JEAN LEBET

LIVING ON AIR
HISTORY OF THE ATMOS CLOCK

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JAEGER-LECOULTRE

COPY

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From the idea to the product: the hazards of success

The history of technology, as any historical approach, feeds on case studies and monographs that make for a better understanding of the general evolution. Jean Lebet, armed with his half-century of industrial experience, takes a look at the origins, the evolution and the development of a product – the ATMOS, the clock that "lives on air". He starts by examining the forerunners who tried to harness the infinite daily variations in atmospheric conditions to operate time measuring machines. With remarkable erudition, he traces the slow progression of such seasoned clock-makers as LEPAUTE, JAQUET-DROZ or HOURIET, whose varied and repeated experiments well show the fascination of this tantalising problem.

There is always a human being behind any innovation or technical progress, although it is sometimes difficult to cite a specific name, as is the case with marine chronometers.

The inventor or creator of the ATMOS clock was called JEAN-LÉON REUTTER (1899-1971) and Jean Lebet tells us of the scientific training and the career of this Neuchâtel engineer who, from his teens, was haunted by *"the idea of industrially producing a clock that could be rewound by atmospheric fluctuations"*. Taking the wealth of archives preserved by the Reutter family and the Le Coultre et Cie clock and watch manufacturers, the author meticulous retraces the origin of the various prototypes while highlighting the influence of other known patents and the many updates and improvements that were made possible only by a degree of persistence bordering on the obstinate. To invent something, to create, mass produce and market it, is no simple matter. After the lack of enthusiasm of manufacturers in the early thirties, production was off to a difficult start because of the sensitivity and novelty of the product. What finally clinched the matter was the encounter between the inventor and the management of *Le Coultre et Cie*, followed by the purchase of the licence to exploit the patent from the French company that had held it since 1935. The necessary conditions now obtained to cross the fine line separating the prototype from the marketable model. This new product, into which considerable investment and collective research had been poured, was wholly in keeping with the wind of innovation that between two wars swept through *Le Coultre et Cie* in Le Sentier, in the Joux Valley and *Ed. Jaeger* of Paris, which had, since 1917, be united by an agreement. At a time when many watch and clock-making companies were downsizing as the crisis reached its peak, these two companies did not hesitate in taking the risk of innovating and diversifying their products. This policy enabled them to prosper and to develop during the one of the most tense periods of the international economic history of this century.

The fascinating history of the ATMOS clock, and especially the internal evolution of this new product that was constantly being improved upon, is a legend in itself, telling the tale of the technical skills of a team of leaders from a wide variety of backgrounds grappling with the unknowns of a revolutionary invention. Their exceptional success cannot be put down to pure chance or luck, but rather to perseverance, know-how and close co-operation between the inventor and the various departments of a company that was already multi-national at that time.

The ATMOS clock became fashionable as a prestigious gift, especially so in Switzerland on the occasion of important official visits and in the United States as a company gift for retirees. That market segment alone soon proved most lucrative and the 500,000th ATMOS left the factory in 1979, half a century after the first patent was filed.

Sometimes the history of a technique lies in the blueprints, in the finer points of construction, losing itself in the intricacies of a process that can be understood only by specialists in the field concerned. In this small, easy-to-read book, Jean Lebet, with his years as manager of the *Le Coultre and C^ie^* clock and watch factory, does not fail to highlight the economic and human context in which the ATMOS was created and whose duration, success and outstanding originality defy fashion and impress its contemporaries. The ATMOS occupies an unique place in the history of products and the author has managed to show this as he examines each new version, supported by pictures and sketches.

Tradition feeds on long-lasting, continuing research and perseverance and *Jaeger-Le Coultre* is proving just how original it is by offering us this history of its flagship products. After the history of the family and of the firm of *Le Coultre et C^ie^* (1983), the story of the REVERSO watch (1992) and, now, the ATMOS, new food for thought is offered to those who realise the importance of the history of companies and their products in fashioning the history of a brand and placing it in a tradition that defies fashion.

François JEQUIER
Professor at the Lausanne University

The attraction of the ATMOS

In 1947, when I was a thermal machine engineer at the Polytechnic Institute of Lausanne University, I was engaged by Mr. Jacques-David Le Coultre to set up and then to manage a Tooling Service, to create special machines and to maintain the machinery at the Le Coultre et C^ie^ clock and watch factory.

After a year of attending various training courses – very necessary if I was to switch from thermal machines to clocks and watches ! – I returned to the factory to tackle the job for which I had been engaged.

Some weeks later, the Production Manager approached me with a hint of a smile : *"We are having problems ensuring the long-term airtight seal on the new motor of the ATMOS clock. As you are an engineer, you will certainly be able to find a solution."* All the motors, in fact, underwent airtight tests for several weeks and, during those tests, a number had been rejected. Despite these precautions, a percentage of the motors had, some months or even a year later proved not to be airtight. To compensate for my lack of practical experience, I had adopted a young and dynamic foreman from the engineering workshop, Mr. Aloïs Ruby, as my favourite assistant. Our team found a solution to the problem – a combination of theory and practice proved positive ! – Such was my first contact with this extraordinary clock.

Over the following years, other "ATMOS problems" were submitted to me, as diversions from my engineering activities – surface quality, friction and wear according to machining conditions or surface treatment, heat treatment, optimisation of the motor, etc. Each of these increased my attraction to this invention and the "finely-tuned" solutions that its realisation required. The power necessary to drive a wrist-watch would suffice for sixty ATMOS ! I had finally been won over by this beauty and the quiet strength of its basic fragility.

I subsequently discovered that everyone who comes to know it is captivated by its charm ! Some are taken by the serene movement of its balance, others by the equilibrium of its shape, others again by the technical challenge that it has required and finally there are those who love it for reasons that escape logical analysis. You cannot explain charm and some people even say that it can be dangerous to try to explain the inexplicable !

It is for these admirers that I am writing this history, *Living on air*, at the request of the Management of Jaeger-Le Coultre. This work has, if anything, increased my fascination, and I hope that it will be the same for the reader!

Part of the principal text comes from two articles that appeared in issues 39 and 40 of the *Chronometrophilia* magazine, which I thank for its help. That original text has been revised and considerably enriched with new elements. In particular two annexes have been added that contain the nomenclature of all the models marketed since the beginning of ATMOS II, with a brief description of each reference, the years during which they were listed in the catalogue and colour illustrations of the most representative models. Nevertheless, over the years, some special designs in very small quantities were produced in single runs at the request of special customers. We did not market those ourselves and they do not, therefore, appear in the said annexes.

Before leaving to you to your reading, I must thank all the persons who, with competence and patience, helped me in my research, those responsible for the archives consulted, particularly the family of the inventor of the ATMOS, Jean-Léon Reutter, and Mr. Edouard Falcy, the infallible specialist in the technical archives of Jaeger-Le Coultre. Thanks should also go to Jaeger-Le Coultre which, with the support of Mr. Thierry Lombard -Reutter, made the publication of this volume possible.

Jean LEBET

"The second class of person that performs experiments is composed of artists instructed in the principles of machines, the laws of motion, the various actions of bodies on one another, and who, endowed with a genius that can break down the most delicate effects of a machine can see in their mind's eye what would result from any given combination and who can calculate it in advance and construct it in the most advantageous manner in such a way that, if they do conduct experiments, they do so less to learn what should happen than to confirm the principles that they have already established".

(Ferdinand Berthoud,
in the Diderot and d'Alembert Encyclopaedia)

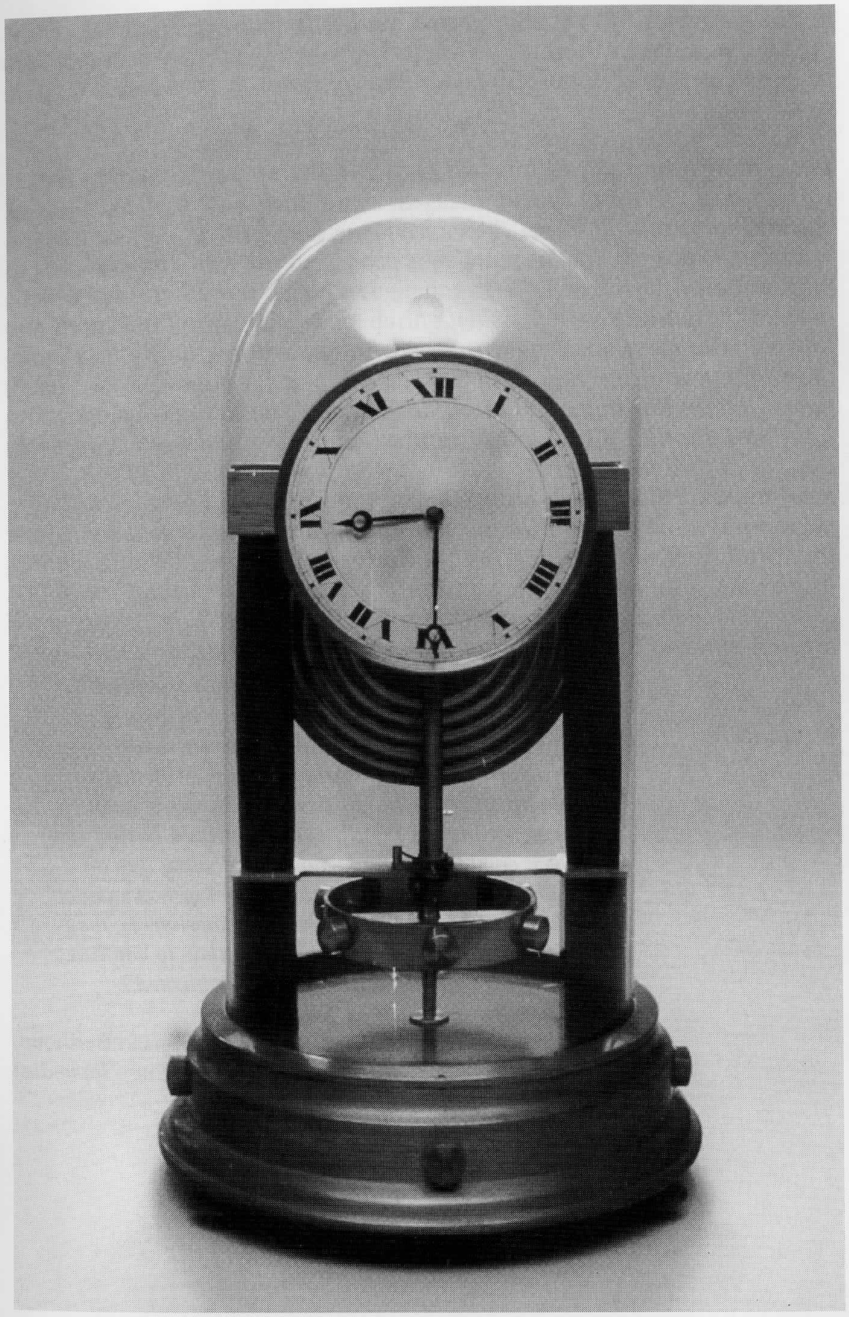


Fig. 9 The first ATMOS 0. Collection of Jaeger-LeCoultre, Le Sentier.

Living on air
The forerunners

Living on air... for the sole purpose of measuring time,... which is even more immaterial...! This conjures up immediately a poetic and somewhat magic word:... strangely unreal and present at the same time, like a spirit,... which marries air and time, glides in... – or "with", whatever it may be – that fourth dimension – the fourth dimensions; controlling that dimension... and, through it – perhaps also – the other three dimensions of material space?

A mystery, too, is this mechanism whereby force, and hence true movement, can be derived from virtually imperceptible atmospheric changes.

A mastery of all, of these subtle problems is essential to anyone who may aspire to solving them for the available energy is so infinitesimal and the problems to be identified and solved so diverse. But most of those who have been drawn by this have seen only one facet of the phenomenon, but a facet whose brilliance has sufficed to blind them to the overall harmony without which any elegant solution for harnessing time is impossible.

Now there is a situation to titillate the human imagination, specially as the first attempts were bound to fail in the face of the complexity of the phenomenon. But the human being, strange animal that he is, is the only creature to have the characteristic of becoming all the more tenacious, the more impossible the task appears to be!

The forerunners

During the first or second century BC, HERON OF ALEXANDRIA illustrated his *Pneumatica* with automatons to help his pupils more easily understand the principals of physics that he wished to explain. Some of his automatic devices were powered by the expansion of heated air. That phenomenon was artificially produced because natural variations in temperature could not by any means have sufficed to move such crude mechanisms.

During the latter half of the XVII century, three physicists touched on the problem that interests us here:

DOM DOMENICO MARTINELLI, of Spoleto, in 1663, in Venice, published *Horologi elementari... fatti con l'acqua, la terra e col fuoco*. In this work, he described the use of natural elements as the motive power to drive clocks.

FATHER KASPAR SCHOTT of Würzburg, in 1664, published his *Technica curisoa*. In chapter XI of volume 9, *Mirabilia Chronometrica*, he cites variations in air pressure as a possible energy source for clocks, *Aeris rarefactiones and condensationes...*

However, neither of these two authors gives any specific examples of the application of the principles mentioned. The techniques of the day probably would not have sufficed.

The Journal des Sçavans, on 5 September 1678, refers to a curious construction produced by THE ABBOT DE HAUTEFEUILLE. While observing a fir hygrometer, he noted *that this machine does shrink quite considerably each day and expands in the same measure each night, ... even during the driest nights of Summer; he thought that it might, by this means, easily rewind a clock, all the more so as he had attached to the lower extremity of his hygrometer a weight of 18 to 20 pounds and noted that, notwithstanding that load, it did manifest the same effect*. He then briefly suggests a means to transmit this movement to the weight of the clock.

Although the hygrometer comprises *several strips of crosscut fir, two inches wide and glued together* – for wood warps more perpendicular to the grain –, we doubt than the daily movement would be sufficient to ensure the proper running of a clock of that day. We nevertheless thought it interesting to mention that original idea.

We shall devote more space to the most astonishing discovery than we made during our research:

On September 29, 1740, PIERRE DE RIVAZ arrived in Basle. He was a Valaisan fascinated by the sciences of his time, and particularly by the art of watch and clock-making. After dwelling at length on the conditions to be met in order to create a near-perfect clock, he had MICHEL FROSSARD DE SAUGY, a clock-maker of Moudon, make a clock according to his studies. The purpose of his trip to Basle was to have his clock examined by a famous scholar and to obtain a certificate such that he could present it to the Academy of Science in Paris. He went to see Daniel Bernoulli, the son of Jean Bernoulli who was, at that time, sick. On December 13, 1740, he received the following certificate:

"Mr. de Rivaz, having made public a clock of his invention, of which the principal characteristics be that it rewinds itself without ever being touched, that it suffers but one sixtieth part of the friction of common clocks, and lastly that it is of an accuracy surpassing anything hitherto attained in this respect;... he has exposed his theory to me, has shown me the construction of his Clock, and did some experiments for me.

"Having therefore examined the reasoning of Mr. de Rivaz, his experiments and his calculations, all of which appeared most ingenious and, having found nothing to belie his expectations as his manner of rewinding the clock required no help other than that of nature, which to me seems quite sufficient for the unique construction of his clock..."

Pierre de Rivaz himself summarised the result of his reflections. He found that the clocks of his day had four principal defects:

"The first is a lack of accuracy. Although several causes combine to disturb the smooth running of clocks, that mathematicians call Isochronism, nevertheless only one seems to surpass all the others, in that it is found even in clocks built by the best craftsmen.

"In order properly to understand the cause of this defect, one must know that heat causes iron to dilate, as indeed all metals used to make the pendulums of clocks, and that the longer the pendulum, the slower the clock runs. Hence, in summer, as the heat lengthens the pendulums, clocks necessarily run more slowly, and the opposite is true in Winter(...) No-one having a better quality clock can be unaware of this fact for it is very rare, that they be not obliged to adjust them each month of the year. [Thermal compensation]

"The second defect of clocks is this obligation to rewind the weights or springs that drive them. It is fairly irksome to be obliged or to have to bother to rewind clocks, or each year to have to pay someone to do so (...). [Perpetual Clock]

"The third defect of clocks consists in the great friction of the wheels, caused by the considerable forces, be they weights or springs, that one is obliged to use to set these wheels in motion and keep them turning. This friction has three major disadvantages. The first is that the clock to a great extent destroys itself and cannot last long; the second is that the wear on the wheels imperceptibly forms dust that, after a number of years, becomes so considerable as to stop the clock consequently making it necessary to clean it; the third is that the pivots that carry the gears, constantly turning in their sockets, cause those sockets so to enlarge that the teeth of the gears no longer align with those of the pinions and gaps form between them. That is why a somewhat ageing clock stops very frequently. [Wear]

"The fourth defect of clocks is not so essential as the three others. It depends on the difference that there is in the apparent movement of the Sun." [Solar time and the time equation]

What is remarkable in this text – as in other writings of Pierre de Rivaz – is this concern to analyse the problem in its entirety while breaking it down into its various parameters in order to provide a coherent solution. This almost scientific reasoning was, at that time much appreciated by the great masters clock-makers. Jean-André Lepaute unreservedly supported him in the dispute he had with the elder son of Julien Le Roy; in the *Diderot and d'Alembert Encyclopaedia*, Ferdinand Berthoud, the contributor of the item on *Clock and Watch-making*, refers to him in these terms:

"To these skilful artists [Sully, Julien Le Roy, Pierre Le Roy], *we owe a great deal of research and especially the perfection of handwork for, as compared to the theory and principles of the art of measuring time, they were barely touched upon; (...) the only work containing any principles is the paper by Mr. de Rivaz in response to a rather bad anonymous letter* [which turned out to have been written by the elder son of Julien Le Roy!] *against his dis-*

coveries. To this paper we owe... the spirit of emulation that fired our modern artists. It would have been much to be wished that Mr. de Rivaz himself had been a clock and watch-maker for his knowledge of mechanics would have done much to perfect this art."

Pierre de Rivaz is the only true forerunner of the ATMOS!

He, in fact stated the three characteristics necessary for the realisation of a perpetual clock:
– Accurate running
– Rewinding by temperature variations
– Low consumption (for this purpose also, the balance of its marine clocks is supported by a metal ribbon that works by torsion!).

We were not able to discover the total number of clocks made according to the inventions of Pierre de Rivaz. The archives refer to the production of more that three hundred. Several perpetual clocks are included in this number, as well as others *"that will run for between one and twenty years without being rewound..."*

Then there were ship's clocks. The excellent adjustment that could be achieved with his mechanisms, prompted Pierre de Rivaz to pursue that path which was being much researched in those days and that could be very profitable. One of these ship's clocks tested by the Academy of Science in Paris and subjected to alternating heat and cold, varied by only one second in fifteen days! The Conservatory of Arts and Crafts still has three ship's clocks made by de Rivaz from around 1750.

In 1755, J.-A. LEPAUTE, in chapter VIII of his *Traité d'horlogerie*, gives details of a clock that he installed at the Academy of Painting and Sculpture of the Louvre. It was still certified to be running well in the XIX century.

Its originality deserves a brief description (Fig. 1). J.-A. Lepaute observed that there always exists a temperature difference between the air outside a building and that inside, due to the thermal inertia of the walls. This difference is particularly great between day and night. A channel traversing an external wall will therefore be traversed by an air current inducing a sort of air turbine.

The air travelling from E to S turns turbine A which, through a set of gears, causes a pulley L to turn. This should carry a pawl, which is not shown, to prevent it from turning backwards. The Q axis is the motor spindle of the clock.

The endless sash PR connects pulleys L and Q, according to the device evolved by Huygens, and passes round a weight S and a counterweight T.

When fully wound, the lever X-Y is raised and the shutter V shuts off the channel ES.

Apart from those crazy people in quest of perpetual motion, Neuchâtel clock-makers, too, were trying to produce a clock "living on air"!

Indeed, at the same time, in 1758, PIERRE JAQUET-DROZ when travelling in Spain presented many of his creations including a perpetual clock which

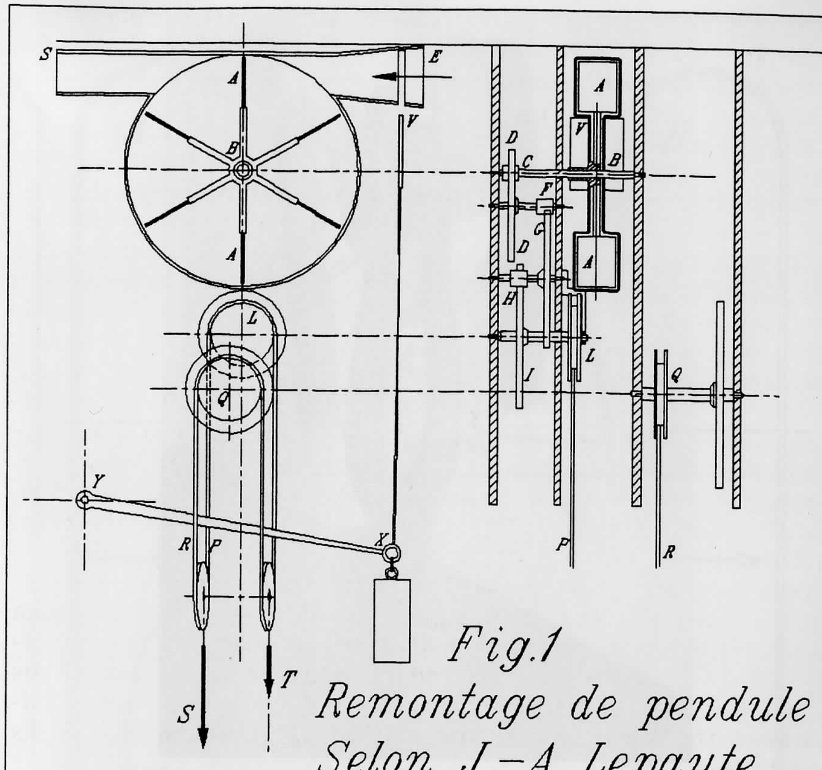


Fig.1
Remontage de pendule
Selon J.-A Lepaute

was rewound by a bimetallic system comprising two metals of different coefficients of expansion. However, according to certain texts, while the system used did make it possible considerably to extend the time between rewindings, it did need a bit of a "leg up" from time to time!

In 1783, the clock-maker SAMUEL ROY of La Chaux-de-Fonds, is purported to have built a "self-winding perpetual clock" but no further details were given on whether it was actually made or about the principles used.

About 1820, the watch-maker, JACQUES-FRÉDÉRIC HOURIET, thought up a *"large scale metallic balancing thermometer to which a clock movement could be adapted and for which it served as a driving force"*. (According to the *Revue neuchâteloise*, the first one was delivered in 1831 and it appeared in the inventory of the physics instruments of the late Mr. Frédéric Houriet of Le Locle that were acquired by the City of Neuchâtel.)

The general view of this apparatus (Fig. 2) shows that it was made with a certain eye to aesthetics and that it was not a simple passing laboratory gimmick even though, at that time (early XIX century) there were many "physics laboratories" which delighted in collecting curious and fine-

Fig. 2 Totalising thermometer by Jacques-Frédéric Houriet (Neuchâtel Art and History Museum).

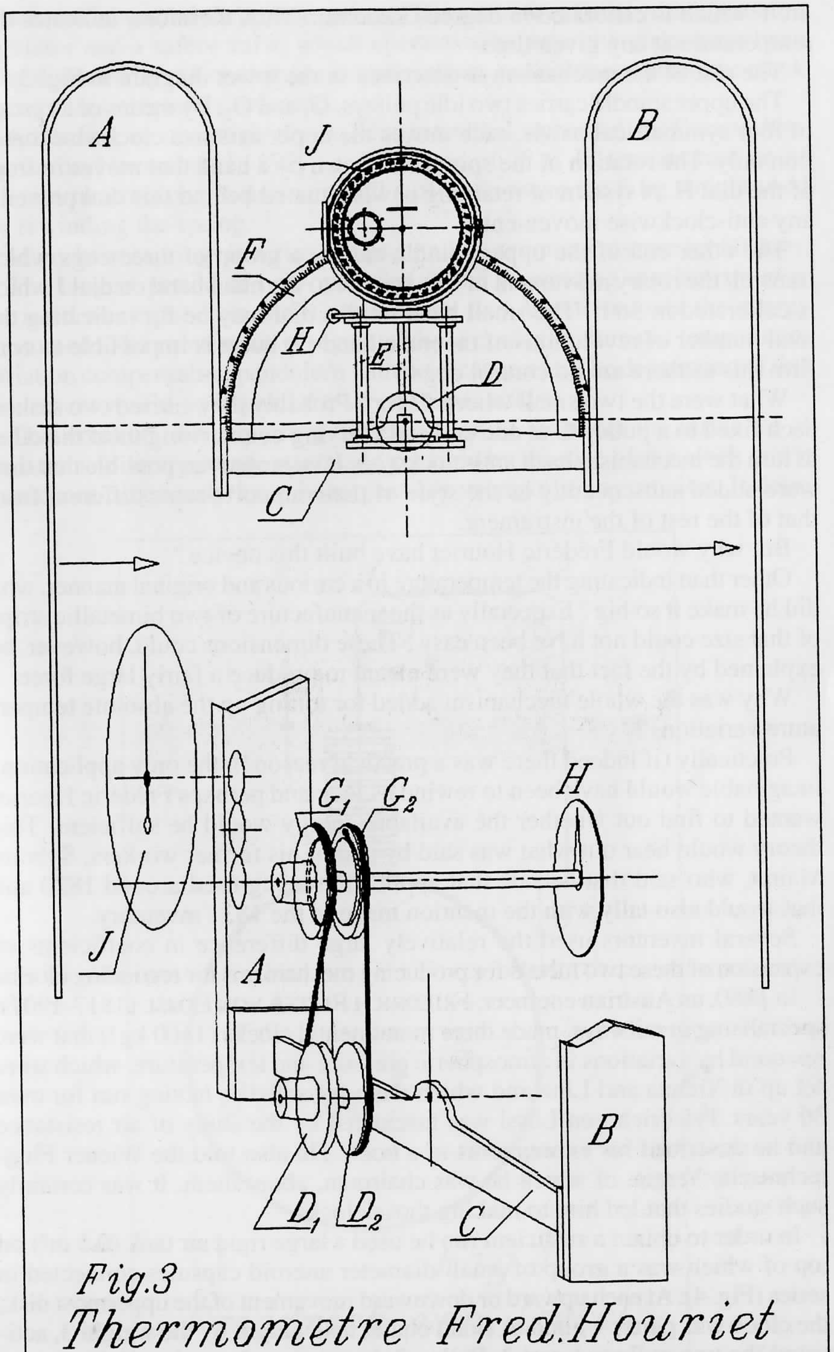
looking instruments, frequently with little interest in their practical application.

The sensitive part of the device (Fig. 3) comprises two large strips, A and B, each having a cross-section of 160×6 mm! The materials used are iron and zinc whose coefficient of expansion are very different:

Iron: 12.10^{-6}
Zinc: 35.10^{-6}

In strip A, the zinc is outside and in strip B, inside. The extremities of the two strips therefore move in the same direction as the temperature changes and this shifts the balance of the whole. The two strips, which are lacquered and decorated, are fixed to the ends of a beam C that pivots on the central axis of the instrument.

Apart from the beam C, there are two main pulleys, D_1 and D_2 as well as a red indicator hand E that are securely fixed to the main spindle. The position of the hand E is adjustable on the spindle. Once set, it moves along the



arc F which is calibrated in degrees Réaumur. This, therefore, indicates the temperature at any given time.

The rest of the mechanism is described in the lower diagram in Fig. 3.

The upper spindle carries two idle pulleys, G_1 and G_2. By means of a system of four symmetrical pawls, each moves the upper axis in a clockwise direction only. The rotation of the spindle is shown by a hand that moves in front of the dial H. A system of retaining pawls situated behind this dial prevents any anti-clockwise movement.

The other end of the upper spindle carries a group of three cogs which transmit the rotary movement of this spindle to the main hand on dial J which is calibrated in 360°. The small hand on this dial may be for indicating the total number of revolutions of the main hand (?) but it is impossible to confirm this as there are no control cogs.

What were the two small wheels H for? Probably they carried two sashes, each fixed to a pulley G at one end and carrying counterweights at the other to turn the mechanism back anti-clockwise. It is, moreover, possible that they were added subsequently as the style of their support seems different from that of the rest of the instrument.

But why would Frédéric Houriet have built this device?

Other than indicating the temperature in a curious and original manner, why did he make it so big? Especially as the manufacture of two bimetallic strips of that size could not have been easy! These dimensions could, however, be explained by the fact that they were meant to produce a fairly large force.

Why was the whole mechanism added for totting up the absolute temperature variations?

Practically (if indeed there was a practical reason!), the only applications imaginable would have been to rewind a clock and perhaps Frédéric Houriet wanted to find out whether the available energy would be sufficient. This theory would bear out what was said by one of his former workers, Sylvain Mairet, who said that he saw that application being used around 1820 and that would also tally with the mention made in the 1831 inventory.

Several inventors used the relatively large difference in coefficients of expansion of these two metals for producing mechanisms for rewinding clocks.

In 1880, an Austrian engineer, FRIEDRICH RITTER VON LÖSSL (1817-1907), specialising in railways, made three monumental clocks (1600 kg!) that were rewound by variations in atmospheric pressure and temperature, which were set up in Vienna and Linz and which were recorded as having run for over 30 years. Friedrich von Lössl was fascinated by the study of air resistance and he described his experiments in a book. He also told the Wiener Flugtechnische Verein, of which he was chairman, about them. It was certainly such studies that led him to making those clocks.

In order to obtain a sufficient run he used a large rigid air tank (0.5 m³) on top of which was a group of small-diameter aneroid capsules connected in series (Fig. 4). At each upward or downward movement of the uppermost disk, the clock was partly wound. A small chain, held taught by the weight 3, activated the two pulleys 1 and 2. Pulley 2, by means of a rack and the appropriate pawls, wound the motor springs. The air tank is fitted with a pressure regulator and a safety valve which operates whenever the disks have been fully distorted by major changes in atmospheric conditions or when the clock springs are completely rewound.

According to an article by A. Hungerer that appeared in *France horlogère* on November 1, 1927, a difference of 1° C in temperature or of 2.5 mm in atmospheric pressure will suffice to move the 6 kg weight used for rewinding the spring.

Many barrel springs in series can accumulate a running reserve for 80 days.

The longest period of non-operation of the re-winding mechanism ever recorded was eight days and it needed only two days to recover the energy consumed. The movement is regulated by a conical automatic temperature variation compensating pendulum with no escapement. The description of this movement would go beyond the scope of this study.

This creation, directly using the expansion of air under the influence of variations in temperature, was made possible by the size of the clock and it would not necessarily have been possible to make it any smaller. It does,

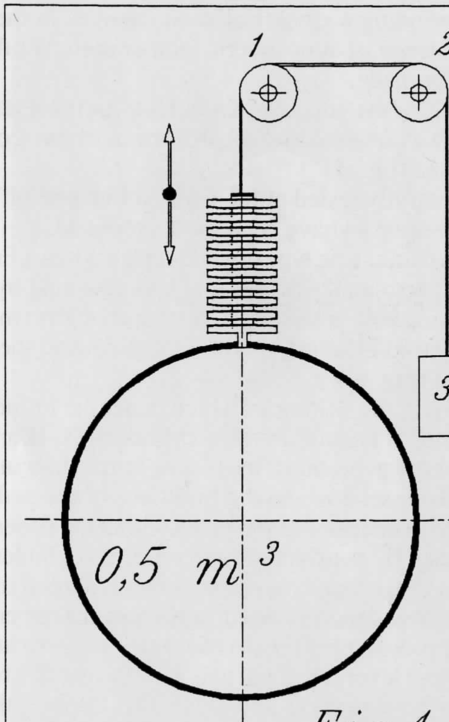


Fig.4
Friedrich von Loessl

however, have the merit of having really worked under difficult conditions for several decades.

Other inventors made clocks based on a similar principle (unknown of Marienburg – 1880, C. Paganini – 1894 to whom we shall be referring, unknown of Indianapolis – 1899, Sildeberg – circa 1900, *et al.*). To the best of our knowledge, none of those inventions was ever mass produced even in very short runs. *The Revue Internationale de l'Horlogerie et des branches annexes,* 1905, on page 724, did however refer to a clock that had been built "one year before" by VALENTIN BOUVET of Beaucaire and which had been considerably smaller than that of F. von Lössl and was rewound by variations in atmospheric temperature and pressure on a relatively similar basis.

From the latter half of the XIX century, several investigators noted that expansion in the volume of liquids offered interesting potential. The two products used because of their high coefficient of expansion were glycerine (coefficient of expansion 5×10^{-4}) and alcohol (coefficient of expansion 10.8×10^{-4} between 10 and 30°). Air has a coefficient of expansion of 3.67×10^{-3} whereas liquids are practically incompressible.

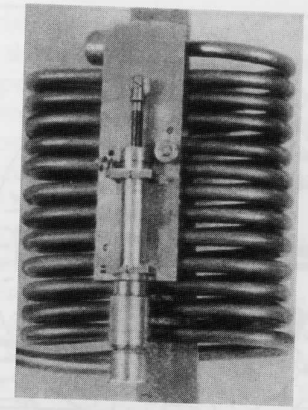
In 1877, the review *Zeitschrift des Vereines Deutscher Ingenieure* described a device for rewinding a clock based on changes in the volume of glycerine under the influence of atmospheric temperature. We do not know whether this was actually made.

Fifty years later, in 1926, the engineer KARL HEINRICH MEIER of Rüschlikon built a clock that was rewound by the distortion of two coiled copper tubes filled with glycerine (Fig. 5).

That clock was successfully tested at the Federal Institute of Technology in Zurich but it does not seem to have been mass produced.

Among the examples of this same type of winding there was a French clockmaker, CHARLES HOUR, who made a clock that was rewound by the expansion of alcohol. Its mechanism struck us as interesting enough to merit description for the energy produced is actually sufficient to rewind the spring of a normal clock movement (Fig. 6).

Alcohol, the variations in the volume of which under the influence of temperature drive the system, is contain in three cylinders, A, B and C, which are set in a line upon on the pedestal of the clock. In the drawing, cylinders B and C are shown in cross-section and the front face of the pedestal is partially cut away. The three cylinders are connected within the pedestal by tubes D. Cylinders A and C may be considered rigid whereas cylinder B is a bellows and can therefore vary in length as the volume of alcohol increase. It is guided by four rails H. A gudgeon is fixed to the uppermost end of B and through two connecting rods it transmits its movements to two angled levers E and F. At the ends of these levers are fixed two flexible metallic blades which transmit these to-and-fro movements to a pulley G. This turns clockwise whenever the temperature falls and anticlockwise when it rises. The pulley spindle is on the same axis as the clock movement motor barrel spindle but independent of it. This pulley spindle moves the spring of a fixed-drum auxiliary barrel and a pawl acting on the clock barrel ratchet.



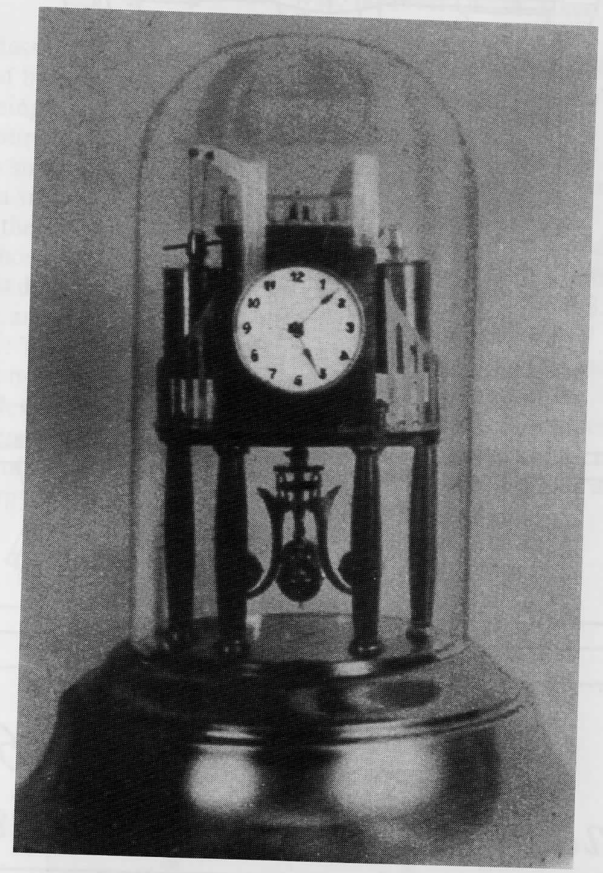


Fig. 5 Clock built by K. H. Meier in 1926.
The detail shows the copper helical tube filled with glycerine.
These photos appeared in the *L'Illustré magazine* on April 1, 1927.

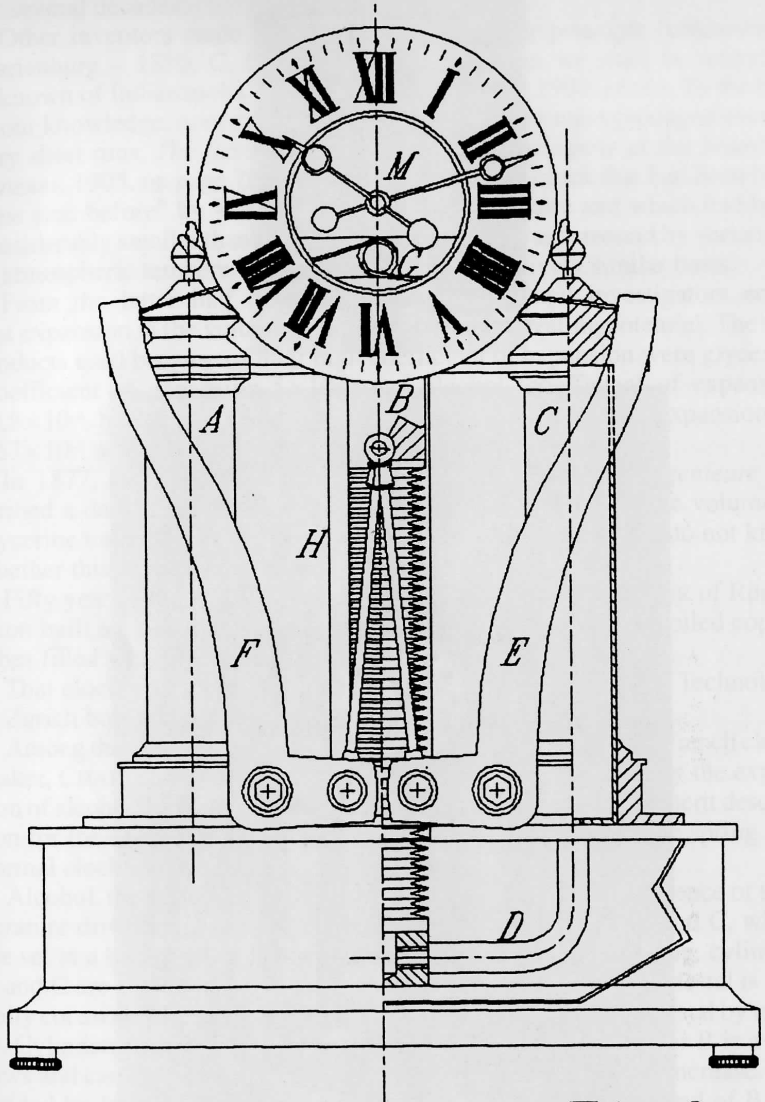


Fig.6
Pendule à alcool Ch.Hour

As the temperature rises, the auxiliary barrel is wound. When temperature falls, the spring winds the barrel motor by the pawl effect. This winding is limited by the torque specific to the fixed auxiliary barrel spring. When the balance is struck, the two flexible blades connected to levers E and F relax as the temperature drops as there is no retraction tension.

Apparently experience has shown that differences in temperature of 1 to 2° suffice to rewind the clock normally.

The weakness of this mechanism is the difficulty in integrating it into different shapes and styles of cabinet.

Finally, we would mention an original method described in a US patent in 1926. This involves using variations of light between day and night to operate a rocker system and the suggestion that such a system could be used to wind a clock (US patents No. 1 of 07.09.26 and No. 1.697.986 of 13.09.26, Ira E. MacCabe, Chicago). The idea was, however, never taken any further (Fig. 7).

Two glass bulbs, 1 and 2, similar to those used in electric light bulbs, are connected by a tube 3. Bulb 1 is tinted in the mass so that it absorbs light transforming it into heat.

This entire recipient contains a given quantity of mercury and a gas which may even simply be air according to the patent. The whole is then sealed and set upon a support 5 that pivots on 6.

When the device is exposed to light, this light is converted to heat in bulb 1 whose internal pressure increases faster that that in bulb 2 and the mercury is displaced. The system then tips until it rests on stop 8. Of course, the whole assembly has to be so balanced that it rests on stop 7 when there is no light ! This see-saw movement can therefore be used to wind the spring of a clock by a device not shown.

Regardless of the media used above to transform a few degrees change in ambient temperature into mechanical energy, the basic problem remains the weakness of the energy generated per unit volume of the device and its ratio to the energy necessary for moving a clock movement.

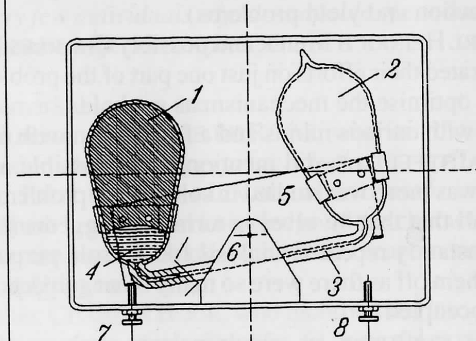


Fig.7
Brevet USA – Ira.E.Mac Cabe – 03.09.1926

That is why successive inventors have sought means of obtaining the best yield from the transformation of thermal energy into mechanical energy. One interesting solution is to use changes in the liquid-gas state of a saturated vapour under the influence of temperature instead of the simple expansion of a perfect gas. In that case, a mass must be found which can pass from the liquid to the gaseous state within the desired ambient temperature range and in easily obtainable pressure conditions. Efforts were made to obtain conditions such that the maximum ambient temperature resulted in the total vaporisation of the product and in this way the risks of explosion resulting from an exceptional temperature peak were considerably reduce. The saturated vapour was then replaced by a gas a that could be considered a perfect gas and the temperature pressure curve flattened out considerably. Finally, the mass had to be such as not to erode the walls of the containing recipient.

According to our documentation, we found mention of the use of saturated vapour in a US patent No.685.269, filed on 10.28.01 by WESTON M. FULTON of Knoxville (Tennessee). That same inventor subsequently filed three other patents, one (No. 737. 093 of 11.25.01) being for a mechanism to regulate the force transmitted to a clock movement, the next (No. 778.237 of 08.03.03) for a mechanism for accumulating energy for subsequent use and the last (No. 824.858 of 06.01.03) for a device more sensitive to temperature variations. This group of patents clearly shows the result of a succession of tests but we were not able to find any trace of any effective industrial application.

Finally, in 1909, PIERRE-A.-J.-M. BOUVIER filed a French patent (No. 408.176 of 10.22.09) in which he described the principle of using a container with two areas filled with saturated vapours and separated by mercury and in which one area is at ambient temperature and the other has great thermal inertia (insulation like a thermos flask and a liquid mass). The difference in pressure between the two areas causes the mercury be pushed from one side to the other and hence make the device rock. The many forms of application of this principle described in the patent are unfortunately very complicated to implement and would certainly not have allowed for practical application (because of production and yield problems).

Apart from KARL HEINRICH MEIER and possibly CHARLES HOUR, all these inventors concentrated their efforts on just one part of the problem to be solved and did not try to optimise the mechanism as a whole.

Some of them, with curious minds and a fascination with novelty, such as the ABBOT DE HAUTEFEUILLE, did mentioned the possible application of a phenomenon that was moreover studied in solving our problem. But the actual realisation, with all that that involves in terms of doggedness, failures to be overcome and constantly repeated analysis for the sole purpose of attaining success soon put them off as there were so many other subjects that constantly kept their minds occupied!

Others, famous craftsmen or clock-makers such as J.A. LEPAUTE, PIERRE JAQUET-DROZ or JACQUES-FRÉDÉRIC HOURIET certainly built one-off clocks rewound by temperature variations but they were not interested in

completely mastering a mechanism that called for branches of knowledge so different from those they had already mastered. So their inventions remained simply very marginal "curiosities" for them.

To conclude this chapter

According to our study of the "forerunners", four men managed to move beyond the initial stages by studying the basic principles used in their clocks and thus followed the thoughts of the great FERDINAND BERTHOUD in the pages he wrote on watch-making for the *Diderot and d'Alembert Encyclopaedia*. His comments are still so topical that we shall cede to the pleasure of citing them!

Although it is necessary to set out from the mechanical principles to build the parts of a clock, it is as well to check them by experiments for, even though those principles are invariable, as indeed they are complicated and applied to very small machines, there are different results which are fairly difficult to analyse. We shall see that, as compared to the experiments, there are two sorts of approaches. The first are those made by persons lacking in intelligence and who simply conduct tests to avoid the trouble of seeking the solution by research which can involve difficult analysis that they frequently do not even suspect, and which results in a haphazard mechanism, lacking in principles and insight.

The second class of person that performs experiments is composed of artists instructed in the principles of machines, the laws of motion, the various actions of bodies on one another, and who, endowed with a genius that can break down the most delicate effects of a machine can see in their mind's eye what would result from any given combination and who can calculate it in advance and construct it in the most advantageous manner in such a way that, if they do conduct experiments, they do so less to learn what should happen than to confirm the principles that they have already established and the effects they have analysed. I admit that such a manner of viewing the problem is very painstaking and that one has to be endowed with a certain genius which means that there are very few individuals who are capable of conducting useful experiments with a precise objective in view.

These four remarkable men are:

- the inspired forerunner, PIERRE DE RIVAZ, who laid the groundwork for a perfect clock and made several *perpetual clocks*;
- the engineer, FRIEDRICH VON LÖSSL, whose motor is described above (Fig. 4) results from his personal knowledge of the characteristics of air, and who also took up the conical clock, without an escapement as such, from the famous physicist Huygens;
- the clock-maker, CHARLES HOUR, who incorporated into a clock movement that he knew well a system of winding (Fig. 6) using the expansion of a volume of alcohol, a simple physical phenomenon to master using the classical mechanical solutions of watch-making;

• The ETH engineer, KARL HEINRICH MEIER, used the expansion of glycerine (Fig. 5) for rewinding a torsion-pendulum movement, of a "400 day", type of clock that requires very little energy.

These four designers came close to a marketable solution. Nevertheless, as we shall see later, the problems of perfecting and manufacturing so sensitive a product and the problems of putting so new a product on the market, were just so many more obstacles to be overcome. These obstacles, so different from their usual preoccupations, were usually just too much for these inventors. But we can hardly hold that against them especially as the industrialists themselves often seriously under-estimated them! There is often many a slip 'twixt the cup to the lip as we shall soon see!

JEAN-LÉON REUTTER and the idea of the ATMOS clock

Jean-Léon Reutter (Fig. 8) was born on August 1, 1899 in Neuchâtel, the son of Max Reutter, the Head of the city tax office.

He had a lively and curious mind for applied sciences and acquired a sound scientific basis. This early training was apparent in all his subsequent research for he abundantly documented himself, analysed and then mastered the relevant laws of physics, then evolved a general synthesis that resulted in the products and finally studied and eliminated any defects that appeared in practice.

Although the ups and downs of life caused him to apply these qualities in many different areas with unfailing success – which proved yet again that a basic training of the mind and reason is more important than launching straight into collecting data the quantity of which does not always clearly show the way to be followed – he was constantly haunted by the idea of industrially producing a clock wound by atmospheric fluctuations.

His technical and scientific training combined with amazing perseverance enabled him to put into practice a dream that his forerunners man merely touched upon.

He himself noted that:
My first efforts at producing a perpetual clock go back to 1913 when I was a pupil at Neuchâtel College (at the age of 14!). *I had speculated on the expansion of liquids or gases and constructed a fairly large number of different devices over the following years simply in the hope that they would work.*

But the subsequent pursuit of his studies was essential:
1917-1921 Zurich Federal Institute of Technology (mechanical engineer)
1922-1923 Ecole supérieure d'électricité in Paris.

As was the start of his working life:
1923-1926 Telephony and high frequency telephony with Marius Latour and Thomson Houston.

Then comes a *gap* of 10 months. As the prototype of the first *perpetual clock* by J.-L. Reutter was set in motion on September 11, 1927, it may be

Fig. 8 Jean-Léon Reutter.

assumed that the inventor had devoted that time to producing that first version. (Two units were made that were operated by air expansion. One of these clocks may be seen in Geneva at the Enamel and Clock Museum.)

For the purposes of our narrative, we shall call that model the ATMOS 0, even though it was never known by that name at the time.

10.15.1927 Compagnie générale de radiologie at Courbevoie (Ets. Gaiffe, Gallot et Pilon) as a radiology engineer.

11.28.1928 First ATMOS I patent (ammoniac and mercury).

Mr. Pilon, one of the partners in the Compagnie générale de radiologie, took an interest in the personal studies Jean-Léon Reutter been conducting (ATMOS 0 which had already existed as a prototype for one year and ATMOS I).

J.-L. Reutter then took six months "leave" (the first half of 1929) and completed the ATMOS I.

On June 1, 1929, he signed a first contract with the Compagnie générale de radiologie and became manager of the new "Clocks" Department.

The ATMOS 0

This first model, of which only two prototypes were made, may be included among the "Forerunners" (Fig. 9).

Although the two units operate on the same principles, there are many differences between the way they were made especially with respect to the transmission of the movements of the transducer to the motor-spring. The following description concerns the clock in the Geneva Clock and Enamel Museum. The various methods used had not yet matured sufficiently for mass production to be considered but were merely at a trial stage, albeit already advanced.

Thanks to the very detailed records kept by the Reutter family, it is possible to follow this first adventure fairly closely and to derive certain lessons from it. Apart from the many practical experiments referred to above, J.-L. Reutter had collected a considerable body of documentation on previous items, patents, press articles, etc. Indeed they contain many details that were used in successive versions of the ATMOS.

Operation of the ATMOS 0

The clock is housed in a glass bell-jar that is fixed to the pedestal with an air-tight seal so that the interior is insulated from the atmosphere. The pressure within then varies with the temperature of the air it contains (Fig. 10).

The two aneroid capsules 1 and 2 are connected in series and communicate with the atmosphere by a tube 3. This tube passes through the base of valve 4 and emerges under the pedestal through one of the structural columns. The aneroid capsules will therefore always be at the atmospheric pressure of the outside air.

Temperature variations of the air trapped under the bell-jar or variations in the barometric pressure of the atmosphere will cause the capsules 1 and 2 to expand or contract. Their movements will be transmitted to lever 5.

That lever carries a double rack of oblique teeth 6 at the far end of two long, very flexible arms. The to-and-fro movements of these arms cause the ratchet 7 at the lower extremity of the motor-spring assembly 8 to turn and this acts as the barrel-spring of the clock movement. The maximum torque limit on the motor-spring is obtained by the flexibility of the two double rack arms 6 ! One can have some doubt as to the precision of the motor torque thus obtained and the ease with which it is obtained !

However feeding such a clock movement would need a "constant force" system yet the isochronics of the torsion pendulum is not good. Moreover, the less energy spent by a device, the greater its sensitivity to variations.

All this part of the ATMOS 0 derives from the patent by C. Paganini (Deutsches Reich – No. 84858 – July 3, 1894). The system has nevertheless been greatly refined and simplified and was not designed to use a very low-consumption movement, without which it was impossible.

The motor-spring 8 is very crucial. It needed:

- a spring with a running reserve such that the running of the clock be ensured during periods of atmospheric stability (several weeks);
- a very flat winding curve to ensure regular running;
- a high yield (95% minimum) to save the limited energy and allow the winding mechanism to take account off minor variations.

J.-L. Reutter thought of using a very long helical spring (Fig. 11) with very fine coils contained in a tube 8. Such a spring, in certain winding conditions, remains in balance without the coils touching one another and without their touching the inside of the tube containing them. This situation exists between a number of turns T_1 and T_2 differing greatly from one another thus solving the problem (but not without difficulty !).

Also, for reasons of yield, care must be taken to ensure that the atmosphere-motor transducer system does not work at either extremity. The valve 4 is used to balance the pressure between the air inside and that outside whenever this occurs. The multiple lever 9 will open this valve in extreme cases. (The return springs are not shown).

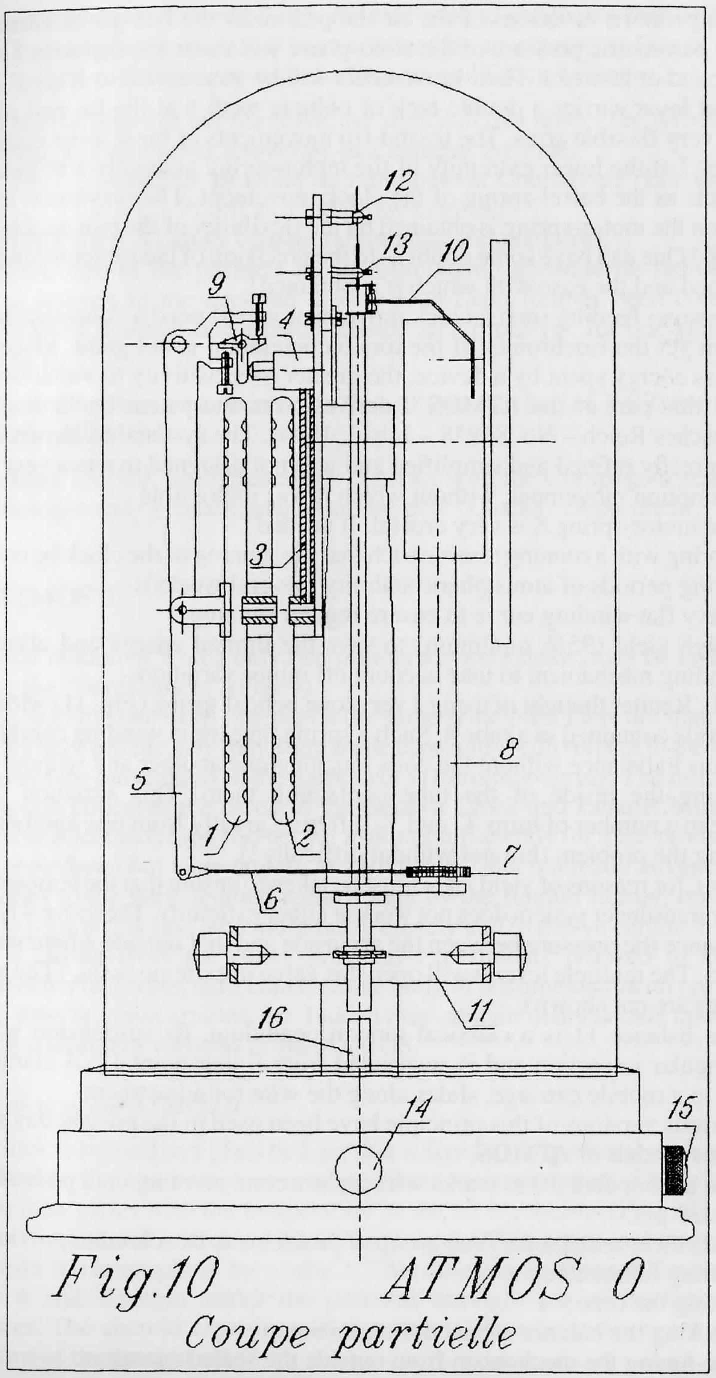
The balance 11 is a classical torsion pendulum. Its suspension wire is rectangular in section and is suspended from fixing point 12. A clamp 13, fixed to a mobile carriage, slides along the wire for adjustment.

Various versions of this principle have been used to the present day in the various models of ATMOS.

The anchor-fork 10 to works with a glass cone pivoting on a point. It has no guard-pin.

Then there remained a final group of problems to be solved to provide the following functions:

- setting the time;
- blocking the balance-wheel during transport;
- fine-tuning the mechanism from outside the sealed container.



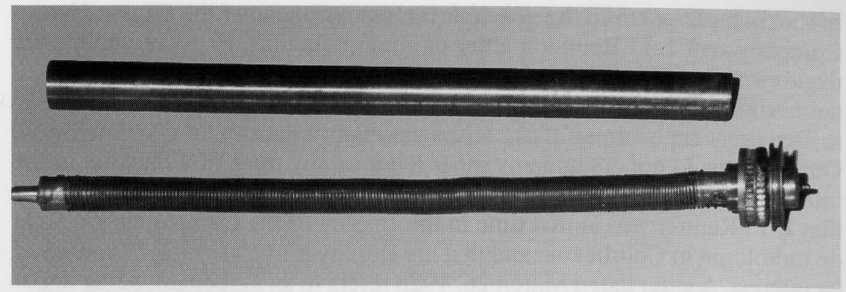


Fig. 11 Motor spring.

Ingenious mechanisms involving rods and levers hidden in the pedestal or structural columns perform these functions more or less satisfactorily. They are controlled by three knurled knobs on the pedestal. Knob 15 is for setting the time, knob 14 is for fine tuning the mechanism and the knob on the other side is for blocking the balance-wheel.

To ensure that these knobs are airtight, each of them is mounted on a long tight-fitted and greased cone.

In concluding this chapter, it is interesting to note the "energy balance" aspects cited in the *Swiss Clock-Making Journal* of January 1928 when the ATMOS was presented to the Press.

Measurements he had previously made on ordinary watch and clock movements had shown him that the power necessary to keep a clock running for 24 hours was between 50 and 100 gram-metres and even more. Patient research enabled him to produce a torsion-pendulum clock movement with a very slow rate of movement, the energy consumption of which did not exceed 10 to 15 gram-centimetres per 24 hours running time, in other words one thousand times less than that required by an ordinary movement.

(...)

From his experiments, Mr Reutter realised that a variation of 1° in temperature, given the 10 litre capacity of the hermetically sealed bell-jar, could provide usable energy of 36 gram-centimetres – in other words double that which was necessary for running the clock for 24 hours. A barometric pressure variation of 3 millimetres of mercury produces the same effect.

The ATMOS 0 and its impact

The correspondence and Press reviews concerning the presentation of this clock give food for thought.

On September 28, 1927, Professor Jaquerod of the Physics Institute of Neuchâtel University sent the management of Longines Watches a letter of recommendation and, on January 27, 1928, after the appearance of the article in the *Swiss Clock-Making Journal*, the management of the Ulysse Nardin Company sent J.-L. Reutter a letter of congratulations. However, neither of those two companies showed any interest in producing it. It is true that they neither made nor sold clocks. On March 8, 1928, the United States Consul in Bern sent the address of an American manufacturer that was interested. Our archives to not contain any other letter or any trace of a reaction in the industrial sector from J.-L. Reutter himself. Why? It should be remembered that J.-L. Reutter was at that time in the employ of the Compagnie générale de radiologie in Courbevoie and that his employer had very likely conveyed its interest. A letter dated March 26, 1928 refers to an agreement being negotiated. That interest took the form of the creation, on June 1, 1929, of a department specially devoted to the manufacture and sale of ATMOS clocks and the signing of a contract appointing him manager of that department. But that was already the model ATMOS I, the first patents for which date from November 28, 1928 and of which we shall be speaking later.

Contrary to the sedate pace of industrial maturing that well shows how far removed the prototype is from the production and sale model, the reaction of the Press to the first article in the *Swiss Clock-Making Journal* of January 1928 was absolutely astounding – a veritable explosion even though there were still, at that time, only two prototypes in existence!

Indeed, in our files we have no less than:

43 Press cuttings from January 1928 covering French and German-speaking Switzerland and certain Belgium newspapers.

34 cuttings from February 1928, most of which are Swiss but including some from Belgium and the Netherlands and the odd mention in Spanish, Italian (Milan), Canadian, Guyanan and Indian newspapers!

16 cuttings from March 1928 from the French provinces and Belgium but also 4 from India and the USA!

8 cuttings during the end of the first half of 1928 of which one from South Africa and one from Warsaw!

We have no idea whether that massive Press campaign had been organised and, if so, how. But the interest was certain and it gave rise not only to praise but to lively dispute. That is how we managed to discover mention of many of the forerunners and to seek details of the more interesting of the inventions that we have described.

Conclusion to Part I

We have tried to describe, through the constant failures of the forerunners and also the tenacity of he who was determined to succeed, how a general idea came to mature.

We also wanted to show the extent to which the experiments done by these forerunners could help someone who really wanted to succeed.

But we would also insist on the fact, already mentioned above, that any experiments, imagination, ingenuity and skill have to be accompanied by sound scientific knowledge and trials if any truly satisfying product is finally to be produced.

We shall now see that this process had to continue unremittingly throughout the entire production and subsequent life of the product. The evolution of the ATMOS to this day, as described in the second part, proves the point.

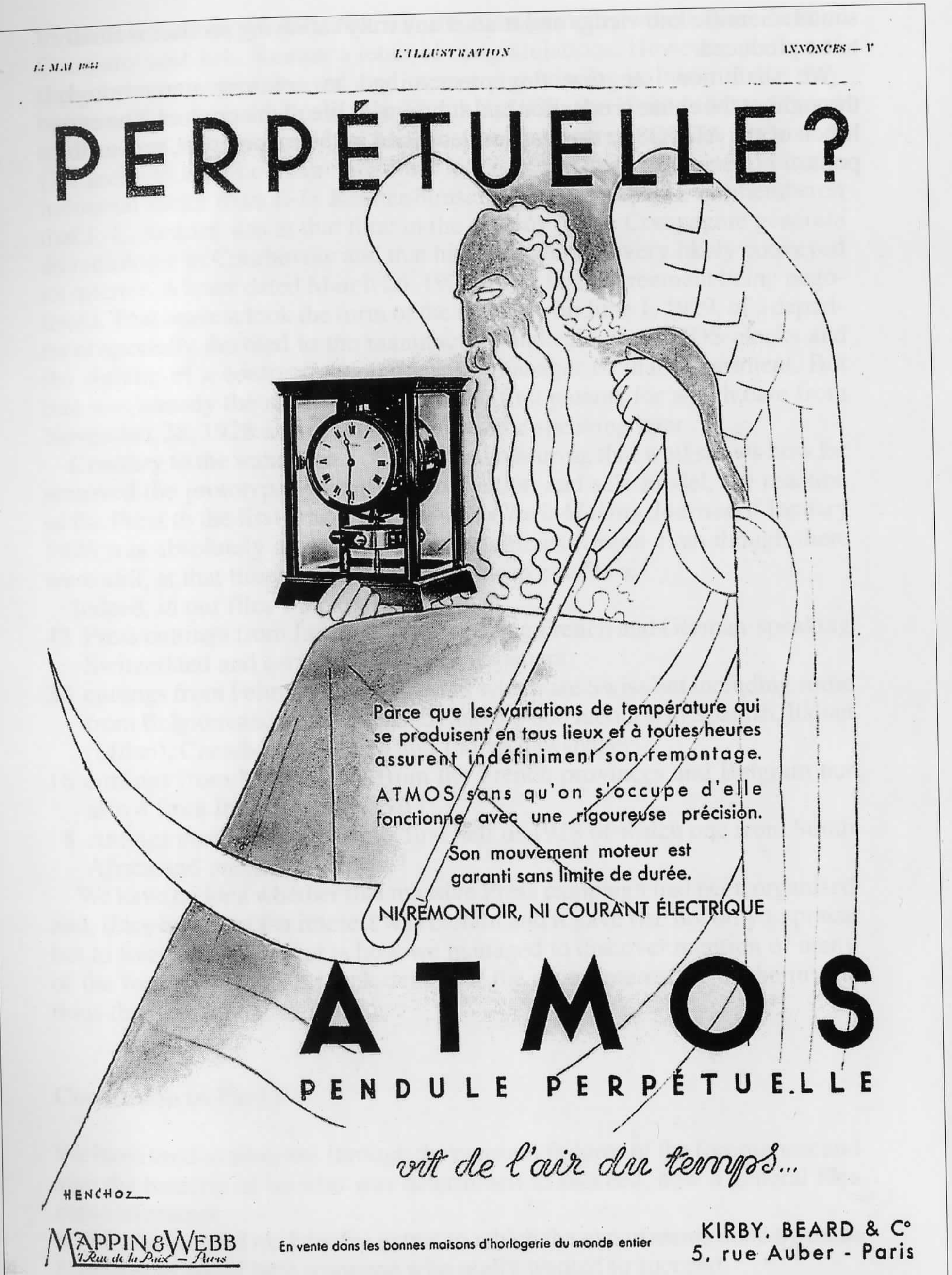


Fig. 12 Advertisement that appeared in *L'Illustration* on May 13, 1933.

Living on air
History of the ATMOS clock

In the first part of this study, we saw the amazing reaction of the Press to the ATMOS 0 during the first half of 1928 even though only two prototypes of the clock were made and set in motion in September 1927.

Jean-Léon Reutter was engaged as a radiological engineer by the Compagnie générale de radiologie in October 1927 and he presented his invention to the directors, one of whom, Mr. H. Pilon, was so excited by this novelty that, in March 1928 there was talk of a future contract but it still concerned only the patents for the ATMOS 0.

It is likely that, once production studies began, it proved impossible to make a product that could be commercially manufactured and marketed. The very principle of construction placed very tight limits on the variety of different models that could be made and the manufacture of the necessary mechanisms was very delicate (blocking the balance, fine-tuning, setting the time and the poising valve).

Figure 13, which probably goes back to the Summer of 1928, shows the change of direction. The ATMOS 0 on the left is one of the two prototypes

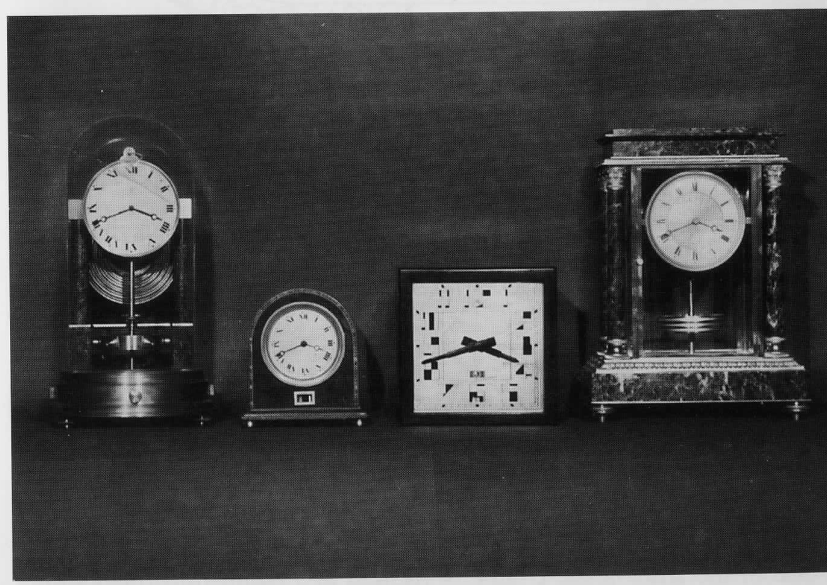


Fig. 13 The early ATMOS's.

that we have referred to. The other three models can in no case have been built on the same basis but they might show the possibilities offered by the new ATMOS I, the first patent for which was filed on 11.28.1928 (French patent No. 664 689). These models are prototypes (whether for presentation or actually in running condition is not known) which do not appear in any of the early catalogues. Indeed we have not to date been able to find any trace of them.

The ATMOS I

The first half of 1929 was devoted to perfecting the product and filing patents. A first contract was then signed on June 1, 1929 between Jean-Léon Reutter and the Etablissements Gaiffe-Gallot et Pilon that later became the Compagnie générale de radiologie. It was a "licence to exploit the above-mentioned invention and patents in France, its colonies and the countries under its protection and mandate". The two basic patents quoted are French patents 624.595 (ATMOS 0) and 664.689 (ATMOS I). It is curious to note that the ATMOS 0 patent still appears on the contract even though it was never exploited.

The Etablissements Gaiffe-Gallot et Pilon then created a Clocks Division and J.-L. Reutter became the Manager.

On March 24, 1931, a new licence contract, similar to that of June 1, 1929, was signed for exploiting the invention abroad, throughout the rest of the world. It is likely that this contract came into being after contacts with de Trévars in England.

How the ATMOS I works

There are four clearly distinct parts to every ATMOS clock:

- The ***thermal motor*** transforms thermal energy into mechanical energy.
- The ***clock movement*** uses the mechanical energy to drive the movement of the balance and display the time.
- The ***pendulum movement*** carries the adjusting organ and the ancillary parts and connects the various parts of the clock.
- The ***cabinet*** produces the aesthetic effort and provides overall protection.

The thermal motor (Fig. 14)

It is certainly possible to find all the constituent elements of this motor in one or another of the patents of the forerunners but J.-L. Reutter had the merit of having made an optimum synthesis, rather as a bee concocts its honey from the nectar gathered from the various flowers visited.

A U-shaped glass tube 1 contains mercury 2 and a liquefied gas 3 as well as its saturated vapour 4 (ammoniac).

One of the arms of the U-tube is encased in a recipient 5 filled with a mass of high specific heat 6 kept at a virtually constant temperature by an

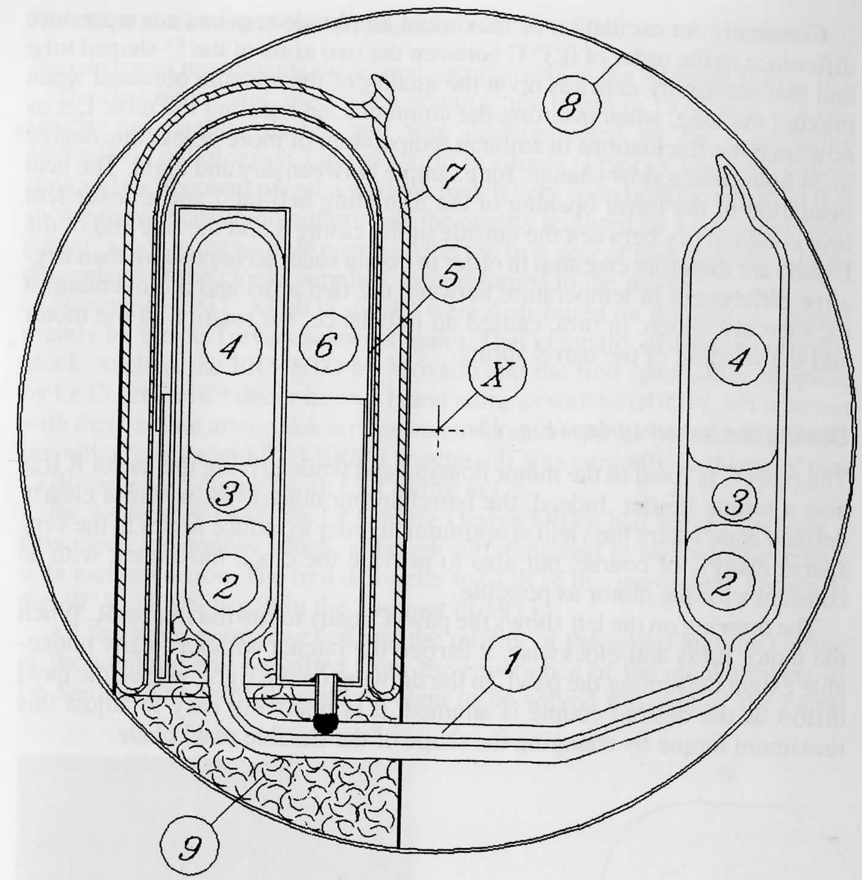


Fig. 14 The ATMOS I motor.

insulating bell-jar 7. The open end of this bell-jar is insulated by a bed of down 9.

The other arm is in the open air and rapidly adapts to variations in temperature.

Thus there are temperature differences and consequently pressure variations between the two arms of the U-shaped tube. The mercury is pushed to the side where the pressure is lower and, by its weight, it causes a see-saw movement about the axis X of the casing 8.

This oscillation, which is repeated each change in temperature, is communicated by a ratchet wheel to the clock movement. A complete oscillation movement with return to the original position accumulates a running reserve of 96 hours.

Comment: An oscillation of maximum amplitude requires a temperature difference in the order of 0.3° C between the two arms of the U-shaped tube and that sensitivity depends upon the quality of the vacuum obtained when making the tube, when inserting the ammoniac and sealing the tube. Let us now imagine fluctuations in ambient temperature of more or less one degree in 24 hours and a slow change, for example between day and night. The heat insulation of the lower opening of the insulating bell-jar 7 and an excellent heat conductivity between the outside of the casing 8 and the free end of the U-tube are therefore essential in order to obtain successive positive then negative differences in temperature between the two arms and a movement of the mercury which, in turn, caused an imbalance, the rotation of the motor and the winding of the barrel spring.

Driving the barrel spring (Fig. 15)

The pawl C is fixed to the motor housing and while driving the barrel R it is also a torque limiter. Indeed, the barrel spring must work within a clearly defined zone where the yield is optimum in order to reduce losses in the very sparse energy, of course, but also to provide the clock movement with as constant a torque motor as possible.

The drawing on the left shows the pawl C ready to rewind ratchet R. When the motor turns anti-clockwise, it carried the ratchet without to any noticeable extent deforming the pawl. In the drawing on the right, we see the pawl distort as the desired couple is attained. It is relatively easy to adjust this maximum torque by changing the shape of the flexible pawl blade.

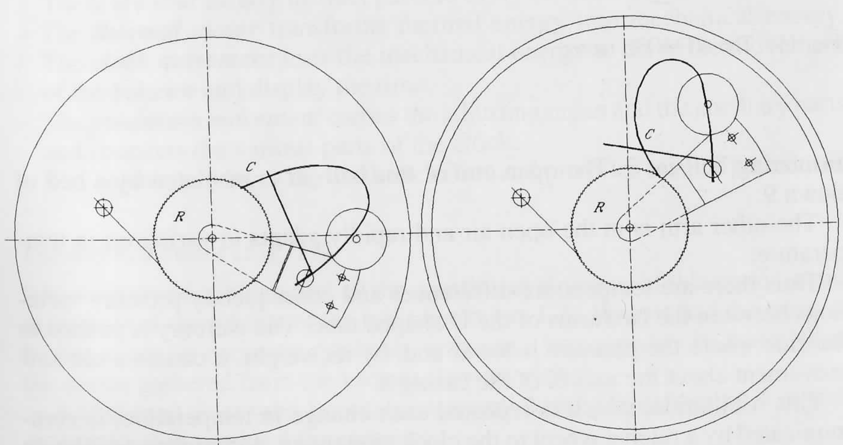


Fig. 15 The barrel-spring drive.

The clock movement (Figs. 16 and 17)

Two different movements were used successively in the ATMOS I (Fig. 16).

The first movement, used when manufacture began in 1930, was of a relatively rudimentary design and was sub-contracted by the Compagnie générale de radiologie (CGR) to a firm in Cluses (France). Only the pallet-staff and escapement wheel were jewelled. It very soon became apparent that such a movement could not provide the quality required by a so-called "perpetual" clock using so little energy. After the first year of manufacture, a large percentage of the clocks supplied were returned to the works.

Starting in 1931, ATMOS clocks were distributed on the British market mainly by the de Trévars sales company. That company distributed original clocks such as the ERMETO by Movado and the first specialities supplied by Le Coultre et C^ie^ under its own brand name as well as DUOPLAN watches with their instant after-sales service and insurance with Lloyd's, small ADOS travelling clocks and REVERSO watches. It was certainly in this way that CGR came into contact with Le Coultre et C^ie^.

By September 1932, the Le Coultre Design Office had started studying a new clock movement which, although different, had to be interchangeable with earlier version. The first deliveries to CGR of this movement, known as the 30"A calibre, began in the Summer of 1933.

All the trains were jewelled and the quality of the pivots and the cutting of the toothing had benefited from the experience of the clock-makers of Le Sentier. The most delicate problem to be solved was that of the barrel

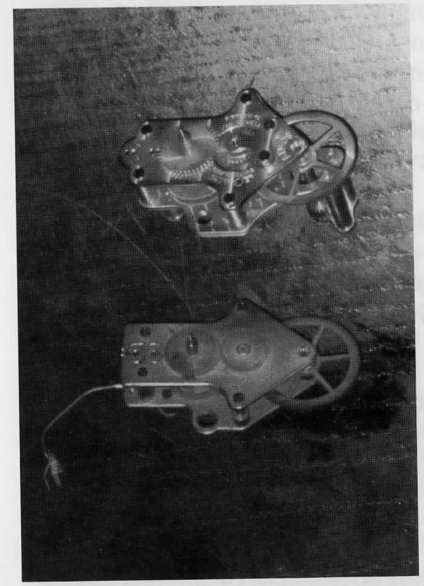


Fig. 16 The ATMOS I clock movements.

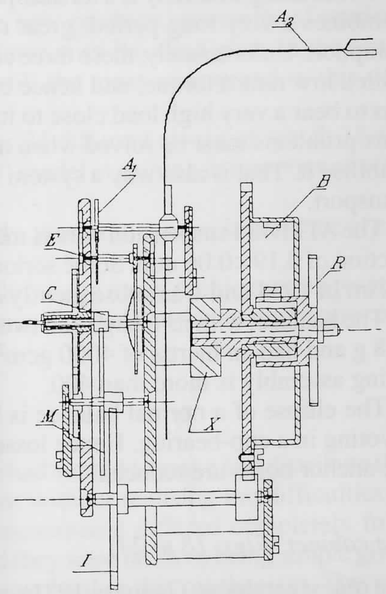


Fig. 17 The calibre 30"A movement.

spring. The winding and unwinding curves had to be as flat as possible with very tight tolerances throughout the run and a yield of at least 95%!

Let us now consider some of the details of this clock movement (Fig. 16). The number of trains is the same in a classical clock – the barrel B – the centre-wheel I – the third wheel M – the fourth wheel C – the escape wheel E and the anchor A. But as the balance had a frequency of one period per minute, it was the fourth wheel which completed one revolution per hour and, as it carried the hands, acted as centre-wheel. Finally, to simplify the gear-train and reduce friction, the third wheel was used as the minute pinion and as a result the indenting was provided by a spring clutch between the pinion and the fourth wheel C. When setting the time, all the gear-train upstream as far as the barrel was moved. The barrel made one complete revolution every 561.587 hours, that is to say in just over 23 days and could therefore run correctly with no variation in temperature for at least six months!

The functions of the anchor are shared by two components – the gathering-pallets working in the classical manner with the escape wheel A while the horns and guard-pins are moved back to the vertical balance plate behind the barrel ratchet R. This arched part A2, has to be as light as possible yet it has to be balanced by a counterweight.

The entire clock movement is fixed to the pendulum chassis by the cross-piece X.

The balance

The oscillating assembly is a torsion-pendulum which is the only device which combines a very long period, great running precision and low energy consumption. Unfortunately, these three conditions also require a suspension wire with a low return torque, and hence considerable mass. As a result, the wire has to bear a very high load close to its elastic limit and this means that complex problems must be solved when trying to process the suspension wire to stabilise it. That is also why a system is essential to block the balance during transport.

The ATMOS I suspension wire is made of elinvar. It has a rectangular cross-section of 0.19×0.06 mm. Some serious study was made of the ageing mechanism in 1934 and was subsequently optimised.

The balance, with its 6 large and two small adjusting screws, weighed about 248 g and had an inertia of 4000 gcm^2. The quality factor of the entire regulating assembly is more than 400.

The ellipse of a normal balance is here replaced by a very light cylinder pivoting in a cup-bearing. Hence losses by friction between the balance and the anchor horns are reduced.

The cabinet (Figs. 18 to 23)

The oldest catalogue (January 1931) offers no less than 19 different models! The greatest possible variety was available ranging from Louis XV, through

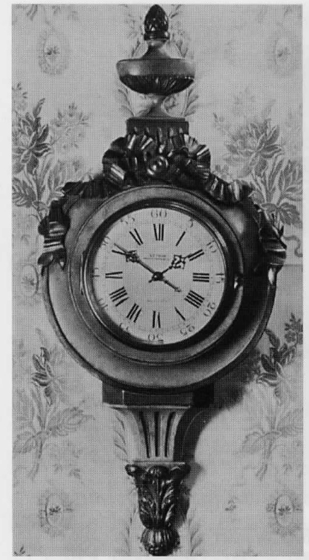


Fig. 18 Model M8. Louis XVI cartel clock.

Fig. 19 Model LG4. Art moderne carved rosewood clock, gilded.

Louis XVI or Regency, modern marquetry clocks, carved wood, ambrolith or moulded glass (Figs. 18 and 19).

The July 1932 catalogue offers nine new products, generally of modern design (Fig. 20). There we see a regulator with bevelled glass in the same style as the ATMOS model which is still the most widespread to this day (Fig. 21).

The January 1934 catalogue contains 24 different clocks of which 18 are new (Figs. 22 and 23)! The "Regulator" model is gaining in importance with six variants.

The annual production of those early years must have been somewhere between one and two thousand units.

Such a variety of models inevitably throws up many problems with respect to supply, quality and stock management as well as for manufacture and distribution.

Production of the ATMOS I

The Compagnie générale de radiologie had started to make and distribute this original clock on a wave of enthusiasm without realising the difficulties of such an undertaking. The problems encountered differed completely from those with which they were familiar and they were far from being simple given the extraordinarily low energy levels involved in this mechanism. The various phases of this adventure can be summed up as follows:

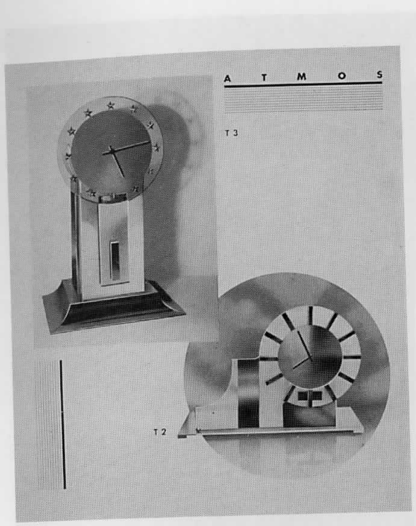


Fig. 20 Models T2 and T3. Art moderne blue nickel, gilded glass panels.

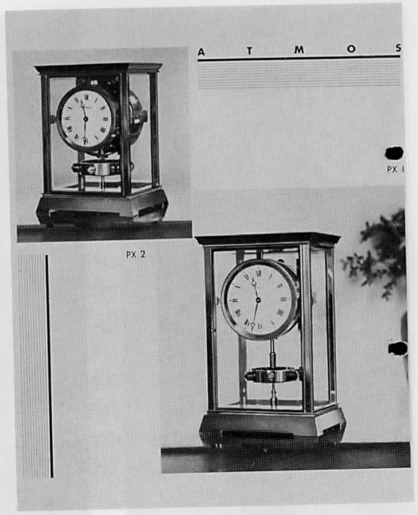


Fig. 21 Models PX1 and PX2, Nickel-plated Regulator.

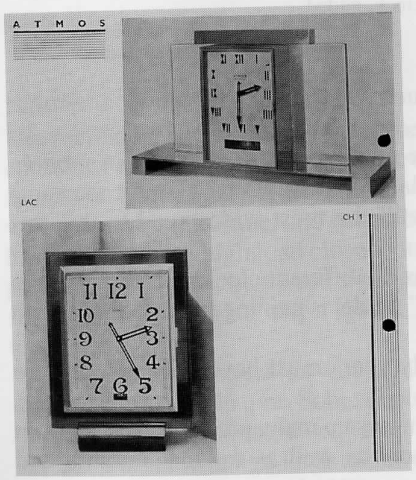


Fig. 22 Model CH1 and LAC. Chromed metal and glass panels. Black.

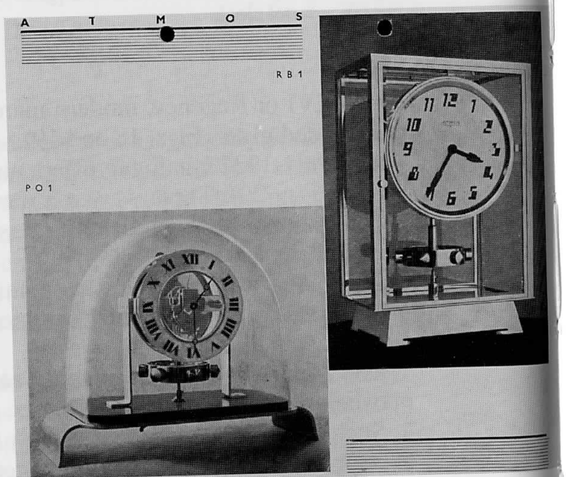


Fig. 23 Model PO1 – under a bell-jar, bronze and marble model RB1 – Regulator.

1930-1932: The product was launched with the clock movement from Cluses (see above), in an excessive variety of models. The main problems concerned stoppages, adjustment and the fragility of the motor during transport.

1933-Summer 1935: Manufacture and distribution by the Compagnie générale de radiologie. The clock movement was supplied by Le Coultre et Cie of Le Sentier (calibre 30"A, see above). On July 27, 1935, the CGR agreed to transfer of its contracts with J.-L. Reutter to Ets. Ed. Jaeger. Spécialités Horlogères SA of Lausanne, which distributed Jaeger-Le Coultre products, brought up the remaining stock of ATMOS I that CGR had left.

1935-May 1938: In early 1936, the ATMOS II went into study with a new, simpler and more robust motor. Meanwhile, Spécialités Horlogères SA, which in 1936 had become the Jaeger-Le Coultre SA sales company, was supplying ATMOS Is from the stock bought up from CGR while awaiting the new product.

The ATMOS miniature clock

During our research, we found a practically unknown breed of ATMOS.

On March 27, 1933, just when the Le Coultre et Cie Design Office was in the midst of studying the calibre 30"A, Jean-Léon Reutter proposed to the management of that company a feasibility study on a small clock wound by temperature variations and using a new motor according to Swiss patent 175.399, taken up subsequently on October 9, 1933.

The result could assume one of two different forms:

- A round movement of diameter approximately 90 mm and height 90 mm, including the motor, to be built into a cabinet of any shape.
- A movement contained in a bollard-shaped cabinet (Fig. 24). The total height being 140 mm, the width 100 mm and the depth 70 mm.

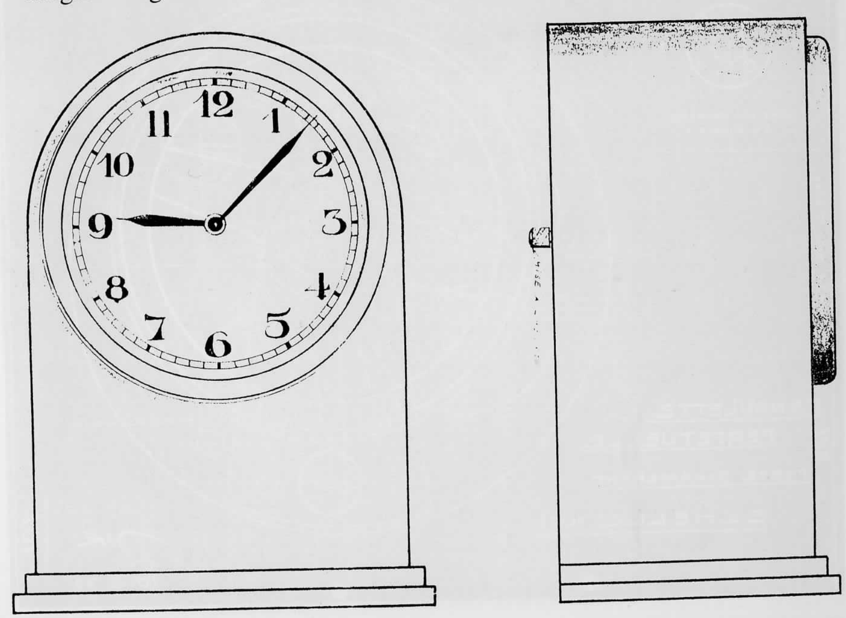


Fig. 24 The ATMOS miniature clock, bollard-shaped.

To achieve this result, there was no question of using a torsion pendulum as that required that the movement be in a stable position and this would be impossible to guarantee in the case of a miniature clock. It was therefore necessary to resort to a classical spiral balance while trying to keep energy consumption as low as possible. To achieve this, therefore, a 9" (9"HPVM 17/12) movement was used for tests. That movement, having neither barrel nor centre wheel, was fitted with a special and very large electron balance which had the following characteristics:

External diameter	16.25 mm
Internal diameter	14.43 mm
Inertia	2.95 gmm^2
Weight	0.059 g

To reduce consumption to a minimum, the balance alternated at a frequency of 7200 per hour. The assembly was used as a **platform escapement** (Fig. 25).

The **movement** proper comprised five trains, from the barrel to the centre wheel plus the motion-work and assembly was relatively complex and a far greater energy consumer than the ATMOS I. According to the correspondence, the torque necessary on the barrel (and the motor) was about 399 gcm.

The oscillating **thermal motor** was of the following dimensions:

External diameter	86 mm
Height	62 mm

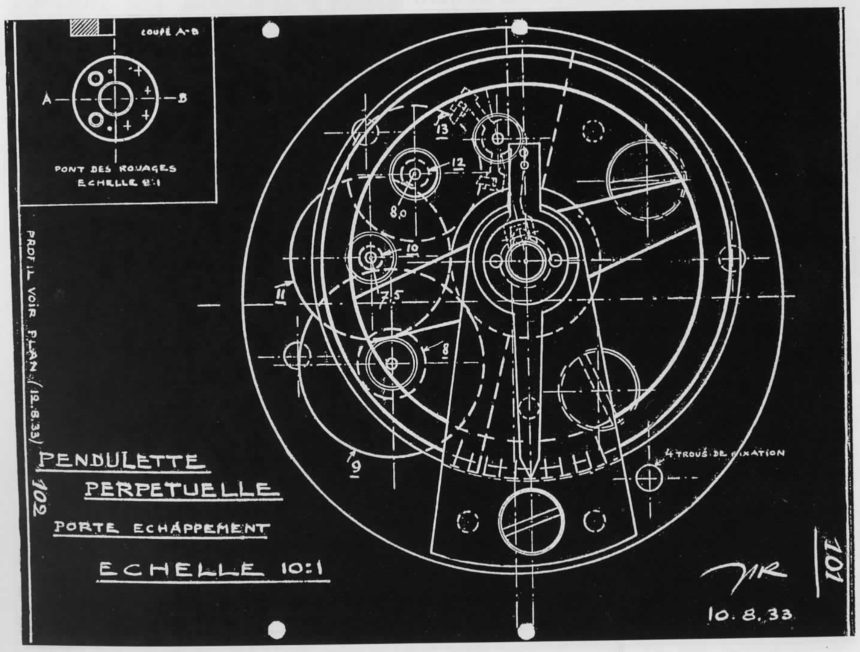


Fig. 25 ATMOS miniature clock, platform escapement.

We do not have any details of the construction but it was in keeping with Swiss patent 175.399 as mentioned above. This patent gives the following description (Fig. 26).

The motor according to the invention offers the advantage… of allowing for the use of fluids under very high pressure and thus to considerably increase the mechanical energy while at the same time reducing the volume of the device as much as possible…

As represented, the motor comprises a hermetically sealed and rigid cylindrical body 1 which can rotate around its own axis X on two bearings that are schematically indicated by 2 and 3. The base 4 of the cylinder 1 carries on its internal face an elastic bellows 5 that is perfectly sealed and the free base 6 of which can move freely and parallel to the axis X-Y.

The space 7 within the bellows 5 is filled with a saturated vapour, for example, whereas the space 22 between the bellows 5 and the external housing 1 contains, for example, a gas…

It should be noted that, according to the invention, the walls of the bellows need to bear only the difference in pressure between the two fluids and that the rigid box bears the difference in pressure between the inside and the atmosphere. It is therefore possible, without damaging the bellows, to use fluids under high pressure (saturated ammonia, nitrogen protoxyde or carbon dioxide, for example) and to take advantage of the considerable variations in pressure that they undergo with changes in temperature.

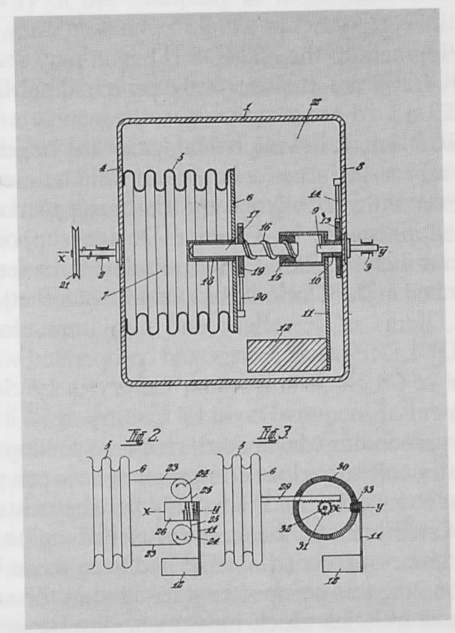


Fig. 26 Motor according to Swiss patent 175.399.

We know that to be able to provide the necessary energy with so small a volume, this device worked with pressures in the order of 70 atmospheres! That pressure caused the management of Le Coultre et C^{ie} many a headache!

In his letter of April 15, 1935 J.-L. Reutter noted that "The ATMOS miniature clock that we have built is completely finished and is giving full satisfaction". He wondered, however, whether it not might not be advisable to rebuild it on the basis of a 11 ½" movement with a balance on a horizontal axis and a simplified gear train!

Apart from fears with regard to the motor, the delicacy with which so complex a construction had to be approached as well as its costs made it likely that the running precision would not suffice.

Furthermore, the negotiations meanwhile entered into with the Compagnie générale de radiologie, to transfer the ATMOS manufacturing contracts to Le Coultre et C^{ie} had just been completed. The study of the ATMOS miniature clock was then dropped.

However, J.-L. Reutter continued to believe in the idea as he filed an additional patent on February 2, 1937 in France and the Swiss patent No. 198.355 on March 17, 1937. Those patents still used the high-pressure double-housing motor but the clock movement was placed inside the gas-filled container to protect the oils from oxidisation and dust. The movement was probably to have been transmitted to the hands by a magnetic clutch.

The ATMOS II

The way the development of the ATMOS II began may seem very complex if we do not briefly recall the situation of the principal parties involved at the beginning of 1935.

Ets. Ed. JAEGER SA of Levallois had, from the beginning of the century, developed a very large turnover in aviation and automobile dashboards and instruments extending far beyond the European market. The company was owned and administered by Gustave Delage supported by Edmond Audemars on the commercial side and Henri Rodanet in research. Clock activities were concentrated in the Clock Department (Paul Lebet) which, produced the first watches, items of jewellery and miniature clocks bearing the JAEGER or LE COULTRE brand names, and co-operated with Pierre Cartier.

The ***Le Coultre et C^{ie}*** clock and watch factory in Le Sentier, under the dynamic management of Jacques-David Le Coultre, was, in parallel with its clock production, producing dashboard clocks, speedometers and other devices. Personal ties and very close co-operation between the persons mentioned in these two companies, and especially between Gustave Delage and Jacques-David Le Coultre, meant that it was often difficult to distinguish what had been made by one company from what had been made by the other. For example, during the 30s, this co-operation resulted in the smallest watch in the world, the miniature stick clock movement, the Reverso, the Duoplan movement and the use of sapphire glass and stainless steel in watch cases.

Le Coultre took up interests in the Spécialités Horlogères SA sales company (which was already selling, *inter alia*, the ATMOS I), in order to promote its own finished goods. From the Summer of 1933, it made the 30"A movement for the Compagnie générale de radiologie.

Ets. Gaiffe-Gallot et Pilon (Compagnie générale de radiologie) of Courbevoie, and particularly its ATMOS Division had, since 1930, been making the ATMOS I with the difficulties we have already seen. The motor, with its glass capsule containing mercury, continued to cause problems during transport. Mastering a clock market so far removed from its customary preoccupations was beginning to weigh on it.

In February 1935, Gustave Delage had a long discussion with Pilon, one of partners in CGR, with a view to jointly exploiting the ATMOS. Jacques-David Le Coultre wanted to drop the current research into the ATMOS miniature clock which he considered hazardous. He was more interested in taking over all the manufacture of the ATMOS.

In June 1935, consideration of the resumption of production began again with an analysis of the situation – an inventory of goods in stock and in hand, manufacturing processes and cost prices were reviewed. Pilon agreed that Jean-Léon Reutter could negotiate a contract with Jaeger. That contract was signed on October 10, 1935.

On 15 December of that same year, that first contract was replaced by a new contract with Jaeger and reference was then made to a "new ATMOS". And finally, on January 15, 1936, Le Coultre amended its articles of association and the activity of the Company as mentioned in article 2 included: *The manufacture of all manner of clocks and more specially of ATMOS perpetual clocks.*

The "New ATMOS", subsequently called the ATMOS II, was to use the 30"A clock movement already being made by Le Coultre. Jean-Léon Reutter, with the help of the Jaeger Design Office, built the clock movement that was to take the balance, the barrel and an intermediate train as well as the new motor according to French patent No. 817 956 which was to be filed on May 22, 1936.

With the exception of the new motor, all the rest of the construction was backed by the experience gained with the ATMOS I and the industrial risk involved was minimum.

The ATMOS II motor (Fig. 27)

According to the patent mentioned above, the motor proper (the lower part of the drawing) comprises a sealed enclosure of soldered tin elements – the motor casing 1, a cover 2, a folded tube 3 and a base 4. The sealed enclosure contains a saturated gas 6 (ethyl chloride). Under certain predetermined pressure conditions, the proportions of liquid and gas – and hence the pressure within the container – vary considerably with temperature. The spring 5, the dimensions of which strike the observer, serves only to attain the pressure zone corresponding to the desired operating temperatures. In the middle zone,

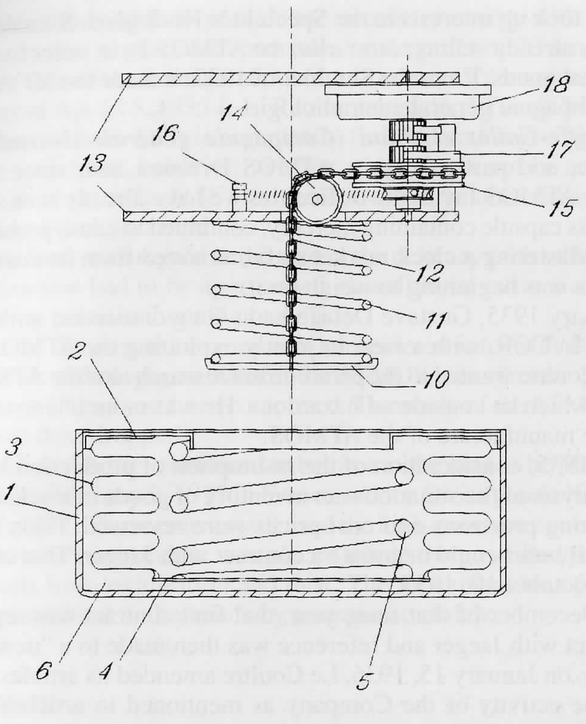


Fig. 27 ATMOS II motor.

1° C variation in temperature produces a movement of 1 mm in the base 4 of the enclosure.

The upper part of the drawing shows the mechanism which uses the movements of the base 4 to rewind the barrel spring. Normally, the motor surrounds the spring 11 and is fixed to the plate 13 while the pan 10 rests on the base 4. The two parts are have been exploded to make the drawing clearer.

Under the effect of the motor, the pan moves to and fro thus rewinding the spring. As it unwinds, it carries the barrel-spring core by means of the chain 12 around the pulley 15, the pawl 17 and the ratchet. When the force of the spring 11 balances the torque on the barrel spring, the winding stops and the base 4 of the motor idles. As time passes, the couple on the barrel spring reduces, the spring 11 can then relax, the pan 10 again enters into contact with the base 4 and winding can begin again. A suitable calibrated spring 11 can thus ensure a precise and almost constant torque on the barrel spring but also demands a very high yield (of at least 95%) from the barrel spring.

When the first unit was made, it was impossible to find a folded tube with a fine enough wall and great enough diameter. It was therefore necessary to replace it by a stack of corrugated discs soldered together (Fig. 28).

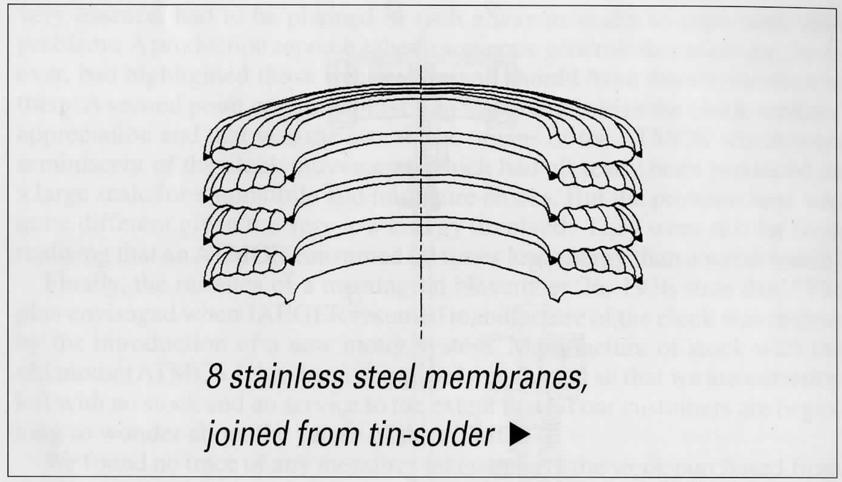


Fig. 28 Motor membrane.

The material used was, in the first instance tinplate then subsequently 0.13 mm thick brass. Such a motor was relatively costly and the fact that so many delicate solder joints had to be made created problems for guaranteeing the seal.

Furthermore, the motor cover had to be soldered to the visible outer side of the motor housing which was decorated (polished, gilded or chromed).

When, in early 1946, the company of BOA of Lucerne managed to manufacture 0.15 mm millimetre thick stainless steel folded tubes of sufficient diameter, construction was simplified and the capsule containing the ethyl chloride was separated from the rest of the motor which also solved problem of finishing. However, it took another year before the problem of the seal had been perfectly mastered.

The ATMOS II balance (Fig. 29)

The form of the balance 1 is greatly simplified. It is fixed to the balance tube assembly 2 by a nut 3 and bolt 4. The nut 3 serves as a support for the blocking device (not shown). The upper end of the bolt 4 is conical and split to provide an anchor point for the suspension wire 5. The roller assembly 6 pivots freely at the upper end of the balance tube 2. Its angular position is determined by the cylinder spring 6c. In extreme cases of knocking or in cases of mishandling, distortion of the pivoted roller 6b (ellipse) by the anchor fork is avoided. The return force of the spring 6c must be sufficient to ensure a correct position of the roller in normal operation yet not so strong as to distort the fork in extreme cases.

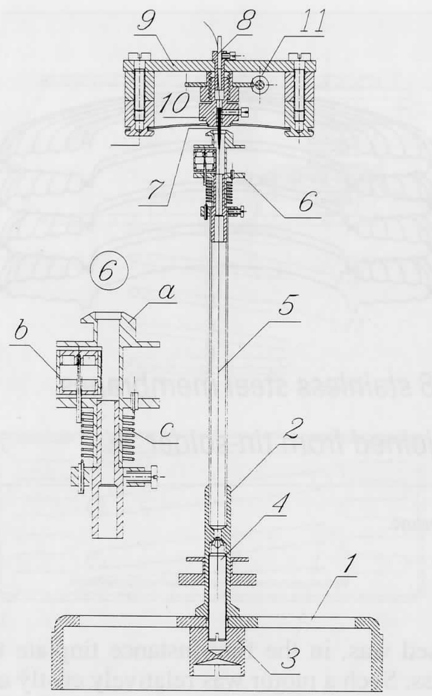


Fig. 29 ATMOS II balance.

At its upper end, the suspension wire 5 passes firstly through an adjusting clamp 7 which determines its active length and is then fixed to component 8 on the upper bridge 9. The adjusting device 10, controlled by the endless screw 11, determines the position of the clamp 7.

In the ATMOS II (and following models), the elinvar suspension wire has a cross-section of 0.183×0.05 mm and the balance has an inertia of 3677 gcm^2. The quality factor of the regulating system is also about 400.

Production of the ATMOS II

As we have intimated in this study, production of the ATMOS had some trouble getting off the ground and the deadlines envisaged at the end of 1935 (deliveries starting in July 1936) were far from being respected. It is interesting to learn a lesson from this as events unfolded.

The first deadline set seemed reasonable to the dealers as the ATMOS already existed and several thousand of them had been made. But what is more surprising is that the General Management thought it so. Indeed, it was a question of progressing from a purely craft production, with all the corrections during manufacture, constant adjustments and lack of reliability in terms both of cost and quality that that implied, to industrial production which, by its

very essence, had to be planned in such a way as really to cope with such problems. A production report by the Compagnie générale de radiologie, however, had highlighted those weaknesses and should have drawn attention to them. A second point certainly played an important role in the clock-makers' appreciation and that was the size of the organs of the ATMOS which were reminiscent of the clock movements which had all ready been produced on a large scale for automobile and miniature clocks. But the problem here was quite different given the very low energy involved! They were still far from realising that an ATMOS consumed 60 times less energy than a wrist-watch!

Finally, the minutes of a meeting on November 26, 1936 state that "The plan envisaged when JAEGER resumed manufacture of the clock was thrown by the introduction of a new motor system. Manufacture of stock with the old motor (ATMOS I) has been completely neglected so that we are currently left with no stock and no service to the extent that all our customers are beginning to wonder about the future of the ATMOS".

We found no trace of any measures taken to have the stock purchased from the Compagnie générale de radiologie assembled by Jaeger in Paris or by Le Coultre et Cie in Le Sentier.

The records of Ets. E. Jaeger have disappeared but according to those of Le Coultre et Cie, we can reconstituted the events of 1936 and 1937.

We would recall that the clock movement is practically identical to that which Le Coultre had made been making since 1933 for the ATMOS I. But the new version comprised only the pendulum movement and the motor.

On May 1, 1936, the head of the Le Coultre Design Office, Edgar Convert, sent a "Report drawn up in Paris on the changes to be made to the plans for the ATMOS clock" by Jean-Léon Reutter. On May 15, Jaeger supplied Le Coultre with the tools necessary to produce the membranes for the new motor. On August 31, Jacques-David Le Coultre informed Gustave Delage that the manufacture of the tools had begun whereas only the designs for the large plates had been completed by that date. All of the other designs were to be registered in November. The cabinet continued to be made in Paris as the Le Sentier factory did not have any sufficient capacity presses. On November 26, 1936, the minutes of a meeting with the dealers refer to first deliveries in June 1937. Many problems arising with the production of the cabinet (tooling and aesthetic quality) meant that the first 25 clocks were not delivered to J.-L. Reutter in Paris for testing until March 28, 1938.

On reading the various documents, one cannot help but think that had the study been conducted in a single place and by a single team much time would have been saved. Here again, the difficulties to be overcome were certainly under-estimated.

All the major problems seemed to have been solved by the end of 1938 when, in March 1939, a new problem emerged. A far from negligible percentage of the membranes proved not to be airtight after a few months! It is true that the first model of the motor comprised 12 parts soldered together by 11 large circular seams and two small seams making a total of 3.4 m in length in frequently difficult positions!

It was not until end of the first half of 1939 – at the start of the Second World War – that production could really begin... faced with all the problems posed by mobilisation.

In the light of the experience with launching the ATMOS I, this first production run comprised only two models whose sole difference lay in the shape of the pedestal (Figs. 30 and 31) and each of them came in two finishes:

Gilded matt, polished styles

Chromed matt, polished styles.

A third variation had been planned (medal bronze) but that seems to have been produced in only very small quantities.

The model with the small pedestal (Fig. 30) was promptly dropped.

It is interesting to note that, from the very start, the sales companies had requested that a less costly model be considered with a desired Swiss retail price of Sfr. 250.–. Such a wish had been expressed throughout the first 60 years during which the ATMOS was produced, the idea being to increase production, whereas a smaller production with better margins would certainly have better suited so exceptional a product.

Once the motor using the folded stainless-steel tubing developed by BOA at the end of 1946 started to be used in the ATMOS, it could be said to have reached its full technical and industrial maturity and its construction was not questioned again until studies were conducted on the 540 calibre in 1982. Nevertheless, during that period it did undergo many modifications because of marketing policy, the creation of new models or the introduction of new production methods.

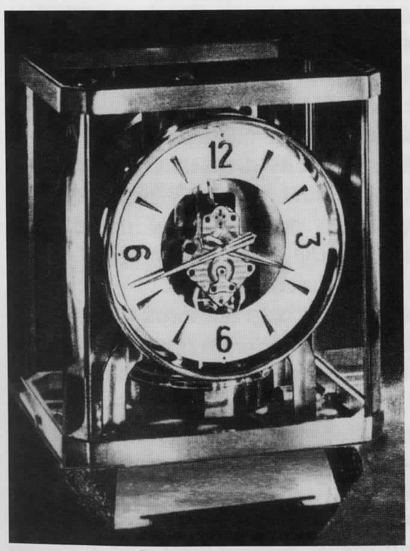


Fig. 30 ATMOS II, small pedestal.

Fig. 31 ATMOS II, large pedestal.

ATMOS - Replacement Parts - LISTED BY MODEL

IDENTIFICATION OF BASIC MODELS

	Model	II	III		IV		V	VI	VII	VIII			Jubilé	Prestige	
	Calibre No./ Movement	None	519	529	522	532	526	528	528	528/1	540 to 543	544 to 546	550	551	547 and 548
Cabinet	Bell-jar	X	X	X				X							
	Pivoting door				X	X	X		X			X	X	X	
	To push door									X	X				
Plate	Width 59mm	X													
	Width 50mm		X		X										
	Width 45mm			X		X	X	X	X	X					
Adjustment	Button	X													
	Index		X	X	X	X	X	X	X	X	X	X	X	X	X
Blockage	Under pedestal	X	X	X				X	X	X			X	X	X
	Under dial				X	X	X				X	X			
Balance		A	AB	BC	CD	D	CD	D	D	D	DE	E	F	F	G

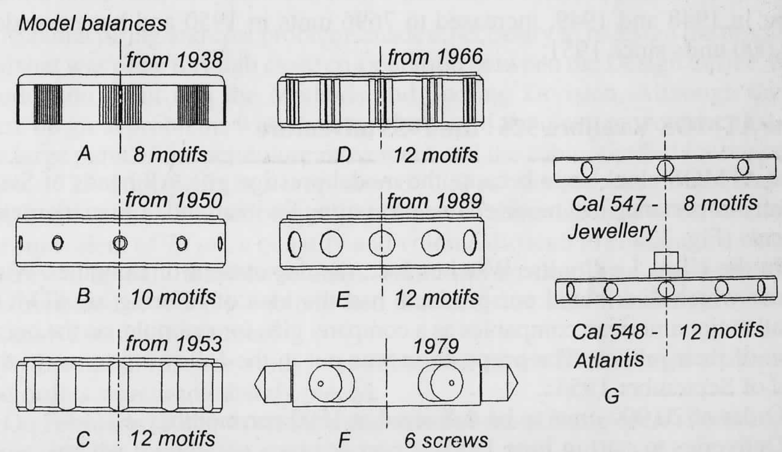


Fig. 32 Table of features of basic ATMOS models.

The denomination of the ATMOS clocks varied according to the epoch and the type of document in question. The original denomination was given in Roman numerals – ATMOS I for the mercury model made by CGR and ATMOS II for the first bellows model made by Le Coultre et C[ie]. These denominations applied to the complete clocks comprising cabinet and movement. In order to administer the many successive versions of the movement (production management and after-sales service), the Design Office introduced a calibre number engraved on the three-quarter plate of the clock movement. Nevertheless, the commercial sector (and here we would recall that this was a different company, the Jaeger-LeCoultre product sales company) for the longest time continued to use a numbering system in Roman numerals to designate a complete product. The table (Fig. 32) summarises the main characteristics of the ATMOS calibres.

Without entering into details, which would be tedious, we shall now review some of the remarkable facts that adorn the history of the ATMOS.

ATMOS III

Once the manufacture of the ATMOS II had been mastered, it proved advisable to modify certain points to take account of the experience thus far and to try somewhat to reduce the cost price while avoiding creating an additional model at a lower price as requested by the dealers because the quantities so did not permit such a spread. Apart from some simplification in the finishes, the pendulum movement plates were made somewhat narrower and the clock movement frame simplified. The adjustment system was entirely rebuilt as the old system did not allow for precise adjustment. Practically no change was made to the cabinet. Production, which had been less than 2000 units a year in 1948 and 1949, increased to 7696 units in 1950 and has exceeded 10,000 units since 1951.

The ATMOS V calibre 526: the 1955 adventure

The ATMOS clock soon became the model prestige gift. All heads of State of any importance had received one on visiting Switzerland or to mark major events (Fig. 33).

In the USA, Le Coultre Watches Inc., the department of Longines-Wittnauer which distributed our products had the idea of offering an ATMOS to all major american companies as a company gift, for example, on the occasion of their jubilee. The proposition was put in the following terms at the end of September 1954:

- Order of 20,000 units to be delivered at 1500 per month.
- Deliveries to start in June 1955.
- Sales price to be reduced by 20% (in order not to exceed the legal limit for the value of a gift).

Fig. 33 An ATMOS clock in Sir Winston Churchill's office.

Manufacturing and cost problems made it necessary to redesign the product and that was done through close co-operation between the Design Office, the Production Plant and the Methods and Tooling Division. Although there were no great problems with the manufacture of the clock movement, that of the large parts of the pendulum movement and the cabinet called for the creation of 23 work-posts in a workshop of 200 m^2. Indeed, the production of 1500 units a month meant that eight tonnes of materials had to be handled, the equivalent of 70 m^3, a quantity and volume difficult to contain in a watch factory! The only feasible solution within the set deadlines was to build a prefabricated wooden workshop and that decision also limited the risk of excessive initial investment.

In January 1955, the study was submitted to the Management, adopted and orders were immediately placed.

On February 18, the worksite was cleared of the existing cycle sheds... and snow, and the foundation could be laid.

On March 12, the structural part was completed.

In April, the machinery was installed.

And finally, in June 1955, as planned, the production of 1500 units a month became a reality.

It is barely necessary to stress the extent to which everyone's commitment had been essential to meet that challenge!

As often happens when a long-term decision is taken under the influence of a major customer that runs its own market virtually independently of the general policy of the supplier, the original tempo slacked off after only a few months!

But the effort made was not, for all that, in vain for the entire ATMOS range benefited from the rationalisation of production, the reduction in cost price and increase in reliability that resulted. Hence, the calibre 526 ATMOS V was, for many years to come, to be the basis for the whole range of less technical-looking variations, decorated in engraved perspex, gold leaf, etc. (Figs. 34 and 35).

At the same time, the models ATMOS III (calibre 519) and ATMOS IV (calibre 522) continued to exist but were henceforth fitted with calibres 529 and 532 which were rationalised in relation to calibre 526 (see table in Fig. 32).

Fig. 34 The ATMOS V.

Fig. 35 Engraved perspex.

The ATMOS Jubilé

By 1979, 50 years had already passed since the first ATMOS patent had been filed. The famous clock was celebrating its jubilee and, that same year, the ATMOS clock bearing production number 500,000 left the factory.

For that memorable occasion, Le Coultre created the Jubilee or "Jubilé" model, in a single run of 1500 units, the cabinets of which are numbered from 1 to 1500 (Fig. 36). This was a reproduction of the K2 clock from the 1931 catalogue. The pendulum movement and the motor had to be entirely rebuilt in order to use the technology perfected over 50 years, and that special calibre was given the number 550. Once the "Jubilé" run had been sold out, the calibre 550 was again used in the "Prestige" model of the same style but different proportions.

The calibre 540

Since the ATMOS II, the various calibres ATMOS had been successive adaptations made in accordance with developments in technology, the market, the

Fig. 36 The Jubilee (Jubilé) ATMOS.

models or production methods. Certain models had been but passing whims while others had lasted. Production management had been complicated by too many detailed variants.

The calibre 550 had been merely a gimmick, made tongue in cheek as a tribute to the first ATMOS and it could not be used as the basis for future production.

It was decided to review the entire construction and even to question the basic principles.

A study was conducted of the various possible systems for using temperature variations to obtain mechanical energy and this showed that the use of a saturated gas is one of the most advantageous solutions both in terms of yield and cost of production and reliability. Some 40 years' experience could not be ignored either. So the principle of the motor was preserved, the whole thing was optimised and modern plasma soldering methods were introduced.

The principle of the torsion pendulum was now beyond question. Its low frequency and high controlling power are, together with an infinitesimal energy consumption, an ideal situation. The main problem was that of the ageing and stabilisation of the suspension wire which had by then been perfectly mastered. Various solutions had been tried for blocking the balance – security of blockage but independence of the cabinet in order to use an identical calibre while leaving the designer free to produce new models. The timing and aesthetic aspects had thus been clearly separated.

Finally, an attempt was made to optimise of parts forming the frame of the clock and pendulum movements. That meant designing a new kinetic chain. During this operation, a barrel completing one revolution in a phase of the

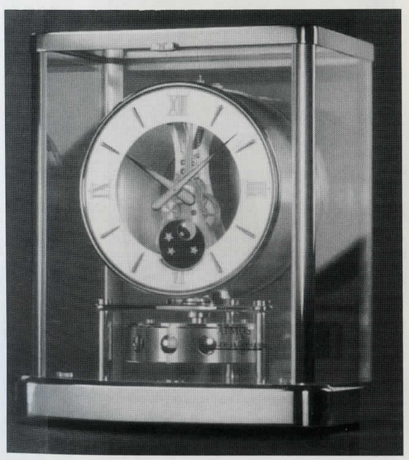


Fig. 37 The ATMOS 540. Lunar phases.

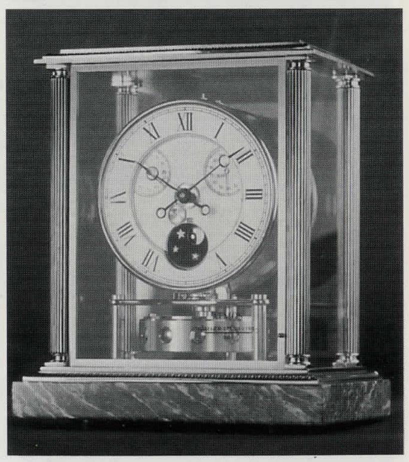


Fig. 38 The ATMOS Vendôme.

moon was selected so that it would subsequently be possible to add an additional complication to the ATMOS ... without consuming any extra energy! That was done some years later (Fig. 37). It might be asked why a barrel completing one revolution in two phases of the moon was not adopted for that would have allowed a more classical representation of the lunar phases but that option would have needed additional gearing which, in itself, would have been an energy consumer.

The cabinet was also refined somewhat.

Original creations

It is remarkable to note that, from the ATMOS I, in 1931, to the present day, that is to say for sixty-five years, the simplest of models comprising five glass panels and a visible movement had without interruption existed in all the collections. It had certainly evolved with time, according to fashion and market needs, but the relationship between these variations has remained apparent and typifies the ATMOS. Figure 37 shows its ultimate form with its clean-cut purity of line and perfect balance, a true symbol of serenity, lightened by the lunar phases.

It is also timeless for, along with this model, the ATMOS movement was used in cabinets of widely differing styles. But these versions were always

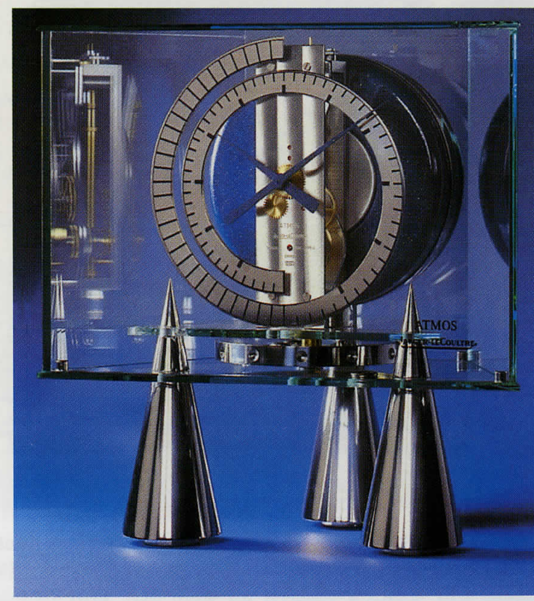


Fig. 39 The ATMOS *"Atlantis"* – Created with the Kohler and Rekow Agency.

marginal and often disappeared comparatively quickly. They just did not vibrate with "the spirit of the ATMOS", for they were first and foremost a clock (sometimes very beautiful indeed!) moved, accidentally, so to speak, by an ATMOS movement. A few rare models have survived through the years although in small quantities, and it is not a mere chance that those were the models that showed the ATMOS movement itself to best advantage. A typical example of this is the *"Vendôme"* clock (Fig. 38).

There are certainly many other ways of blending the mystery and serenity of the ATMOS movement that "live on air" with artistic endeavour. At a time when our contemporaries often feel that they are the victims of time, it is comforting to note that we can also thrive on and master it!

Other current examples show the extent to which the ATMOS can inspire different styles, from the purity of line of the *"Atlantis"* clock, created with the Kohler and Rekow agency (Fig. 39) to the refinement of the ATMOS *"4 Seasons"* Marquetry clock by Jérôme Boutteçon, the marquetry craftsman (Fig. 40).

Fig. 40 The ATMOS *"4 Seasons"* marquetry clock by Jérôme Boutteçon.

LIVING ON AIR...

While measuring time...

...is foreign to the concept of an ***END***...
(as long as we still have time)...

...but implies that we must dance to the music of time,
with a supple yet steady rhythm.

This is why, there can be no end to so beautiful Adventure.

JAEGER-LECOULTRE has clearly understood this to such an extent that its desire always to move with the times recently surfaced again when it laid the foundation stone of a new building – ready to move into the third millenium!

And it was no mere fluke that the ATMOS was intimately associated with the event!

Here is the text composed on that occasion:

An ATMOS ensconsed in stone
Make a date for 500 Years from now

Everyone present will confirm that what they saw on June 27, 1996, will again see until December 31, 2496.

The reason is simple. The laying of the first stone of the new Jaeger-LeCoultre building in Le Sentier was the scene of a rare event: a glimpse of a new vision of time, looking ahead toward five centuries of history still to be written.

It is indeed only December 31, 2496 that the time will have come to take a look at the *ATMOS Atlantis 2000* clock, sealed within the first stone marking the extension of the Jaeger-LeCoultre Manufacture. Not because five hundred years will suffice to exhaust this watchmaking marvel, but because the masterwatchmakers have decided this is how things would be.

Since this brilliant invention in 1928, some 680,000 ATMOS clocks have been crafted in the workshop of the Manufacture. Nonetheless, the *ATMOS Atlantis 2000* sealed into the stone on this special day is totally unique and worthy of the event it has been designed to mark.

Atlantis 2000 echoes the famous glass cage and three conical feet of the famous ATMOS *Atlantis* line, designer by Robert Kohler, but there is one big difference: *Atlantis 2000* displays neither the hours nor the minutes. Its spiral dial only indicates the phases of the moon and the years – engraved from 1996 to 2496 – thereby opening up an entirely new perspective on time. Time viewed no longer as a master but rather a companion; time which restores its full value to the cycle of years and the rhythm of the seasons.

A living, symbol of this natural vision of time which is all too often swallowed up in the hustle and bustle of daily activities, the ATMOS *Atlantis 2000* has set out in pursuit of this ideal. It has five centuries ahead of it...

Fig. 41 The *ATMOS Atlantis 2000.*

ATMOS Models from 1963 to 1984

Before 1963

The ATMOS was made in a very limited number of different models. The quantities made each year and the cost prices to be attained justified that policy. The indications in the main text suffice to identify each model. (See also the table in figure 32.)

Since 1963

The quantities made justified a greater variety. Nevertheless, at first the variations concerned only the outside of the cabinet or the dial. By 1969, the variety had become such that, in 1970, a model numbering system was introduced. Those numbers were not however always engraved on the cabinet, which is what makes this annex so interesting at it provides an overall view.

The dates of the catalogues that presented each of these models are sometimes followed by a date in brackets which correspond to the very last year in which a model was still available although no longer in the collection.

Numbering of movements: each ATMOS movement carries the calibre number and an individual production number. From these numbers, the factory can tell on which date each movement left the adjusting workshop at which the record of the results obtained are kept on file.

- ATMOS V – Calibre 526 – *"Classic"* model
- ATMOS V – Calibre 526 – *"Classic"* variants
- ATMOS V – Calibre 526 – Fantasy models
- ATMOS *"Royale"* – Calibre 526
- ATMOS VII – Calibre 528/1
- ATMOS VIII – Calibre 528/1
- ATMOS *"Style"* – Calibres 526 et 528
- ATMOS – "Christopher Lawrence" Collection
- ATMOS *"Jubilee"* and *"Prestige"*.

Scale: unless otherwise indicated, the illustrations are on a scale of approximately 1/5.5.

ATMOS V – Calibre 526
"Classic" Model

Basic model: reference 5800:
First model made using calibre 526
First deliveries 1955.
Catalogued until 1984 (1985).

Reference 5845:
Nickeled cabinet, silvered ring dial, 4 Arabic numerals, 8 black applied hour-symbols.
Catalogued 1974 to 1979, 1983 (1985).

Reference 5852:
Silvered cabinet, silvered background dial, 4 Arabic numerals, 8 black applied hour-symbols, gold-plated movement.
Catalogued 1979 to 1984 (1988).

Ref. 5800

Dial variants

5831 Black ring dial, 4 applied Arabic numerals, 8 applied hour-symbols, gilded cabinet. Catalogued 1963, 1969, 1972 to 1974, 1985.
5832 Round dial, full, white, 12 black transferred Roman numerals, gold-plated cabinet. Catalogued 1969, 1972 to 1974, 1985.
5833 White ring dial, 12 transferred black Roman numerals, gilded cabinet. Catalogued 1969, 1972 to 1985.
5846 Shaded black ring dial, 4 applied Arabic numerals, 8 applied nickel hour-symbols, nickel cabinet. Catalogued 1974, 1985.
5847 Wooden ring dial, 4 applied Arabic numerals, 8 applied gilded hour-symbols, gilded cabinet. Catalogued 1974 (1985).
5848 Lapis-lazuli ring dial, 4 applied Arabic numerals, 8 applied gilded hour-symbols, gilded cabinet. Catalogued 1974 to 1979, 1983 (1985).
5849 Lapis-lazuli ring dial, 4 applied Arabic numerals, 8 applied nickel hour-symbols, cabinet nickel. Catalogued 1975 (1985).
5850 Grey-blue ring dial, 4 applied Arabic numerals, 8 hour-symbols applied nickel, cabinet nickel. Catalogued 1975 (1985).

Ref. 5833

Ref. 5845

Ref. 5848

ATMOS V – Calibre 526
"Classic" variants

The faces of this cabinet were surfaced in many different ways. The cabinet and the movement are identical.

***"Gold-Leaf"* models**

5801 *"Caravelle"* motif.
Catalogued 1962 to 1971.

5802 *"Constellation"* motif.
Catalogued 1962 to 1975.

***"Engraved Perspex"* models** Colour of the Perspex: black or (opal).

		Catalogues
5803 (5807)	*"Bees"* motif.	1969 to 1975.
5804 (5808)	*"Caravelle"* motif.	1963 to 1975.
5805 (5809)	*"Chinese"* motif.	1962 to 1975.
5806 (5810)	*"Fish"* motif.	1962 to 1975.

***"Engraved glass"* models**
Catalogued 1972.

5821 Brown background.
5822 Green background.
5823 Gilded background.

***"Painted glass"* models**

5826 Grey marbled green.
Catalogued 1972 to 1975.
5827 Autumn.
5828 Aquamarine.
Catalogued 1973.
5829 Emerald.
5830 Black opal.
Catalogued 1973.

***"Jeannin decoration"* models**
Catalogued 1974 to 1975.

5842 Green-gilded.
5843 Green-blue-red.
5844 Turquoise.
Catalogued 1973.


Ref. 5801


Ref. 5803


Ref. 5843


Ref. 5822


Ref. 5810

ATMOS V – Calibre 526
Fantasy models
(Scale: 1/6)

Comment: Under this denomination (which is not used elsewhere!) we have grouped models that deviate from the ATMOS design and appeared but sporadically.

***"Elysée"* model**

5811 Gilded cabinet, porphyry varnished surfaces, gilded dial. Transferred Roman numerals.
Catalogued 1970 to 1975.

5820 Gilded cabinet, shell varnished surfaces, gilded dial. Transferred Roman numerals.
Catalogued 1970 to 1983.

***"Windsor"* model**

5824 Gilded cabinet, shell varnished, engraved gilded dial. Black Roman numerals.
Catalogued 1972 to 1974.

5825 Gilded cabinet, flame-red varnished, engraved dial. Black Roman numerals.
Catalogued 1972 to 1974.

***"Trianon"* model**

5813 Engraved silvered ring dial, black Roman numerals.
Catalogued 1969 to 1974.

***"Bamboo"* model**

5853 Gilded ring dial, transferred Roman numerals.
Catalogued 1979 to 1984.

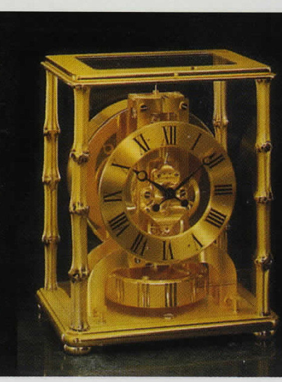
***"Bow-fronted"* model**

5854 Lacquered columns and dial ring, Roman numerals and fleur de lys.
Catalogued 1979 to 1984.


Ref. 5820


Ref. 5824


Ref. 5854


Ref. 5853


Ref. 5813

ATMOS V – Calibre 526
“Royale” model
(Scale: 1/6)

Comment: This model has existed in three successive families, the first two of which were fitted with the 526 calibre and are shown below. The third, using the 540 is shown on the corresponding page.

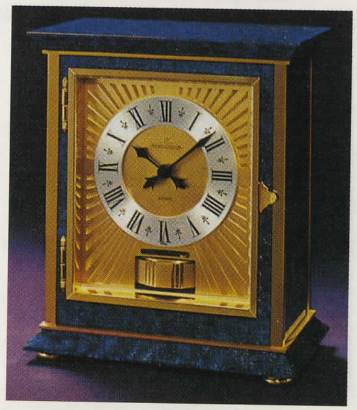
***“Royale”* model – First family**

5814 Gilded cabinet, silvered chapter-ring, polished circle, 12 Roman numerals +12 fleurs de lys.
Catalogued 1969 to 1975.
5815 As 5814, but rhodium-plated cabinet.
Catalogued 1969 to 1975.
5816 As 5814, but base and sides Bordeaux lacquered.
Catalogued 1967 to 1975.
5817 As 5814, but base and sides black lacquered.
Catalogued 1967 to 1975.
5818 As 5814, but base and sides lapis-lazuli lacquered.
Catalogued 1969 to 1975.
5819 As 5814, but base and sides flame red lacquered.
Catalogued 1969 to 1975.
5851 As 5814, but base and sides green lacquered.
Catalogued 1976-1977.

***“Royale”* model – Second family**

5855 Gilded and Bordeaux lacquered cabinet, sides glazed, polished gilded chapter-ring, 12 black Roman numerals.
Catalogued 1978 to 1984.
5856 Gilded cabinet, sides, base and top lacquered Bordeaux.
White dial, Roman numerals, minute circle.
Catalogued 1978 to 1984.
5858 As 5818, but sides green black moiré.
Catalogued 1977.
5859 As 5856, but lacquered black or brown with Japanese decorations.
Catalogued 1978 to 1984.

Ref. 5814



Ref. 5818

Ref. 5855 Ref. 5856 Ref. 5859

ATMOS VII – Calibre 528/1

Comment: The designation ATMOS VII concerns a model of cabinet; the movement used is the normal calibre 528/1. The appearance and dimensions are reminiscent of the 5811 and 5820 “Elysée” equipped with the calibre 526.
A characteristic of the ATMOS VII cabinet are the two knurled wheels under each side of the pedestal for levelling it.

5900 Gilded cabinet, black lacquered sides, white varnished dial.
Catalogued 1967 to 1970.
5901 Gilded cabinet, red lacquered sides, white varnished dial.
Catalogued 1967 to 1970.

***“Embassy”* model**

5904 Gilded cabinet, front et sides lacquered veined red, gilded chapter ring, circular buffed, 12 Roman numerals and 12 engraved fleurs de lys lacquered black.
Catalogued 1969 to 1979.
5905 Ditto, but front and sides lacquered veined green.
5918 Ditto, but front and sides lacquered solid black.
5919 Ditto, but front and sides lacquered solid red.

Ref. 5901

Ref. 5904

Ref. 5905

ATMOS VIII – Calibre 528/1

Basic model: Reference 5902
This model is the direct successor to the ATMOS III, IV and VI: same appearance and proportions; different calibre, gilded cabinet, ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
Catalogued 1967 to 1984 (1985).

Dial variants

5903 Square white ring dial, 4 applied Arabic numerals 8 applied gilded hour-symbols. Catalogued 1969 to 1984.

5907 Round shaded green ring dial, 4 applied Arabic numerals 8 applied gilded hour-symbols. Catalogued 1971 to 1985.

5908 Round lapis ring dial, 4 applied Arabic numerals 8 applied gilded hour-symbols. Catalogued 1972 to 1974.

5909 Round gilded ring dial, 4 applied Roman numerals 8 applied black hour-symbols. Catalogued 1972 to 1984.

5910 Round shaded green ring dial, 4 applied Roman numerals 8 applied gilded hour-symbols. Catalogued?

5911 Round lapis ring dial, 4 applied Roman numerals 8 applied gilded hour-symbols. Catalogued 1979 to 1984.

5912 Square shaded green ring dial, 4 applied Roman numerals 8 applied gilded hour-symbols. Catalogued 1979.

5913 Square lapis ring dial, 4 applied Roman numerals 8 applied gilded hour-symbols. Catalogued 1979.

5914 Square gilded ring dial, 4 applied Roman numerals 8 black applied hour symbols. Catalogued 1979 to 1985.

5915 Round white ring dial, 12 transferred Roman numerals. Catalogued 1979 to 1985.

5916 Round black ring dial, 4 applied Arabic numerals 8 applied gilded hour-symbols. Catalogued 1975.

5917 Round red ring dial, 4 applied Arabic numerals 8 applied gilded hour-symbols. Catalogued?

5920 Square white ring dial, 4 Roman transferred numerals 8 applied gilded hour-symbols. Catalogued 1979 to 1985.

Ref. 5902

Ref. 5903

Ref. 5909

Ref. 5911

ATMOS *"Style"* – Calibres 526 and 528

***"Vendôme"* model**
This is the *"Style"* model which, with a few variations of detail, lasted the longest.
Originally, it was also called the *"Empire"* or *"Directoire"* model.

5812 Lacquered marble columns, gilded metal base. Calibre 526 – Catalogued 1969 to 1972.

5834 Fluted bronzed columns, metal gilded base. Calibre 526 – Catalogued 1973 to September 1985.

5857 Fluted bronzed columns, marble base. Calibre 526 – Catalogued 1962 to 1978. Originally, Paris Model.

***"Neuchâteloise"* model**

5906 Calibre 528 Neuchâtel style clock cabinet. Various hand-painted floral motifs, black or green lacquer. Catalogued 1967 to 1970.

Modern style model

5921 Red gold-plated cabinet. Calibre 528. Catalogued 1974, 1975.

5922 Ditto, rhodium-plated cabinet, nickeled movement. Catalogued 1974, 1975.

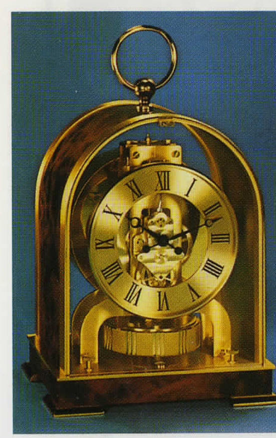
***"Borne"* (Bollard) model**

Bollard: Cabinet surround repoussé brass, leather or red lacquered with gilded bead. Calibre 526. Catalogued 1962 to 1967.

5924 Cabinet surround and base brown tortoise-shell. Calibre 528. Catalogue.

Ref. 5812

Ref. 5921



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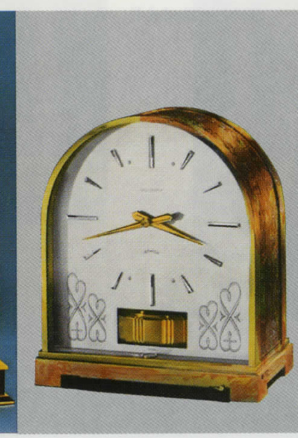


Bollard

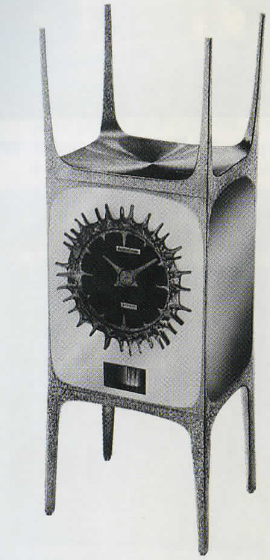
Ref. 5906 (Scale 1/12)

ATMOS – Calibre 526 – *"Christopher Lawrence"* Collection

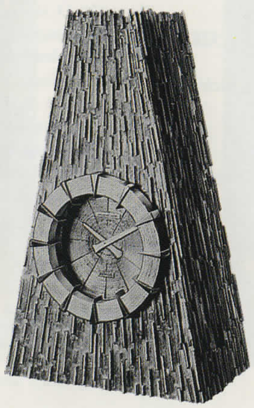
(Scale: 1/6)

Introduction

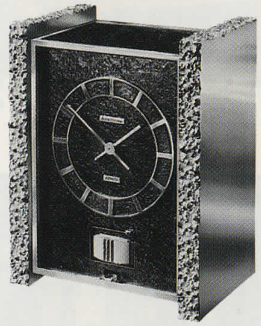
In 1972, a British artist, *Christopher Lawrence*, designed five very original solid silver ATMOS cabinets. Despite their originality, they remained catalogued only until 1975.
As we have pointed out at the end of our study, these were *objects d'art* rather than ATMOS clocks and this type of product has never lasted long in the collection.
We nevertheless wanted to include them in this presentation of ATMOS models, while stressing their originality.



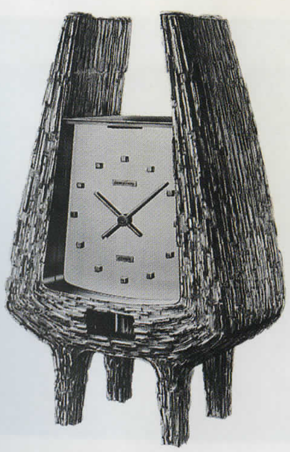
5837 – Model A



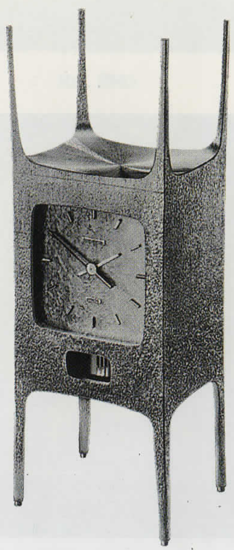
5841 – Model E



5838 – Model B



5839 – Model C



5840 – Model D

ATMOS – *"Jubilee"* and *"Prestige"*

***"Jubilee"* model**

To celebrate the fiftieth anniversary of the creation of the first ATMOS clock by Jean-Léon Reutter in 1928, a model called *"Jubilee"* was designed and produced in a single limited run of 1500 numbered units, based on the K2 model from the January 1931 catalogue.
The calibre 550 was created especially, to look like the old ATMOS I calibre, but with a modern motor replacing its former mercury motor. This *"Jubilee"* model has the internal reference 5861.

***"Jubilee"* model**

***"Prestige"* model**

As the *"Jubilee"* model was produced in a limited run, the *"Prestige"* model was designed on the basis of the old K1 model of which the proportions are differents. It is equipped with a Calibre 551. The *"Prestige"* Model is referenced 220.001. Catalogued from 1981 to 1988.

***"Prestige II"* model**

The *"Jubilee"* model, despite its success, could not be put back into production. The calibre 545, derived from the new calibre 540, and a new dial resulted in the *"Prestige II"* model. Reference number 220.018. This model was dubbed *"OPERA"* in 1990. Catalogued from 1987 to 1996.

***"Prestige"* model**

***"Prestige II"* or *"OPERA"* model**

ATMOS models from 1984

Model numbering

The new calibre 540 was launched in 1983 and... the ATMOS production management was computerised resulting in a new model-numbering system and the beginning of a new range of products.

How the product evolved

The ATMOS 540 collection keeps its main families but each model has been reworked in its finest details in order to bring it even closer to perfection.

Two phases can be distinguish in this change – the *Classic* phase, from 1985 to 1988 and the phase of the individual families since 1989.

Once changed, the *Lunar phase* and *Atlantis* models add an original new touch to the entire range.

- Calibre 540 – *"Classic"* models.
- Calibre 540 – *"Classic"* variants.
- Calibre 540 – Fantasy models.
- Calibre 540 – *"Elysée"*, *"Beaubourg"* and *"Rivoli"* models.
- Calibre 540 – ATMOS *"Royale"*.
- Calibre 540 – ATMOS *"Fontainebleau"*.
- Calibre 544 – *"Lunar phase"* models.
- Calibres 547 and 548 – *"Atlantis"*, *"Jewellery"* models.
- Calibres 540 and 546 – *"Style"* models.

Scale: unless otherwise indicated, the illustrations are on a scale of approximately 1/5.5.

Calibre 540 – *"Classic"* models

Ref. 220.017.0.1

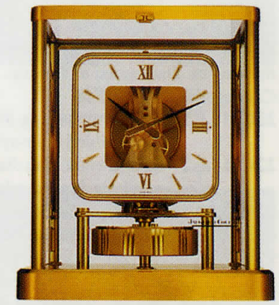
Introduction

This family of models shows the concern with achieving perfect harmony between tradition and evolution. The new calibre 540 deserved a new and similarly simplified cabinet in keeping with the ATMOS *spirit*.

Basic models

Reference 220.007.0.1
Gilded cabinet, buffed base and capping. Round white ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
Catalogued from 1984 to 1989.

Reference 220.017.0.1
Gilded cabinet, buffed base and capping Square white ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
Catalogued from 1984 to 1989.

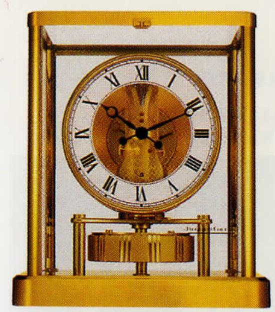


Ref. 220.017.0.2

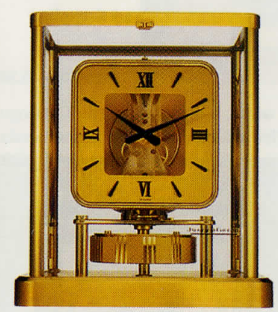
Dial variants

The last figure of the reference indicates the finish of the dial and the type of symbols. It is identical for both the above references.

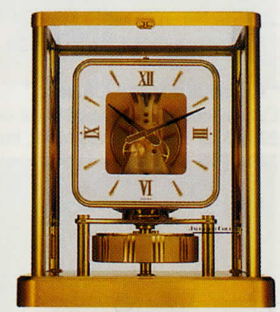
X.X.1 Cf. 220.017.0.1.
X.X.2 White dial, 4 Roman numerals and 8 applied gilded hour-symbols.
X.X.3 White dial, 12 transferred black Roman numerals, with minute-circle.
X.X.4 Gilded dial, 4 Roman numerals et 8 applied black hour-symbols.
X.X.5 Rounded gilded dial, 12 transferred black Roman numerals with minute-circle.



Ref. 220.007.0.3



Ref. 220.017.0.4



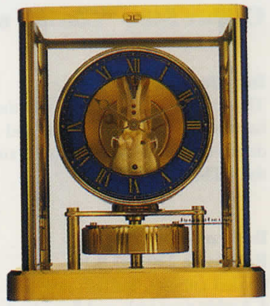
Ref. 220.007.0.2

Calibre 540 – Variants *"Classic"*

"Lacquered Classic"

The cabinet is gilded, the dial and columns are lacquered.
Catalogued 1985 to 1988.

220.012.1.1 Gilded cabinet, Bordeaux lacquered columns and round ring dial, 12 Roman numerals and transferred gilded minute-circle.
220.012.3.3 Gilded cabinet, lapis-lazuli lacquered columns and round ring dial, 12 Roman numerals and transferred gilded minute-circle.
220.022.1.1 Gilded cabinet, Bordeaux lacquered columns and square ring dial, 12 Roman numerals and transferred gilded minute-circle.
220.022.3.3 Gilded cabinet, lapis-lazuli lacquered columns and square ring dial, 12 Roman numerals and transferred gilded minute-circle.

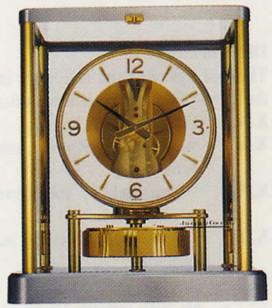


Ref. 220.012.3.3

"Bicoloured Classic"

Buffed rhodium-plated base and capping, gilded columns and movement. Dial coded as *Classic*.
Catalogued 1985 to 1988.

220.014.0.1 Round white ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
220.014.0.2 Round white ring dial, 4 Roman numerals and 8 hour-symbols applied gilded.
220.014.0.3 Round white ring dial, 12 Roman numerals and transferred black minute-circle.
220.014.0.4 Round, gilded ring dial, 4 Roman numerals and 8 applied black hour-symbols.
220.024.0.1 Square, white ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
220.024.0.2 Square, white ring dial, 4 Roman numerals and 8 applied gilded hour-symbols.
220.024.0.3 Square, white ring dial, 12 Roman numerals and transferred black minute-circle.
220.024.0.4 Gilded ring dial, 4 Roman numerals and 8 applied black hour-symbols.

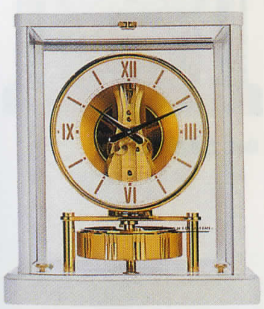


Ref. 220.014.0.1

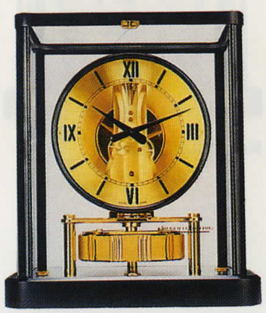
"Contemporary Classic"

Cabinet entirely lacquered black or white, gilded movement. Catalogued 1987, 1988.

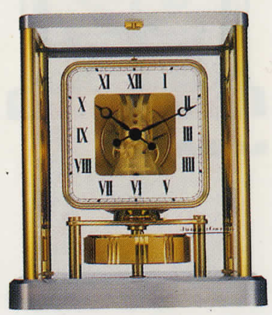
220.031.3 Lacquered black, buffed gilded dial, 4 Roman numerals, 8 black indices, minute-circle.
220.031.8 Lacquered white, white dial, 4 Roman numerals, 8 gilded indices, minute-circle.



Ref. 220.031.8



Ref. 220.031.3



Ref. 220.024.0.3

Calibre 540 – Fantasy models

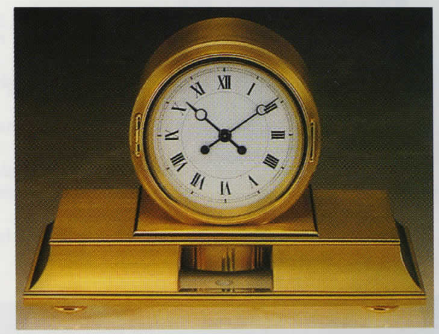
Introduction
This calibre, as calibres 526 and 528 (page 65), was also used for models that were not included in the normal ATMOS ranges or which were made for special occasions.

ATMOS 150th
220.006 Calibre 541 – Model under a blown glass bell-jar, based on the first 1927 prototype. Produced on the occasion of the 150th anniversary of the Company, in 1983.

Ref. 220.006 – 150th

ATMOS – *Mantle*
220.008 Model differing completely from the rest of the usual ATMOS range. Produced in 1983.

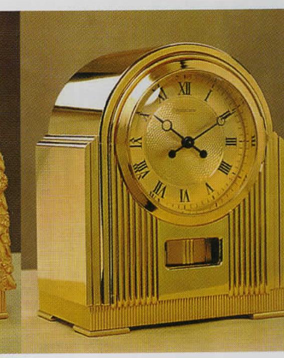
ATMOS – *Bollard*
220.029.1 Cast brass and gilded cabinet, reproducing model LG4 in gilded rosewood from the 1931 catalogue. In the collection from 1987 to 1990.
220.028.1 Same model, but with narrower carving. In the collection in 1987 and 1988.
220.025.1 Cast brass and gilded cabinet, without carving. In the collection in 1987 and 1988.
220.026.1 As 220.025.1, but wider and striped base. In the collection in 1987 and 1988.
220.027.6 Cast brass and gilded cabinet with lapis lacquer-work. In the collection in 1987 and 1988.
220.027.7 As 220.027.6 but shell lacquered. In the collection in 1987 and 1988.



Ref. 220.008.0 – *Mantle*

Ref. 220.027.6

Ref. 220.028.1

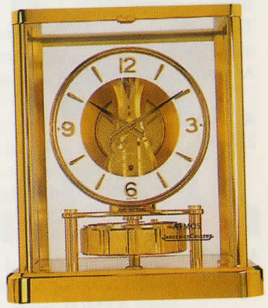


Ref. 220.026.1

Calibre 540 – *"Elysée"*, *"Beaubourg"* and *"Rivoli"* models

"Elysée"
This great classical model is the direct successor to the ATMOS V *"Classic"*, calibre 526 range, produced in 1956, then the *"Classic"*, calibre 540 range, produced in 1984. In the collection since 1989. The cabinet is entirely gilded and polished. The last number of the reference indicates the type of dial. (Same coding as for the *"Classic"* 540.)

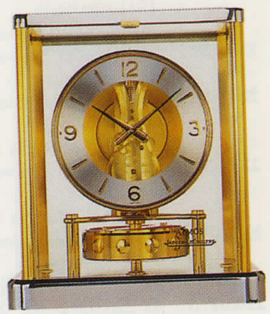
220.107.1 Round white ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
220.107.2 Round white ring dial. 4 Roman numerals and 8 applied gilded hour-symbols.
220.107.3 Round white ring dial with minute-circle and 12 transferred black Roman numerals.
220.107.7 Round full white dial with minute-circle and 12 transferred black Roman numerals. In the collection since 1991.
220.107.8 Special model for the House of "TIFFANI"
220.107.9 Special model for the House of "HERMÈS"
220.117.1 Square white ring dial. 4 Arabic numerals and 8 applied gilded hour-symbols. In the collection since 1989.
220.117.3 Square white ring dial, with minute-circle and 12 transferred black Roman numerals. In the collection since 1989.



Ref. 220.107.1

"Beaubourg"
Two-coloured (X.114) or rhodium-plated (X.116) models from the *"Elysée"* range. In the collection since 1988.

220.114.1 Round rhodium-plated ring dial, 4 Arabic numerals and 8 applied gilded hour-symbols.
220.114.3 Round rhodium-plated ring dial, 12 transferred black Roman numerals.
220.116.1 Round rhodium-plated ring dial, 4 Arabic numerals and 8 applied blue hour-symbols. In the collection since 1989.
220.116.3 Round white ring dial, 12 transferred black Roman numerals.

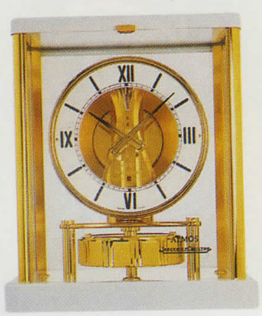


Ref. 220.114.1

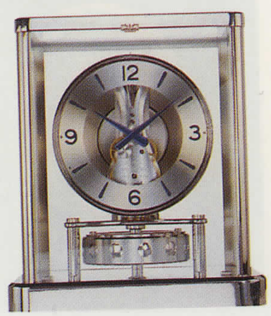
"Rivoli"
Base and capping lacquered, polished gilded columns. In the collection since 1988.

220.032.3 White varnished cabinet, round white ring dial with minute-circle, 4 Roman numerals and 8 transferred indices.
220.032.4 Black varnished cabinet, round, gilded ring dial with minute-circle, 4 Roman numerals and 8 transferred indices.

Ref. 220.032.4



Ref. 220.032.3



Ref. 220.116.1

Calibre 540 – *"Royale"* models

Introduction
The *"Royale"* models have appeared in the ATMOS collection since 1969 and have developed with the calibres and the tastes of the day.
Models prior to calibre 540 are described in Annex I.

Basic *"Royale"* models

220.010.1 Bordeaux *"Royale"*. In the collection from 1984 to 1996.
220.010.2 British Racing Green *"Royale"*. In the collection from 1984 to 1988.
220.010.3 Midnight blue *"Royale"*. In the collection from 1984 to 1994.
220.010.0 Rough cabinet for special finishes. For example, supplied to Japan and painted by a Japanese artist. In the collection from 1984 to 1988.

Ref. 220.010.1

***"China"* models**
Black lacquered cabinet with hand-painted Chinese motifs.

220.009.0 Without chapter ring or dial. In the collection from 1984 to 1996.
220.009.9 Gilded flange and base with 2 boss beads. Richer designs. In the collection since 1997.
220.011.0 *"Chinese flower"* from 1985 to 1988.

Model with lunar phases

224.010.3 As 220.010.3, but with lunar phases, thermometer and hygrometer. In the collection from 1995 to 1997.

Ref. 220.010.3

Ref. 220.010.0 Japan

Ref. 220.009.0

Ref. 220.009.9

Calibre 540 – ATMOS *"Fontainebleau"*

Introduction
On being offered a market, the Company launched an ATMOS with a wooden cabinet in 1987, one model in walnut varnished black and one in mahogany. The references were:

220.030.3 Black varnished walnut cabinet, square ring dial, 12 vertical transferred Roman numerals. Collection 1987-89.

220.030.4 Mahogany cabinet, square ring dial, 12 vertical transferred Roman numerals. Collection 1987-88.

***"Fontainebleau"* models**

220.029.3 Mahogany cabinet, round ring dial, minute-circle, 12 Roman transferred numerals. Collection 1989 to 1996.

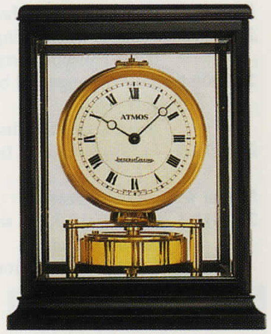
220.029.6 Black varnished walnut cabinet, full round white dial, minute-circle, 12 transferred Roman numerals, Bréguet hands with counterweights. Collection 1991 to 1996.

220.029.7 As 220.029.6, since 1993. Before 1993, hands without counterweights. Collection 1990 to 1996.

Model with lunar phases

224.029.3 Mahogany cabinet, full round dial, minute-circle, 12 transferred Roman numerals, Bréguet hands with counterweights, lunar phases, thermometer, hygrometer. Collection 1990 to 1997.

Ref. 220.030.3



Ref. 220.029.7

Ref. 220.029.3

Ref. 224.029.3

Ref. 220.029.6 (7)

Calibre 540 – ATMOS *"Lunar phases"*
(Scale: 1/6)

Introduction
We have seen that, from the very outset the calibre 540 was designed to take a lunar phase indicator. The dial of the first models produced (Ref. 224.XXX.X) also included a thermometer and a hygrometer.
These two accessories were dropped from Models Ref. 223.XXX.X.

***"Vendôme"* models**

224.013.3 Lunar phases, thermometer and hygrometer. Collection 1990-1997.

223. 013.3 Lunar phases only. Collection 1997.

***"Fontainebleau"* models**

224.029.3 Mahogany cabinet, lunar phases, thermometer and hygrometer. Collection 1990-1997.

***"Royale"* models**

224.010.3 See comments on the *"Royale"* models page 79. Collection 1995 to 1997.

***"Opéra"* models**

223.018 Lunar phases only. Collection 1997.

***"Elysée"* models**

223.107.3 Gilded cabinet, lunar phases only. Collection 1997.

223.116.1 Rhodium-plated cabinet, lunar phases only, Arabic numerals and fixed hour-symbols. Collection 1997.

223.116.4 Ditto, Roman numerals and fixed hour-symbols. Collection 1997.

Ref. 224.013.3

Ref. 224.029.3

Other models
See *"Marquetry"*, *"Jewellery"* and *"Atlantis"* ranges.

Ref. 223.107.3

Ref. 223.018

Ref. 223.116.1

Calibres 547 et 548 – *"Atlantis"* and *"Jewellery"*

(Scale: 1/6)

Introduction
In 1988, to mark the sixty years since the first ATMOS was produced, and to shown that such a marvellous clock still had great aesthetic potential, the Company asked the stylists *KOHLER* and *REKOW* of Paris to come up with a thoroughly futuristic clock. Two such units were made and dubbed ATMOS 88 and they remain the property of the JAEGER-LE COULTRE Company Museum. En 1995, on the basis of the ATMOS 88, the *"Atlantis"* and *"Jewellery"* models were designed and its movement was enhanced by the lunar phases (just a few units of each model).

ATMOS 1988

***"Atlantis"* models**

228.088.1 Crystal cabinet, gilded movement, with lunar phases, polished gilded feet. Since 1995.

228.088.2 Crystal cabinet, rhodium-plated movement, with lunar phases, polished rhodium-plated feet. Since 1995.

Ref. 228.088.1

***"Jewellery"* models**

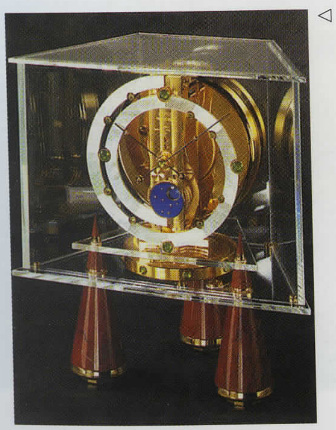
224.088.0 Crystal cabinet, gilded movement, with lunar phases, blue quartz feet, hours and balance with tourmaline cabochons. Since 1991.

224.088.1 Crystal cabinet, rhodium-plated movement, with lunar phases, crystal feet, hours and balance with cabochons. Since 1995.

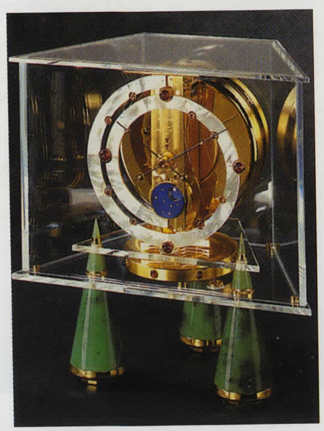
224.088.2 Crystal cabinet, gilded movement, with lunar phases, red jasper feet, rhodium-plated dial, hours and balance with green chrysolite cabochons. Since 1995.

224.088.3 Crystal cabinet, rhodium-plated movement, with lunar phases, blue quartz feet, hours and balance with tourmaline cabochons. Since 1995.

224.088.4 Crystal cabinet, gilded movement with lunar phases, rhodium-plated dial, nephrite jade feet, hours and balance with garnet cabochons. Since 1995.



◁ **Ref. 224.088.2**



Ref. 224.088.4 ▷

Calibres 540 and 546 – *"Style"* models

***"Vendôme"* model**
This model, successively fitted with various ATMOS calibres has been in the collection without a break since 1962. It still appears in the 1997/1998 catalogue in its lunar-phase version, Ref. 223.013.3, (page 81).

220.013.0 and 3 Fluted columns, marble base, white dial with minute-circle, 12 Roman transferred numerals. Collection from 1985 to 1997.

220.013.5 Ditto, but dial gilded. Collection from 1987 to 1989.

Ref. 220.013.0 et .3

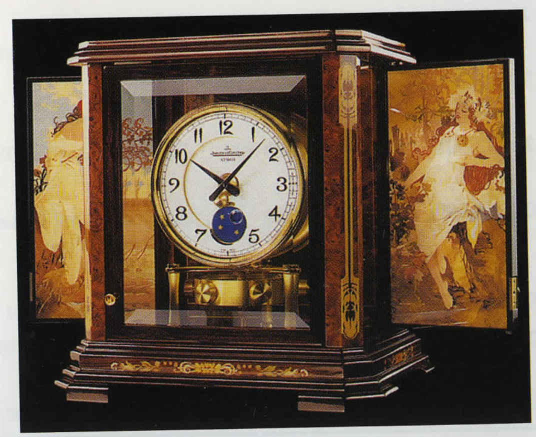
***"Marquetry"* model**
These de luxe models are produced in very short runs. they are fitted with the calibre 546, carry a screw balance and indicate the lunar phases.

226.020.1 Macassar ebony and burr laurel cabinet with marquetry medallions. Made to order, since 1991.

226.027.1 Burr walnut marquetry cabinet, with various medallions. Made to order, since 1995.

226.027.2 Marquetry cabinet made by the master cabinetmaker Jérôme Boutteçon. Panels showing the "4 Seasons" by Alphonse Mucha. Limited run of 25 units. Since 1997.

Ref. 226.027.1



Ref. 226.027.2

Patents

Country	Number	Application date	Inventor	Short abstract	Other country of registration
AH	16111	17.08.1880	Anton Harder	Torsion-pendulum	USA: 18.07.82*
USA	386557	30.03.1886	Is. L. Roberts	Alcohol-expansion = winding a clock*	
D	84858	03.07.1894	C. Paganini	Air winding-mechanism ATMOS 0*	
USA	685269	03.01.1900	W. M. Fulton	Satured gas+perfect gas	
USA	737093	25.11.1901	W. M. Fulton	Device for limiting the torque*	
USA	824858	01.06.1903	W. M. Fulton	Satured vapour-motor*	
USA	778237	03.08.1903	W. M. Fulton	Drive motor-barrel*	
F	408176	22.10.1909	P. A. J. Bouvier	As ATMOS 1, but complicated*	
UK	187894	28.12.1921	John J. Heywood	Barometric devices*	
USA	1697986	07.09.1926	Ira E. Mac Cabe	Light operated apparatus*	
CH	XXXXX	1926	Karl H. Meier	Glycerin-expansion (?) winding a clock	
F	624595	15.11.1926	Jean L. Reutter	Basic patent ATMOS 0	D, CH, UK, USA
CH	124789	22.02.1927	Karl H. Meier W. Hussy	Winding-mechanism	
CH	129637	22.02.1927	Karl Hch Meier W. Hussy	Winding-mechanism	
CH	131145	31.01.1928	Karl Hch Meier Walther Hussy	Glycerin-motor	
F	664689	28.11.1928	Jean L. Reutter	Basic patent ATMOS I	USA, D, CH, B, UK, E, I
F	676145	04.06.1929	J. L. Reutter	Regulating and locking Device for Torsion Pendulums	UK
CH	175399	09.10.1933	J. L. Reutter	High-pressure motor	D, F, UK
F	817956	22.05.1936	J. L. Reutter	Basic patent ATMOS II	CH, USA, UK, D
F	778490	02.02.1937	J. L. Reutter	High-pressure motor	CH, UK

(*) Patents know to J. L. Reutter.

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Archives of the Rivaz family, *Archives of the Canton of Valais*, Sion.
Archives of the Le Coultre et Cie SA clock and watch-making company, *Archives of the Canton of Vaud*, Lausanne.
Technical Archives of the Jaeger-LeCoultre SA clock and watch-making company, Le Sentier
Musée d'art et d'histoire, Neuchâtel.
Musée de l'horlogerie et de l'émaillerie, Geneva.
Musée international d'horlogerie, La Chaux-de-Fonds.

We would like to thank all the staff members of the above-mentioned institutions for their kind and efficient assistance.

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