

ment of the mainspring, English springs being tapered and generally filed thin at the eye, but the arbors should be snailed (and they probably will be now by the movement maker), and the hook should not project beyond the thickness of the spring.

65. Hooking in the Spring.—A spring of the proper length and strength being fitted to the barrel, it should be hooked in as follows :—With the spring in the barrel, drill a small hole in the barrel a little nearer to the bottom than to the cover, so that it may be in the centre of the inside of the rim, and within half-an-inch of the end of the spring; the drill will mark the spring. Remove the spring from the barrel, and broach the hole to nearly the size it is intended to leave it at an angle of 45° ; file this hole with a small square file, having a safe edge, until it is oblong, and, when it is of the required size, finish it with a drift. If the hole is in the middle and has not been drawn to either side of the barrel by filing it, the end of the spring can be softened, as far only as the hole for the hook, until it is a light blue colour, but it should not be made softer; the hole is drilled by gripping the spring against a piece of wood or brass in a small hand-vice.

The hook should never exceed one-third the width of the spring, a larger hook unnecessarily weakening the barrel and holding no better. A piece of rectangular steel is fitted to the hole in the barrel, and a mark is scored on it with a sharp point along the inside of the barrel. This mark will give the angle at which the shoulder should be made; if the angle is less than 45° , the hook will probably draw out if the spring is fully wound round the arbor. The pivot on the hook is often made by filing, but it is much better and quicker to make it with a cutter. As the strain comes on the back of the hook, the pivot should be kept as near the front as possible. The cutter is a piece of steel with a hole drilled in it and fine teeth cut on its face; it may either be a piece of wire with a ferrule on it, or it may be fitted

to a drill stock. In the latter case the hole should be broached from the back to enable the cutter to free itself, but as the pivot need not be long, this is not imperative; the cutter should be slightly convex on the face to ensure a firm seat for the hook when riveted. A point or centre being left on the steel which is to form the hook, a few strokes of the bow will form the pivot, and the angle of the hook when the pivot is made should correspond with that of the hole in the barrel. The pivot is fitted by broaching and chamfering the hole in the spring, and riveted by gripping the steel in a blunt pair of nippers and screwing them up in a vice; the rivet should be left long, and made with a few strokes of a rather heavy hammer. There is a good deal of strain on this hook, and for that reason the attempt (generally a failure) at using a hook a second time should never be made.

About three-eighths of an inch of the spring should be left beyond the hook, and this end must be filed away to a knife edge, the thinning to commence at the hook. If the spring is left the full thickness at the end and an unusual strain is put upon it, it will break across the hole where it is weakest, or the hook will draw out. Most watch jobbers know this, and generally make the end of the spring so soft that it bends, and all the advantage of a rigid attachment is lost.

If the spring is fitted to a new barrel, the hook can be filed down from the outside of the barrel, and finished on an arbor in the turns; if, however, the barrel is gilt or polished, the hook must be finished before it is finally put into the barrel; it is brought to height by trying it in the hole from the outside, and filed down and finished on a cork; the hook must not project beyond the barrel. If there is any difficulty found in getting the height of the hook by trying it from the outside, the thickness of the rim and mainspring can be measured separately by a *douzième* gauge; the thickness of the two together will be the thickness of the mainspring and hook. This

is the best way of hooking in the mainspring of a fusee watch, but there are various reasons for departing from it in going barrel watches, one of the principal being that a flexible attachment of the spring to the barrel to some extent affords an adjustment; the pull of the inner coils is not affected by the attachment, but, when the outer coil is called into action, it falls away from the barrel with less resistance when the attachment is flexible than when it is rigid. To satisfy myself of this, I made the following experiment, which I think conclusively proves my assertion to be correct. Having carefully adjusted the mainspring of a "two-day" marine chronometer which had a hook in the barrel, I removed the hook in the barrel and substituted the square hook in the spring. Upon again trying the adjustment, I found that to obtain an adjustment the spring had to be set up considerably more than it was before, and the weight of the adjusting rod altered, as the pull of the spring was greater throughout.

Again, there is greater uncertainty in fitting a spring of the proper strength to a going barrel than there is to a barrel with the fusee, in consequence of the inequality of the arcs of vibration of the balance during the unwinding of the spring of the former; for if the balance vibrates over a turn when the watch is nearly down, it will be liable to bank with the least external motion when fully wound, especially if the lever escapement be a good one; and it is much less convenient to change a spring with a hook in it, than one that has only a square hole punched out of the end.

As the springs are now nearly always fixed in going barrels with a steel hook in the barrel, some system should be observed in making them. In English watches the greater part of the mainspring is brought into action, and, as no pivoted brace is used, the hooks must be made more secure, otherwise the spring will either slip off or pull the hook with it.

If a small screw plate is made with two or three

holes of the sizes required, drilled and tapped at an angle of 45° , the pin or hook can be tapped, and the end of the screw filed up into a hook of the required form, and to the proper height; or it can be tapped in an ordinary screw plate, and afterwards screwed into the slanting hole and finished, but it is necessary first to screw the pin into the barrel, and mark for the inside of the hook close to the rim, so that, when the hook is in the right position, the screw part of it will be flush with the inside of the barrel and quite tight.

If this hook is properly formed and at a sufficient angle, the spring will not draw off, even if it be left very little higher than the thickness of the spring; the end of the spring in this case is made softer than if it had a rigid attachment. The hole should be oblong and perfectly square at the outer end, bevelled off from the inside to take a good hold of the hook, and there must not be any length of spring left beyond the hole but what is required for strength, as, if there is, it acts as a lever and pushes the spring off the hook, even if thinned. On the other hand, if a round hole be made in the spring, the strain draws the middle of the outer circumference of the hole to that of the hook, and unless the two correspond or are exactly in the middle of the rim, the spring will press either the cover or the bottom of the barrel, and add considerably to the jerking action of the spring, so familiar to watchmakers in the winding and unwinding.

Another, and better, although more difficult way of hooking in the spring is to screw the hook in from the inside of the barrel. The chief trouble attached to this method is in getting the hook square to the barrel rim when screwed home to the shoulder; it must be tried first and marked for the square, a little being allowed for it at the last to be screwed home very tight, as in marking for dog screws. In addition to the other reasons for not hooking in the spring as in fusee watches, the

extra width of the great wheel teeth attached to the barrel has to be considered, which would necessitate in most cases this hook being placed at one side of the spring instead of in the centre of it.

66. Adjusting the Chain.—When the spring has been hooked in, the fusee piece made and planted, and the fusee and barrel run in, the chain should be attached and the stop work filed up and adjusted. Care must be taken that the hole in the barrel for the chain-hook be placed so that the chain will be just free of the plane of the top plate; the hole may be drilled anywhere in the barrel, provided a little is filed out of the cover to free the end of the hook should it project into the sink, which it generally does. If the chain is too far from the plate, the second turn will probably ride on the top of the first, hence the necessity of keeping it as close to the plate as possible, and to avoid this riding of the chain it must not be left too long. The barrel hook should come to the outer edge of the top plate when the chain is wound up.

The hollow in the stop may be filed out to nearly its proper thinness (see chronometer finishing, page 82), but in no case should this process be considered sufficient.

If watch finishers, or even examiners, had thoroughly understood the uses of the adjusting rod and freely used it, half the faults that have been found with the fusee watch would have been avoided. It is not that the actual adjustment of the mainspring is of such importance at this stage, but, with the fusee and barrel only in the frame, any fault that may afterwards give trouble can be seen and removed. If the chain does not lie square on its edge on the barrel, it should not be used, as no filing will make it do so; it ought to lead freely into the grooves of the fusee, and not touch the stop the turn before the final one, and, when it does touch it, it should bring it close to the top plate as the hook of the fusee cap comes to it; at all other times the stop should be quite free of the hook, and not rise high enough for