BRITISH
HOROLOGICAL
INSTITUTE

Fred Lip - Electronic Watch

The electric watch balance patent specification and lecture to members of the BHI, 1953

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THE ELECTRIC WATCH BALANCE

Patent Specification of Lip Invention

THE patent specification of the Lip electric watch, now published (No. 1.011.914), explains the impulse system employed and tells the secret of how a good electrical contact is made at the switching part of the circuit. No information is given on how the balance wheel drives the hands of the watch. Since the oscillations of the balance have to be converted to a progressive rotation in one direction, presumably a form of ratchet is employed.

Details of the balance and electrical part of the watch are shown in the diagrams, taken from the patent specification. In Fig. 1, the lever (6) acts solely as an electrical switch, taking no part in impulsing the balance. Since power is applied through the balance itself, there is no escapement. At bottom right can be seen the coil (9) with its forked pole piece (10), magnetic fields being formed at the end (18), near the balance roller, and the end (20), opposite the tail of the lever, when the coil is energised.

From the battery (said to last for two years) contained in the watch, current is taken by the lead (16) to the balance cock, passing through the balance spring and its collet to the roller. Mounted on the roller is a contact pin (2), where the impulse pin would normally be. When part of the contact pin is in contact with the lever, current passes through it, along the lever itself and its arbor and cock (12), along the lead (11) to the coil (9) and thence via lead (8) back to the battery.

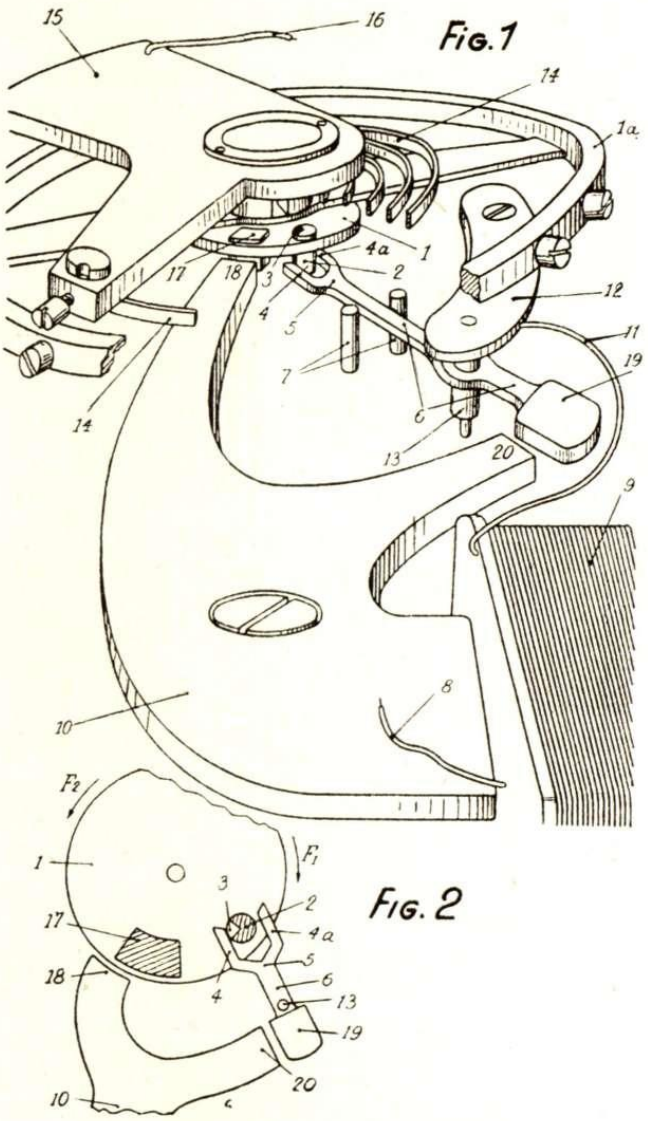
THE IMPULSE ACTION

The action of the electric balance is best explained by reference to Fig. 2, in which it may be seen that the contact pin (2) is made of an insulating material with a segment (3) of conducting material. When this segment is in contact with the arm (4) of the fork, the electrical circuit is completed; but when the contact pin is clear of the fork, or the non-conducting side is bearing on the other arm (4a), the circuit is broken.

Imagine the balance wheel to be turning in the direction shown by the arrow F1 (Fig. 2). The contact pin has entered the fork and the segment (3) has made contact with the arm (4) of the fork, completing the electrical circuit through the coil and energising the pole piece so that there is a magnetic field around the pole piece ends (18 and 20). On the balance roller is a piece of soft iron (17) positioned so that at this moment in the action it is as shown in Fig. 2. The soft iron mass is attracted by the pole piece end (18) which impulses the balance in the direction of arrow F1, taking the contact pin out of engagement with the fork and breaking the electrical circuit. The balance continues to rotate until its energy is expended, when the balance spring reverses it in the direction shown by the arrow F2. When the contact pin enters the fork on the return journey, no electrical contact is made because the non-conducting side (2) bears on the arm (4a) of the lever.

One action remains to be explained. When the balance is being impulsed, as in the position shown in Fig. 2, it is essential for a firm contact to be made between the contact pin and the lever fork. On the tail of the lever is a soft iron mass (19), which is attracted to the pole piece end (20) when the circuit is made. This causes the lever to resist the greater impulsing pull on the other soft iron mass on the balance roller, which gives firm contact between lever and pin.

The patent specification also mentions that the entire contact pin could be made of conducting material and one arm (4) of the fork of the lever of conducting material and the other (4a) of insulating material.



Drawings taken from the patent specification.

The system, it states, is particularly intended for watch movements, but may be used for all movements where a "pendular movement" must be maintained.

PUBLICATIONS RECEIVED

FROM *Rolex*, 18 rue du Marché, Geneva, beautifully produced calendar in full colour with a fresh picture of Swiss scenery for each month. Also "Rambling in Geneva" a verbal tour illustrated by 48 fine pictures reproduced in gravure.

From *S. E. Litchfield, FBHI*, 51 Rochester Road, Coventry, an attractive coloured calendar, "Raising the Standard."

WHO OWNS THIS WATCH?

THE Superintendent of Police, Kent County Constabulary, Dover, wishes to trace the owner or repairer of a watch found in the possession of a man awaiting trial for housebreaking. It is a lady's wristwatch, nickel chrome case, known in trade as "F.H.F.," 5¼ ligne, calibre No. 190; 15-jewel lever; Swiss make, and has the following marking inside case: "P8/7/Staff"; on 9 carat gold loop and ring chain bracelet with expanding link fastening. Approximate value £10.

"Electronic" Watch on Sale Here Next Year

M. Fred Lip comes from France to Lecture to Members of the British Horological Institute

BATTERY-POWERED watches from the Lip factory will be given a trial in this country this year and will be on sale here for between £30 and £35 next year. This announcement was made by M. Fred Lip when he addressed a crowded special meeting of BHI members at the Royal Society of Arts on June 18.

Introducing M. Lip to one of the biggest audiences ever seen at the Hall, the BHI chairman, Mr. W. W. Cope, said that since the Institute was formed in 1858 the leading inventions in the horological world had been announced from the lecture platform of the Institute. He instanced the inventions of the late F. Hope-Jones and Mr. W. H. Shortt, Col. Edgecombe and, in 1949, Mr. W. A. Marrison, whose invention of the quartz clock earned him the Institute's Gold Medal. For thirty years there had been an increasing electrification of clock mechanism but nothing on the practical application of electricity to watches. It was, therefore, a privilege to meet M. Lip, head of the concern responsible for designing and producing the world's first "electronic" watch.

M. Lip said June 18 was a date with special memories for him. It was on June 18, 1940, after the battle of France that he and a hundred of his workers heard on the BBC broadcasts that there was still some future for them. It was the first news they had had for a month.

He went on: "I will not read you a lecture, but will speak to you as friends about the 'electronic' watch and what we can hope of it for the future, for I believe it to be the watch of the future and not for just 10 or 20 years."

M. Lip referred to recent progress in the field of electronics—especially with regard to thermistors and transistors. "There will be watches with very few wheels in them in the next few years," he said, "the design of such watches is being considered."

The present version of the electronic watch marked a transition period from the purely mechanical to a quite different watch. The mechanical watch had been basically the same for many years—Marie Antoinette wore a pedometer watch—but the electronic principle opened up a whole new field for watch work.

In the ordinary watch a considerable torque was applied to the mainspring which gave the torque back to the balance over a period of 24 or 36 hours. The torque was changed from a rotative movement of the wheels into an alternating movement of the balance.

The electronic watch had a different system of power supply. Instead there was a rotor and there were coils of wire, the power being derived from one or two batteries. In the American version of the watch one battery was used; the European watch required two batteries. The rotor was thus driven by a battery, and a special device cut off the current after an impulse was given, the rotor behaving like a balance in an ordinary watch. As with the ordinary balance the rotor was fitted with a balance-spring. The rotor was used to drive an ordinary watch train to the hands.

Mr. M. L. Bateman (Ingersoll managing director) and Mr. W. W. Cope (BHI chairman) have a look at M. Lip's watch.

The rotor-balance was required to supply very little power, for in the ordinary watch the torque was mainly spent in driving the train and balance.

The complete motor with coil weighed 0.02 oz. Running free, the motor consumed 6 micro-watts; when driving the train it consumed 10—11 micro-watts.

Efficiency of the motor was about 20 per cent, as compared with 70 per cent for an industrial motor, 15 to 20 per cent for an automobile motor and 7 to 8 per cent for a steam engine.

The volume of the motor was 0.025 cu. in. The coils were wound with 130 ft. of 0.001 in. diameter wire* in 10,000 turns.

MAKING THE COILS

"We had to design new machinery to make these coils and we can now make a coil in six minutes," said M. Lip.

The capacity of the batteries used was 1,000 coulombs, about 150 times less than the capacity of a six volt car battery. The watch battery had an EMF of 1.3 volts.

"It was very important to develop that battery," said M. Lip. "M. de St. Vaulry has designed the watch and done the mathematics and he has had to overcome many difficulties, but the battery was one of the major ones. To have so sensitive a motor we had to have a special battery. We have, with watches already made, obtained timekeeping of the order of 10—15 seconds, but we shall not get that in the production model. In production we hope to have a watch which will give one or two minutes a month. If the voltage drops, the watch is not a good timekeeper, so we had to find a battery with a new feature—that the 1.3 volts EMF would not vary by more than one per cent over a long period. We have designed and produced a battery that gives that voltage for two years, and then goes down in a few days."

Another feature of the battery was small size and gas prevention. The gas given off by a battery would oxidise the interior of the watch, so a method of preventing this had to be found.

The volume of the battery was 0.12 cu. in. and it weighed 0.05 oz. "The efficiency of the battery in terms of percentage of zinc was 95 per cent," M. Lip said.

The entire motor consumed 100,000 times less energy than a torch lamp. "We have also compared it with electric car-clocks and have found that new car clocks made in America use 70,000 times more energy than the watch. Jaeger, Paris, car clocks consume 5,000 times more, and Smiths latest car clocks use 3,000 times more than the watch.

"You know that in every watch or clock that is used with electrical contacts there is oxidation of those contacts. We found that if the contacts in the watch became oxidised then the resistance of the circuit went up and the watch stopped.

"We have discovered a way of using some rare metals, treated by new methods and given a special polish, all of which help to avoid oxidation."

The electrical contact lasted for one millisecond in each complete cycle of oscillation.

The angle during which the rotor was not free was 8 degrees. In an ordinary watch this was 12 degrees,

**Wire of 50 SWG is 0.001 in. diameter.*

and in a pendulum clock it was 6 degrees, thus the "electronic" watch was a nearer approach to a free escapement.

The contacts operated about 150 times per minute, weighing only 50 microgrammes (10^{-6} oz.); a contact is soldered to a special, inelastic, metal.

In the main, however, all problems came back, in the end, to the design of the battery. A battery was produced to a specification that had never been done before and which opened up new fields in the uses of electronic systems, especially in such things as hearing aids and other devices requiring small batteries. This reduction in weight and size was typical of the modern trend. When 50 or 100 years ago, a machine to give 300 h.p. weighed three or four tons, to-day the same power derived from a machine of about 6 cwt.

"I think," Mr. Lip said, "the future is in smaller things. The armament manufacturer needs small components for the proximity fuse of the guided missile, the weather forecasters need ultra lightweight apparatus for radio sonde observations at great heights."

Part of the overflowing British Horological Institute audience that heard M. Fred Lip's lecture.

When next there was an exhibition in London, M. Lip said, his firm would show the complete power plant of the watch, which had a total weight of about 0.05 oz. There should prove to be many new uses for so small a power unit. it may be that it would prove of use in surgery, especially in head surgery, and so help to save and prolong life.

From production of the watch would spring the means towards even more research and the discoveries that still awaited them. He apologised for the difficulty he had had in expressing himself in a language not his own and on a subject on which expression would have been difficult even in French.

Mr. Cope congratulated M. Lip on his lecture. They would have to give the new invention very careful and unbiased consideration. "We live in an era of constant change, and the marvel of to-day may be the stock product of to-morrow," said Mr. Cope.

Major R. A. Fell opened the discussion and questions on the lecture. He said: "There are, of course, a lot of points unanswered, there is a certain amount of secrecy about the job. I have been thinking about this watch since it was first announced and I think perhaps it would be right to sum it up like this: in principle it is very much the equivalent of the Jaegar or Smiths clock in which you have a contact maintained balance and you count the oscillations and use them to drive the hands."

M. Lip: "Generally it is similar but I should say the clocks you are speaking of are simpler. There are 35 or 40 patents coming along and so we cannot tell everything about the watch. When first we announced the watch, in March last year, people said 'it is not true,' 'it cannot go—we do not believe it.' We have worked for years to perfect the watch, so let them now work too. It is good sport. We must not lose to other people—the Swiss for instance—the advance we have gained. When our watches are on the market we can speak, but not now. When we can give all the details a great many questions will be answered, such as why the watch is called electronic." Until that time all he could offer to do was to let Major Fell see the electronic watch he was wearing and passed it over to him. Major Fell said: "You can see a lot through a steel case," to which M. Lip retorted: "I do not tell you you are not intelligent because I do not see your brains!"

Major Fell said they all realised the need for secrecy. He continued with a question about the capacity of the battery to which M. Lip replied: "The motor must not require more than 12 micro-watts because that is all the battery will stand. We are designing a lady's watch that will use only five micro-watts. Later on people will make one to use only three micro-watts, which will run five years off one battery."

A MOST EVEN SOURCE OF POWER

Major Fell commented on the battery used in the watch. He said it was unquestionably the most even source of motive power for a watch that had ever been used. So small a voltage decrease would result in excellent timekeeping. He added: "I know that in Belgium they have developed some very small silver-zinc accumulators of a size that could be accommodated in a watch. I will look forward to seeing this watch when it comes on the market."

Another questioner said he had seen the Lip watch at the Ingersoll showroom and had noticed that the progress of the sweep seconds hand was jerky.

M. Lip answered that this was due to the transference of the alternating movement of the rotor into a rotative movement of the train. With this it was inevitable that the movement should progress in steps—but, he added, the noise of the watch was very much less than that of a normal watch and the progress smoother and lighter.

Another questioner put his query in French. M. Lip, replying, said: "This Swiss gentleman asks a Swiss question. He asks: "What is the advantage of the electronic watch, because the present automatic watch gives good results?" The automatic watch has made great progress, but if the watch is not worn for a time such as when a person is sick, it stops after one or two days. The electronic watch can be left by your bedside, or on your desk, for months and will continue to give correct time."

Another question put to M. Lip was concerned with the wire used for winding the coil. It was suggested the act of winding would stretch the wire resulting in increased resistance. M. Lip agreed this was so; special instruments were incorporated in the coil winding machine to overcome the difficulty.

A Rolex representative asked if positional errors affected the "electronic" watch as much as the normal watch. "You have exactly the same difficulties but only

Mr. S. J. Smith *(left)* inventor of the radio master clock, tells M. Lip of the electrically maintained free balance he invented in 1931-2. An example is in the Science Museum.

Mr. Gerald Sanders, managing director, James Walker Ltd., is flanked by the BHI Secretary, Major F. B. Cowen, MC, and his assistant, Mr. F. West. In the background is Mr. W. H. French, director of Frodshams.

(Below) Smith's corner *(L to R)* Mr. W. Chas. Tucker of RTN, Mr. D. W. Barrett, CBE, director and general manager of Smiths English Clocks, and Mr. Rex Smith, sales director. On the extreme right is Mr. A. N. Williamson of Rotherhams.

in the rotor. There is no escapement error," replied M. Lip. "There is no escapement."

Mr. Barnes, of Selfridges, referred to M. Lip's comment that the "electronic" watch was a kind of connecting link between ages. "Does that mean," he asked "that in 15 or 20 years there will be no wheels in a watch?"

M. Lip: "No wheels."

Mr. Barnes: "That means there will be no need for watchmakers."

M. Lip: "In your time there was once a big industry producing keys to wind watches—same thing."

Mr. Bainbridge Bell,* who described himself as an amateur who did not mend watches said: "One of my cares in life is producing and helping to produce glossaries used in electrical engineering. It seems to me that the term 'electronic' is used of this watch for a slightly bogus reason, that is that electronics were apparently used in the development of the watch. Electronics is used in a bakehouse, but we do not eat electronic bread. This word 'electronic' is wearying us very much. American manufacturers have used the term for practically everything. Electronics, to this audience, is what happens inside a wireless valve, it is the passage of electricity NOT through an ordinary copper conductor and unless there are some secrets occurring in this watch like that I feel it is rather a pity that this word, already becoming a commercial word for anything, should be extended to a watch. If the watch is an electric watch why not leave it at that?"

"WATCH IS 'ELECTRONIC'"

M. Lip replied: "There *is* something electronic in this watch. Great progress has been made, specially in the transistor and thermistor† field, and this watch has got between the battery and the motor, some new things developed in America that help to get better utilisation of energy and thus we call it 'electronic.' In a year or two you will see it is not a bad name for this watch."

In view of M. Lip's assurances, Mr. Bainbridge Bell withdrew his objection to the use of the term "electronic."

Mr. Hollis said the only thing he could see wrong with the watch was the use of a contact. He asked if the contact was reliable in all positions and in the presence of vibration.

The contact had been tested through 50 million operations, replied M. Lip. With normal vibration it had behaved perfectly well. He added "that the special contact developed for the watch could also be applied to 'electronic' clocks for cars."

Mr. Hollis said that whatever else was done, theoretically there was a spark at a contact point.

M. Lip: "We think it would not be the same with alternating current."

In response to a question about production M. Lip said: "We have 100 watches being worn and 5,000 watches being manufactured. We will not put them on the market until we have tested 1,000 watches which will never be sold. We think we will sell watches in England at the end of next year. There will be some of my friends in England who will wear this watch on their wrists before the end of this year."

Mr. E. Jones asked if the "electronic" watch would be the answer to the search for a non-magnetic watch. M. Lip replied: "We know that our watch is certainly more anti-magnetic than any watch in the market now; there is permanent magnetism in it.

"This is specially for the watchmakers," M. Lip continued. "My family have been watchmakers since 1810—I am the fifth generation—and we agree that the new watch must be sold by watchmakers; it cannot be sold by the man selling vacuum cleaners, refrigerators and television sets. Those watchmakers who say: 'I am not interested in electricity' will make a big mistake, they must learn first to sell and then to repair watches with new mechanisms. There may soon be watches with no wheels, there may even some day be chemical watches, for there are now people doing research in those fields. The watchmaker must change with progress. I think it would be a pity to let electrical traders take over the 'electronic' watch—for they would then have to learn the mechanical part."

Asked about lubrication problems with the new watch, M. Lip replied that they were the same as in a normal watch. He went on: "When the watch is delivered to the retailer the battery is disconnected. This is shown by a red indicator appearing in a window in the watch. Movement of a small switch sets the watch going and the red sign disappears. The owner of the watch can disconnect in the same way when he wishes to set the hands, or to keep the watch out of use for a time."

Mr. W. Charles Tucker asked if there was any possi-

* Mr. L. H. Bainbridge-Bell, a member of the Admiralty Signal and Radar Establishment, is a campaigner for clear presentation of technical information.

When the "electronic" watch was first announced, M. Lip said: "'Electronic' is a trade mark given to the watch, which is actually an electric watch." Evidently progress has been made in a new direction since then.

†A transistor is a newly developed electronic device based on the crystal and cat's whisker of the old crystal set. It can do much of the work of radio valves, but can be reduced to a size little bigger than a match head. It is best regarded as a component that replaces current by voltage or voltage by current.

A thermistor is a device for stabilising current.

These two components could be used as the basis of an oscillator to produce the alternating current to which M. Lip referred.

bility of there being made a radio-controlled watch. "There are many people trying to develop such a watch," replied M. Lip, "but among the many difficulties are such things as the varying reception at different distances from the transmitter. I think it would be better to have an 'electronic' watch or even an automatic watch."

On the subject of selling price, M. Lip said the watch would be marketed in a steel case at a tax-paid price (in this country) of about £30 to £35—"but in five or six years the price will almost certainly decrease," he said. The watch, he added, was more simple than an automatic watch, or even an ordinary one. He said: "We will put 17 or 19 jewels in it to please you. It needs seven jewels, but we will try to find some places for some more!"

Mr. Clark asked about an illustration in the January issue of the HOROLOGICAL JOURNAL referring to the Lip watch. "That was the original patent we were obliged to take out because so many other patents were being taken out," replied M. Lip. "It does not tell you anything now. There are some patents that will be issued in England next month* that will be 'interesting.'"

Mr. M. L. Bateman, thanking M. Lip for his talk, said that as well as being the first non-British Fellow of the Institute, M. Lip was also well qualified to be a CMBHI. He added: "Do not let us be too shy about accepting new ideas as perhaps we have been guilty of doing in the past."

* The Lip company made applications for British patents on May 15, 1953, for "an electronic watch," on May 22 for "electric connection methods," and on June 5 for "electric clocks." Details of these will not be available until the patents are accepted, which normally takes about a year.

Astronomer Royal's Report

New Basis for Time Service Transmissions and Bulletin

FROM July 1, Greenwich Mean Time was abandoned for the basis of transmitted time signals and the Time Service Bulletin of the Royal Greenwich Observatories. The new basis is a provisional Uniform Time system, which is corrected for the variations of the Earth's rotation and in the position of the Poles, as was referred to in HJ last month in the article on "Broadcast Time and Frequency Standards."

Reasons for the change are given in the Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, read at the annual visitation on June 13. The report adds, "the derivation of GMT (as previously used) from the adopted time system will be included in the Bulletin for users desiring to maintain continuity with the old system."

Time determination is carried out by correcting astronomical observations (420 were made at Greenwich and Abinger during the year) for polar variations and referring the result to the mean of five or six selected quartz clocks. As a further step to accuracy in time determination, an investigation has been made into the effects of systematic star-place errors.

QUARTZ CLOCK PERFORMANCE

Quartz clocks using ring crystals have proved their superiority during the year and standards of this type have been used exclusively for prediction and preparation of final corrections to the time service. At Abinger, oscillator E5, which has a silk-supported ring crystal, was stopped on November 25 after running 2½ years without interruption. After some changes to the oven in which the crystal runs, it was put back into service on December 9. Two quartz crystal clocks are to be built at Greenwich, on brick pillars, to the same specification as those at Abinger. A general account of quartz clocks employed in the Greenwich time service is being published in "Monthly Notices."

At the beginning of the year, five pulse dividers operating from 1,000 pulses to one pulse a second were brought into service at Abinger. These pulse dividers have replaced phonic motors* for clock inter-comparisons and for mean time radio time signal reception, but the motors are still used for time signal transmission, rythmic signal reception, and sidereal time. The mean deviation of output pulses is of the order of one microsecond, compared with ten microseconds for the phonic motors.

Several methods of determining the accuracy of a chronometer by using radio time signals have been investigated and a report is being prepared.

The chronometer department of the Observatory, which is at Herstmonceux, had 15,353 chronometers and watches on charge during the year, exclusive of those in the hands of outworkers for repair, and 8,556 were received and 8,437 issued. In addition 12,393 Air Ministry watches were received and 8,939 issued. The Shortt free pendulum No. 40 used as the time standard in the department has been checked against Rugby broadcast signals and the daily rate found to be accurate to about ±0.015 seconds from the mean rate. Two improved versions of water test apparatus constructed in the Observatory workshop have been employed for testing waterproof watches and a smaller model of simpler design presented by a Swiss watch company has also been in use.

Several standard clocks have been overhauled during the year by the chronometer department and an appreciable amount of experimental work has been done towards modifying a watch movement with a view to its being used as a portable current integrating meter measuring minute currents. During the year, Harrison's No. 3 timekeeper was renovated and has been returned to the National Maritime Museum. All four Harrison machines and Larcum Kendall's No. 1 are now in going order.

The first watchmaker apprentice to be trained in the chronometer department has completed his term of apprenticeship and one journeyman watchmaker and another apprentice have been engaged. There are two remaining vacancies for journeyman watchmakers which have still to be filled.

*Phonic motor—elementary synchronous motor capable of being driven with low power from valve oscillators.

Export of Works of Art and Antiques

ACTING on recommendations made by the Committee on the Export of Works of Art, etc., the Board of Trade has made relaxations in export licensing control, operative from July 1, 1953. Control on grounds of national importance will be confined to objects more than 100 years old, not imported within the last 50 years, and (except for manuscripts and documents) of a value not less than £500.

Previously, articles more than 75 years old and all works of art are subject to export licensing control to all destinations.

The relaxations provide that from July 1 the minimum age limit for antiques is increased to 100 years and generally a licence will not be necessary to export:—

(a) to scheduled territories,
  (i) works of art not more than 100 years old,
  (ii) antiques and works of art more than 100 years old (other than manuscripts, documents and certain specified exceptions) if the value is not more than £500.
(b) to non-scheduled territories,
  antiques and works of art (other than manuscripts, documents and certain specified exceptions) if the value is not more than £100.

A leaflet explaining the procedure may be obtained from Export Licensing Branch, Board of Trade, Atlantic House, Holborn Viaduct, London, E.C.1.