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Autor: Gottraux, Emmanuel

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SPECIALITIES OF THE SWISS WATCHMAKING INDUSTRY

HIGH PRECISION CHRONOMETRY IN THE SERVICE OF SHIPPING AND AVIATION

Whenever one mentions the watchmaking industry, one generally thinks of its most familiar side: wrist-watches and household clocks. And yet, in spite of its importance, the indication of the time to a degree of precision sufficient to enable the man in the street to order his everyday affairs is by no means the only justification for the existence of the Swiss watchmaking industry. The precise recording and indication of the time are such common, everyday occurrences nowadays that one tends to forget the general problem behind them: the actual measurement of the time. A vast number of fields from astronomical observatories to scientific laboratories, and including factories, various means of transport, athletic contests and sports meetings, require the measurement of time, and for each the watchmaking industry provides the most suitable solution. Electricity meters, automatic time-switches controlling the lighting and heating of premises or systems of traffic lights alone represent an infinite number of watchmaking movements possessing clearly defined characteristics. To the apparatuses which thus replace human supervision and intervention must be added those that enable men to carry out measurements under exceptional conditions. In this connection let us just mention sports timing, parachute jumping and underwater exploration, for all of which chronographs and special counters have been produced.

It would be impossible to try and list all the fields in which watchmaking plays an indispensable part and we have no intention of attempting to do so. On the other hand, the mere length of this list of specialities is enough to show the enormous amount of creative imagination and ingenuity involved. In these qualities lies the strength of Swiss watchmakers, who have made their sphere the realm of perpetual invention. Starting with this number, " Swiss Industry and Trade " intends to devote a series of articles to a number of these specialities, selected according to the interest of their design and their special applications, provided of course their technical description is not likely to discourage the layman.

In dedicating this first article to marine chronometry and its modern derivatives used in flying, we have been guided not only by the chronological criterion, owing to the " seniority " of this type of production, but also by the wish to pay homage to a certain spirit of enterprise. In this day of space exploration, it may appear pointless to those not in the picture for our watchmaking industry to undertake research in a field that is to a great extent — and not only for geographical reasons — outside the Swiss sphere of activity. Now among all the arguments that may be put forward to convince the sceptics, one of the most convincing is the paradoxical example of the birth in the 19th century of an industry producing ship's chronometers in a country completely devoid of any shipping of its own at the time. In order to complete our example, let us add that this industry was destined rapidly to compete on equal terms with those who were already pastmasters in the field — the British — and to give the only Swiss firm producing ships' chronometers today the pride of supplying the fleets of sixty countries and several hundreds of scientific institutes.

The plotting of position in navigation

In order to understand the strange connection between maritime navigation and Swiss watchmaking, let us go back to the 18th century when the technique of navigation called for the measurement of time in determining the position of vessels. Up till then, apart from meteorological factors, sea voyages were hazardous undertakings; the tales of the Ancients and even of the Crusaders, for example, show us what terrifying experiences they could be. The borrowing of the compass from the Arabs and the Chinese, at the end of the 15th century, was a considerable help to European navigators, but they had to wait another 200 years to be able to apply the discoveries of cosmography. In 1676, with the foundation of Greenwich Observatory and the choice of the meridian through Greenwich as the origin for the Standard Time Zones, it became possible to determine any point on the earth's surface in timekeeping units corresponding to angular units plotted on the map. As everyone knows, the determination of the longitude of a point is not sufficient in itself; it has to be completed by the determination of its latitude too. Sailors use various methods, based on the same principle, for carrying out this twofold operation. We shall limit ourselves here to briefly describing the most orthodox of them, even if it is not the one most commonly used.

The navigator determines the altitude of a star at its zenith (by day the sun, by night the moon, a planet or star) by means of a sextant; a table of declinations for the star observed then gives the altitude of the elevation of the pole (north pole in the northern hemisphere and south pole in the southern hemisphere) at this spot, which corresponds exactly to the latitude looked for. At the same time, the navigator notes the Greenwich time at the moment the altitude of the star is at its maximum. A comparison of the sidereal time of the place (given in tables published every year) with the Greenwich time gives the time longitude, subsequently converted into degrees and minutes. In actual practice, several different measurements are carried out so as to reduce the coefficient of error. Nevertheless it is vital for the chronometer indicating Greenwich mean time to be extremely precise, for a variation of only 1 second, at the equator, would result in an error in longitude of well over a quarter of a mile.

The success of Swiss chronometer makers

Today the broadcasting of the time by radio enables ships to check the accuracy of their chronometers daily. This precaution was not possible previously and, once the time had been set at the port of departure, the captain of a ship had to rely entirely on his precious timekeeper, which according to strict regulations, was wound up once a day with the greatest care, as may well be imagined.

In spite of the advent of radio-telecommunications, the international laws governing shipping continue to require the existence of a ship's chronometer on board every ship so as to guard against any breakdown in radio transmissions. In the case of warships, the possibility of jamming or compulsory radio silence makes a ship's chronometer absolutely indispensable.

It is easily understood therefore that the two main qualities of such a chronometer are, first, exceptional precision, and second, great reliability of operation. These requirements, which were successfully tackled by British and French master watchmakers in turn, could not fail to arouse the interest of the most skilled Swiss craftsmen of the 19th century. As often occurs in such a case, helped by the spirit of competition, the best chronometer makers soon

began to congregate in close proximity to one another, the better to benefit from their respective discoveries. It was in this way that the town of Le Locle, in the Swiss Jura, gradually came to monopolise this speciality. And in 1876 a small factory in this town took over the entire production of ships' chronometers and rapidly made a name for itself. With the discovery, in 1895, of a new alloy for balance wheels by the physicist Charles-Edouard Guillaume, its success became outstanding. To date, this firm has won over 4,000 prizes for precision awarded by the big observatories, including in particular that of Neuchâtel.

Contrasts of a big watchmaking centre

Hearing that this factory was exploring new fields in chronometry, we went up at the beginning of the winter to the Jura " watchmaking valley ", which was already deep in snow, the children warmly muffled up and making their way to school on skis and sledges. In these districts known for their hard climate, one would expect to see woodcutters and huntsmen and wooden chalets as everywhere else in the Swiss Alps. To our great surprise we discovered, on the contrary, towns brightly lit, as soon as evening fell, with the thousands of lighted windows of their factories and small family workshops. At La Chaux-de-Fonds and Le Locle, everyone is connected with watchmaking in one way or another, either closely or remotely. Take a stroll at random through the quiet streets and you will find side by side the watch crafts of yesterday and today, like a living exhibition of the history of the industry: behind the window of a low dwelling a man is hunched over his bench, adjusting under the lamp, with almost motionless hand, a tiny pinion; a few yards further on, you pass the huge front of a modern factory, all glass and concrete, giving the passer-by a glimpse into huge workshops, with rows of brightly gleaming machine-tools supervised by white-overalled workers, keeping a close check on the quality of the parts machined by each of them.

The secrets of a movement

From the small family workshop to the factory with its own research laboratory is quite a jump, and these two extremes have to be reconciled for the manufacture of ships' chronometers or any other high quality timepiece. This is what we were told by one of the heads of this firm, in which each department bears witness to the wonderful work carried out year after year by succeeding generations; he stressed the importance of properly regulating the chronometer, most important operation of all, carried out according to a long and careful process by craftsmen so skilled and experienced that their work is almost an art. Errors due to variations in temperature, the mean deviation indicating the stability of timing, the difference between the first and the last period of observation are some of the inaccuracies that have to be reduced painstakingly by shaping the hairspring or touching up the balance wheel, modifying them almost imperceptibly.

And here, in its walnut case inlaid with brass, is the completed ship's chronometer. Hung on gimbals which will keep it level irrespective of the ship's motion, the classical type of ship's chronometer has a dial roughly 4 inches in diameter and a case about 2½ inches high. Its mechanism differs from that of an ordinary watch in that it has a spring detent escapement (instead of the usual level) allowing the chronometer to tick half-seconds: this was a stipulation of the navigators who, once they have glanced at the time, can follow the ticking by ear and concentrate on observing the other instruments. Finally the fusee, which was previously found in the movement of ordinary watches, has been kept in the ship's chronometer to improve the regularity of timing. These timepieces are also used by research institutes and surveyors, in which case they are provided with an electrical seconds recording mechanism.

The layman will undoubtedly be astonished at the very beautiful but rather old-fashioned appearance of the ship's chronometer; our hosts readily agreed but explained that shipbuilders tend to be rather conservative in this respect.

The quartz ship's chronometer

Nevertheless the chronometer makers of Le Locle do not neglect new techniques or forget the spirit of research that made their name. Far from it! In 1961, in collaboration with a big Neuchâtel firm specialising in electronic research applied to watchmaking, they produced a quartz ship's chronometer offering greater precision than any mechanical chronometer and less sensitivity to outside factors. Every part of the quartz chronometer is easily interchangeable, i.e. the electronic unit (quartz resonator, transistorised oscillator, frequency divider, and power amplifier), the self-starting motor, the mechanical counter transmitting the rotation of the motor to the hands (ticking half-seconds), the current supply unit, which can be adapted to either alternating or direct current from the mains, the accumulators automatically providing the necessary power in case of a breakdown in the supply of current from the mains and finally the relay operating a contact connected to an output plug for controlling a secondary clock network. These are the main characteristics of this ultra-modern timepiece, whose appearance in the form of a metal case with functional lines represents a complete break with the shape of the traditional ship's chronometer that we admired previously.

A unique creation for air navigation

Finally, once again among the novelties, let us mention the creation of a chronometer for air navigation, specially designed for rapidly carrying out the calculations based on a knowledge of the Greenwich hour angle corresponding to the sidereal time. Previously, the navigator obtained this angle by looking it up in quarterly tables. The new chronometer gives the value of the Greenwich hour angle instantly and with greater precision by means of three red hands indicating the degrees, minutes and seconds of arc. Simultaneously, a set of white hands indicates the Greenwich mean time (civil time) on a dial divided into 24 hours.

The mechanism of this instrument makes use of the principle used in astronomical clocks, which indicate the civil time and sidereal time simultaneously by synchronising the movements of the two sets of hands by means of a single regulating device. The ratio between the two types of time being known, it has been introduced into a differential mechanism, with such a degree of precision that after a year's continuous running, the error between the two indications would be less than 1.4 seconds. Used separately or with an automatic position calculator, this chronometer is at present being tried out by several airline companies.

We left Le Locle — not by air or by sea — but quite simply by an evening train taking the workers from the big watchmaking centres to their homes in the outlying hamlets. In the carefree hum of conversation in the compartment, we glanced through a list of the governments and the big organisations that have ordered their chronometers from this Swiss firm " lost " in the heart of the Jura. It is a veritable " Who's Who " of the shipping world, such as one could find for example in the records of a big port. We imagine that very few among these far-off buyers realise the amount of perseverance and ingenuity required to open to the seven seas the limited horizon of the Jura valleys. These qualities are moreover prominent throughout large sections of the Swiss watchmaking industry.

EMMANUEL GOTTRAUX. (*" Swiss Industry and Trade."*)