FIFTY YEARS' PROGRESS IN CLOCKS AND WATCHES.[1]

II.

TO pass on to another phase of mechanical improvement, a wonderful advance in the mechanism of chronographic watch-work has been made during the period we refer to. In this department the first chronographs to be introduced were those having a kind of double hand, the lower portion of which carried a tiny vessel of ink. When an observation was requisite, the upper part of the hand passed through a small orifice in this ink-vessel, marking a dot upon the dial below. We have had of late years, however, much cleaner and more convenient arrangements. The most usual form is as follows. In addition to the ordinary minute and *centre*-seconds hands there are auxiliary hands, which always stand at zero when not moving. Pressure on the crown-piece sets them going, a second pressure stops them, and the third pressure sends them back to zero; and it is interesting to observe that they always return to zero—their normal position—the shortest way round the dial. The nature of the mechanism by which these operations are effected is briefly as follows. Pressure on the crown-piece causes a wheel carrying different sets of cams to advance step by step. These cams, which correspond to the starting, stopping, and returning of the hands, operate on springs and levers. The first motion frees the auxiliary hands, and also throws them into gear with the watch-train. The second motion throws them out of gear and clutches them so that they shall not shift. The third motion sends them back to zero, and this is effected in the case of both by what is called a heart-piece. This heart-piece, as regards the seconds-hand, is shown in outline at the centre of Fig. 8,[1] which has already appeared as Fig. 5 in the first article. It is to be mentioned

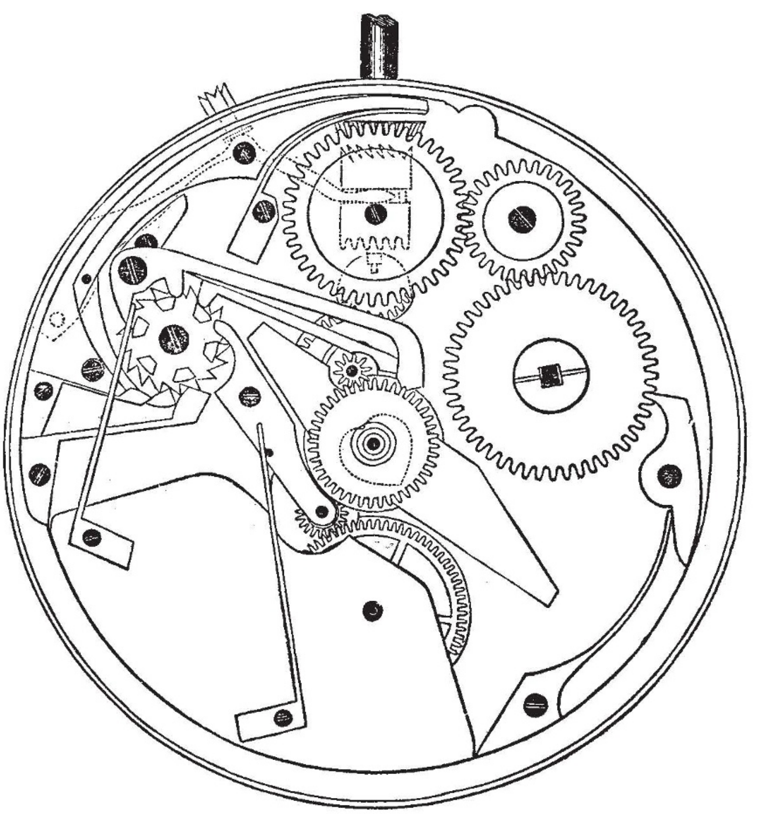

FIG. 8.—Chronograph with Swiss Keyless work.

that the heart-pieces go round with their respective hands. The third pressure releases the clutches and also causes the lever, shown above the heart, to descend upon it; the heart and hand being now free to move, the lever draws round the heart until it finds the lowest position of it, which, as is natural, is arranged to correspond to the normal position of the hand. The gearing-wheels and clutch-levers can be very well seen in Fig. 9.

In another form of chronograph a long seconds-hand is superimposed over another so as to appear as one with it. They both travel with the watch-train; until a first pressure stops one, and a second pressure the other; the interval between the two pressures can now be read off at leisure. A third pressure sends them flying to the place where they would have been if they had not been stopped at all, even should they have been kept standing for a week. They, also, always return the shortest way. The mechanical arrangements consist of a heart-piece for bringing the hands together, and they achieve the position where they would have been had they not been stopped by means of a kind of cylinder sliced through at an angle not perpendicular to its axis. Whilst the hands are travelling, the faces where the cylinder is cut are kept pressed together by springs, but they are parted when the hands are brought to rest. One half of the cylinder goes on with the watch-train, the other half (in connexion with the hands) remains suspended above it; at the third pressure of the crown-piece the top half is permitted to descend, when it naturally seeks its former position with

[1] Continued from p. 395.

[1] We are indebted to Mr. Britten for the use of Figs. 5, 9, 10, 11, 12, and 15, and to Mr. Glasgow and the Messrs. Cassell for Figs. 13 and 14. Readers who wish further insight into the details of our subject should consult both Mr. Britten's and Mr. Glasgow's books.

respect to the other, which has been permitted to go on with the watch-train.

The form of mechanism which is applied for the purpose of maintaining and showing a calendar has undergone considerable development. Calendars are now made to be perpetual, correcting themselves for everything, including leap-year. The following (Fig. 10) is the plan generally adopted in clocks, and is the invention of the late M. Brocot. M *m* is a lever which is worked by a pin, *e*, in a wheel in the clock-train going round every twenty-four hours. As *e* advances in the direction indicated by the arrow, M *m* is moved to the left, and the clicks G and H, which it carries, pass over the top of a single tooth each of the wheels A and B, the wheels being meanwhile held loosely in position by weak springs called "jumpers." As soon as *e* has passed the end of M *m*, the latter falls back by its own weight, dragging back A and propelling B each one tooth respectively. B has seven teeth, and works the days of the week; A has thirty-one, and serves for the days of the month. All months, however, have not thirty-one days, and provision is made for the difference by a supplementary thruster, N. In A there is a pin, *i*, which comes regularly below N every twenty-eighth day. The tail of N rests against a wheel, V F, which goes round once in four years. V F is graduated with notches of different depths. These notches correspond to the respective lengths of each month, and those representing the Februaries are conspicuously noticeable; that one which is the shallowest of the four identifying the leap-year. During the months of normal length, N maintains the position which is shown dotted in the diagram, and does nothing. But whenever there occurs a short month, the tail of N will enter one of the notches; in consequence, N will descend, and, engaging *i*, propel A forward a day or more, depending upon the depth of the notch. This happens whilst M *m* is travelling to the left. When M *m* falls back, the click G will act in addition, and as usual. Fig. 11 shows the dial; the hands on dials right and left are in connexion with A and B (Fig. 10). The hand upon the lowest dial shows the month of year; its progression is continuous. The hand at the top shows the equation of time, and alternates on each side of noon, + or −, as may be required. It is worked by a rack which reposes against a cam of suitable form revolving once in twelve months.

FIG. 9.—Chronographic watch-work.

The phases of the moon are indicated (as may be seen in the diagram) by the passage of three shaded disks across a circular aperture.

Magnetism exercises the most destructive influence upon watches or chronometers, turning their balances into compass-needles, and causing the coils of their balance-springs to stick together.

In these days of large magnetic engines it has therefore been found necessary to revert to an idea of the elder Arnold, and to construct watches for the use of those having to do with such engines upon a plan which shall render them indifferent to magnetization. This result is obtained by making the balances of silver and platinum, or an alloy of iridium, or of some other non-magnetizable material, and the balance-springs of gold or palladium; and the use of steel is avoided in certain parts of the escapement. Watches carefully constructed on such plans give results little inferior, as regards time-keeping, to others.

Amongst the multifarious purposes to which clocks have recently been applied, we must not omit to mention those which are designed for registering the proper performance of a watchman's duty. The old-fashioned principle was that there should be a separate clock at each station the watchman had to visit, and by pulling a string or handle he was enabled to leave record of his presence. Now, either he carries the clock (or large watch) with him, or else it is fixed at a central station, and is operated upon by electricity. In the first case there is a revolving paper dial inside the clock, and by placing the clock within specially arranged orifices at the

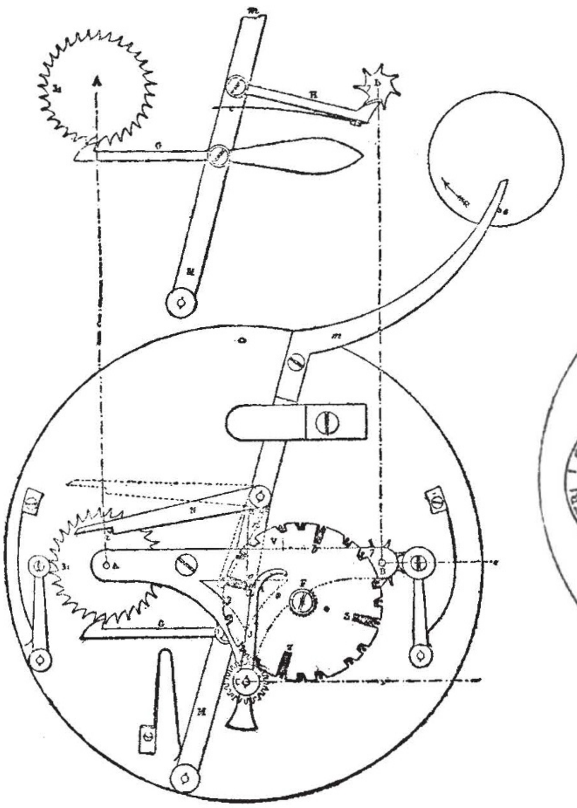

Fig. 10.—Brocot's Perpetual Calendar.

different stations he has to visit, he is enabled to get printed off upon the paper dial a mark or letter showing the time at which he was at the station. In the latter case the clock is provided with a large drum or cylinder, and wires lead to it from the different stations; and when a button at any station is touched, a mark follows upon the cylinder, indicating the where and when of the person who made it. At one large lunatic asylum the system is so perfect that the night superintendent, sitting in his own room, can follow the movements and whereabouts of all his men. Clocks have also been designed for registering the gross aggregate or integral of daily temperatures or barometric pressures. In the former case a watch is used, and has a balance compensated the wrong way, so that the effects of changes of temperature are magnified. In the latter case a barometer is used as the pendulum.

Until three years ago there was no public institution in Great Britain where a serviceable authentic trial of the performance of a watch under varying conditions as regards temperature and changes of position could be obtained. At that date, however, under the auspices of the Royal Society, a department of the Kew Observatory was established for the purpose. It satisfied a want which had long been felt, and provided with every requisite for

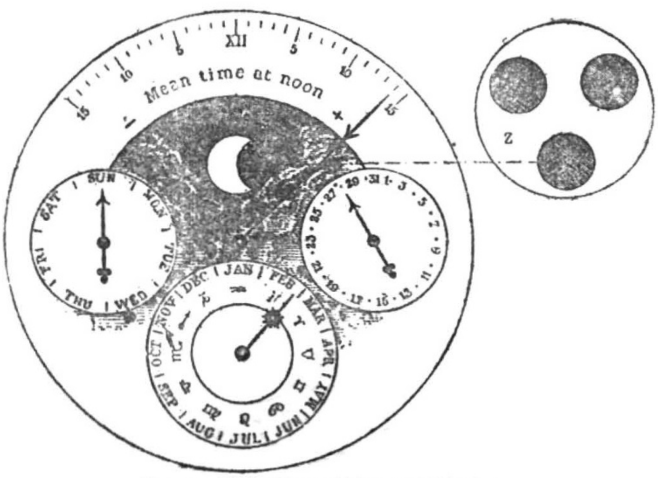

Fig. 11.—Dial of Brocot's Perpetual Calendar.

timing both in temperatures and positions, a considerable and increasing number of watches are regularly sent there for the purpose of obtaining its certificates. In Class A (the first class) merit-marks are awarded in addition to the certificates, in the following proportions: 40 for a complete absence of variation of daily rate, 40 for absolute freedom from change of rate with change of position, and 20 for perfect compensation for effects of temperature.

The subject of the application of the balance-spring, and the process of timing, which is subsequent, must be reckoned beyond the scope of the present article. But we may briefly allude to the fact that the causes which operate upon a watch to make it keep different times in different positions are generally three. For instance, the balance may be out of poise, the balance-spring may not be isochronous, and the action of the escapement generally is irregular in different positions. Putting the balance in poise is done roughly in a poising tool; the finer adjustment follows the results of trials when the watch is kept going in different positions. Isochronism is more important and more difficult of attainment. Without isochronism a watch might keep tolerably near time when placed successively 12, 3, 6, or 9 upwards, and still possess a very wide error between all these and the

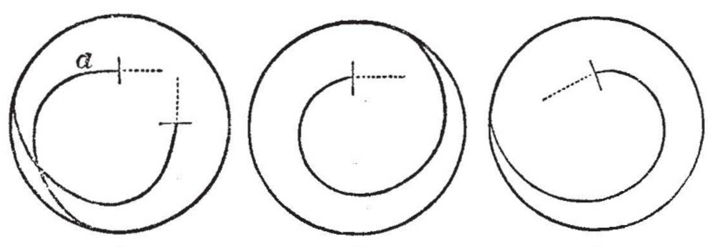

Fig. 12.—Diverse forms to which balance-springs are fashioned.

dial up (flat) position. Want of isochronism would also cause it to vary its rate considerably as time went on. Isochronism is obtained by a careful adjustment of the weight of the balance to the motive power; and by suiting the length, number of coils, and forms of the curves at the terminations of the balance-spring to circumstances, as may be required. For example, A, Fig. 12, shows the contour of the curves which terminate the spring of a marine chronometer; B and C, the contours of a pocket chronometer spring. It must not be supposed that all marine or pocket chronometer springs are alike. The correct form is generally arrived at after prolonged trial and patient fashioning.

Technical education has not been neglected in recent years by English watch-makers. Indeed, the necessity

Fig. 13.—Loseby's Balance.

for it has been too keenly felt to allow them to forget it. But for a long time there was nobody to help or even to advise them. Under such conditions a small party took the matter into their own hands, and founded the Horological Institute. With very little encouragement they at first worked on, but have now the satisfaction of seeing their efforts successful to an extent which they could have scarcely anticipated. Workshops, science and drawing classes are to be found at the Institution; and examinations, under the auspices of the City and Guilds of London Institute, are periodically conducted, and certificates of proficiency granted.

Before concluding we give two diagrams which may be of interest. They refer to the subject of secondary compensation, one of them, Fig. 13 (Loseby's), representing

Fig. 14.—Kullberg's Balance.

one of the oldest, and the other, Fig. 14 (Kullberg's), one of the most recent forms of balance for the purpose. It will be seen that Loseby's object was effected by means of curved mercurial thermometers—the lower the temperature the more indirectly the mercury receded from the centre, checking the action of the compensation: with Kullberg's the supplementary compensation screws are checked directly.

There have been many improvements in the lever escapement. Fig. 15 shows one of the most remarkable. In this case the discharging is effected by means of two pins in the roller, and the impulse given by means of a pin in the lever working into the notch on the roller. The effect is that the unlocking takes place at about the line of centres, and the impulse is given more advantageously. Resilient escapements are those which will enable the watch-balance to make several turns in the same direction without injury to the escapement. They often save a breakage in the case of a blow or jerk; their invention is due to Mr. Cole. We ought not to close this article without mentioning the fact that the manufacture of the

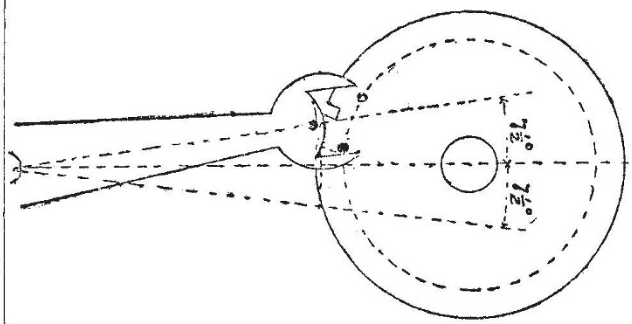

Fig. 15.—Savage's Two-pin Lever Escapement.

duplex escapement, which was at one time reckoned the very first, has been completely abandoned. Besides its liability to stop, it was found that the wear in the pivot-holes made its timing and adjustment exceedingly precarious.

Henry Dent Gardner.

THE BRITISH ASSOCIATION.

SECTION F.

ECONOMIC SCIENCE AND STATISTICS.

Opening Address by Robert Giffen, LL.D., V.P.S.S., President of the Section.

The Recent Rate of Material Progress in England.

In coming before you on this occasion it has occurred to me that a suitable topic in the commercial capital of England, and at a time when there are many reasons for looking around us and taking stock of what is going on in the industrial world, will be whether there has been in recent years a change in the rate of material progress in the country as compared with the period just before. Some such question is constantly being put by individuals with regard to their own business. It is often put in political discussions as regards the country generally, with some vague idea among politicians that prosperity and adversity, good harvests and bad, in the most general sense, depend on politics. And it must always be of perennial interest. Of late years it has become specially interesting, and it still is so, because many contend that not only are we not progressing, but that we are absolutely going back in the world, while there are evident signs that it is not so easy to read in the usual statistics the evidence of undoubted growth as it was just before 1870–73. The general idea, in my mind, I have to add, is not quite new. I gave a hint of it in Staffordshire last winter, and privately I have done something to propagate it so as to lead people to think on what is really a most important subject. What I propose now to do is to discuss the topic formally and fully, and claim the widest attention for it that I possibly can.

There is much *primâ facie* evidence, then, to begin with, that the rate of the accumulation of wealth and the rate of increase of material prosperity may not have been so great of late years, say during the last ten years, as in the twenty or thirty years just before that. Our fair-trade friends have all along made a tactical mistake in their arguments. What they have attempted to prove is that England lately has not been prosperous at all, that we have been going backwards instead of advancing, and so on; statements which the simplest appeal to statistics was sufficient to disprove. But if they had been more moderate in their contentions, and limited themselves to showing that the rate of advance, though there was still advance, was different from and less than what it was, I for one should have been prepared to admit that there was a good deal of statistical evidence which seemed to point to that conclusion, as soon as a