens by the United States Department of Agriculture Forest Service may be of interest:—

"Splints tested with the epidermis (outer enamel) intact and up showed consistently higher values for fibre stress at proportional limit, modulus of rupture, and modulus of elasticity . . ."

"The higher strength values obtained for most properties of culms than for those of splints cut from them may be attributed to the presence of the tough epidermis on the culms and its absence from the splints."

APPENDIX

Roach-Poles

A very special kind of split-cane, if it can be so called, is that used in roach-poles. The lower sections of these poles are of considerable diameter, and have to be hollowed-out not only to reduce weight but to serve as containers, in transit, for the upper sections of the rod.

An alternative to boring out these sections consists in splitting them longitudinally into two approximately equal halves, and working on the inside with gouges. Skilful workmanship gives excellent results, the mating faces of the half-canes being left as nearly as possible their original width. Having reduced the wall thickness to the desired amount, the canes are then glued together again, dressed on the outside, and carefully whipped.

As well as cane, such woods as mahogany are sometimes used in this way.

Staggering of Knots

Because I have stated a preference for split-cane in which each knot is staggered relative to the next, it should not be inferred that such a construction has appreciable advantages over that commonly used by professional rod-makers. In practice, I have been unable to detect any difference between the two constructions; but complete staggering is theoretically safer and presents no difficulty to the amateur.

Error Compensation

Some compensation for slight errors in the dimensions of individual strips may be obtained by planing a little off the inside edge of each. The amount removed should not exceed 5 per cent. of the flat-to-apex dimension of the strip. The result is a very thin core of cement in the part of the rod where the stresses are least, which is preferable to having some sections "proud" of others, necessitating excessive rounding of corners in finishing the rod.

CHAPTER FOUR

DEALING WITH OTHER MATERIALS

GREENHEART is a material which cannot easily be planed; in order to reduce its dimensions it is necessary to employ a scraper. To work up Greenheart from the plank by hand is a long and tedious business, and the amateur will find it much more satisfactory to buy Greenheart already dowelled and tapered and to scrape it down to its final dimensions; or he can buy a square-section strip and work it down to size with a scraper and the aid of a grooved board, having a number of 90° V-grooves of various depths in it. Such a board is useful even when dealing with round-section Greenheart.

The timber should be scraped carefully and turned frequently, while a constant check for roundness must be maintained. For this purpose a gadget can be made as shown in FIG. 25; the timber is placed in the Vee and the pencil adjusted so that it marks the timber on any high spots. These are then scraped down, and the process continued until the timber is perfectly round. A piece of Greenheart should be checked in this way every three or four inches throughout its length before the final rubbing-down, which should be done with fine glasspaper.

The durability of Greenheart can be improved by impregnation with raw linseed oil; it is a somewhat lengthy process, but for those who have an affection for Greenheart it is well worth carrying out.

The rod-joints are first finished to size, and rubbed down with glasspaper. They are then washed in warm water, using a fine nail-brush or old tooth-brush to remove all the dust, etc., from the grain. Then they are hung up, with a weight at the end of each piece, until thoroughly dry. A section of pipe must be obtained, a little longer than the rod-joints and of only just sufficient inside diameter to take all the joints. This is firmly corked at one end, stood upright, and almost filled with raw linseed oil. The Greenheart

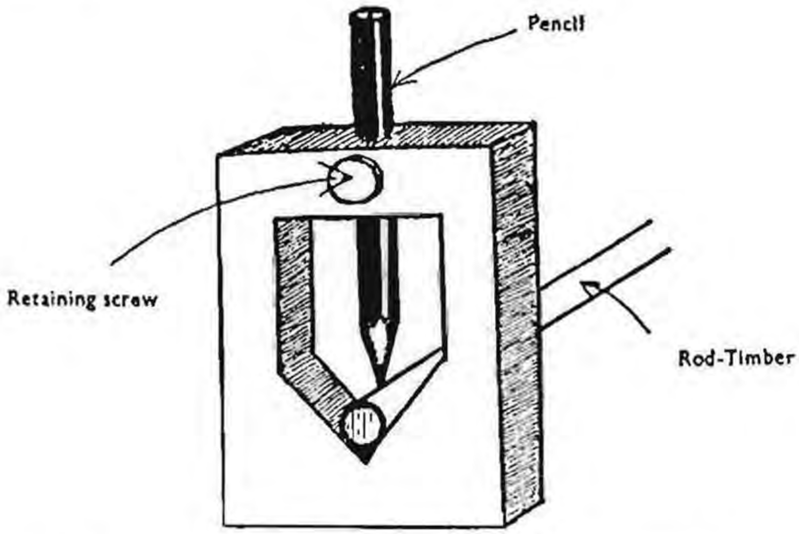


FIG. 25 Device for checking roundness of timber

is then heated in front of a fire until it is uniformly quite hot—though care must be taken not to scorch it—and is put into the pipe containing the linseed oil, where it is allowed to soak for two or three days.

Each piece is then removed, wiped down and again hung up to dry, with a weight to keep it straight. The drying takes several months. When the pieces are quite dry, they are rubbed down with the fine glasspaper and given a rub over with a linseed oil-soaked rag, after which they are allowed to hang for a further period until quite dry. The timber is then ready for the ferrules, handle, rings, etc., to be fitted.

Greenheart is much more compressible than bamboo and great care must therefore be taken to ensure a really firm fit for the ferrules. The timber should be carefully scraped and sandpapered where the ferrules are to fit, making sure that it is kept perfectly round, until it is within a few thousandths of an inch of the right size. It should then be burnished, using a piece of smooth, round, hard steel rod about $\frac{3}{8}$ in. diameter, and considerable pressure, the purpose being to compress the wood slightly and thus attain the final size by a means which will discourage further compressing action by the act of casting when the rod is complete. It is essential to use splintend ferrules on Greenheart rods, and the splints should be bound firmly in place, the whipping extending half-an-inch or so beyond the ends of the splints. Always heat the ferrule to expand it before driving it into position.

The hole in the timber within the female ferrule which takes the spigot of the male, should be made slightly undersize and no more than $\frac{1}{8}$ in. deeper than necessary. Its size should be increased to take the spigot by forcing in a piece of metal of the same size as the spigot; this should be done after the female ferrule has been fitted.

Spanish Reed cane is a very fragile material, and must be treated as such. In structure it resembles Tonkin bamboo, but it is much thinner in the wall, and not only are its fibres softer, but there is less cohesion between them. *It must never be scraped on the outside to reduce its diameter,* and it is therefore necessary to choose material which is of the correct size in its natural state. In this state, however, it has insufficient taper for the majority of purposes, and it becomes necessary to splice several pieces together in the making of a rod.

In order to ensure that these pieces fit together properly, the inside diameter of the larger of two adjacent pieces must be increased to take the smaller piece; before this is done the end should be firmly whipped to avoid the danger of splitting. The outside of the smaller piece should be roughened for an inch or so from the end to allow the glue to grip; make sure that all the roughened part goes into the larger piece. Before setting the pieces together, file the larger piece to a steep taper at the end to be joined, as in FIG. 26. After the pieces have been glued together, this taper can be decreased and a smooth change of dimension produced which is finally covered by a neat whipping. (FIGS. 27 and 28).

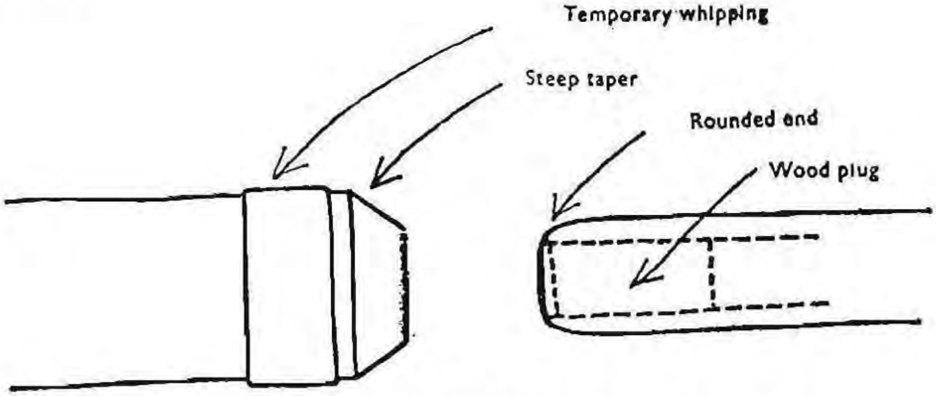


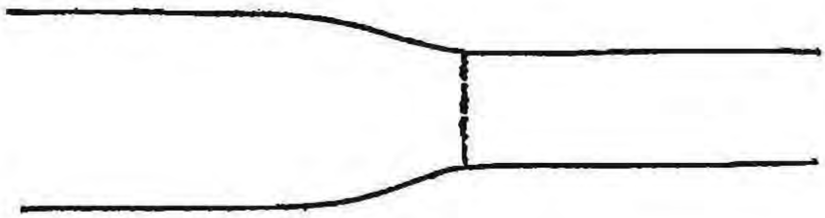
FIG. 26 Joining Spanish Reed or bored Tonkin

The method of fitting ferrules is described in another chapter. In the case of Spanish Reed, since the outside diameter must on no account be reduced to take the ferrules, the latter will have to be obtained of the size nearest above that of the cane, and the latter built up by whippings to a good fit. The cane must be plugged with wooden dowel, and this should be done after the whippings for the ferrules are in place, or there will be splitting. Where the cane fits the ferrule accurately without whippings, the ferrule must be driven *on* and the plug driven *in* together.

All rods made of Spanish Reed should be closely whipped, not only at the knots but at closely-spaced intervals between them.

Bored-out Tonkin bamboo is probably the best material for the butts and middles of long, light rods, provided the material is chosen and bored carefully. The most important points to bear in mind in choosing the material are constancy of diameter and roundness of cross-section. Unless the diameter is reasonably constant, the wall-thickness after boring-out will vary, and, since the bore must be chosen to allow sufficient wall thickness where the outside diameter is least, the piece will be unnecessarily thick in the wall elsewhere. Similarly, if the bamboo is oval in cross-section, it will again be impossible to obtain uniform wall thickness.

Tonkin is bored by means of an extended bit held in a carpenter's brace. It is beyond the average amateur to make these bits himself, and he will have to have them made for him. The simplest type consists of an ordinary



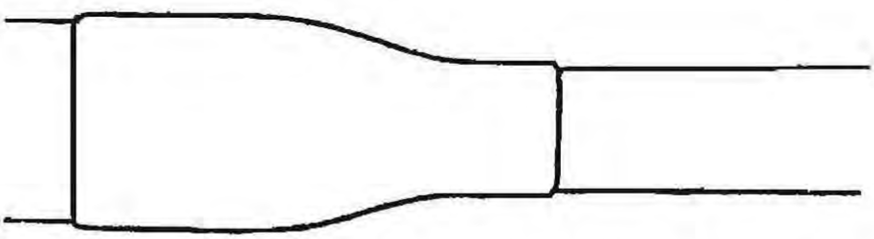


FIG. 27 (Top) After cement has set, temporary whipping removed and larger section neatly tapered

FIG. 28 (Bottom) Whipped over and finished

engineer's twist drill brazed or soldered to an extension shaft of somewhat smaller diameter, whose end is squared to fit the jaws of the chuck on the carpenter's brace.

The twist drill is ground down from the shank end until no shank remains. This enables chips to pass down the flutes and get away behind the drill.

Before commencing to bore, the bamboo must first be straightened by heating and pulling over; it is important to get it absolutely straight and true. It should then be checked for accuracy of cross-section and any tendency to ovality removed by heating and carefully squeezing in a vice. Then the knots are filed down flush and the ends of the cane are firmly whipped for at least two inches with stout thread; it is an advantage to carry the whipping in open spirals right down the cane and back. The cane is then bored, the drill being removed every inch or so and the chips shaken out.

Once the halfway point has been reached, the bore may be recommenced from the other end. It is an advantage to use a series of drills of increasing diameter, the smallest passing through first, followed by successively larger ones until the desired diameter is reached.

In order to help in keeping the bore straight, a small sleeve whose outside diameter is equal to that of the drill and whose inside bore is an easy fit on the drill extension shaft, can be put on the shaft and, after the drill itself has disappeared into the bamboo, this sleeve can be pushed in after it; the provision of a small flange will prevent it going in too far. This will ensure straightness of bore, provided that the extension shaft and drill are both straight and in line, which it is essential that they should be.

Special care must be taken when the drill is going through a knot, as if it is in any way forced, the cane will surely split. It is a wise precaution to bind firmly all the knots before boring is commenced.

For short tips on rods of this kind, built cane made from flat strips is perfectly satisfactory and possesses the advantage of being by far the easiest to produce. In splicing-in tips, remember that a great deal of the strain of playing a fish comes on the splice, which must be strong and thoroughly well made if it is to stand up to its work.

Practice and experience will produce excellent results; a great advantage of bored Tonkin bamboo being its very high ratio of rigidity to weight which enables rods of considerable length to be made with both lightness and high rapidity of striking.

It is, of course, necessary with bored Tonkin to obtain the desired taper by joining sections of different diameter in a similar manner to that used for Spanish Reed. Since Tonkin bamboo is very much harder and stronger than Spanish Reed, a small reduction in outside diameter to obtain accurate fits is permissible, and the outer skin or enamel may be scraped or planed, in order to improve the appearance, without much danger to the action or strength of the rod. Makers of the finest match rods of bored Tonkin usually plane the outside to give constant outside diameter and circular cross-section. The higher the quality of the material chosen, the less outer surface has to be scraped to achieve this. The bamboo must, of course, be plugged where ferrules are fitted, to provide a firmer foundation for them.

Neither Spanish Reed nor Tonkin are satisfactory materials in their natural state for the tips of rods, and tips of built cane or Greenheart must be spliced-in to provide the desired tip action, built cane being by far the most satisfactory for the purpose.

A material which is used much less nowadays than formerly, is East India cane, an Indian brown taper bamboo. This is in many ways similar to Tonkin, but is lighter and more "stringy" in fibre; it is thus rather less brittle. It has a much more pronounced taper, the knots are more prominent, and "bumps" are present at the knots where the leaf-shoots have been removed. Owing to the taper, it is not possible to bore to so thin a wall as in Tonkin, but considerable lightening can be done by a carefully chosen succession of boring drills. Although the knots and "bumps" appear prominent, they will file down nicely, and the cross-section is less prone to ovality than in Tonkin. East India cane is a material worthy of more consideration than is now accorded to it.

As well as actual timber, we have also to consider materials for rod handles. For rods used for freshwater fishing, cork handles have no equal, and we need consider no other materials. The best handles are built from corks which can be bought in appropriate diameters and ready-bored to any desired size.

Handles are built-up by coating the part of the butt timber with adhesive—I find "Durofix" very satisfactory—and pushing on the corks one by one, using plenty of adhesive both on the rod timber and on the ends of the corks, which must be pressed tightly together. Ample time must be given for the adhesive to set; three days is not too long for "Durofix". Then the corks are shaped with a file and finished with glasspaper. Where a lot of cork is to be removed, a sharp knife dipped in water can be used to whittle down the cork, care being taken to leave enough for the final shaping with file and glasspaper. Finish with glasspaper of a very fine grade.

Cork handles may also be made up and shaped before fitting to the rod. A number of cork rings are assembled, with a suitable adhesive, on a bolt of similar diameter to the rod timber, a washer being put at each end and the nut tightened to hold the corks together. After the handle has been shaped the bolt is removed and the handle fitted to the rod.

Where a long, stiff handle is desired, as on salmon and pike spinning rods used with stout tackle, the butt-joint timber can be made short and set into a wood or whole cane handle, over which the cork grip is built up. Beech dowel, straight-grained, is satisfactory, but perhaps the best of all materials for these handles is rattan cane, diameters of from $\frac{5}{8}$ in. to $\frac{3}{4}$ in. being used. Stout Tonkin, well whipped at the ends and knots, also does very well. These handles are, of course, covered by corks as usual.

Cork is not altogether satisfactory as a handle material for sea rods, and a much used alternative is a binding of varnished twine over a wood handle into which the rod-timber is set as described above. Some modern sea rods have attractive grips made of plastic materials.

Setting rod-timber into a wood handle* is a very simple operation, similar to splicing sections of whole bamboo. The handle is bored to take the rod timber to a depth of three or four inches, care being taken to keep the bore in line. A temporary whipping is put on to prevent splitting and the rod timber, plentifully smeared with adhesive, is driven into the handle. When the adhesive is set the temporary whipping is replaced by a permanent one of stout thread or fine twine.

The use of a lathe is of great help in finishing handles; for shaping corks a high speed should be used. A complicated machine is not necessary, the only requirements being a hollow headstock and a tailstock fitted with a centre or a hollow bearing; an electric motor of $\frac{1}{4}$ h.p. will provide ample power. But it must not be thought that a lathe is necessary in order to produce good and professional-looking handles; they can be made with ordinary hand tools.

As many books dealing with fishing tackle mention materials other than those already dealt with, a short list of some other materials is included here, with brief comments:

Lancewood. Used for tips on cheap rods. Warps very badly indeed and breaks easily. Fishing stresses soon give it a permanent bend.

Hickory. A heavy timber which also warps badly; it is highly shock-resistant.

Blue Mahoe. A kind of over-heavy, inferior Greenheart.

Black Palm. Used for some American sea rods. I have never seen this timber.

The ordinary well known hardwoods, oak, ash, teak, etc., are not suitable for fishing rod construction; beech has its uses for handles and ferrule stoppers. Some soft woods are sometimes employed for the neutral-stress region of laminated rods, white pine being perhaps the most usual; see chapter on design.

APPENDIX

In long stiff match-rods having their butt and middle sections of Spanish reed, it is often found that in order to be able to build up a cork grip having a reasonable thickness of cork over the timber, it is necessary to have a considerable overall diameter of cork—often as much as $1\frac{3}{8}$ in. or even $1\frac{1}{2}$ in. So fat a grip is disliked by many anglers, myself included; it interferes not only with comfortable holding but with adequate control of the reel.

The remedy lies in replacing the lower twenty inches or so of the reed butt section with a spliced-in-length of tonkin of smaller diameter. This must be

* See Appendix.

firmly set inside the Spanish reed and a stout whipping laid over the join. Corks are then built up on the tonkin, allowing a grip diameter of one inch or thereabouts. Gloomy predictions that such a construction would fail to stand up to fishing stresses have not been fulfilled in the case of a rod that I use constantly.

Reducing diameter is possible with some kinds of natural canes, especially tonkins. A bell-mouthed brass or steel tube is used and the heated cane, whose diameter initially exceeds the inside diameter of the tube, is driven inside. The tube itself may be heated also with advantage. By the use of metal tubes of successively smaller diameter, quite a considerable reduction in the diameter of the end six inches or so of a cane may be made, so that a step in taper can be made at a ferrule, or a stronger join obtained at a splice.

CHAPTER FIVE

FITTINGS

RODS are equipped with some or all of the following fittings:—

Rings or line-guides,
Ferrules,
Reel-fittings,
Shoulder collar,
Butt-cap.

Rings are available in a variety of shapes and sizes (FIG. 29.) The old-fashioned, lie-down rings are now completely obsolete. Snake rings are unsatisfactory except on fly-rods and even there they are not so good as the more modern type of bridge ring. The best rings are those based on the principle of the "Bell's Life" ring. These are obtainable in three types, known respectively as High Bell's Life, Low Bell's Life, and Fullopen Bridge. Of these, the first two are used chiefly on the longer rods used in float and general coarse fishing; the last are well suited for use on fly and spinning rods, those for the latter purpose being stouter and heavier in the wire, while for fly rods a light ring is more satisfactory. All metal parts in rod rings ought to be of nickel-silver; plated, hard-drawn brass, or stainless steel; ordinary rings made of steel, however heavily plated, will sooner or later show signs of rust.

For *intermediate* rings there is no need to consider anything but one of the three kinds of rings on the "Bell's Life" principle, except possibly on fairly stout spinning-rods, where agate-lined (or synthetic agate lined) rings are worth consideration. It is a great mistake to fit agates throughout on light rods, as although the friction on the line is slightly reduced thereby, the extra weight of the agate rings seriously impairs the action of the rod. Unless agate rings of very much lighter design than those now on the market eventually become available, it can be said definitely that lined rings should never be fitted as intermediate rings on anything but pike and salmon spinning rods and even heavier weapons.

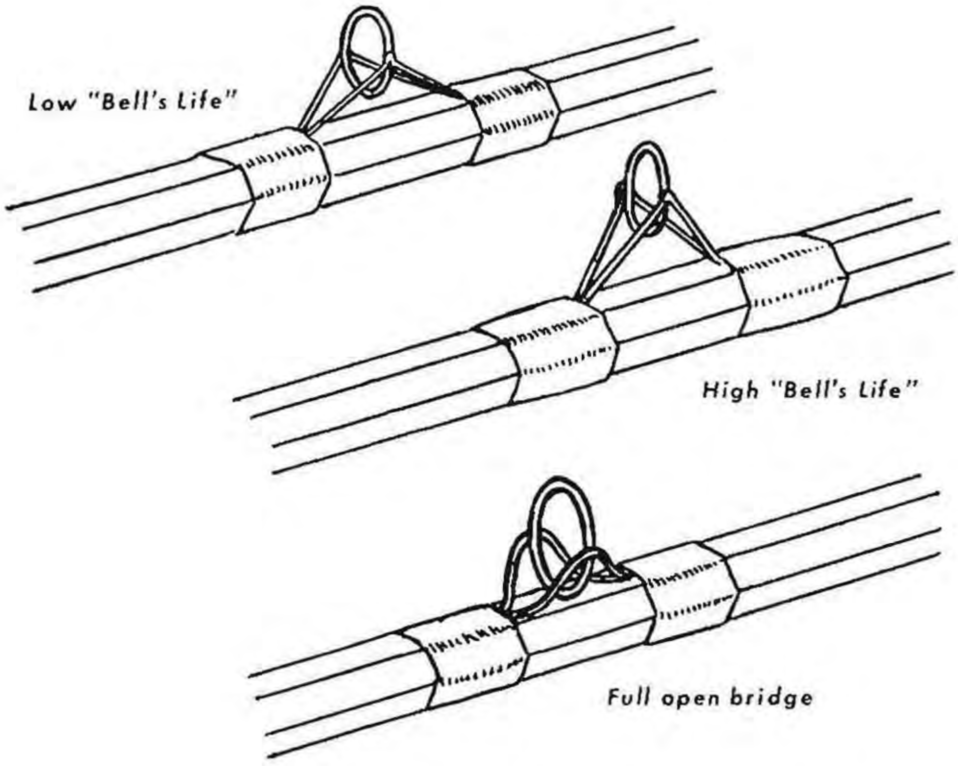


Fig. 29 Types of intermediate ring

It is a different story with butt and tip rings; these should be agate or synthetic agate lined on all good rods; rods used with fixed-spool reels should have extra large agate-lined butt rings standing well away from the rod; these are available in 18 and 26 millimetre sizes, and where lines of 6 lb. breaking strain or over are to be used, the larger size should always be fitted.

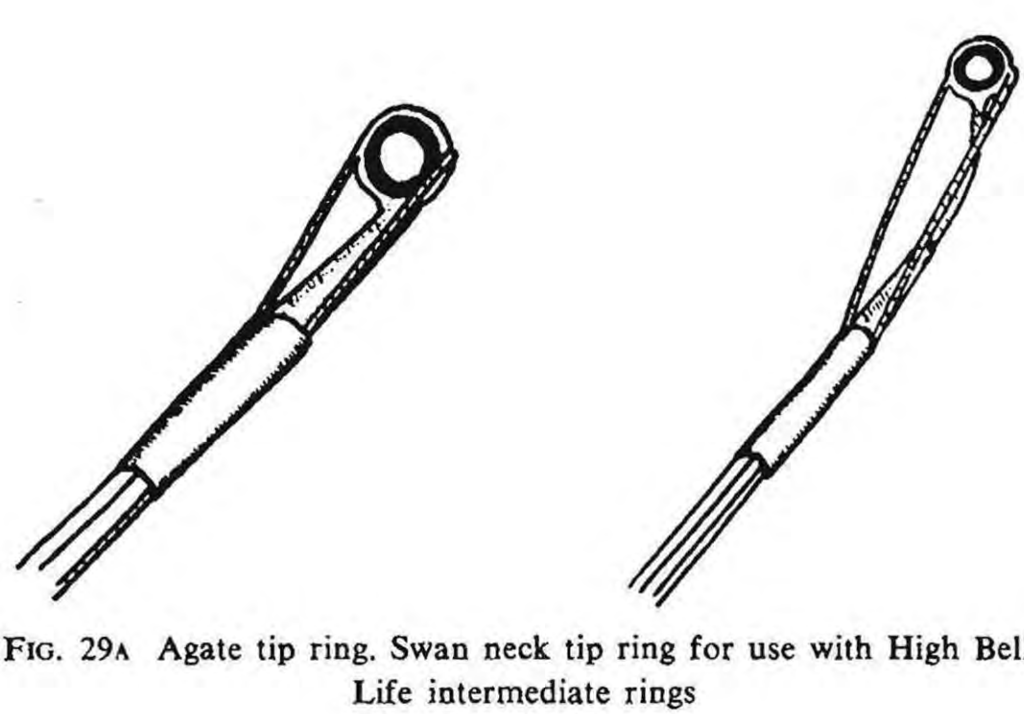


FIG. 29A Agate tip ring. Swan neck tip ring for use with High Bell's Life intermediate rings

Ferrules, also, are of various kinds (see FIG. 30). Since the ferrules are always the danger spots of a rod, none but the very best is worthy of consideration. Many ingenious "lock-fast" devices have been used to prevent separation of the ferrules of a rod in use. They all add weight; most of them are effective, but I think no better than first-class reinforced splint-end suction ferrules, made of hard-drawn brass and really accurately fitted. For extra light rods, which are not intended to stand heavy work or continuous casting, plain ferrules are quite satisfactory, while for long rods used in roach fishing—14 feet and over—hard duralumin reinforced splint-end suction ferrules, provided they are properly cared for, are great weight-savers, though their wearing qualities are not, of course, equal to those of hard brass ferrules. As far as I am aware, duralumin ferrules are not made commercially in England, though they are available in the U.S.A.; if they are wanted they will probably have to be made specially.

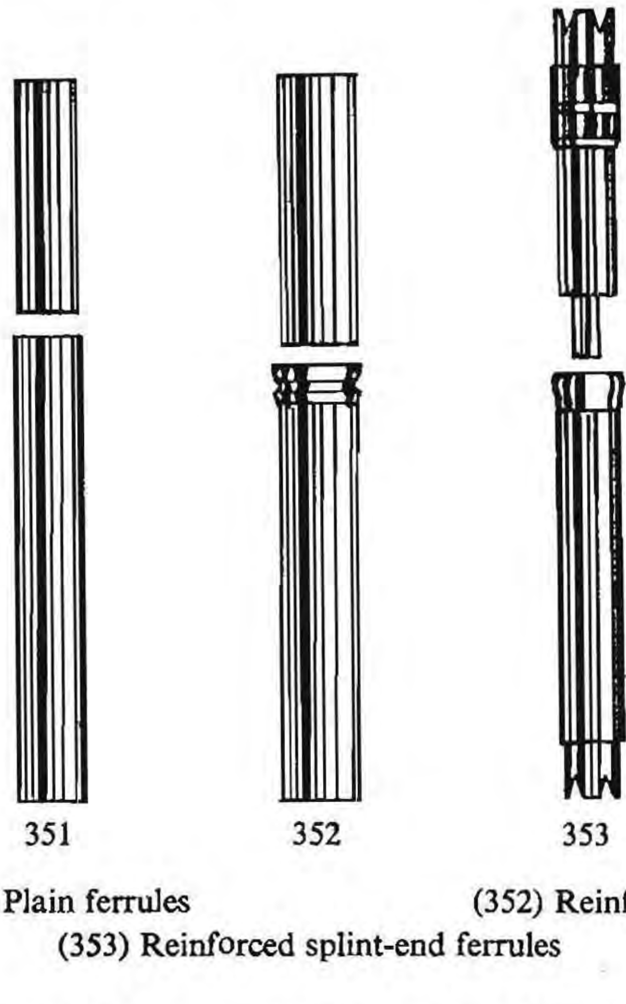


FIG. 30 (351) Plain ferrules (352) Reinforced ferrules (353) Reinforced splint-end ferrules

Some highly specialised match rods have no metal ferrules at all, the joints being made with the timber of the rod, and when these are well made they are quite effective, provided they are kept as dry as possible.

Of *Reel-fittings* for float-fishing and general rods, the plain, tapered sleeve fittings are quite satisfactory, and enable the reel to be placed anywhere on the handle. I like very much the duralumin knurled ones. These fittings also do well enough on spinning rods, especially on light threadline rods; but on heavier spinning rods and on fly-rods there is much to be said for screw-grip reel-fittings.

Shoulder collars are largely for appearance sake, and are omitted on many of the latest rods. A light duralumin collar at the junction of the cane and the cork handles does, however, improve the appearance of a rod, as does a butt cap of the same material. Where a rubber button is desired a metal butt cap is essential, except where the rod-timber at the butt is large and firm enough to be drilled and tapped, but rods of high quality are now on sale which have no butt cap at all, the corks being simply rounded off at the extreme butt end.

Professionally-built fly rods are sometimes provided with ingenious means of carrying a spear in the butt which can be brought into operation when desired. Unless the amateur has access to a lathe and knows how to use it, he will have to do without such devices; if he wants a spear he will have to use the ordinary screw-in type, in conjunction with a butt cap designed to take it—the ordinary kind with a $\frac{3}{8}$ in. B.S.F. screwed hole being quite satisfactory as long as the spear is not mislaid or lost. I have never used a spear myself, so I do not miss having one.

The attachment of these various fittings to a rod is as important as the material of which the rod is made. No matter how high the quality of the rod timber, it cannot do itself justice if the rings or ferrules are badly fitted, or if the reel is continually falling off.

Rings are whipped on with silk or artificial silk. At one time I would use nothing but pure silk, but now I use artificial silk—"Sylko"—wherever a

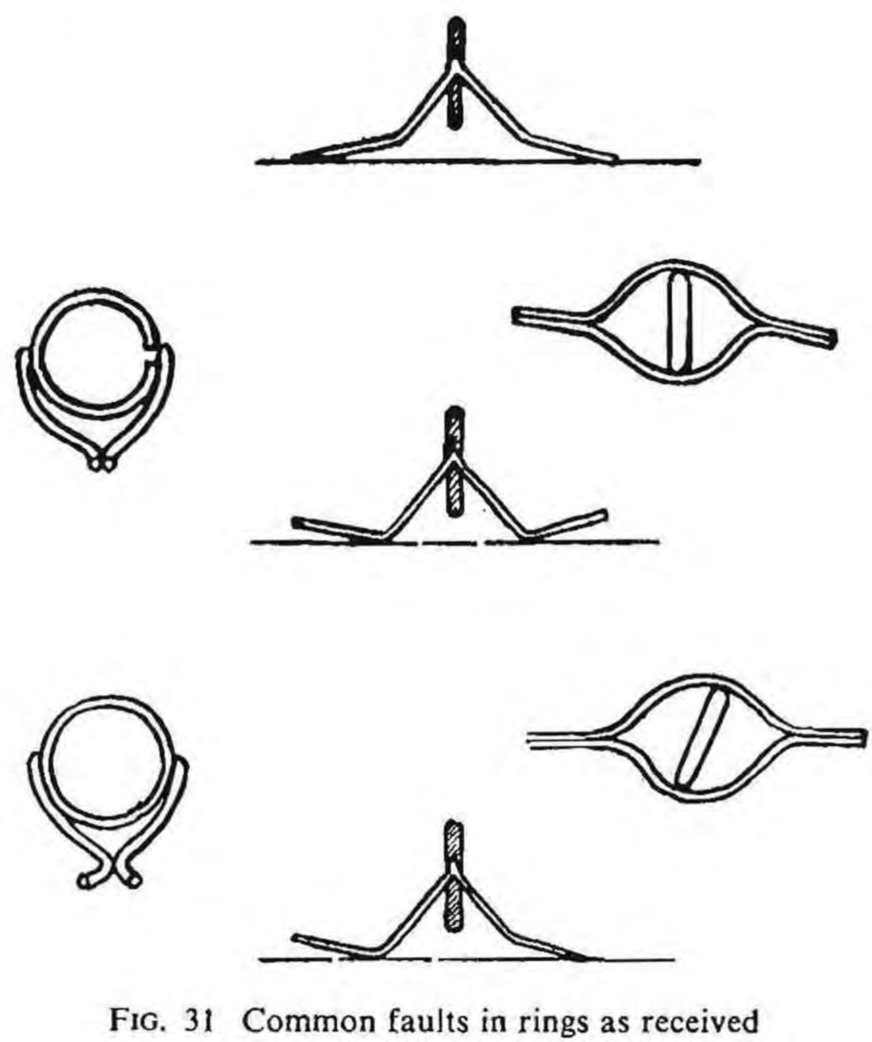


FIG. 31 Common faults in rings as received

really strong whipping is needed. It doesn't look *quite* so beautiful as the pure silk, but it is stronger as well as cheaper and stands up better to wear and tear. I still prefer the pure silk for very thin tops as it is less bulky and makes a neater job. Nylon monofil in the thinner sizes also makes a good whipping material, and never rots or weakens.*

Most rings as purchased will be found to require some filing of their legs to make these taper nicely and so prevent a gap in the whippings at the end of the legs. Rings should be held against the rod to see if their legs are straight and not bent one way or the other. (See FIG. 31.) Straighten where necessary, and also make sure that the legs are flat and true so that the ring is upright and not canted. A fine file and a pair of pliers will remedy any defects of this kind.

The beginner will find the whipping-on of rings much easier if he attaches the ring to the rod by means of adhesive tape around one leg. "Sellotape" is very good for this purpose. The other leg is then whipped down. Begin by making one turn of the silk round the ring leg and rod, catching the end of the silk under. (FIG. 32.) Continue the whipping by holding the silk taut in one hand and rotating the rod with the other. Keep the turns touching one another. When the end of the ring-leg is passed, bind in a loop of silk and after winding on four or five more turns, put the end of the silk through the loop. (FIG. 33.) Pull on the two loose ends of the loop so that the end of the main whipping is pulled back and under the last four or five turns, when the loop will come clear away. Cut off the loose end as closely as possible, and the whipping is complete. The tape can now be removed from the other leg and a whipping put on instead.

The whippings must now be secured, and the "dope" used for this purpose depends on what finish the rod-builder requires. If it is desired to retain the original colour of the whipping silk, it should be soaked—after the whipping is completed—in diluted "Durofix", consisting of one part of "Durofix" to two of Acetone. Clear cellulose varnish will cause the whipping to darken several shades and to become translucent. A transparent effect can be obtained by using pure white silk for the whippings; but where translucent or transparent effects are desired care must be taken to keep the silk free from oil or wax.

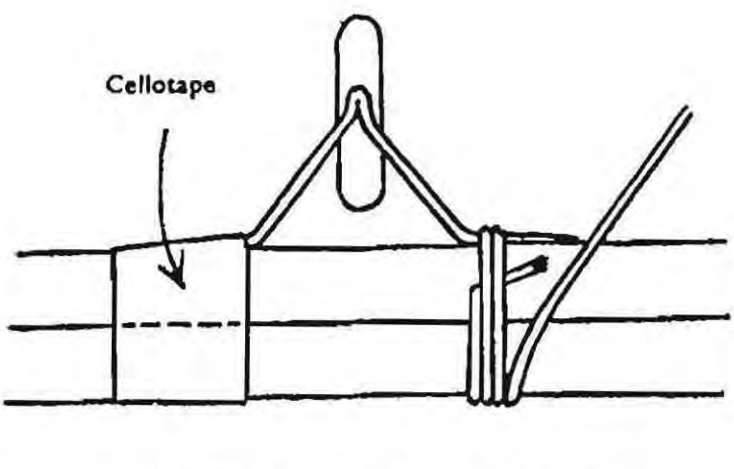


FIG. 32 Starting a ring whipping

* Fine nylon thread is now available and is probably superior to all other whipping materials.

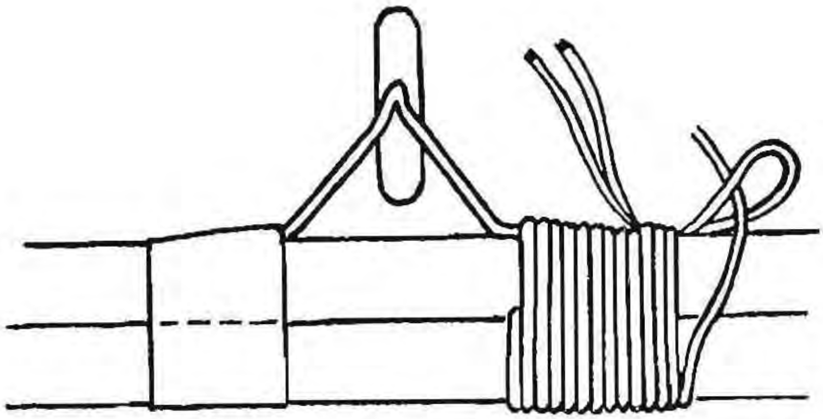


FIG. 33 Finishing a ring whipping

Whether diluted "Durofix" or Cellulose is used, the whipping should be held between thumb and forefinger after soaking and the rod rotated as the "dope" dries; this sticks down the "whiskers" of silk. This should be repeated with the second coat of "dope"; the third can be put on with a soft brush. The "dope" should be kept off the rod-timber as far as possible.

Butt and tip rings on the stouter rods may be well whipped on partly with silk and partly with fine copper or other wire; I find 5-amp. fuse wire very satisfactory.

Tip rings are of various sorts; those which have a small sleeve to fit over the end of the rod will require proper fitting. It is customary to file flats on the end of the top joint to accommodate the "legs" of tip rings; this must not be over-done at the expense of the strength of the top.

On the proper fitting of *ferrules* depends their life and that of the whole rod. It is essential to fit ferrules very firmly and accurately indeed.

All split cane rods which are designed for arduous work should have the bamboo built up where the ferrules are to go. This is hardly necessary on light fly rods and threadline spinning rods, but even there the additional work is not wasted. Building up consists of glueing thin slivers of bamboo on to each flat of the hexagon for a distance of about two inches from the end where the ferrule is to fit. The end of the piece is coated with glue, the slivers are attached and held in position by a thread binding until the glue has set. The whole may then be filed or turned down to take the ferrule. (FIG. 34.)

It is a great advantage to have a micrometer to use when fitting ferrules, but the amateur who is without one can produce a sound job by taking time and working slowly to ensure a perfect fit. The best method is to carefully scrape or file down the rod-timber, being careful to keep it perfectly round and in line with the rest of the joint, until the ferrule just goes on with a hard push fit. Then remove the ferrule and coat the place where it is to go with two coats of cellulose varnish. Allow this to dry thoroughly; then dip the ferrule in hot water and tap it into position with a piece of soft wood. The hot water causes the ferrule to expand; when cool it will grip the rod tightly.

The female ferrule must be set on to the right distance; when the male ferrule is right home there should be at least 1/16 in. between its end and the rod-timber inside the female ferrule. Ferrules seldom go right home when new, but room must be left so that they can eventually do so after wear has taken place.

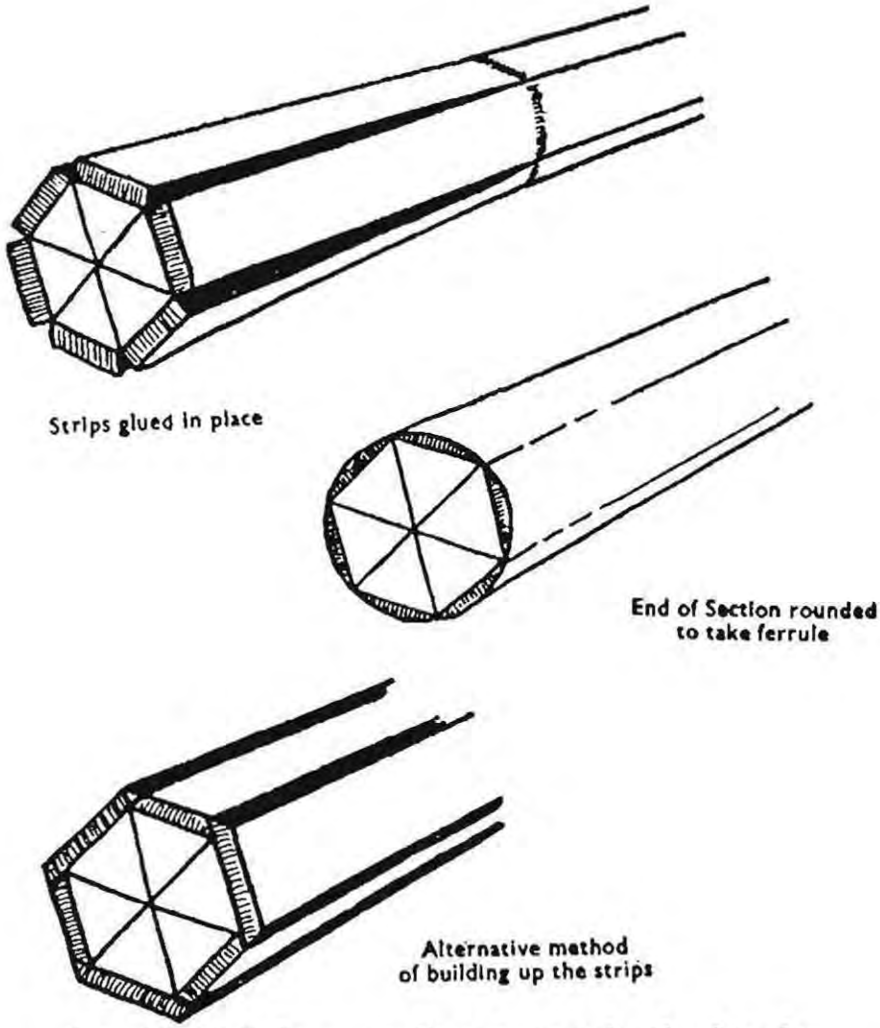


FIG. 34. Building up split cane to take the ferrules.

The spigot on the male ferrule is not necessary on light rods and may as well be cut off. On heavier rods it may have some advantage and a hole should be drilled in the bamboo which fits in the female ferrule, to take the spigot. Really stout rods ought to have a metal liner made for this hole, with a flange at the top to fit the inside of the female ferrule; this is a simple job for anyone who can use a lathe.

Where ferrules have six prongs for whipping down to the rod timber, no difficulty is encountered. Some of the best ferrules, however, are made with only four prongs, and when used on hexagonal built cane these have to be tapped to fit the cane after the ferrule has been fitted, using a very light hammer. The whipping is then put on, commencing on the ferrule and working to a point on the wood about half-an-inch beyond the ends of the prongs. The whipping is treated as described for the ring whippings.

Frequently it is found that the prongs of splint-end ferrules are rather too thick at the ends, and they should be filed down to avoid an ugly step in the whipping. The filing should be done before fitting the ferrule; the easiest way is to grip in the vice a piece of wood dowel on which the ferrule is an easy push fit, push on the ferrule and file the prongs to a fine termination.

It is also necessary to file the prongs of splint-end ferrules to a point; many of them are supplied with wide ends to the prongs and if these are left it will be found that the cellulose filling of the whipping over the prongs will crack at the end of the prongs, which not only looks bad, but may admit moisture.

Ferrules set on whole bamboo must be on firm foundations, and to ensure this the hollow bamboo must be plugged; a plug of well-seasoned beech dowel is quite satisfactory, but one can often find an odd end of built cane which has been left after cutting a joint to length, and this, rounded with a file, makes a good end plug. It is preferable to drive in end plugs at the same time as the ferrule is set on; this avoids any danger of splitting the bamboo. This is especially important in the case of Spanish reed, which is very easily split.

Plugs should go well into the bamboo, as far as the ferrule whipping will be carried, and the end which enters should be chamfered all round.

Before fitting ferrules, the rod timber should be heated where the ferrules are to go and the end dipped in cellulose varnish while hot; the joint should be held so for a minute before removing it. The heat expands the air in the pores of the wood; it contracts on cooling and sucks the cellulose well in, preventing moisture from entering in use and spoiling the rod. Holes drilled to take spigots should also be treated in this way, and cleaned out after the cellulose has dried. Little details of this kind make the difference between a first-class lasting rod and one which may look as good but whose fishing life is very much less.

Some writers on rod making advise the builder to drill a transverse hole in the fitted ferrules and to drive in a small brass brad. Do not heed such advice. If a ferrule is properly fitted, it will never come loose in use and, in fact, will be very difficult to get off under any circumstances. If it is not properly fitted, no transverse pin will save it from becoming wobbly, and will not only hinder it from being removed and firmly re-fitted, but will weaken both the ferrule and the timber which supports it. No rod builder who has seen as many breaks as I have, caused directly by the use of transverse pins in rod-ferrules, would ever dream of using such a device.

It sometimes happens that a beginner will accidentally take off too much wood and find that his ferrules fit too loosely. The remedy in this case is to whip the timber where the ferrule is to go, varnish the whipping and allow to dry before fitting the ferrule. A gauge of silk should be chosen which will result in a good tight fit.

Reel fittings are easy enough to fit; the sliding kind only require to be an easy sliding fit on the cork handle. Screw grip fittings are of various kinds; among the most satisfactory being those which incorporate a thread cut on a length of plastic tubing. Anglers who have had no experience of them are liable to be afraid that these plastic threads may be more susceptible to damage than the metal kind; my experience has been that the reverse is the case. An accidental blow may damage the plastic threads, but it will not prevent the fitting from working, whereas damage to metal threads will often cause jamming.

All these screw reel fittings are easily fitted. Either the cork handle can be filed down until the sleeve is a good fit, or, better, a piece of wood dowel of the right outside diameter can be bored to fit the appropriate place on the rod-timber, *i.e.*, where the reel-fitting is to go; this is then cemented in position and the reel-fitting set on it before the work of building up the cork handle is commenced. One of the advantages of the plastic type of fitting is that corks can be cemented firmly to it by the use of "Durofix".

Shoulder collars consist either of a tapered sleeve or a shaped solid fitting, in each case of appropriate bore to fit the rod-timber at the top of the cork handle. Where tapered shoulder-collars are used, it is necessary to shape the cork to take the fitting. Both kinds of collar are held in place by a whipping on the rod-timber which prevents the collar from shifting away from the corks. As on no account must the rod-timber be reduced in diameter to take the collar, it will be necessary when ordering a collar to specify the size next above that of the timber, and in awkward cases this may mean that the collar will be a loose fit. This can be overcome by building up the diameter of the timber by a whipping of silk or thread of an appropriate gauge.

Butt caps as fitted to most rods consist of a tapered sleeve with the end tapped to take a $\frac{3}{8}$ in. B.S.F. screw, so that either a rubber button or a spear can be attached as desired. This being the case, room must be left in fitting the cap to allow either of these fittings to be screwed right home without coming up against the rod-timber. (The fittings are usually provided with a screw at least twice as long as necessary, some of which may well be removed by means of a hacksaw, so that the butt cap may be set firmly on without an excessive allowance having to be made to take the screw.)

A butt cap is the only rod-fitting which gains from the provision of a transverse pin to keep it in place. After tapering the butt end of the rod or corks accurately, to suit the cap, and fitting the latter firmly in place, a small hole can be drilled through it, the cork, and the rod-timber, and a long transverse pin driven right through, its ends being filed down flush. The pin should preferably be of hard brass.

Butt caps used in conjunction with screw reel fittings on fly-rods are available either built integrally with the fitting, a $\frac{3}{8}$ in. B.S.F. tapped hole being provided at the end to take rubber button or spear, or, in the case of some of the plastic fittings, a neat duralumin button is fitted.

The only other fitting so far not mentioned is the small ring which is fitted to some fly rods just above the shoulder collar, for securing the fly while not actually fishing. This little ring, which should be small and unobtrusive, can be easily made from copper or preferably nickel-silver wire. It is a useful accessory.

CHAPTER SIX

DESIGN

BEFORE we start designing rods we ought to consider how a fishing-rod works. In fact, it has several jobs to do. Generally speaking, these jobs are casting, striking and playing a fish, and rods are designed with emphasis on whichever of these functions is considered most important for the rod concerned. Thus fly and spinning rods have the emphasis on casting, match or roach rods have it on striking, and heavy sea rods, as used for tunny and the like, have the emphasis placed on their suitability for playing a fish.

Casting rods are by far the most complex in design, and fly-rods are the most complicated of this type. A cast is made by forward momentum being given to whatever is being thrown; since momentum is the mass multiplied by the velocity, we can easily see that the higher the velocity imparted, the longer the cast will be. Our task in designing a rod whose primary function is casting, is to impart velocity to whatever the rod will have to cast, whether it be fly-line, plug, spinner or lead.

There are two factors which influence the speed which the tip of a rod attains when a cast is made. The first and simplest is the speed at which the rod is moved by the angler. If the rod were completely rigid, this would be the only factor to consider. If an angler were casting with a completely rigid rod ten feet long, and moved it through an angle of, say, 90 degrees in 1/10th second, the tip speed would be 157 ft. per second.

The second factor is the speed of recovery from bending of a rod which is flexible. When a cast is commenced, a flexible rod bends due to its own inertia and that of whatever weight is attached to its tip. It bends backwards, then recovers and springs back, through the straight position, in a bend forwards. Its recovery speed is therefore added to the speed due to the change in angle, the sum of the two being the velocity to whatever is being thrown.

Of these two factors, the second is the more important. It is this which decides the "action" of a rod.

"Action" is affected mainly by three things. One is the material used for the rod, one is the type of taper, and one is the type of cross-section used.

All materials have what is known as a modulus of elasticity, stress divided by strain. It varies according to the material; thus Greenheart may be said to have an "easy" action compared to built cane of similar dimensions.

The type of taper influences the action of a rod in another way. According to how the taper is disposed, a rod may have what is known as a tip-action, a butt-action, or something between the two, or, which may come as a surprise, both butt- and tip-action. Let us consider how deflection of a rod is influenced by taper.

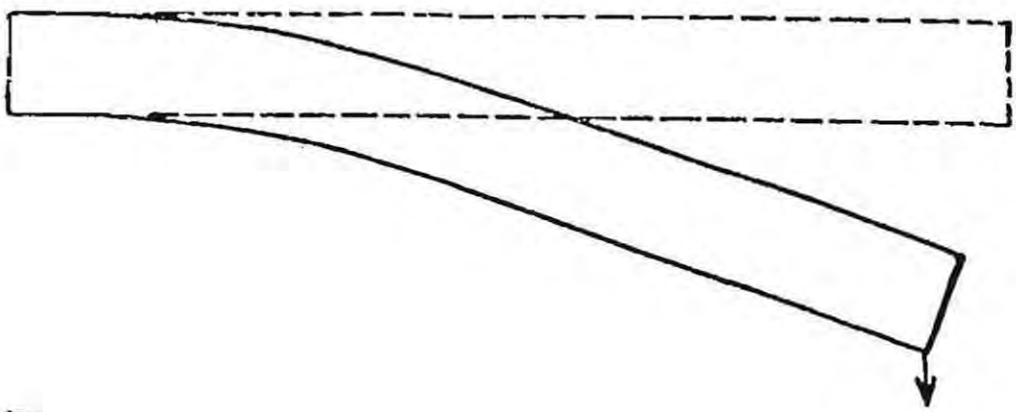


FIG. 35

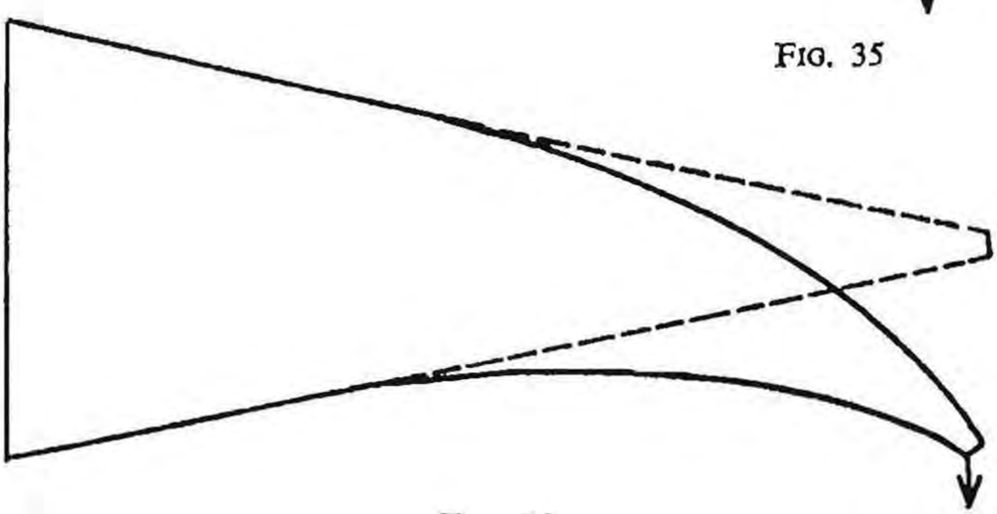


FIG. 36

If a piece of rod of uniform cross-section, *i.e.*, not tapered at all, is held at one end and loaded at the other, most of the bending will be near the point where it is held. (FIG. 35.) If the rod is tapered very steeply, most of the bending will be at the loaded end, *i.e.*, the top. (FIG. 36.) It is obvious, therefore, that there will be a taper which gives uniform bending from butt to tip, so that the curve described by a bent rod is the arc of a circle. A taper steeper than this will result in a tip-action rod; a less steep taper is a butt-action rod.*

Many modern fly rods are made tip-action; the butt and the lower half of the top (in a two-piece rod) have a taper which results in a bending which is the arc of a circle, while the upper part of the top has a steeper taper, resulting in greater bending there. (FIG. 37.) The majority of dry-fly rods, however, have more action near the butt, a stiffish middle and action in the top similar to a tip-action rod; this is achieved by making the taper of the lower part of the rod less steep than would give a true arc-of-circle curve. The rod then bends as in FIG. 38.

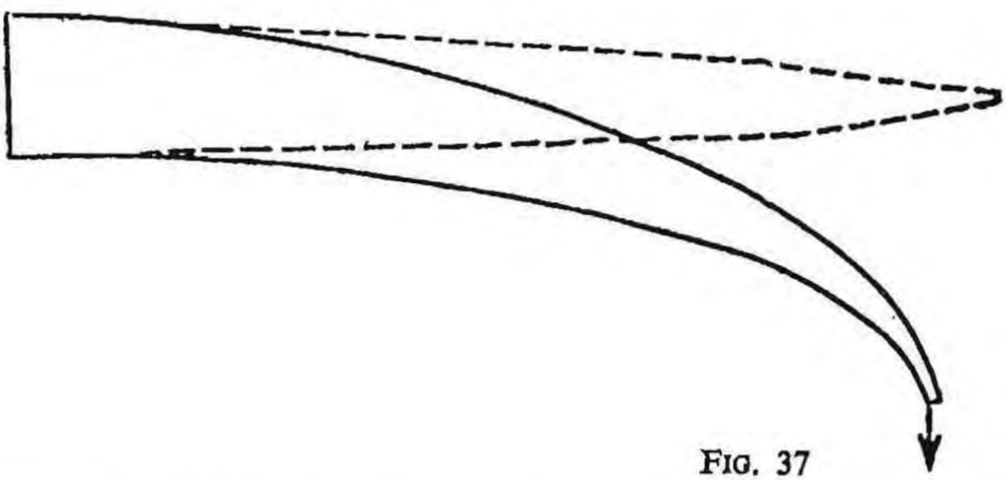


FIG. 37

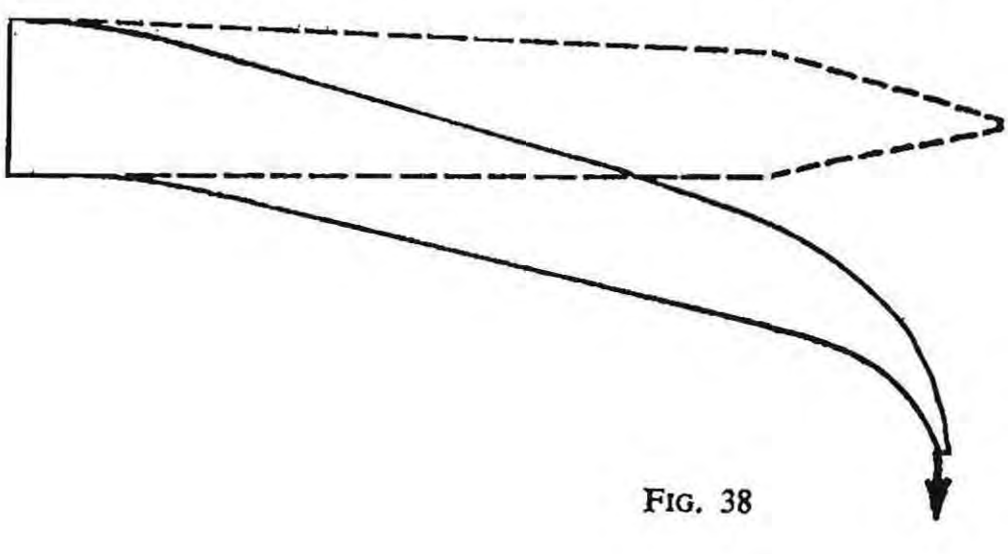


FIG. 38

* The greater the force used in casting, the more the rod will bend near the butt, irrespective of its taper.

In fly rods, provided they are well built, the preference of the particular user has a lot to do with the type of action chosen, but on a basis of very broad generalisation, butt-action is for distance and tip-action for accurate, short-range work. The "double-action" rod is a good and sensible compromise and suits most anglers well. For bait-casting, the type of reel to be used matters, the tip-action being best suited to the flick of the threadline technique, and the butt-action to the longer swing of the multiplier or even longer pirouette of the old-fashioned Nottingham style caster.

In most rods, these combinations of plain tapers will do all that is necessary. In practice the change of taper is not always abrupt; sometimes it is curved as in FIG. 39.

Any of these tapers can be "worked" from the hand grip of the rod, or they can be made to commence operation from some point above the hand by

FIG. 39

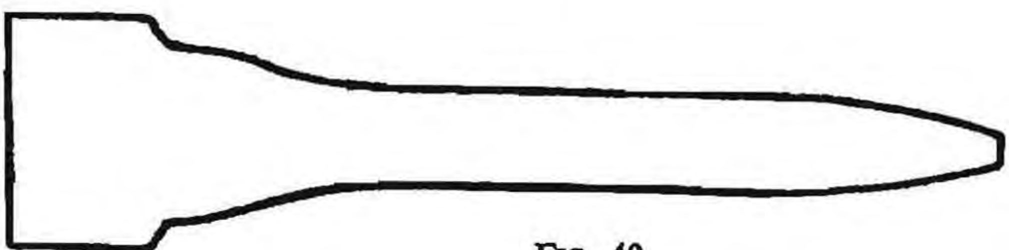


FIG. 40

FIG. 41

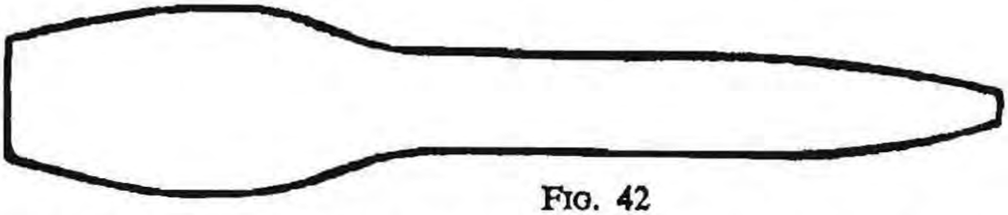


FIG. 42

FIG. 39 Usual dry-fly taper FIG. 40 Large diameter section at butt
FIG. 41 Castle Connell taper FIG. 42 Convex taper at butt

having a comparatively large diameter section under the grip and extending as far as desired above it, with a sharp, almost "step", taper down to the proper rod diameter. The effect of this is to make the rod feel stiffer. (See FIG. 40)

A famous rod action which enabled casts covering a great distance to be made was the Castle Connell, which had a section near the butt made definitely thinner than the section above it. (FIG. 41) This action, though now obsolete, has produced an offspring in the convex taper, which is used in some fly rods; there is a backwards-taper just above the butt. Such rods have great long-range casting abilities, but I find myself very unhappy using a rod of this type against a strong wind or for close, accurate work. (See FIG. 42)

The shape of the cross-section of a rod is almost always made constant throughout its length, the most popular form of construction for split-bamboo rods being a hexagonal or six-strip section. There has, however, been a great deal of discussion about the best number of sides for a polygonal rod and some notions exist on this matter, especially in the U.S.A., which are mistaken. These misconceptions are due to lack of mathematical knowledge on the part of rod-makers and also on incorrect basis of comparison.

The first error is in supposing that a polygonal rod has what are known as "preferred planes of bending". It is quite commonly supposed that a six-sided rod bends more readily "across flats" than "across corners". This is just not true. It is equally stiff in either condition, its deflection for a given load is identical in no matter which plane it is bent. This is true of all polygonal rods having four or more sides.

Of course, if you take a piece of hexagonal rod and bend it in your hands, it will *feel* stiffer when bent across the corners, because your hand will be against an edge, and the *pressure* will be greater in pounds per square inch against your hand; but the *load* for a given bend will be the same.

You may also get the impression that a rod has a preferred plane of bending by using it, with reel—and rings—attached, for casting. As the rings are attached on a flat, and the reel is in line with the rings, when you cast you will feel a tendency for the rod to bend in that plane, because the centre of gravity of the reel is well offset from the centre line (or neutral axis) of the rod. It will thus tend to swing round in line with the force applied. But this is nothing to do with the construction of the rod; you can prove that by fixing your rings and reel on a corner instead of a flat, when you will find that the rod appears to prefer to bend "across corners".

Five-strip construction has been advocated to avoid this supposed "preferred plane of bending", and has become quite popular in the U.S.A. I have been shown five-strip rods which are alleged to have been made to "the same dimensions" as six-strip, and which are definitely more rigid than the six-strip rods with which they were compared. But the dimension chosen for comparison was the distance from the apex of each strip to the opposite flat. This results in a greater cross-sectional area for the five-strip; a greater weight of bamboo has been used. On this basis of comparison, five-and seven-strip rods *will* be stiffer than four-, six-, or eight-strip. They will also be heavier.

To my mind the proper basis of comparison is that of equal cross-sectional area, which is the same as equal weights of material. On this basis we find that for rods of four or more sides, the greater the number of sides the less rigid is the rod, the stiffness and maximum stress figures being as follows:—

Number of sides	Stiffness	Maximum stress
4	0.812	1.54
5	0.795	1.45
6	0.791	1.39
7	0.786	1.36
Circle	0.787	1.27

From these figures it will be seen that the difference is only slight. While the four-strip rod appears to be best, it is inconvenient to make, the ferrules being awkward to fit, though it has the advantage of utilising a higher proportion of hard outer bamboo fibre than the other designs.

With the decrease in the number of sides, the stress in those fibres most remote from the neutral axis is increased for a given amount of bend, and the likelihood of breakage is therefore increased. It is always possible to make any rod stiffer at the risk of greater susceptibility to breakage by baking the bamboo more. On balance, therefore, there is nothing to be gained by departing from the popular hexagonal construction for polygonal split-bamboo.

In practice, the faces of polygonal rods are not flat but slightly rounded, and the corners are usually rounded-off in finishing. The difference in rigidity between rods of different numbers of strips will therefore be even less than the theoretical figures would appear to indicate.

Laminated or flat-strip rods allow a variety of cross-sections. This is a field hardly touched by professional rod-makers, but one in which the amateur can make experiments easily. On some salt-water rods, heart-shaped cross-sections are used. When any rod is bent, all the fibres above a line drawn through the centre of gravity of the cross-section are in tension (stretched), while all those below it are compressed. In a heart-shaped cross-section, the centre of gravity is high and consequently more compression is applied over a longer up-and-down dimension. Most materials are much stronger in compression than in tension.

FIG. 43 shows a laminated rod of heart-shaped cross-section built up of bamboo strip. If you know anyone interested in archery, ask him to show you a modern laminated longbow. You will learn a lot from it, and your archer friend may very likely learn a lot from you.

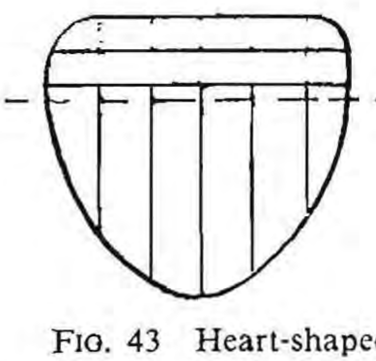


FIG. 43 Heart-shaped cross-section

Rods for match fishing and general float work are made with striking power one of the most important considerations. Striking is little understood. We all know that it should be fast; what is not so well understood is that the action used to obtain it is dependent on the range at which the strike has to be made. Comparison of the equipment used on two well-known rivers will illustrate this. The Bedfordshire Ouse is in most parts a slow-flowing and dirty river. This allows the angler to fish almost under his rod-tip; the fish cannot see him because the water is so coloured. He can, therefore, use a rod stiff in all sections except the extreme tip, which will move fast over a short distance. As he has very little line out, he will get a very quick strike with this kind of rod.

The Hampshire Avon is a chalk stream, quick-running and the water is very clear. It is, therefore, necessary to fish at some considerable distance, either by making a long cast or by "swimming down" methods. In either case a lot of line is out and must be picked up when a strike is made. The rod-tip has to move a long way to do this, and this has resulted in a design of rod having built cane middle and top on a stiff, whole cane butt. Its top moves both fast and far when striking.

We can see, therefore, that the action of match-fishing and float-fishing rods has to be suited to the type of work in hand. It is, however, necessary in most cases to build in more stiffness, especially at the butt-end, than is used in fly and spinning rods. Greater stiffness calls for greater diameter, and in the means used to obtain it, without adding too much weight to what is probably already a longish rod, lies the art of the skilled designer of this kind of weapon.

Although there is perhaps less complexity of taper in these rods than in casting-rods, I think it is true to say that the production of a first-class modern match rod is the height of the rod-builder's art.

Sea-rods are pretty simple things by comparison. The only ones which merit consideration from the casting point of view are beach- and surf-rods. These are designed on the same basis as any other casting rods; for the rest, the main consideration is lifting weight. Weight-lifting is best accomplished by a semi-circular curve, with perhaps a little increase in curvature towards the tip, the arc of the rod approximating to a half of a parabola. Probably the best cross-section is the heart-shaped one shown in FIG. 43, but the conventional hexagonal built cane construction is perfectly satisfactory.

No really satisfactory method of testing the action of a rod has yet been evolved except that of actually fishing with it under all kinds of conditions. Two workshop tests have been evolved which will help a rod-builder to make comparisons between different materials, but these tests must be used with a certain amount of caution. The first is the deflection board test. A very large board is set up, marked, like graph paper, in feet and inches in both directions. The rod under test is fixed with its butt at the top corner of the board and dead in line with the horizontal top line. A standard weight is then attached to a string which passes through all the rod rings and is attached to the butt of the rod. This causes the rod to bend, and its curvature can be noted and recorded. Comparisons with other rods can thus be made.

This test only indicates the static performance of the rod. To obtain some idea of its dynamic performance, a test known as the "free deflection" test was devised. This consisted in counting the number of "waggles" the tip of a rod did per minute after having been deflected and released. It gave some indication of the speed of recovery of a rod. A modification of this test is to attach to the tip a weight equivalent to what the rod is intended to throw, again measuring the number of vibrations to the minute.

It is not, however, really sufficient to measure these vibrations and attempt to deduce the performance of a rod from them. In the U.S.A., casting machines have been devised which give some indication of the casting power of a rod; but even these do not take into account the human element. There are subtle and complex factors which cause a rod which one angler might find excellent to be almost useless in the hands of another.

This is why the finest professional rods are always produced by firms whose directors or designers are competent practical anglers. Experience of rod making and actual fishing enables a rod-maker to build a rod for an individual angler which will suit him better than anything he could buy ready-made. I once made a rod each for two brothers with whom I had fished on several occasions. Although the rods were for use on the same water, I found it necessary to build them with considerably differing actions to suit the gentlemen concerned. This was not a matter of faddiness, but of difference in physique, wrist action and striking technique, and the result was satisfactory to both fishermen.

As well as taper, cross-section and material, a rod is also affected by its fittings. Of these the one having most effect is the reel; owing to its weight, it may exert a considerable influence on the way the rod behaves. This becomes more pronounced the further the reel is from the point at which the rod is held. In the case of fly rods the reel is usually below the hand and acts as a counterweight. It is, therefore, necessary to arrange the grip at a suitable point in order to allow the action of the rod to be fully developed. This brings us to an important consideration—the correct position for the point of balance.

There is only one point at which a fly rod can be held for it to develop its proper powers, and its position depends not only on the placing but also on the weight of the reel. All fly rods should be tried with the reel which will be used with them attached, before the cork grip is shaped. After having marked the position of the hand which gives proper control of the action of the rod, the corks can be shaped to provide a comfortable grip at that position. With very light fly rods it is sometimes difficult to find a position near enough to the butt. The only remedy then is to lighten the butt and reel fittings as much as possible, and if that proves insufficient, a lighter reel will have to be used. It is very difficult to obtain a reel suitable for fly rods of 8 ft. or under, except by buying one with far too small a drum diameter.

Rings have considerable influence on action. Rings which are too heavy slow down the action of a rod. Tip rings on light rods are often bad offenders in this respect. The spacing of the rings is important, too. In the past the majority of rods, and especially spinning rods, have had far too few rings. Differences of opinion exist as to the correct number and spacing. I think there should be at least one ring per foot run of rod, not spaced at one foot intervals, but closer together as the top is approached. A good arrangement for a nine foot, 2-piece fly rod would be one on the butt, three or four on the middle and four or five on the top, not counting the tip ring. A spinning rod ought to have nearly as many. There should always be a ring within four inches of the tip of a fly rod. Rings should be graded in size; for most rods three different sizes of intermediate rings will be sufficient. For rods which will be used "rings-up", the rings should be spaced so that the line does not touch the rod when it is bent as it would be in playing a fish.

All sorts of arrangements are possible for the handles of rods. It is important to decide whether the handle shall be stiff or flexible, especially in the case of spinning rods, whose handles may be as long as thirty inches, and, if stiffened, will have a tremendous effect on the action of the rod. Some handle styles are shown in FIG. 44

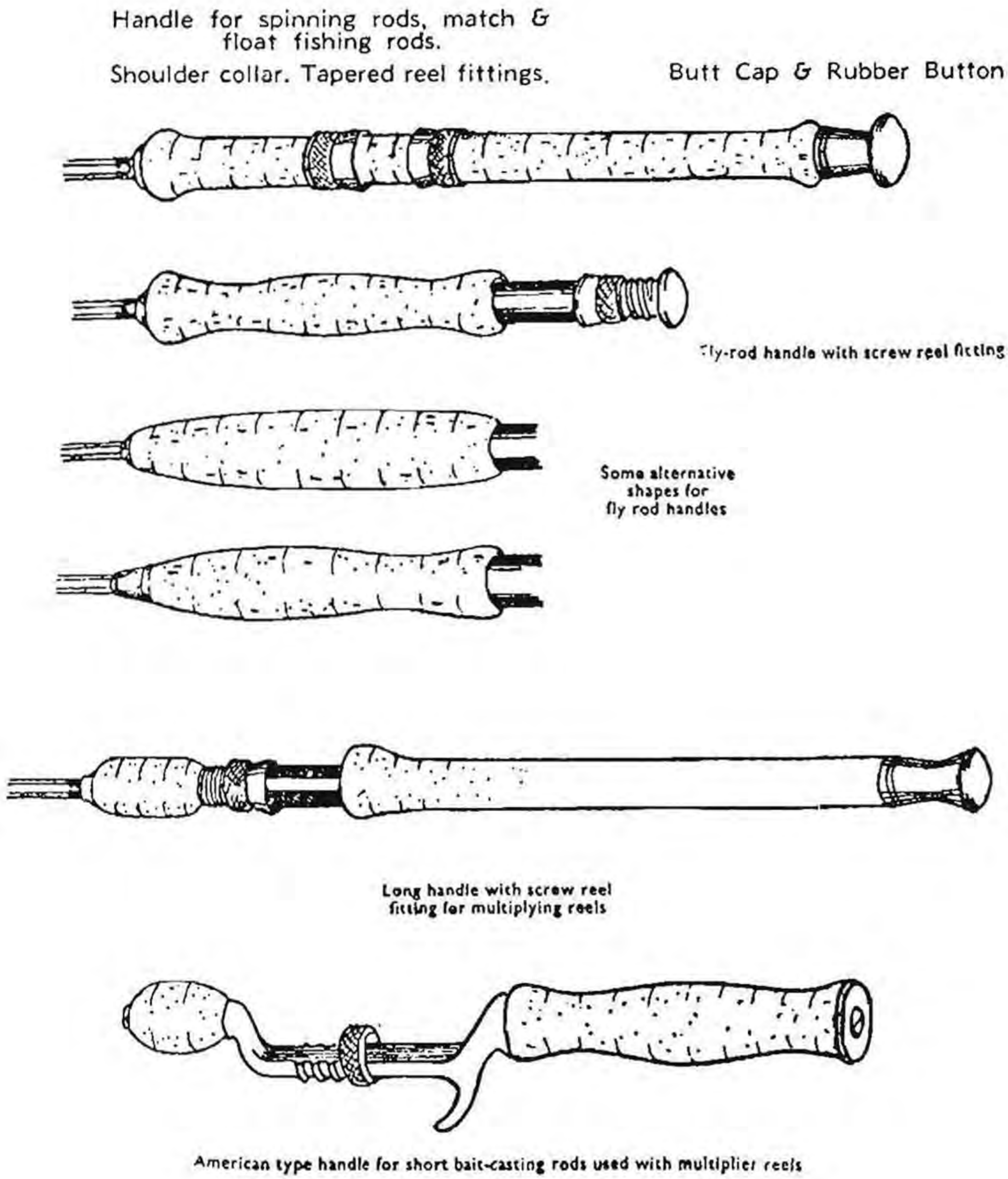


FIG. 44 Handles

It is almost impossible for a novice rod-builder to design a rod without reference to either another rod whose action is known, or to dimensions available.

I am, therefore, giving a few sets of dimensions at the end of this chapter; but these will be insufficient for many people's requirements. By far the best plan for the amateur is to collect his own information, borrowing as many rods as he can, trying their action, measuring them, weighing them, and making notes of the fittings, etc. In order to take the dimensions of a rod, a micrometer and a long piece of wood marked in feet and inches are needed. I have a five foot board with a tape measure glued to it. The measurements of diameter should be taken at least every six inches, preferably closer. On round-timber rods, take two measurements at each point, at right angles to one another, and note the average. On hexagonal rods, always measure across the flats, never the corners. If you want the corner-to-corner dimension, multiply the flat-to-flat reading by 1.155. Take all the dimensions you can get, including handle diameter and length, ring-spacing, ferrule sizes, etc., and make notes of the action of the rod and any other features of the rod which you wish to record.

It will help if you plot a graph of the taper. FIG. 45 shows the tapers of three dry fly-rods of 7, 8 and 9 feet respectively, the 8 foot rod being a tip-action design.

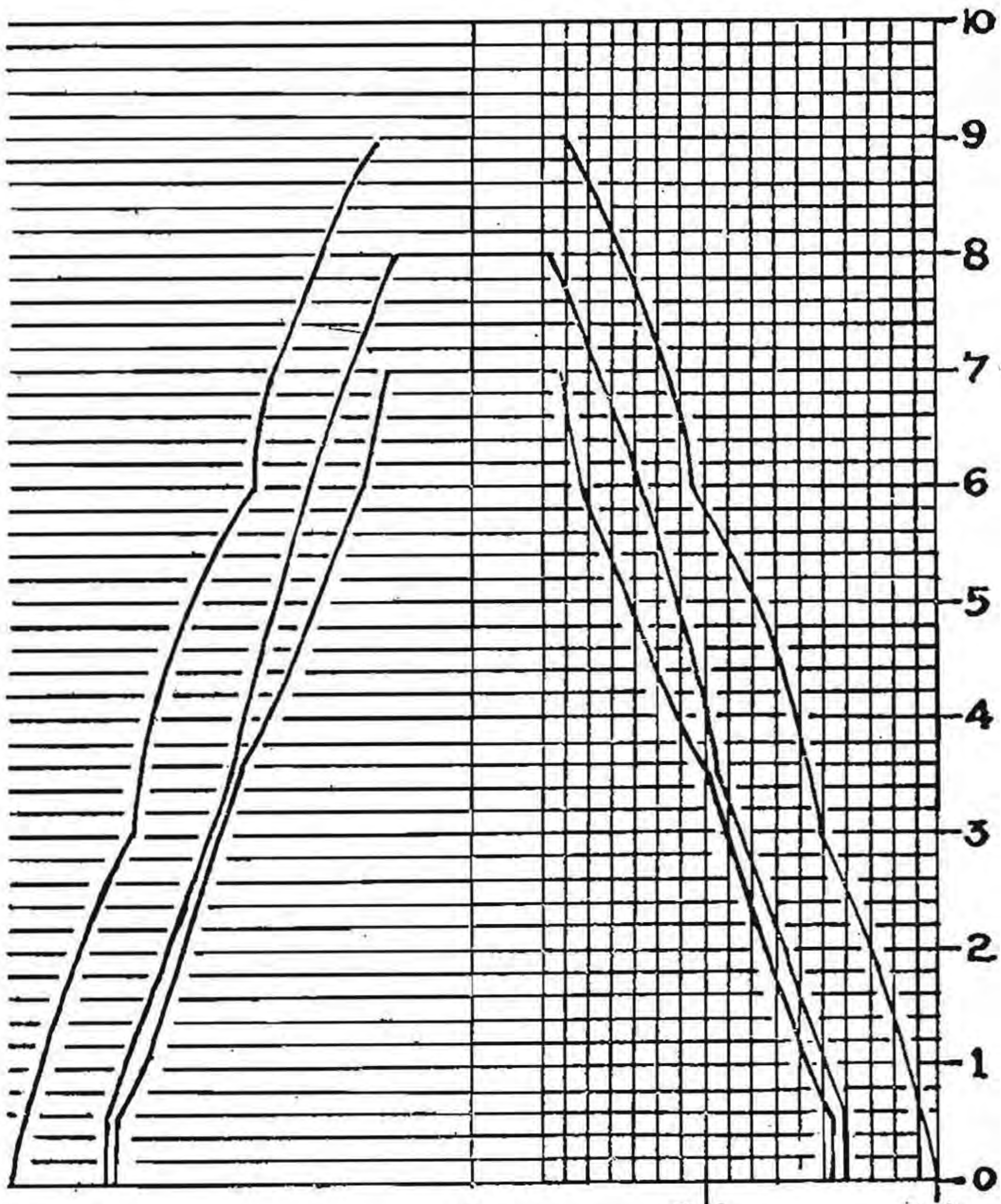


FIG. 45. Graph of tapers of three fly rods; measurements are from inner apex to centre of flat of each strip.

A collection of notes and graphs of this kind will enable the amateur to produce a wide range of rods for he can modify the dimensions of any of the rods in his list to alter their length or action in any way he desires. Where it is desired to alter length or deflection, the following formula may be useful.

$$\text{The deflection of a rod} = \frac{wl^3}{3EI}$$

where w is the load, l the length, E the modulus of elasticity and I the moment of inertia.

The modulus of elasticity E is a function of the material, and the moment of inertia I is a function of the type of cross-section, being 0.06 d^4 for a hexagonal rod, where d=diameter. It will be seen that the formula giving the relationship between load, length and diameter is:—

$$\text{Deflection varies as } \frac{wl^3}{d^4}$$

Readers who are mathematically-minded will be able to work out the necessary alterations in length or diameter should they wish to modify an existing design.

Certain types of angling demand rods whose ability to play a fish is a very important attribute. In threadline angling the relationship between the deflection of the rod and the strength of the line is important. Figures can be obtained for the load which deflects a rod to a definite extent; a popular and useful figure is that for the weight or pull required to bend a rod so that the line is a continuation of the curve of the tip and at right-angles to the butt. I find that a suitable figure for this pull is one-fifth of the breaking-strain of the line in use; *i.e.*, a rod for use with a five-pound breaking-strain ought to take the bend described above with a pull or load of one pound.

The appendix at the end of this chapter contains dimensions of a number of rods of various kinds, excluding sea rods. I do not hesitate to admit that I do not like sea-fishing and know little about the right kinds of rod for its various aspects. The fresh-water rods given are all proved designs.

Wherever built cane is specified, the dimensions given are from the apex of each strip to the opposite face, *i.e.*, half the diameter of the rod taken across the flats. All the split cane for these rods is hexagonal.

One-piece baitcasters are given with full handle allowance. Where detachable offset handles are to be fitted an appropriate amount must be omitted at the butt-end.

The dimensions given for whole Tonkin and for Spanish Reed are approximate only. It would be impossible to obtain natural materials to exact sizes, and in the case of coarse-fishing rods, which have nearly all their action in the tip, small variations in the diameter of the whole cane parts is not important.

The list of dimensions is not intended to cover a complete range. It is simply a list compiled from rods belonging to me and to friends of mine, plus some tapers which have been recommended as effective. As stated earlier, every amateur rod-builder should compile his own list; readers of this book can take my list and add to it, thereby getting off to a good start.

MATCH RODS

1. 12 ft. ferrule-less 3-piece.
Butt, whole Tonkin, tapering from 27/32 in. to 25/32 in. outside diameter, bored 21/32 in. Length 51 inches.
Middle, 2 pieces whole Tonkin.
One piece tapering from 11/16 in. to ⅝ in., bored ½ in., length 26½ in., spliced to one piece tapering from ½ in. to 15/32 in., bored 11/32 in., length 26½ in. Overlap 2 in.
Top, one piece whole Tonkin, one piece built cane. Tonkin tapering from ⅜ in. to 5/16 in., not bored, length 14½ in. Built cane, straight taper 0.100 in. to 0.040 in., length 37 in. Overlap 2 inches.
Lower ends of top and middle joints are reduced to 11/32 in. and 21/32 in. respectively, to fit bore of piece below. Middle is reduced for 2 inches. Top is reduced for 1½ in.

2. 13 ft. 6 in. ferrule-less 3-piece.
Butt, whole Tonkin, tapering from 29/32 in. to 13/16 in., bored 11/16 in., length 57 in.
Middle, 2 pieces whole Tonkin.
One piece tapering from 23/32 in. to 21/32 in., bored 17/32 in., length 29½ in., spliced to one piece tapering from 17/32 in. to ½ in., bored ⅜ in., length 29½ in. Overlap 2 in.
Top, one piece whole Tonkin, one piece built cane.
Tonkin tapering from 13/32 in. to 5/16 in., not bored, length 20½ in. Overlap 2 in.
Built cane as for 12 ft. rod above.

3. 11 ft. 2-piece, duralumin ferrule.
Joints as in 12 ft. rod above.
Butt, outside diameter 0.550 in., tapering to 0.475 in., whole Tonkin, bored 11/32 in., length 66 in.
Top, one piece whole Tonkin, tapering from 0.425 in. to 0.325 in., bored ¼ in., length 36 inches, spliced to built cane tip, straight taper from 0.090 in. to 0.040 in., length 32 in., built up for 2 in. at thick end and rounded to ¼ in. diameter.

4. 15 ft. 3-piece duralumin ferrules.
Butt, Spanish Reed, tapering from 15/16 in. to ⅞ in., length 60 in.
Middle, two pieces Spanish Reed.
One piece tapering from 13/16 in. to ¾ in., length 48 in., spliced to one piece tapering from 0.560 in. to 0.550 in., length 12 in.
Top, one piece Spanish Reed, one piece built cane.
Spanish Reed tapering from ½ in. to 13/32 in., length 18 in., spliced to built cane tip, straight taper 0.150 in. to 0.040 in.

GENERAL RODS

1. 11 ft. 3-piece Roach Rod.
Butt, Spanish Reed, tapering from ¾ in. to 11/16 in., length 44 in.
Middle, two pieces.
One piece Spanish Reed, tapering from ⅝ in. to ½ in., length 32 in., spliced to one piece Tonkin, tapering from .350 in, to .325 in., length 14 in. Overlap at splice, 2 in.

Top, two pieces.
One piece Tonkin, tapering from 0.280 in. to 0.220 in., length 14 in., spliced to built cane tip, taper 0.090 in. to 0.045 in., straight taper, length 31½ in. Overlap at splice 1½ in.

2. 11 ft. 3-piece Avon Rod.
Butt, one piece Tonkin, tapering from 19/32 in. to ½ in., length 26 in., set in solid wood handle ¾ in. diameter, length 20 in., overlap 2 in. (Handle is cork-covered after assembly.)
Middle, built cane, straight taper 0.200 in. to 0.135 in., length 44 in.
Top, built cane, straight taper 0.130 in. to 0.045 in., length 44 in.

3. 11 ft. General Rod. 3-piece.
Butt, one piece Tonkin, tapering from .675 in. to .600 in., length 44 in.
Middle, one piece Tonkin, tapering from .555 in. to .475 in., length 32 in., spliced to one piece Tonkin, tapering from .375 in. to .365 in., length 14 in., overlap 2 in.
Top, one piece built cane, lower 18 in. tapering from 0.175 in. to 0.100 in. Upper 26 in. from 0.100 in. to 0.045 in. Twin taper, all one piece.

4. 9 ft. 2-piece Punt Rod.
Butt, whole Tonkin, tapering from 17/32 in. to 15/32 in., length 54 in.
Top, two pieces. One piece whole Tonkin, tapering from 7/16 in. to 13/32 in., length 6 in., spliced to one piece built cane, straight taper, 0.125 in. to 0.055 in., length 50 in., overlap 2 in.

SPINNING RODS, ETC.—ALL SPLIT CANE

	1	2	3	4	5	6	7	8	9
0″	.188″	.188″	.188″	.228″	.219″	.130″	.220″	—	.250″
6″	.188″	.178″	.188″	.228″	.219″	.133″	.216″	¾″	.237″
12″	.188″	.168″	.188″	.228″	.219″	.133″	.212″		.225″
18″	.173″	.148″	.173″	.212″	.139″	.131″	.207″	.250″	.215″
24″	.157″	.126″	.157″	.189″	.130″	.127″	.202″	.233″	.207″
30″	.149″	.110″	.149″	.173″	.125″	.121″	.195″	.220″	.200″
36″	.141″	.102″	.134″	.157″	.117″	.108″	.186″	.207″	.195″
42″	.126″	.094″	.118″	.140″	.093″	.094″	.175″	.197″	.192″
48″	.118″	.086″	.102″	.120″	.085″	.092″	.163″	.186″	.175″
54″	.102″	.079″	.087″	.100″	.077″	.090″	.148″	.175″	.162″
60″	.094″	.071″	.071″	.084″	.067″	.081″	.135″	.165″	.152″
66″	.087″	.063″	.063″	.070″	.056″	.074″	.127″	.154″	.142″
72″	.073″	.055″			.045″	.065″	.117″	.145″	.132″
78″	.063″					.060″	.107″	.136″	.122″
84″						.055″	.092″	.127″	.112″
90″							.072″	.121″	.092″
96″							.070″	.115″	.082″
102″								.104″	
108″								.092″	
114″								.075″	
120″								.060″	

* Wood handle

1-piece rods.	No. 1—6½′ baitcaster for ⅝-oz. baits. No. 2—6′ baitcaster for ⅜-oz. baits. No. 3—5½′ general baitcaster. No. 4—5½′ general baitcaster, more powerful than 3.
2-piece rods.	No. 5—6′ 4-lb. threadline rod. No. 6—7′ 4-6-lb. threadline rod. No. 7—8′ Salmon spinning rod. No. 8—10′ rod for heavy carp, barbel, etc. (Mk. IV). No. 9—8′ powerful Salmon or Pike spinning rod.

FLY RODS—ALL SPLIT-CANE

	1	2	3	4	5	6	7	8	9
0″	.156″	.160″	.163″	.200″	.173″	.160″	.162″	.155″	.210″
6″	.156″	.160″	.163″	.195″	.173″	.157″	.162″	.155″	.207″
12″	.142″	.149″	.156″	.187″	.173″	.154″	.160″	.154″	.203″
18″	.133″	.143″	.152″	.179″	.172″	.150″	.157″	.152″	.197″
24″	.123″	.135″	.142″	.171″	.165″	.143″	.148″	.145″	.194″
30″	.116″	.119″	.131″	.161″	.152″	.134″	.135″	.130″	.184″
36″	.108″	.113″	.126″	.149″	.142″	.126″	.132″	.125″	.175″
42″	.102″	.105″	.113″	.145″	.140″	.118″	.128″	.122″	.167″
48″	.087″	.102″	.108″	.139″	.137″	.111″	.124″	.115″	.157″
54″	.078″	.094″	.102″	.131″	.130″	.105″	.115″	.100″	.150″
60″	.068″	.087″	.099″	.121″	117″	.099″	.105″	.084″	.142″
66″	.056″	.079″	.096″	.108″	.105″	.095″	.087″	.078″	.134″
72″	.046″	.072″	.092″	.094″	.094″	.088″	.082″	.075″	.127″
78″	.043″	.064″	.082″	.091″	.089″	.081″	.080″	.066″	.124″
84″	.039″	.055″	.074″	.084″	.084″	.067″	.075″	.057″	.117″
90″		.042″	.068″	.075″	.076″	.054″	.060″	.042″	.110″
96″		.031″	.057″	.064″	.066″	.040″	.047″	.035″	.100″
102″			.041″	.055″	.049″		.039″		.092″
108″			.031″	.040″	.039″				.085″
114″									.074″
120″									.063″
126″									.052″
132″									.045″

No. 1—7′ 2-piece light dry fly rod.
No. 2—8′ 2-piece tip-action fly rod.
No. 3—9′ 2-piece fast action dry fly rod.
No. 4—9′ 3-piece powerful dry fly rod.
No. 5—9′ 3-piece stiff action fly rod.
No. 6—8′ 2-piece powerful dry fly rod.
No. 7—8½′ 3-piece light stiff dry fly rod.
No. 8—8′ 3-piece light stiff dry fly rod.
No. 9—11′ 3-piece medium action sea-trout or grilse rod.

	Flat to centre	Wall Thickness	Block length	
0"	.275"	.093"	½"	Cork handle
6"	.275"	.093"	½"	
12"	.275"	.093"	½"	
18"	.275"	.093"	½"	
24"	.275"	.093"	½"	
30"	.237"	.082"	½"	
36"	.223"	.073"	½"	
42"	.212"	.068"	½"	Ferrule two 2" support blocks
48"	.205"	.065"	½"	
54"	.200"	.063"	2" + 2"	
60"	.182"	.055"	½"	
66"	.166"	.053"	½"	
72"	.150"	.051"	⅜"	Splice 3" long from 81" to 84"
78"	.135"	.049"	⅜"	
*81"	.127"	.047"	splice	
84"	.095"	.095"	—	
90"	.088"	.088"	—	
96"	.081"	.081"	—	
102"	.067"	.067"	—	
108"	.054"	.054"	—	
114"	.040"	.040"	—	

5

9' 6" Hollow-built light fast Matchfishing rod. Designed for use with Hardy "Altex" No. 1 fixed-spool reel for slow and still-water matches.

I have been asked to clarify further the application of the formula:—

$$\text{Deflection varies as } \frac{wl^3}{d^4}$$

Perhaps the following examples will do so:—

Suppose we have a rod whose curve when bent, either in casting or in playing a fish, is of the shape we like, but whose power is too great. The rod bends, let us say, to a quarter-circle when the pull in the line is 1½ pounds. We wish to design a rod whose curve has the same shape, but which will bend to a quarter-circle with a pull of 1 pound. The length is not to be changed.

In other words, we want to know how much the diameter of the rod must be reduced to reduce the load (w in the formula) by 50%, keeping the length and the deflection the same.

Let us try what a reduction in diameter of 10% will do. It reduces d to 90 per cent. of its former value, so that d^4 will be 90 per cent. of 90 per cent. of 90 per cent., of 90 per cent. *i.e.* 65.61%.

If l and the deflection are to remain the same, then w varies as d^4; *i.e.*, if d^4 is reduced to 65.61 per cent. of its former value, so also will w be reduced. w was 1½ lbs; 65.61 per cent. of 1½ lbs. is 0.98 lbs. That is as near as makes no matter, one pound, which is what we wanted. So we can say that *to reduce the loading of a rod by 30 per cent. for the same length and deflection, we must knock 10 per cent. off its diameter throughout its length.*

In the same way, we can see that *adding* 10 per cent. to the diameter of a rod, keeping length and deflection the same, will increase its loading (or "*test curve*" rating) by 46 per cent., which is near enough 50 per cent.

Varying the length has the opposite effect, an *increase* in length means a *decrease* in the loading for a given deflection and diameter. For example, an increase in length of 10 per cent. means a decrease in loading of approximately 15 per cent. A decrease in length of 10 per cent. means an increase in loading of about 25 per cent.

By these calculations it is possible to obtain figures for any reasonable modification to an existing design, *provided similar materials are used.* Figures obtained must be regarded as approximations, however; bamboo and similar materials vary somewhat and there are sure to be deviations from mathematical exactitude.

Rods of tubular construction deserve further explanation.

A tube is a particularly rigid construction for a given weight of material, but it is not very suitable where considerable bending is demanded. Directly it begins to bend, its cross-section ceases to be a circle and becomes an ellipse. The stiffness of a rod depends on the moment of inertia of its cross-section, which, in a cross-section that is a regular polygon (including a circle) is proportional to the fourth power of the diameter (d^4) as has been explained earlier. The moment of inertia of an ellipse, however, is proportional to the major axis multiplied by the *cube* of the minor axis. Now, as bending in a tube increases, the major axis increases, but the minor axis is reduced. Let us suppose that the variation in each is 10 per cent. Then the moment of inertia becomes 110 per cent. x 90 per cent. x 90 per cent. x 90 per cent., which is 80 per cent. approximately.

In a nutshell, then, the stiffness of a tube decreases the more it is bent; so it is well to avoid tubular or hollowbuilt constructions in rods, or sections of rods, that have to bend a great deal.

It has always seemed to me that the right application of fibre-glass tubes in match-rods is not in providing fine, much-bent tips spliced to Spanish Reed or Japanese Cane lower sections, but in replacing these whole canes in the lower sections, the tip being of hexagonal split-bamboo.

In rods of tubular construction, or hollow-built, the stiffness is proportional to the fourth power of the *outside* diameter, minus the fourth power of the inside diameter. If this is known, it is possible to calculate the effect of modifying a solid-rod design by making it hollow-built, or to find what increase in diameter will be necessary to retain the original stiffness.

Casting Action

It should be noted that there is an important difference in the action in casting between fly-rods and rods used to cast a concentrated weight, such as a spinner or ledger-lead.

In casting a fly-line, a tangent to the arc of the rod, at the tip, must never come below the line extended in the air. If it does, part of the power inherent in the recovery of the rod from its bend will be wasted, while timing and accuracy are likely to suffer. In practice, this means that the rod must not, in casting, bend further than a quarter-circle at most.

No such limitation applies to rods designed to cast concentrated weights. These are made to fly round in a circle, with accelerating angular velocity, and are released at the appropriate instant, flying off at a tangent. The action is similar to that employed in athletics by hammer-throwers, but aided by the recovery from bending of the rod. A casting-rod may therefore bend beyond a half-circle in casting and still utilise all its power in recovery.

A useful rule-of-thumb for casting-rods is to make the test-curve load, *i.e.*, the pull that will bend the rod into a quarter-circle, about sixteen times the weight the rod is intended to cast. For example, the Mk. IV rod casts 1½ oz. as its best weight (maximum range) and has a test-curve loading of 1½ lbs. This weight of 1½ oz. should be regarded as the maximum that the rod should be used to cast constantly, for it is the one that exercises the full inherent power of the rod. A greater weight would produce excessive stress; but maximum casting range will not be achieved with lesser weights. Similar principles apply to all casting-rods.

CHAPTER SEVEN

BUILDING A ROD

WE have now seen how the various portions of a fishing rod are produced; how built cane is made; how Greenheart is tapered and treated; how whole bamboo is cleaned down, bored and pieces spliced together; and how the various fittings are attached. Now let us go through the process of building a rod, doing the various operations in their logical order.

We will take an 8 ft., 2-piece split cane fly-rod. Our first task, having decided on the dimensions desired, is to prepare the former or grooved boards, according to which method we choose to employ. Next, we take our bamboo pole, bake it and split it up into strips, which are cleaned-up and cut as described. They are then shaped with the aid of the boards or former, and cemented together. When dry, they are cleaned down, measured for diameter, and the surplus length allowance cut off to give the correct sizes.

In building the rod-sections, deal first with the strips for the butt section. If too much is inadvertently removed from a strip, it can be passed on for use in the top, after further planing, and thus is not wasted.

To obtain the correct action, we decide in this case to cut the butt section at its thin end and to the same diameter as the thick end of the top joint, an equivalent amount being cut from the thin end of the top. Although this is to be a light rod which will not be called upon for very arduous work, we decide to build up the bamboo for both male and female ferrules. This we do, and, the adhesive having set, we carefully file the ends of the two pieces of split cane to fit the ferrules and, having obtained the correct fit, we warm the prepared ends and then dip them in cellulose varnish to seal the pores of the cane.

It has been decided to fit a plastic, screw-grip, reel-fitting to this rod; we therefore scrape down the corners of the built cane of the butt section at the thick end, and finish off with a file to produce a circular cross-section for about four inches. Next, a piece of light dowelling is shaved down until it fits nicely into the plastic tube of the reel-seat; it is coated with "Durofix" and the reel-seat tube pushed on. Then the dowel is bored right through to take the rounded bamboo of the butt, which is driven in with a liberal amount of glue.

The best trout fly rods all have the upper reel clip concealed under the bottom of the cork grip. The clip is made to fit, not on the plastic tube, but on the dowel on to which the plastic is fixed, enough of the dowel being allowed to protrude at the top end of the plastic to take the fitting, which is pinned firmly in place with *two* pins. In order to secure firm adhesion of the cork which will cover this clip, it is desirable to entirely cover the clip with a whipping of linen thread. The clip must, of course, be positioned correctly with regard to the rod-rings.

Now the corks are put on. One or more must have an inside bore to fit over the plastic or upper reel-clip; smear with "Durofix" where the corks are to go, the "Durofix" being kept away from where it is not wanted by the use of "Sellotape". The big-bore corks are then pushed on; one is usually enough, and it should be pushed all but fully on to the plastic or the reel-clip; a little must be left proud, though, because the next cork to it, which is one with a bore to suit the bamboo, must butt up tight against it. As many of the smaller-bore corks as desired to form the handle are now put on, both the bamboo and the faces of each cork being plentifully smeared with "Durofix". As each cork is squeezed against its neighbour, lots of "Durofix" will be extruded; this can be scraped off and used, with additions, for the next cork, and so on until all the corks are in place.

Nothing more should be done to the handle until the "Durofix" has had time to set; it is best to wait for three days at least. Meanwhile, work can be continued with the ferrules and rings.

These fittings are carefully examined and any filing which may be necessary is done as described in earlier chapters.

Then wrap some glasspaper round the top joint, about two inches from the thick end, and grip it firmly in the vice so that enough protrudes to allow the male ferrule to be driven on. Brush the protruding end with cellulose varnish; then heat the ferrule—a dip in boiling water is as good a way as any—and quickly drive it home, using a wooden or a hide mallet. A previously made mark on the bamboo at the right distance from the end will indicate when the ferrule is fully driven on. Wipe off any surplus cellulose varnish.

With a light tack-hammer, tap down the prongs or splints of the ferrule until they are shaped to fit the hexagonal bamboo. If the ends of the splints do not lie down flush with the bamboo, put on a temporary whipping of stout thread at the ends of the splints, to force them into place. Then commence the permanent whipping, working from the reinforced part of the ferrule towards the ends of the splints. When the temporary whipping is reached, cut it off and continue the permanent whipping for at least half an inch beyond the end of the splints; then finish with a whip-finish

The female ferrule can now be set on the butt-joint in the same way, but before doing so, make sure that the shoulder collar for the cork handle will pass over the female ferrule. If it will not, it must be slid on before the ferrule is fitted. It need not be anchored in place yet.

If it is decided to retain the spigot of the male ferrule—and this is not really necessary on light rods—a hole must be drilled in the end of the bamboo to take it before fitting the ferrule. An easy and satisfactory way of ensuring a good fit is to drill the hole oversize and fill it with plastic wood. Then fit the female ferrule, grease the male, including the spigot, and connect the two, working the male in as far as it will go, which in the case of high-class ferrules will be short of fully home. Then separate the two joints and allow the plastic wood time to set. When set, extend the hole made by the spigot with a drill of appropriate size, so that as the ferrules wear, the male may eventually go right home. Run a drop of cellulose down the hole.

The glue of the corks having set, the cork handle may be shaped. If there is a lot of cork to be removed, some of it can be pared off with an old table knife or a jack knife, which must be kept very sharp. Dipping the knife in water helps it to cut more easily. Be careful not to take off too much cork. Continue shaping with a file and finish first with medium and finally with fine glasspaper. A lathe helps considerably in shaping and finishing cork handles, but with time and patience a good job can be done without one. If an excessive crack or cavity appears in the cork, fill it with a mixture of "Durofix" and cork filings and smooth over with glasspaper when it is set. The shoulder collar should be kept well away from the cork while the latter is being shaped; when the handle is finished the collar can be set in place and held there by a whipping.

Join the two sections of the rod and sight along it; if it is not straight—and few are—turn the top joint round until all the bends are in the same direction. If the bends are considered excessive, they can be straightened by heating or steaming and pulling-over, but if the sections of the split cane are cemented with "Seccotine" or "Duroglue", care must be taken that they do not separate; a temporary criss-cross binding will prevent this. If the bends are only slight, however, it is an advantage, for if the rings are arranged correctly relative to the bend, their weight and that of the bamboo itself will cause the rod to be straight when held as it will be in actual fishing; *i.e.*, the bend should tend to be upwards and the rings, if the rod is to be used "rings down", should be put on the outside of the bend.

The rod we are making uses a reel-fitting which allows the reel to be put on in line with whichever face of the hexagon we have chosen for the rings. Some screw reel fittings have to be aligned with the rings and cannot, therefore, be fitted until it has been decided to which face the rings are to be attached.

With the rod put together, mark with a pencil where the rings are to go. Then separate the joints and, before putting on the rings, lay on any intermediate or ornamental whippings which you may decide upon. With well-made split cane, cemented with urea-formaldehyde, intermediate whippings are quite unnecessary, but on any rod a few neat rings of coloured silk just above the handle improve the appearance.

Fine fly-tying silk is best for ornamental and intermediate whippings. Then whip on the rings and varnish the ring-whippings with successive coats of cellulose varnish until they are nice and smooth. Finally, put on four coats of the very best quality copal varnish. Don't use a brush, except underneath the rings; use your finger and let each coat be put on as thinly as you possibly can. Allow plenty of time for each coat to dry before applying the next.

When a rod has reached the varnishing stage, it is very irksome to have to wait a fortnight or more before the varnishing is completed. Unfortunately, there is no way of speeding-up the process without detriment to the final result. If you simply can't wait to try a rod once the rings are on, don't use copal varnish. Use cellulose, which dries quickly, and only put on two coats. It isn't satisfactory, but it will last for the rest of the season, after which you can clean it all off with cellulose thinners and revarnish with copal. You will probably spoil some of the whippings in cleaning off the cellulose; that is the price of impatience.

All varnish should be allowed to dry in a warm, dry and dust-proof place with as free a circulation of air as possible.

The procedure in building is the same in general principle for all rods, but there are one or two additional points to bear in mind in dealing with other types.

The cork handle on bottom-fishing rods is long, and where Spanish Reed is used for the butt, of large diameter, there is a considerable variation in diameter, the knots in this material being of less diameter than the average run of the cane. It is necessary to build up the narrower parts with whippings or plastic wood in order to ensure a firm base for the corks.

All natural cane or hollow-built split cane should be protected by temporary whippings during construction; these can be replaced by permanent whippings before the rod is finally completed.

Where the design of a rod calls for the splicing together of canes of different diameter, or where the pieces are built up in stages as in the case of hollow-built, stepped rods, always complete the building-up of each section before fitting ferrules or other fittings, and secure the job with stout temporary whippings. Don't forget the squeezing powers of a damped flax or linen thread binding, and always allow ample time for cement to set.

When split-cane is used for short American-type bait-casting rods, it must be built up to larger diameter at the ferrule. These rods, which have short tips of from 4 to 5½ feet fitting into a metal handle throw all the casting stresses on to the ferrule, and unless this is made particularly sound the bamboo will come loose in the male ferrule, or the male ferrule will get slack, or both. To avoid this, build up the end of the bamboo to take a ferrule at least 30 per cent. oversize, using building-up strips about six inches long, and put a whipping over all. This will, of course, stiffen up the butt and you must design your rod accordingly.

Here are some small points which apply to all rods. Where a whipping needs to be extra secure, as in the case of the whipping at the end of the cane of the lower sections of ferrule-less match rods—the part that corresponds to the female ferrule—use locked whippings. These are done by laying a number of threads lengthwise on the rod; they can be held in place with cellulose varnish or "Sellotape". The whipping is commenced over these, but after four or five turns have been laid on, the ends of these threads are turned back and held down by the continuation of the whipping. (See Fig. 46)

A matt or non-flash finish can be obtained by using matt varnish or by rubbing down the last coat of varnish with fine pumice powder; an "egg-shell" finish, in which the greater part of the flash of a rod is removed without the finish being actually dull, can be obtained by rubbing down the rod with a piece of linen soaked in raw linseed oil. This, done at intervals to rods in use, helps to preserve the varnish and to keep out moisture. Some anglers like their rods stained brown or green; this can only be done on bamboo if the outer enamel is first scraped away, which must not be done on Spanish Reed.

Where the enamel is to be left intact, colouring can only be done with paint or spirit stain, and the appearance of a rod treated in either of these ways does not appeal to me at all.

A very durable protective finish can be applied to the butts and middles

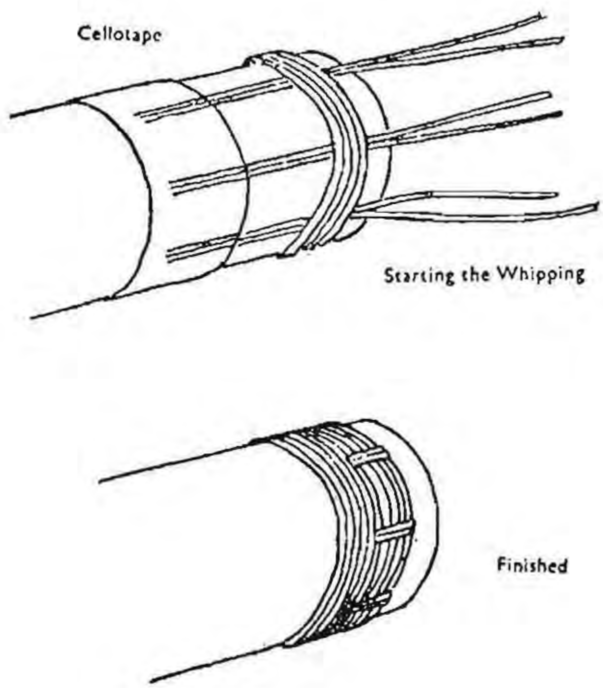


FIG. 46

of built-up whole cane or hollow-built rods, and to heavy spinning or sea rods—in fact, to any rod where the action will not be affected—by covering with a spiral binding of hemless silk tape of the kind used for interleaving the windings of electrical transformers. The binding is laid on with the edges touching, and given several coats of varnish before the rings are whipped to the rod.

Never attempt to use cellulose varnish on top of copal. Try it on an odd piece of cane, and you will quickly see the disastrous result!

Some rod-makers advise waxing the silk used for whippings; others recommend spirit-varnish or shellac for this purpose. My advice is to steer clear of either. By far the best way is to soak the whippings in cellulose varnish or dilute "Durofix" and to twist the whipping round and round between the fingers while still wet, thus "laying" the "whiskers".

You can put your name on your rods in Indian ink, just above the shoulder collar, using a mapping pen, before varnishing.

You should make stoppers for all the female ferrules; I make mine of greenheart or beech, using an electric drill in the vice as a "lathe". I always lose the stoppers the very first time I go fishing with the rod, but I keep on making stoppers because I know how important they are. I am pleased to say I found one a short time ago, at the bottom of a fishing bag, and I have made a note to try to find the rod belonging to it some time!

It is no good making a fine rod and then allowing it to spoil by neglect. Practically every book on angling tells you how to look after your rods. I will, too. If at all possible, have a proper rod rack or cupboard, with arrangements for stowing your rods vertically, like billiard cues. Never leave them in their bags, or leaning against a wall. If you can't stand them upright, lay them flat. Clean them properly after every outing, look them over carefully and re-varnish if the original varnish cracks or chips. Repair loose or frayed whippings directly you see them; if ferrules show signs of loosening, put them right immediately. Grease the ferrules before putting the rod together, and clean off the grease when you take the rod apart. After a few times fishing, the cork handle will get dirty. Clean it with soap and water and a soft nail-brush; don't wait until it becomes black and filthy.

A duralumin tube or a bored bamboo carrier is an excellent protector for your rods while travelling, but never *keep* your rod in either at any other time. If you belong to a fishing club which runs charabanc outings, never put your rod either on the rack or in the boot. Carry it yourself, between your knees, butt-end down.

If you don't use a duralumin or bamboo tube, have a landing-net handle a bit longer than the longest joint of any of your rods, and tie your rod, in its bag, to that for travelling purposes.

And if you're going to make rods for other people, have all these instructions on the care and maintenance of rods typed out, and give away a copy with every rod you sell.

CHAPTER EIGHT

REPAIR AND RENOVATION

BESIDE the repairs to his own rods which will be necessary from time to time, any angler who is known to his friends as a rod-maker will inevitably be asked to undertake rod repairs ranging from the renewal of one or two whippings to the complete overhaul of a rod, including, perhaps, the repair or replacement of broken sections or worn-out ferrules.

In many cases judgment, based on experience, is required to decide just how comprehensive the repair work should be. In the case of a broken built cane top, for example, one can either build or buy a new top; splice the old one, or, if the break is close to one end, shorten the top a little. Both of the last two expedients will considerably alter the action of the rod, and one has to decide whether such alteration can be tolerated. Again, one frequently meets with rods the ferrules of which are slightly worn, just enough so that movement can be felt when the rod is in action. Here again there are several courses open to the repairer. He can fit new ferrules, probably the best course in the case of cheap, plain ferrules. He can remove the male ferrule and have the fitting part plated with chrome or cadmium, rubbing it down to a good fit after replacing it on the timber; or he can very lightly hammer the male ferrule, without removing it, in a 60° vee-block, which will set it out of round and slightly triangular. This is quite a useful method to employ in renovating rods which are not in constant use.

The most difficult job in rod-repairing is the joining of a break in the timber of a rod. Of the various timbers, Greenheart is the simplest to mend. Where a diagonal break has occurred of sufficient length, it is sometimes possible to join the two halves without further preparation, but more commonly the fracture is complex. Then the ends should be first squared off, and then rubbed down at an angle, which must be equal on each piece, and at a slope which will allow overlap by an amount which is dependent on the diameter of the timber, a greater overlap being necessary where the diameter is large. For fly rod tops, an overlap of one inch is usually sufficient.

A simple gadget to ensure accurate rubbing down is shown in FIG. 47. The block carrying the broken piece of rod is moved up and down between the guides until a true, smooth face is produced by the glasspaper.

The best adhesive for joining the broken surfaces, whether prepared or otherwise, is the urea-formaldehyde adhesive previously mentioned. Having

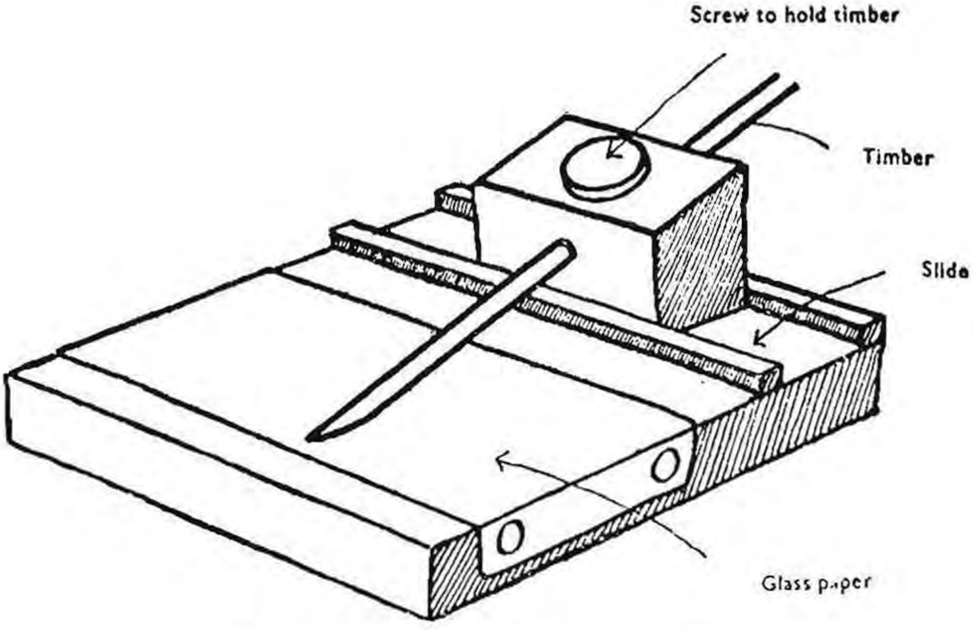


FIG. 47 Device for preparing timber for splicing

coated the surfaces with the adhesive, they must be bound firmly together and the cement allowed to set. The whipping can then be removed and the junction smoothed with glasspaper, before being covered with a neat, well-varnished whipping. Transparent whippings are especially suitable. Where fractures have been repaired it is an advantage, if possible, to re-position the rings so that one is placed at the repaired break; not only does the ring itself add strength, but its whippings serve the dual purpose of holding the ring on and reinforcing the joint in the timber.

Breakages in built cane can be repaired in the same way as in Greenheart if they are clean breaks. In many cases separation of the sections also occurs; these must be re-cemented before the break is made good.

Actual breakage of whole cane is most uncommon; where it is found to have taken place it is usually an indication of rotten material, which will have to be replaced. Longitudinal cracks in the whole cane are frequently encountered, however, especially in Spanish Reed. Repair is quite easy and effective. First of all, any existing whippings covering the crack must be removed, together with the varnish, until the whole extent of the crack is laid bare. A stout whipping is then put on a little way beyond each end of the crack. Then a little wedge is made of hard bamboo and driven into the crack so as to open it, as in FIG. 48. Another bit of hard bamboo is then planed and sandpapered until one end is very thin indeed, and this thin end is used to work adhesive well into all parts of the crack, the wedge being removed while the thin bamboo is adjacent to it; the latter is then worked along so that the whole of the crack is well coated. Finally, the edges of the crack are brought firmly together and held by a binding of stout thread or thin twine until the cement is set, the repair being then cleaned down and whipped as considered necessary.

Sometimes, where inferior cement or gross neglect have played their part, split bamboo suffers from separation of its sections—"sprung" is the term often used to describe the condition. Sometimes only one section of the six comes adrift, and where several coats of flexible varnish have been applied it is not always easy to spot the trouble; the user complains that his rod lacks the "punch" that it used to have; that "it has got a bit lazy", or that "it

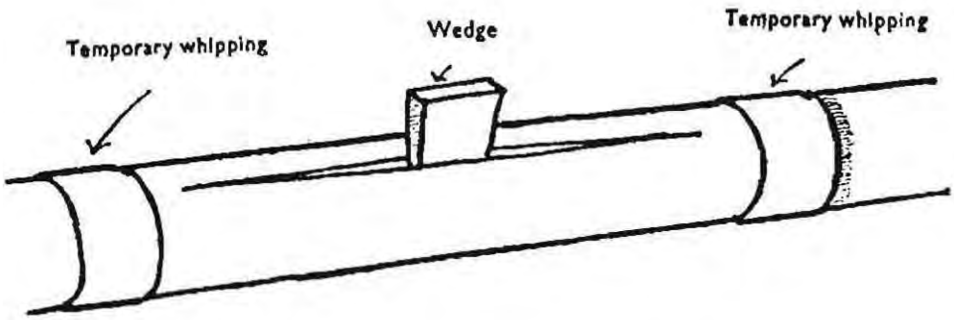


FIG. 48 Wedging open a crack for glueing

feels funny, somehow". Meticulous examination will sometimes reveal the aforementioned trouble. Sometimes, of course, the separation can be easily seen. The remedy is re-cementing, in most cases using the same technique as used for repairing cracks in whole cane. Where one of the separated sections has broken, one must decide whether to cement the broken ends in place—usually quite satisfactory—or whether to remove the ferrules, completely separate the broken strip, make a new one to replace it, and re-cement the whole lot together, a remedy not far short of completely replacing the joint concerned.

Ferrules which have become loose on the timber of a rod must, of course, be removed and replaced. It is usually sufficient to whip over the timber from which the ferrule has been removed so that it is a tight fit when replaced. Ferrules are often most difficult to remove, even when loose. Heat will often help by expanding the metal; if the ferrule is then gripped firmly in a vice and a hearty, straight pull applied to the timber, it will usually come away. In the case of high-class ferrules with reinforcement and integral brass tenons, beware of applying excessive heat, as such ferrules are often made of several parts soldered together, which excess heat may cause to separate. Too much heat may also soften the brass, which should never, in any case, be cooled off rapidly after heating. Where a break has taken place in the rod-timber just at a ferrule, always drill out the timber remaining inside; use a drill well undersize and pick out the remaining wood. Never attempt to burn out the wood; if you should be tempted to do so, read Alexander Wanless's "Science of Spinning for Salmon and Trout".

Where ferrules have got to be removed, it is wise to steel oneself to the possibility of their destruction and, in the case of a friend's rod, to warn him of that possibility before commencing the attempt to remove them. In the case of a well-loved rod, it is by far the best plan to sacrifice the ferrules rather than cut timber; in the case of solid-ended male ferrules, cut off the extreme end and drive out the timber with a piece of hard dowel and a mallet, if it proves impossible to remove the ferrule by ordinary means.

The complete overhaul of rods involves removal of all the old varnish. This should be done after all the rings and whippings have been removed, the varnish being softened by applying cellulose thinners liberally by means of a brush. It is then carefully scraped off with a knife, which is better for not being too sharp, or the timber of the rod may be damaged. Removal of the varnish must be done thoroughly; the timber is then rubbed down with fine glasspaper.

Cork handles may be cleaned by scrubbing with soap and water; particularly filthy examples may need pumice powder to get them properly clean. When ing. Baked bamboo is very hard and soon takes the keen edge off a plane. I have had my plane blades heat treated so that they are glass-hard, and this saves resharpening to a considerable extent, but it is not by any means essential. It is, however, essential to keep the cutting edge dead sharp, and the necessity of doing so, if I have not sufficiently stressed it, will soon become apparent to anyone who is inclined to neglect it.

For cutting bamboo the blade should be ground to a steeper angle than is used for planing ordinary woods; in engineering terminology, a smaller rake should be used. The less the rake, the less chance there is of "picking-up" and splintering of the material, but more force will be needed to push the plane. I must, therefore, leave it to the reader to arrive at the rake which best suits his skill and strength.

Where triangular formers are to be used, additional accuracy can be obtained by having a guide fitted to your plane, set at 60° to the plane's under-surface. This allows the plane to straddle the former and ensures a perfect 60° angle on the bamboo.

As mentioned earlier, planes used for grooved-board methods may with advantage be fitted with angle plates at each side, which can be adjusted to set the cutting level at whatever height is desired above the board. These plates should run the full length of the plane on each side, and the part of them which runs on the board should, of course, be wider than any of the grooves. A small hand drill or wheelbrace will be useful, with a selection of small twist drills. For boring bamboo, extended twist drills as described earlier will be required with a carpenter's brace to hold them. A selection of carpenter's bits will be needed to bore wooden handles.

The selection of files should include one 12 in. flat coarse file without a handle for shaping corks, plus one medium 10 in. half-round file if more elaborately shaped cork handles are envisaged. A 10 in. flat fine file will deal with ferrule fitting, and a small fine flat file, 4 in. or 5 in., is best for trimming ferrule splints and ring legs. Finally, a coarse tapered round file is invaluable for opening-out the bores in corks which turn out to be undersize.

A light wood or hide mallet should be provided for driving on ferrules, and a light tack-hammer will serve for tapping ferrule-splints to shape and for driving in brass brads to hold butt-caps. The same hammer used in conjunction with a small pin-punch will be necessary to repair work, to drive brads right through to enable fittings to be removed.

For splitting bamboo, use an old blunt table knife; another, kept sharp, will do for shaving down corks. For scraping, use a good penknife or a sharpened section of hacksaw-blade, or you can, if you like, use broken glass; I don't! For cutting off bamboo and for a variety of other purposes, I know of nothing to beat those invaluable little "Eclipse" miniature hacksaws.

A quantity of medium and fine glasspaper will be needed; glue some strips of the latter on to little blocks of wood for cleaning down built cane.

These are the tools which are necessary. There are some appliances and accessories which are of assistance in getting the work done more quickly, or which help in other ways.

A small vice is nearly, if not quite, indispensable. Next to this, the most useful by far is a lathe. It need not be elaborate, but the ordinary type of woodworker's lathe is of no use, as it is not provided with a hollow headstock. Probably the best plan for the amateur who intends making enough rods to justify the acquisition of some kind of lathe is to approach some engineering firm which specialises in making small machines to order; or he may have a ing. Baked bamboo is very hard and soon takes the keen edge off a plane. I have had my plane blades heat treated so that they are glass-hard, and this saves resharpening to a considerable extent, but it is not by any means essential. It is, however, essential to keep the cutting edge dead sharp, and the necessity of doing so, if I have not sufficiently stressed it, will soon become apparent to anyone who is inclined to neglect it.

For cutting bamboo the blade should be ground to a steeper angle than is used for planing ordinary woods; in engineering terminology, a smaller rake should be used. The less the rake, the less chance there is of "picking-up" and splintering of the material, but more force will be needed to push the plane. I must, therefore, leave it to the reader to arrive at the rake which best suits his skill and strength.

Where triangular formers are to be used, additional accuracy can be obtained by having a guide fitted to your plane, set at 60° to the plane's under-surface. This allows the plane to straddle the former and ensures a perfect 60° angle on the bamboo.

As mentioned earlier, planes used for grooved-board methods may with advantage be fitted with angle plates at each side, which can be adjusted to set the cutting level at whatever height is desired above the board. These plates should run the full length of the plane on each side, and the part of them which runs on the board should, of course, be wider than any of the grooves. A small hand drill or wheelbrace will be useful, with a selection of small twist drills. For boring bamboo, extended twist drills as described earlier will be required with a carpenter's brace to hold them. A selection of carpenter's bits will be needed to bore wooden handles.

The selection of files should include one 12 in. flat coarse file without a handle for shaping corks, plus one medium 10 in. half-round file if more elaborately shaped cork handles are envisaged. A 10 in. flat fine file will deal with ferrule fitting, and a small fine flat file, 4 in. or 5 in., is best for trimming ferrule splints and ring legs. Finally, a coarse tapered round file is invaluable for opening-out the bores in corks which turn out to be undersize.

A light wood or hide mallet should be provided for driving on ferrules, and a light tack-hammer will serve for tapping ferrule-splints to shape and for driving in brass brads to hold butt-caps. The same hammer used in conjunction with a small pin-punch will be necessary to repair work, to drive brads right through to enable fittings to be removed.

For splitting bamboo, use an old blunt table knife; another, kept sharp, will do for shaving down corks. For scraping, use a good penknife or a sharpened section of hacksaw-blade, or you can, if you like, use broken glass; I don't! For cutting off bamboo and for a variety of other purposes, I know of nothing to beat those invaluable little "Eclipse" miniature hacksaws.

A quantity of medium and fine glasspaper will be needed; glue some strips of the latter on to little blocks of wood for cleaning down built cane.

These are the tools which are necessary. There are some appliances and accessories which are of assistance in getting the work done more quickly, or which help in other ways.

A small vice is nearly, if not quite, indispensable. Next to this, the most useful by far is a lathe. It need not be elaborate, but the ordinary type of woodworker's lathe is of no use, as it is not provided with a hollow headstock. Probably the best plan for the amateur who intends making enough rods to justify the acquisition of some kind of lathe is to approach some engineering firm which specialises in making small machines to order; or he may have a friend who will be able to help him to get the work done. A very simple lathe powered by a small electric motor will tremendously speed up jobs like shaping cork handles, rounding split-cane and other materials to take ferrules, making plugs for whole cane and ferrule stoppers; it can be used to polish metal fittings by fitting a polishing mop, and by the aid of guides and suitable tools and circular saws, it can be used to make grooved and triangular formers and for roughing-out bamboo strip.

A small tool-grinder, self-powered, with a fine grinding wheel, is a great asset and saves a great deal of filing; I find mine specially useful for the legs of rod-rings. It also enables tools of all kinds to be kept in good order. With the aid of a guide, it can be used for cutting into bamboo where hollow-building is done. I do not find my electric drill is a very great asset, and usually use a wheelbrace for small holes. The main use of my electric drill is making ferrule stoppers.

Have a $\frac{3}{8}$ in. B.S.F. tap in case you come across a butt-cap with a tight or damaged thread.

In addition, every amateur will in time accumulate a number of home-made gadgets which have special application and which help to facilitate his work.

Although hardly coming under the heading of tools, an important point to consider is that of measuring instruments. It is absolutely necessary to have a rule marked in divisions down to 1/64 in. For real accuracy one must also have a micrometer, 0-1 in. Inside and outside calipers are most useful, a very small pair of inside calipers being of great assistance in fitting male ferrules. Also a 60° gauge is desirable for checking triangular formers; a piece of steel rule marked in divisions of 1/64 in. attached to the gauge helps in measuring the width of flats on these formers, but the only true measurement is that obtained when the micrometer is used on a bamboo strip produced on the former; measure from flat to apex and multiply by 1.155 to get the width of the flat.

It is also helpful to mark the bench at intervals of one foot and at six inches; this helps when cutting strips to length, as well as in many other ways.

Another useful accessory is a length of large diameter tubing, in which sections of split-cane can be kept before cementing together. The fine strips used in making top joints are very fragile and easily broken unless safely protected.

Dust is a nuisance to drying varnish, and to avoid its effect a box can be made of hardboard (compressed cardboard) or plywood, on a timber frame, of sufficient size to accommodate two or three rods. The box should be stood vertically, with protected ventilation holes or louvres at top and bottom. To speed up drying, an electric lamp can be fitted inside, near the bottom. This will provide heat and a steady current of air through the box.

Of course, many of these devices can only be employed where a room or shed can be set aside for rod-building. It must not, however, be thought that they are essential or that rods cannot be made as well without them. I made many rods on the kitchen table, and although I can do them much more quickly now that I have a proper workshop complete with numerous gadgets, I cannot make them better. Kitchen table work is not always easy to those blessed (or afflicted) with wives, not even the magnificent fire-lighting qualities of bamboo shavings being always sufficient to overcome prejudices. In such cases I can only suggest that a delicate, beautifully finished, light built-cane rod, with whippings in the lady's favourite colour, might well be made the first job.