WATCHMAKING BY MACHINERY

By David Glasgow

(Taken from Glasgow, David, circa 1890, *Watch and Clock Making*, parts 20 and 21, The New Technical Educator, London: Cassell, circa 1890.)

Machine-made watches is a misleading term, as no watches have as yet been made by machinery alone, and no watches have been made in our time, nor for ages before our time, without the aid of machines. Watches two centuries old had the teeth of the wheels cut in an engine, and the use of the lathe is much older; but the use of extensive machinery and the factory system in the manufacture of watches in England is of very recent date.

Although the earliest record of a system of making watches by elaborate machines that would make watches of uniform size, and that would make the several parts to gauges, so that they might be interchangeable, was introduced here about the year 1840 by a Swiss named Ingold, who, with the assistance of some watchmakers and others, was able to form a company about that date for this purpose, and a factory was established in Soho. Amongst the directors at least two names were familiar to both watchmakers and the public, Messrs Earnshaw and Barwise, so that the trade could not have been said to have been all against it. The active Clerkenwell manufacturers of course disliked an innovation on the part of a foreigner that was likely to injure them, and the workmen could hardly be expected to favour a system that had for its avowed object the substitution of the unskilled labour of men or girls for their skilled labour, even if it did reduce the price of the product. The company seems to have been badly managed; the few watches that were turned out were more costly than those made on the old plan. The company soon got into difficulties, and was wound up, Mr Ingold going to the United States and taking his machines with him, where he settled in the city of Boston. I have recently seen a series of drawings of these machines, beautifully executed and signed by the draughtsman, John Edison, dated 1843. It is a curious coincidence that about the time Mr Ingold went to America a Mr Dennison was located in Boston and engaged in inventing machines for the manufacture of watches. Mr Dennison got partners or formed a company for the manufacture of watches by his machines, which resulted in the great American Waltham Watch Company. Much controversy has been expended as to which of these inventors the priority belongs. They were probably both the original inventors and independent of each other.

The American companies made little progress until the outbreak of the Civil War, when the large armies all wanted watches this country could not supply, when watch companies sprang up everywhere. But the financial results of this company did not encourage the formation of similar companies here; we went on in the old way. Vested interests prevented the trade from forming companies, and the scheme did not hold out sufficient inducements to the public to enlist therein. However, the competition of the Swiss and Americans began to tell heavily against our low-priced watches, and a bad model and want of uniformity in the article produced made it clear to some of the manufacturers of low-priced watches that some improvement was necessary. I have already explained the system of watch movement making in Prescot. There were then many movement

makers; each one had either his own or his customer's size for movement, plates, wheels, etc., and in consequence of this variety in everything, dials and cases had to be made to each movement separately.

This was found to be a great disadvantage to watchmakers who had customers in America, as in consequence of a high duty imposed on finished watches the completed movements without cases were usually sent, on which no duty was charged, so that the Americans made watch cases long before they made watches.

The late Mr John Wycherley of Prescot, a movement-maker, finding a difficulty in supplying the demand for his movements, and being a man of more enterprise than some of his neighbours, set up a steam-engine, and invented or procured some very ingenious machines for the production of movements of uniform size and thickness or height, and in other things carrying the work of the watch a little further towards completion by drilling the holes for dial feet, and in some cases the holes in which the pivots were to run in the frames. But the demand for watches at this period was mostly for full-plate watches with fusees, and fusees would be very difficult to make by any complication of machinery, so the wheels, pinions, and fusees were made in the old way by hand, the wheels stamped out roughly one space at a time, and crossed out by hand with files afterwards. Still the improvement was great in facilitating the manufacture of cheap watches, as it enabled manufacturers to get their dials made by the dozen, or more, instead of separately, and casemakers made silver cases to blocks that fitted Wycherley's movements.

In the meantime the believers in machinery were developing their ideas, and the establishment of agencies by two American companies in London stimulated the faculties of English watchmakers, and also exercised the minds of the public, who lost no opportunity in the press and otherwise of censuring English watchmakers for their apathy in not establishing factories and competing with the foreigners in our own markets. But the censors did not see the matter from the watchmaker's point of view. In the first place, if the factory system was to succeed it meant the ruin of his business, and even if he had capital to put into a company he was not sure of any very profitable return for it, as it was generally believed that many of the American companies were failures.

Progress may he retarded but it cannot be stopped, and it is sometimes well for those who are not first in the field of invention, although it may turn out well for those that come after. I believe the Messrs Guye, of London, were the first to risk their fortune in machinery for the manufacture of watches here some twenty-five years ago. The firm had all the initial difficulties of pioneers to face and struggle with, but they have developed, and now employ over a hundred hands. There are two establishments or factories in Birmingham for the manufacture of watches by machinery, more or less - the English Watch Company and Messrs Erdhart and Sons. But in the early days of the factories they did not make their own movements, just as in the early days of the American factories they got dials, jewel holes, and other parts and material from England. But as time went on and factories progressed, they began to make their own movements, especially if they were keyless ones, and the Prescot movement-makers found their trade declining, when, after a considerable amount of suffering and hoping for better times, an agitation was got up in favour of amalgamating all the movement-makers and forming a company for the manufacture of the complete watch. This company was projected in 1887, but it was not until 1889 that sufficient progress was made to enable the company to buy land and commence building operations. This company have extensive shops for the making of new machines and the repair of the machines in action, as it is evident these machines must require constant attention, although I believe many of their most complicated and costly machines were made in America. They have also extensive shops for making movements as

hitherto, for notwithstanding the progress of the factories the private watchmaker is not yet extinct. Nor have machine-made watches reached that high standard of perfection to which our best so-called hand-made watches have attained, nor do I think they can ever do so, as I think companies will always have to work under conditions from which the individual watchmaker is free - as, for instance, no matter how large the factory and varied the machinery, there must he limits to the varieties of the watches turned out, as each size and height of movement must have a whole set of machines to itself. Whereas I can order and obtain a dozen movements any height and size I like and vary the construction of the watch as it suits me.

In order to verify my statement that watches have never been made wholly by machinery, I quote from the company's description of the various parts of the building. The second floor is used for jewelling, gilding, escapement making and balance making, and the third floor for assembling-room, dial and hand making; gilding watches is very much the same process as gilding anything else, and hand and dial making can be carried on in a private workshop quite as well and as economically as in a factory, as these last three operations are more of an art or craft than a mechanical process.

Watch dial making has long since been brought to the highest perfection in England, and enamelled dials a century old are often the admiration of the collectors of horological curiosities. Some of the most valued are of an opal tint enamelled on gold, and the painting of figures and names is very beautiful. There are two distinct branches of dial making, enamelling, and painting - that, in fact, are different trades - and it puzzles the uninitiated to understand how these small names and fine lines can be made by hand, when the copper on which the enamel is now always laid is turned up at the edge just sufficiently to hold the enamel. The enamel, which looks like very fine china, is ground and made into a rather thin paste, and is then spread over the copper and the moisture absorbed by a clean cloth, until it can be spread smoothly and thin; the dial is then put into the furnace and the enamel melted. After this operation any small specks are removed and the surface ground flat and smooth. The dial is then ready for the painter, and is placed on a dividing engine to have minutes marked, as it is of the utmost importance that the divisions of hours, minutes and seconds on a dial shall be absolutely correct, otherwise they will not agree, and it would be impossible to tell to which of two minutes the seconds belonged.

The painting is not laid on with a brush or pen, but a blotch of paint put on for a figure and worked off until only the figure, or letter, is left, when the dial is again put into the furnace, the paint fixed, and the beautiful smooth surface we see on the best dials is obtained. The dials to English watches have mostly feet soldered on to them for the purpose of attaching them to the movement. The late Mr. Willis had a very beautiful way of doing this. He first made a small indentation in the copper disc at the back, the size of the foot, where the foot was to be fixed; this foot was cut from a piece of copper wire strongly coated with silver by the electric process, so that when he laid the foot in the recess he had only to apply the blowpipe to the silver-coated foot; the silver flowing ran to the bottom, forming a perfectly solid whole.

Fashion has had a great deal to do with the change that has come over the trade of watchmaking of late years. Up to within a few years, ladies' watches had mostly gold dials and, as a rule, engraved cases; the fashion now is to have the cases, even of ladies' watches, plain, with perhaps a crest or monogram engraved on them; so, of course, gold dials went out with the coming in of plain cases. Watches made for Spain and Spanish America had generally two or more dials with each watch, a silver dial with gold border and chased gold centre and figures, the cases also elaborately chased on the edge and engraved, the whole looking very rich. Fashion has changed all this, and these branches of the watch trade are now nearly extinct.

The tendency in the factories is to have less complicated machines than was at first thought best. Mr Wycherley, a short tune after he adopted machinery, showed me a very complicated machine, that from a solid disc of brass made a barrel complete without any change of headstock or cutters, by only turning the barrel when one side was complete. Mr Hewitt, of the firm of Wycherley and Hewitt, exhibited at the late Inventions Exhibition, I think, ten machines for completing the barrel and its arbour. At the same Exhibition, the American Watch Company exhibited (one of the sights of the Exhibition) machinery in motion. Some of these machines were marvellous productions of mechanical genius: a screw-making machine which pushed the wire forward to have the body turned down, then withdrew it, pushing forward again to have it tapped, cut the screw from the wire, and then cut the slit in the head and dropped it into a box by an entirely automatic machine.

There was also another feature in this display that merited the attention of watchmakers; that was their mode of applying the balance spring to watches. It has been admitted that however roughly the majority of common American watches were made, they were good timekeepers, and I believe that was to be attributed to the mode of applying the balance springs in the first place. The balances, for certain sized watches with staff and roller complete, were of the same size, thickness, and weight; the springs made from the same wire were put into numbered boxes. Of course the wire was of graduated strength for each box of springs. The springs being of the same size, and having an equal number of turns, were pinned into their collets, and then into the studs, not at haphazard, but at a point completing the spiral or what is termed equal turns, the necessity of which I have pointed out when treating of springing.

The weight, etc., of the balance being ascertained, and the number of the spring, it would be known what spring would suit the balance, or nearly so; the spring was then applied to the balance, and the balance put into a tool resembling a large depthing tool, in one side of which was a normal balance fixed, vibrating to mean time; the two balances were then set to vibrate together and if the time of the one under trial was too fast or too slow, it was seen in a few seconds, and another spring weaker or stronger was applied, when, if found correct, the balance with its spring was placed in a box ready for use, but no taking up or letting out of the spring was resorted to, or supposed to be resorted to. This system could only be carried out where great numbers of watches of one size are made - that is, as applied to low-priced watches. Of course it can be, and is, attained in springing watches of a high class, as the springer either makes his own springs, or has them made to the balance he is using, and I have found no difficulty in getting a dozen balances made to a gauge so near weight and size that I can order a dozen springs that practically will suit any of them; but in adjusting a watch, where the difference in different positions must not exceed two or three seconds per day, no fixed point can be determined for pinning in the spring; that must be ascertained by practice and trials. There is no doubt that a good deal of the discredit obtained by the cheap English watch was due to the slovenly and unscientific method of attaching the balance springs. A spring was chosen that was thought would be about the strength required, it was put on too large, and if the watch was near to time it was left there, although, when the balance was at rest, the coils of the spring were compressed on one side and widely separated on the other.

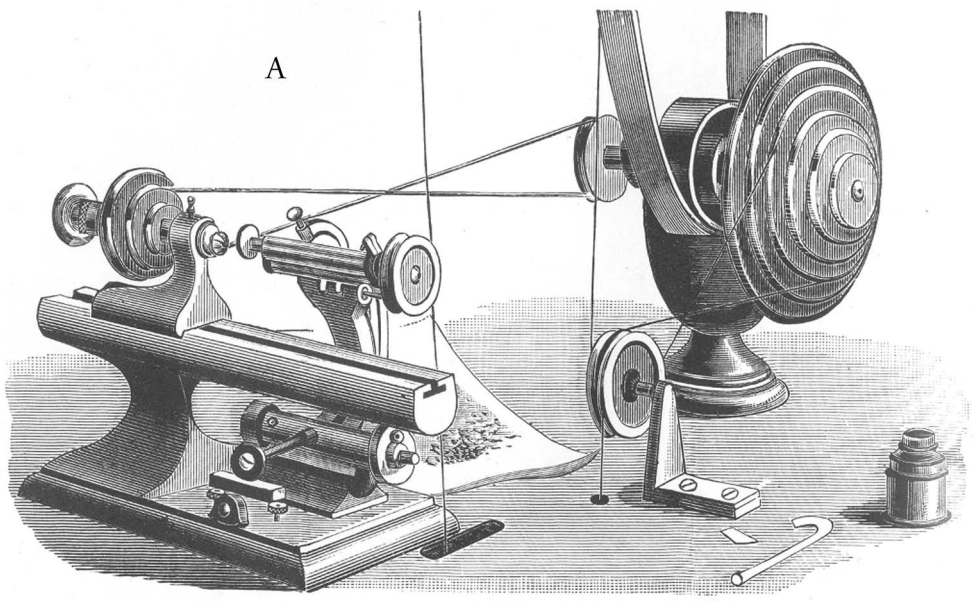
The firm of Rotherham and Sons is, perhaps, the oldest in England, the family having been established as watchmakers in Coventry a century and a half ago.

The ground floors are used for forges, furnaces, rolling-mills, etc.; they are very clean, well ventilated and lighted, and not too high. One of the advantages of a huge firm is in the purchase of their material. Messrs Rotherham use only the best Swedish charcoal steel, and as the brass and steel are purchased in large quantities, they are more likely to be uniform in quality. The brass is

rolled hard to the various thicknesses required for the various pieces. There are about 400 hands employed in the factory, nearly half of whom are girls; and the experience here is rather against the popular theory of the "light touch of the female hand," as nearly all the first parts of the work are done by girls - that is, the parts requiring least skill. The work is divided into minute operations. For instance, a girl is attending a drilling machine, the work consisting of drilling one hole through a piece of brass, and as all this kind of work is piecework, she is paid one penny for drilling 100 holes through 100 different pieces; but there are other operations requiring more skill and care, such as drilling the small holes for the pins in the index. This girl is also paid by results, but if she drills over a certain number of holes without breaking the drill, she receives an additional price for those she drills over that number.

The work is kept correct by a staff of foremen seeing that the machines are in order, and gauging the last few pieces that are turned out. It would be impossible at a moderate length to give a detailed description of even a few tools in use here - ingeniously contrived chucks for holding the various-shaped pieces which constitute a watch, watch stamping, milling and other tools. The principle acted upon is to make each operation as simple as possible, and to have a tool for each.

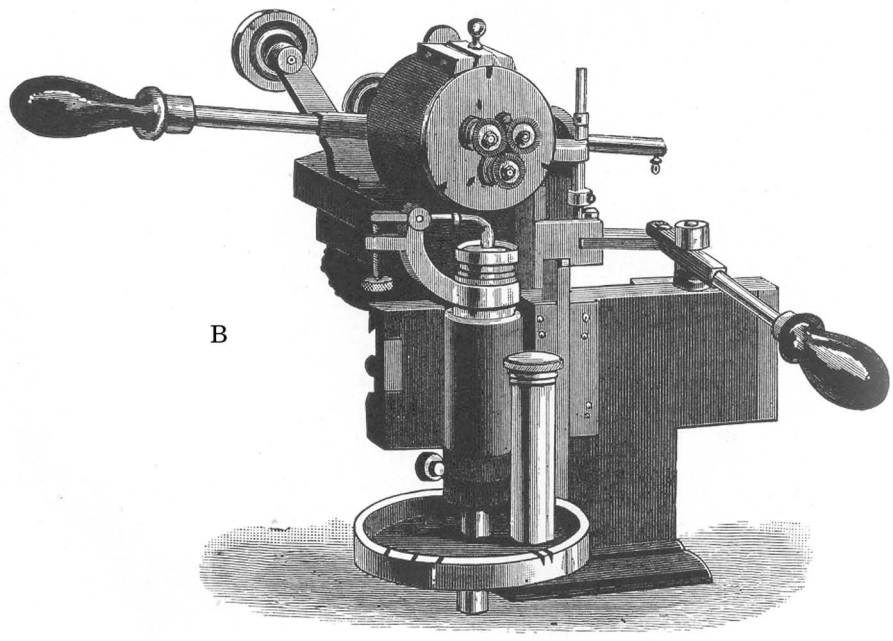
Figure A in the Plate is of a pivoting tool or machine in use in this factory, and it is on an entirely principle to those in use in the earlier factories.



The early pivoting machines were not satisfactory; they were called wigwags. A long straight polisher, like that used by hand, had a rapid forward and backward motion given to it by the machine, the pivot revolving in a bed. In this machine the polisher rotates at a high velocity, the work is chucked in the lathe, and revolves in a contrary direction to the polisher, but at a much slower speed. The polisher is mounted on a swinging frame that moves freely to or from the centre of the lathe, but is kept from the work by a weak spring. This frame, while it moves freely to or from the centre, is also capable of a motion parallel to the bed of the lathe. An arm fitted with a roller which is part of the swinging frame is adjusted easily to ride on an inclined plane, to give any taper to the pivot or arbour required, or it can be set to give a straight pivot or arbour. The operator brings the polisher and frame up to the work, using only the necessary pressure to reduce the pivot to the required size, which he ascertains by a gauge: as this is skilled work it is done by a man.

The advantage of this machine is that it finishes the arbour and pivot at the same time, and corrects any warping that may have occurred in the process of hardening and tempering.

Figure B in the Plate represents a pallet-cutting engine for shaping the angles, which have to be expressed on the steel of an English covered pallet. The three cutters (of three different angles) are mounted in a revolving frame having a dividing plate for bringing each cutter into action in succession, while the steel blank is fixed with its staff hole in the cutter of another dividing plate attached to a horizontal slide.



A series of sixteen stops, not visible in the drawing, are geared with internal connectors, and so related that they are automatically moved by the backward movement of the handle of the machine. By these stops the various shifts of the work and of the cutters are regulated, so that the angles are milled much as a wheel is divided in an ordinary engine. The features of this machine are that the angles of the pallet are a reproduction of the spaces set off by the angular movement of the dividing plate, and that any slight variation of the angle of the cutters does not affect the angle of the cut on the pallet blank.

This machine, Fig. 58, is what is technically called a “shaving punch,” for finishing the interior surfaces of a wheel.

The old process of crossing a wheel was a slow and rather skilful one. After the spaces were roughly punched out, the arms were formed by filing and finished by scraping. This machine finishes the whole of the twenty or more surfaces that require dressing (after the first punching out of the spaces) in less than thirty seconds, by taking off a fine shaving. The swing table and the setting arm for adjusting the wheel arms under the cutting punch are shown on the side of the body of the instrument. These shaving dies are built up in sections, so that the cutters can be redressed and polished when they become dull from use. This machine is very costly, as each sized wheel requires a separate punch; but it is one of the most useful and beautiful tools that have been invented for saving hand labour in watchmaking.

That the new system will supersede the old for the manufacture of watches for the million there is no doubt - indeed it has already done so; but that machine-made watches will ever attain to the perfection of those made by the skilled labour of our best workmen I entirely disbelieve.

There is also a financial problem as yet unsolved. Watchmaking never was a large trade in England; the enormous capital necessary to create and maintain a thoroughly efficient factory can

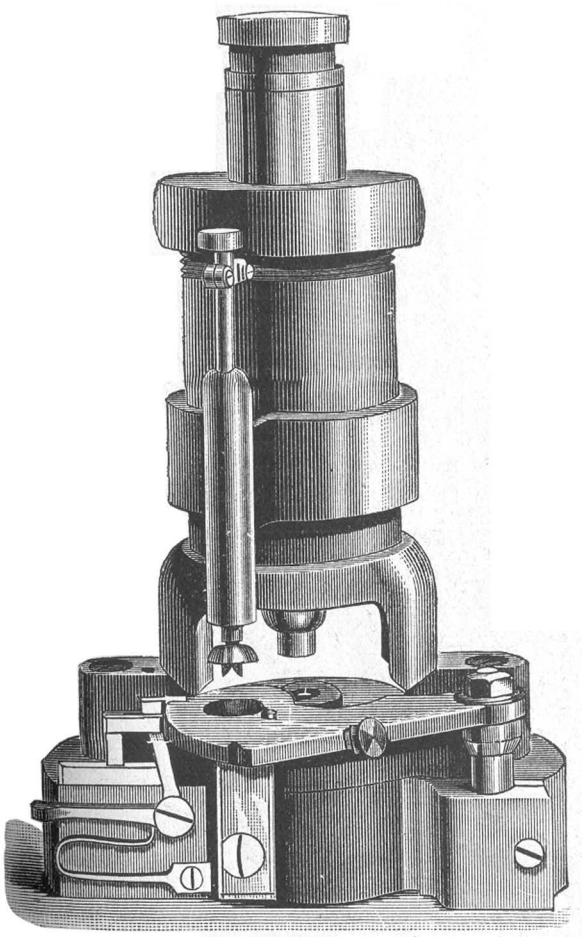


Fig 58

only yield a return by the large and steady sale of its products; and watches are mostly a luxury, and fashion is fickle.

If, however, we are to form our judgment by the experience of the past, I would say that the outcome of the present apparent transition of the trade in England will result in a compromise. More machine tools will be employed in the manufacture of fine watches, but I the knowledge and manipulative skill of the artist must remain, as hitherto, essential to the production of the highest class of work.

In the United States of America, where for many years no expenditure of money or energy has been spared on the perfecting of machinery for the production of watches, there is a reaction in favour of the best English and Swiss watches of the old type, and a demand, which has been and is supplied in the face of a duty on these articles that was meant to be prohibitory. Therefore I think there would be wisdom as well as worldliness in being a little more careful of the skill still left to us.

The unwise and entirely unnecessary competition amongst makers of ships' chronometers for some years past has not only lowered the quality of these instruments, but has so reduced the prices paid for the different branches of the work that chronometer finishers were glad to accept any other employment. Then when, in consequence of a revival of the shipping trade, a demand sprang up, the chronometer makers were at a stand for want of workmen to finish their chronometers.
