



jewels, and if broken or defective, replace them equal to the original or better. Remove hair-spring and place the broken staff with balance wheel in place and keep in position as nearly as possible, and see just how much clearance there is for balance wheel and roller, and if any alteration is to be made in the height of either, make a note of it and correct the fault when turning the staff. Place and screw balance cock in position, and with both cap jewels removed measure exact distance between outside of jewels, which will give exact length of staff, which we will suppose to be 27° on the douzieme or degree tool. Then measure by same means the exact length of old staff, in broken condition, which we will suppose to be 24° ; this will show a total difference of 3° between length of staff required and length of broken staff, which will be just $1\frac{1}{2}^{\circ}$ for length of each pivot.

Now remove roller from old staff, using a tool for this purpose which will not scratch or mar the edge. Closely examine the manner in which the balance is fastened on the staff, and if the rivet is much spread do not attempt to remove the wheel by punching the staff out, but place in the lathe and carefully cut away the rivet, being very careful not to touch the balance arm. This precaution must be taken more especially with a fine compensation balance than with a plain balance, as every alteration in the former by bending, even in the slightest degree, will tend to change the rate.

Having procured the requisite and correct measurements, we proceed to cement one of the prepared blank staffs in the lathe by first heating the chuck by holding an alcohol flame under it while slowly revolving in the lathe and at the same time holding a piece of shellac over it, which should be prepared in sticks, and manipulating it so that as it melts it is deposited on the end of the chuck and a ball is formed of sufficient size to hold the piece firmly. After the shellac has been deposited satisfactorily, take the blank staff in a pair of coarse tweezers and while the shellac on the chuck is warm, push the lower end through so as to catch the centre in the chuck and then allow the shellac to very slightly set, and then by slowly revolving and holding the finger against the exposed end of the staff, it will be found to run true. Or it may be trued with a peg wood, as in Fig. 4, holding it firmly back against the chuck and at the same time keeping true in the round.

Before I leave this part of the subject, and while I am speaking of shellac, I want to say that it requires a very great deal of practice to use it correctly, and should you at any time have the shellac burn from overheating on the chuck, turn it right off clean, for shellac that has been burned is worse than useless.

However, should you be unable to get the rough staff to run exactly true, just get it to run as true as you can as it will not make any difference whether it is exactly true or not at this stage of the work. Now with a medium sized and well sharpened graver proceed to turn the shoulder A, Fig. 5, to fit the hole in the balance. There is no necessity for taking the measurement with an instrument, for we have the hole, and it must be tried frequently to avoid turning it too small, for if it is too small it will be impossible to fasten the wheel on centrally. It should fit very snugly and at the same time not so tightly as to require any force to put in place. The corner must be cut out clean and sharp, which can only be done with a very finely

pointed graver. Another point to be observed at this stage is to see that the seat for the balance is perfectly flat, for if it is undercut, even to a slight degree, it will have a tendency to throw up the outer ends of the balance arms and thus distort it and change seriously, if not entirely ruin, its rate.

After having the balance seat turned satisfactorily, cut off the height of the shoulder exactly level with the thickness of the balance arm, and turn shoulder B, Fig. 5, to fit the hair-spring collet. This should be turned with as much care as the previous operation, and should be tapered very slightly so that the collet will admit of a free introduction of the upper end of the shoulder, and yet fit very snugly when pressed down in proper place. It must allow of being readily removed without straining the balance in any way, and admit of being readily turned as occasion demands in placing in beat.

After finishing, this shoulder must be turned off to same length as one on old staff. The rivet or undercut for holding the balance wheel must now be turned as at E, Fig. 5. This should be very carefully cut with a small sized and very finely pointed graver, and care must be taken not to reduce the size of the hair-spring shoulder. Do not get discouraged if the point on the graver breaks frequently at first, for it requires a great deal of patience and practice to accomplish such a cut perfectly and retain a point on the graver.

The end of the hair-spring shoulder may be turned off flat or it may be undercut for appearance. I usually leave them flat and polish afterwards.

The small piece D, Fig. 5, at the root of the pivot, is to be turned next, and it should be turned to about the same diameter as on old staff, and then the length from the balance seat to the end of the broken pivot must be obtained and allowance made on the new staff for length of pivot broken off, and after carefully marking, turn off at that point and proceed to turn the pivot.

If a conical pivot is required, as is usual with most balance staffs, be sure and have it *conical* and not tapered. There is a vast difference in ideas among watch repairers as to what a conical pivot should be. The conical part should take the place of the beveled edge at the root of a square pivot. It should be an easy curve inward till it reaches the pivot itself, which should be perfectly straight and even throughout. When turning, it should be left a trifle larger than the jewel hole, and then with the round edged steel polisher and a little oil-stone dust it should be polished until all graver marks are removed and the proper size obtained. That is, the jewel must fit the pivot without any perceptible side-shake, and yet when the jewel alone is placed in position with the pivot through the hole, it should drop off readily when the staff is inverted. After reducing to the required size with steel and oil-stone dust, take a piece of pith and thoroughly clean off all the oil-stone dust, and then with the bell metal polisher and a little crocus-antimony polish out all the marks left by the oil-stone dust. Carefully clean with pith and then with a peg wood, cut like the previous polishers and a little diamantine; proceed to polish until a fine gloss is obtained.

(Concluded next month.)

SAN FRANCISCO, with a population of about 400,000, has only 120 churches, with a seating capacity of 40,000, and an average attendance of 25,000.