Electrical and Electronic Timepieces and their Maintenance

by Lothar M. Loske

(Continued — see "Swiss Watch and Jewelry Journal" 5-6/1965)

ETA Movement No. 2420-2421

The ebauches factory of ETA S.A. at Granges offers an electro-mechanical movement for clocks; with a plate diameter of 50 mm. the movement is contained in a Plexiglas case (Fig. **31**). This movement is intended for various styles of domestic clocks, for cars, aeroplanes, and radios; the diameter of the dial must not exceed 15 cm. and the hands must be very well balanced. One model has a centre seconds hand. The consumption of current, which is 1300 mAh enables a flashlight cell of 1.5 volts to operate the clock for about 2 years. The proper connections as regards polarity of the cell are assured by markings on the case.

The principle of the ETA movement is shown in Figure **9** (see "Swiss Watch and Jewelry Journal" 1965 No. 5). The balance operates in the usual way and it receives electromagnetic impulses to maintain its oscillations. Familiarization of this double function will facilitate repair work. Figure **32** shows the purely mechanical components of the movement, while Figure **33** shows the coils, the pole-pieces of the electro-magnet, the contact springs, and the connections between the different components. Taking down is carried out in the same way; after separating the two units (mechanical and electrical), it is important not to distort the contact springs.

When dealing with electric clocks, particularly those of good quality, the watch repairer must be thoroughly competent to manipulate a balance-spring. Like the balance-spring, these clocks revenge themselves in the event of any unskilled treatment by refusing utterly to run. This means that electric clocks demand skilled treatment from the watch repairer.

Method of operation.

The balance and escapement components—wheel and lever— are rather unusual in this movement; the balance and spring is not only the controlling element with a fixed frequency, but also provides the drive to the wheel train and hands. The maintaining energy does not arrive via the train to the escapement, to be held and distributed, but by magnetic attraction of the balance rim, or rather of a metallic plate which is solid with it. The balance carries a pair of poles in the form of easily magnetized thin metal plates.

The impulse pin, which is of the usual form, does not receive impulse from

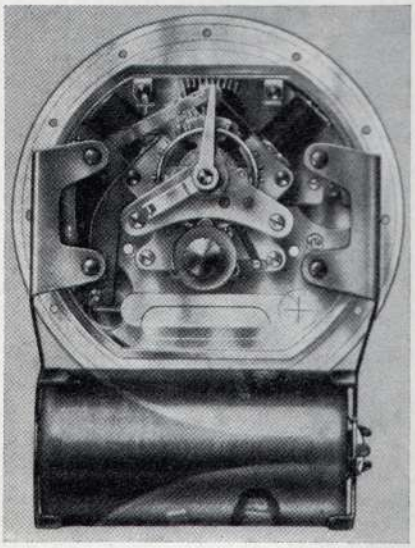
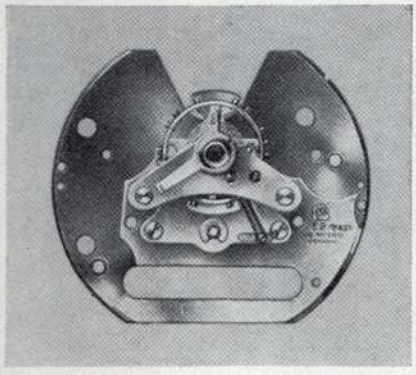


Fig. 31 ETA clock movement No. 2420-2421 in a transparent Plexiglas case, for a cell of 1.5 volts. In the best quality calibre, the balance is provided with KIF 230/190 A shock-resisting settings and 7 other jewels. The ordinary quality movement has only 1 jewel.



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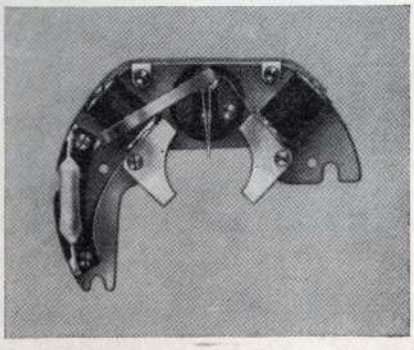


Fig. 32 Mechanical unit of ETA movement 2420 on its plate. All the components can be dealt with according to the procedure used for repair of ordinary watches.

Fig. 33 Electrical unit of ETA movement 2420 on a special demountable plate. This unit should not normally be taken down and must not go into the cleaning machine.

the pallets, but transmits the motion of the balance to the fork, and thus to the pallets. It is not a question of a normal lever escapement, but of a driving lever which has the appearance of the normal pallet and escape-wheel teeth (Fig. **34**). Wheel and pallets have the usual relationship: one component drives the other, but in the inverse sense. The impulse plane of the pallet, while sliding, causes the tooth and wheel to rotate. This mode of operation is frequently found in other mechanisms (steam engines, motor car engines, impulse mechanisms, etc.).

The shape of the teeth is striking;

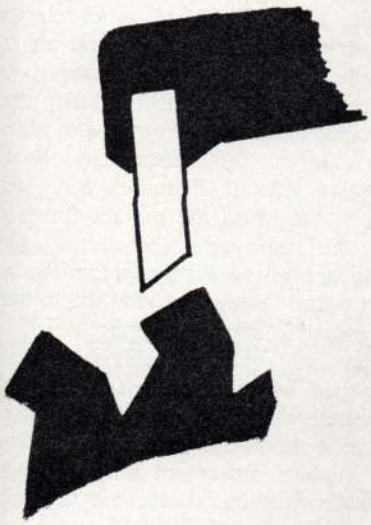


Fig. 34 Pallet and escape wheel tooth form of the ETA calibre. Pressure of the pallet on the impulse plane of the tooth turns the wheel forwards. It is not an ordinary escapement, but a device for driving wheelwork from the pallets.

they are far more solid than those of an ordinary watch escape-wheel, where the shock due to such a mass hitting the pallets could not be permitted.

The transmission of motion from the pallets to the wheel is a simple process that observation will render understandable. The balance having been taken out, lead the fork with a piece of sharpened pegwood, first in one direction and then the other, while observing the transmission of pallet movement to the impulse plane of the wheel teeth. From the pinion of the escape-wheel several other toothed wheels form a train to actuate the hands at the required rate. The gear-cutting and pivoting must be particularly well carried out, otherwise too much energy will be absorbed from the balance. Thus, even a hand which is too heavy or poorly balanced reacts on the oscillations of the balance.

The relative functions of the wheel tooth and the pallet render the angle of draw of the usual lever escapement ineffective. Nevertheless draw is needed, so that the pallets can rest against the bankings during the supplementary arc; it is achieved by a magnetic attraction. The little plate with two circular openings on the pallet staff is made of a permanently magnetized material. The interior of the hole must not touch the banking pin but simply exercize a magnetic constraint. Mechanical contact with the bankings is achieved by the pallet flanks. Here also it is wise to follow a plan of operations during practical work made, to understand the arrangement of the components and their relationship to each other.

The balance staff carries a roller with a finger (Fig. **35**) as well as a double roller. Contact of this finger with the two springs **C** does not complete the circuit; **F** has only a mechanical function and could never be responsible for defective completion of the circuit.

The circuit is made as a result of the flexing of springs **C** and to contact by the pins **P** with **S**; the points **S** are critical, and these contacts are made of a metal highly resistant to oxidation. In the rest position of the balance, finger **F** must not push either of spring blades **C** against the pins **P**; this would produce a flow of current without it being sufficient to start the balance. With the circuit closed, and the battery connected, it should be necessary to give the balance a small starting impulse. In general it is sufficient to twist the whole movement so that this moves the finger, and the balance, having left its rest position, is within range of the magnetic field. When the movement is properly set it should not be self-starting; it is important to check that this is the case, in order to avoid searching for non-existent faults.

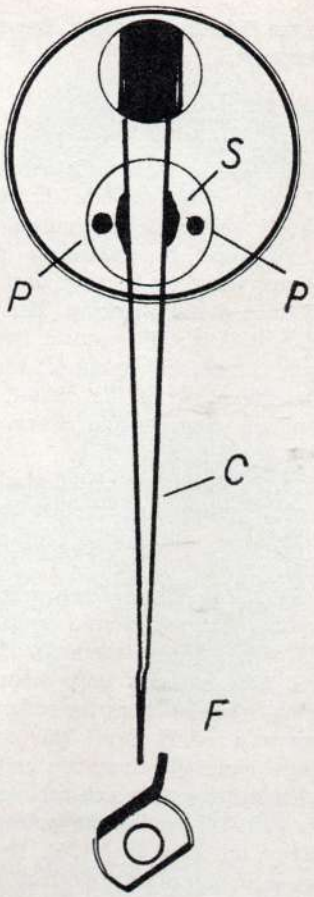


Fig. 35 Electrical contacts of the ETA movement. The roller carrying finger **F** is mounted on the balance staff below the normal rollers. During oscillation of the balance, **F** displaces the contact blades C sufficiently for one of them to touch a pin P. The electrical contact closing the circuit, is made at **S** and not at **F.**

The action commences after sufficient agitation of the clock for the balance to leave its rest position and start to oscillate. This is followed by contact of a spring **C** with one of the pins **P** and completion of the supply circuit to the coils. A magnetic field is established around the pole-pieces which produces sufficient impulse to maintain the balance oscillation. Further rotation of the balance causes the contact finger to leave the spring, and the circuit is once again open

while the balance completes its supplementary arc.

Repair procedure.

Careful separation of the two functional units—the mechanical and electrical parts—will facilitate the watch repairers' work. The mechanical unit (Fig. **32**) must be examined; check the pivots and their bearings and then clean them in the machine. The electrical unit (Fig. **33**) requires that its contacts should be examined, as well as the insulation of the circuit. The pole-pieces, contacts and connections should be cleaned dry.

The proper treatment of the mechanical unit (Fig. **32**) is assumed to be sufficiently well understood in this series of articles.

The electrical unit is easily removed from the plate; it should be turned on its side and two screws removed. Never take off this unit before removing the balance, as the rollers and finger can easily bend the contact springs. Normally there are only two mechanical defects which occur in this unit: bent springs or the pole pieces M loose or bent (Fig. **36**). If these pole pieces can only be corrected with difficulty the whole electrical unit should be replaced. The same applies to the contact springs which are screwed onto an insulating disc with their mounting so that they can easily be replaced. Slight bends can be corrected with tweezers. The two contact springs are in order when, seen from the side, the two blades lie in the same plane, the two ends are parallel, and when the two tips press lightly against each other so that there is no gap between them. Neither of the projecting contacts should touch either of the pins.

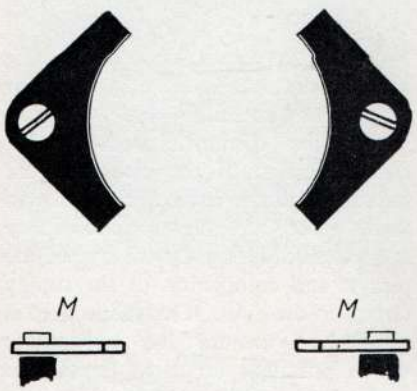


Fig. 36 Pole pieces of the ETA movement. These must not be permanently magnetized. They should lie perfectly flat and in the same plane.

The electrical unit should be checked when it is separated from the mechanical part; if they have not been separated the results may lead to an incorrect interpretation. For example, a dirty finger may stick to one of the contact springs so that during checking one might believe that there was a short circuit. After cleaning the mechanical unit including the balance and its finger, this defect, which would have been considered an electrical fault, would disappear. Bad mounting of the balance collet could lead to the same phenomenon.

It is easy to see if the electrical unit is in order. A glance will show unskilled work in the shape of poor soldering at one of the connections or to the coil wire or the resistance. These defects result in the clock failing to run even after several years. The manufacturer does not seek to impose unusual processes of repair on the watch repairer, apart from anything else, it would not be to his advantage. It is unnecessary to rewind a solenoid, or to unsolder a resistance and its connections. Professional status will only be maintained by inserting a new unit supplied by the manufacturer. It is the same for other technical products even though repair is very often possible.

If, to all external appearances the electrical unit is without fault to impede normal functioning, we recommend the following test. As shown in Figure **37** place the unit either on or near a small compass and connect the battery. When the connection is made the compass needle should not be disturbed. If one presses with a piece of sharpened pegwood against the contact springs so that one of them touches its corresponding pin **P**, the compass needle should be deviated in a particular direction; in this event the electrical unit is in proper order. The most critical function—the making of contact—has been checked. There is nothing else to be checked, other than to be assured that after the circuit has been completed a magnetic field is set up which disappears as soon as the circuit is opened. All the measuring instruments for checking voltage, resistance, and current, can rest in their boxes. In spite of the recommendation to replace the whole electrical unit when there is any defect, it should not be forgotten that every component of the unit can be obtained from the manufacturer.

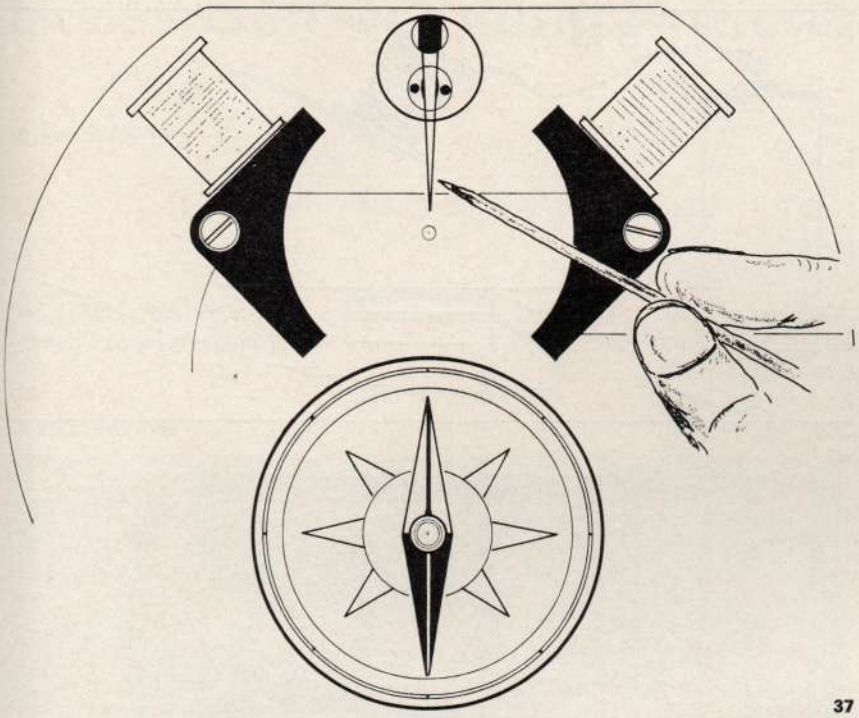
Author's Note.

It is particularly recommended that the ETA movement be studied. It has been developed in the research laboratories of Ebauches S.A. at Neuchatel, and the principle of this movement is the basis of other electric clock movements to be found on the market. There are, for example, calibres 9000/9001 ESA, the Derby electric alarm, and other types with alarm by other manufacturers. The electric wrist watch of Ebauches S.A. now to be found on the market functions in the same manner; certain components have a distinctly familiar appearance. We recommend that a 9001 movement should be purchased for study and practice. This is the best method of instruction for both the trained watchmaker and his apprentice; it shows the new features in such a modern movement and also what details need to be attended to during repair.

ESA movements numbers 9000/9001

The small electric movement No. 9000 is shown in Figure **7a** (see « Swiss Watch and Jewelry Journal » No. 5, 1965). It resembles the ETA movement which we have just described very closely. Apart from this the principal components are interchangeable. What has been said under **method of operation** and **repair procedure** is also valid for ESA 9000/9001. This calibre has, in addition, an electrical contact facility to actuate an electric bell or alarm.

The electrical unit (Fig. **38**) differs from that of the ETA movement only in the shape of the plate and the position of the resistance. Be careful to see that when measuring the resis-



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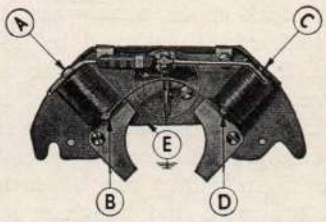

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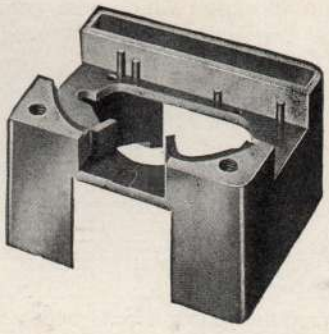

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Fig. 37 Simple method of checking the electric unit by displacing the contact blades with a piece of pegwood. If the compass needle is displaced when the circuit is closed, one can assume that all the electrical components are in order. If the needle hardly moves the cause may be: poor connection with the battery, poor contact of the connecting strip between the resistance and the pins (see Fig. 35), a defective coil, dirty contacts between **C** and **P** at **S.**

Fig. 38 Electrical unit of the ESA movement 9000/9001 of Ebauches S.A.

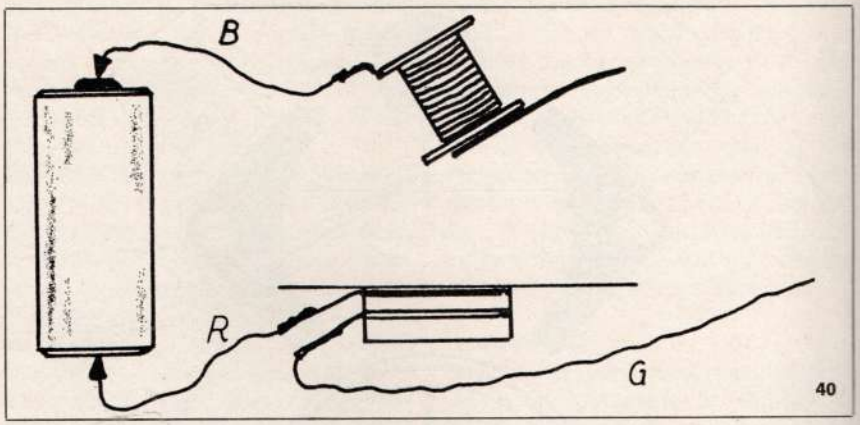
Fig. 39 Movement holder for the electrical unit of Ebauches S.A. movement ESA 9000/9001.

tance, the contact blades are not touching the pins, this can be assured by removing the mechanical unit.
The movement holder shown in Figure **39** has been specially designed for this calibre and facilitates work enormously. The electric unit can be kept safely on the holder, while the mechanical unit is being worked on.

The alarm release.
The basic movement is not an electric alarm, but it possesses, in conjunction with the mechanical unit, an electric contact device which can be closed at a time set against an arrow on the dial.
The arrangement of the alarm setting hand differs from that normally in existence. It functions in a purely mechanical way, unnecessary to explain in detail. The displacement is made directly between a disc divided into 12 hours and the hour hand, so that during going the two components move together. At the set time a small lever falls into a slot and closes a strong contact. These two components are quite visible so that further explanation is unnecessary. All the parts can be put through the cleaning machine; the two contacts should be buffed and remain dry. The path of the contact lever on the disc can be slightly greased with keyless-grease. There is only one arbor for setting the hands. The alarm dial can be displaced, or the hands set to time, by either pushing or pulling according to the type of case. It is important to check that the spring which disengages the arbor from the motion work is adequate, otherwise the movement will stop. The intermediate wheel which meshes with the idler for setting to time must be very free, without lubrication, to avoid friction due to sticking on the plate which will cause a loss of energy and a fall in balance amplitude.

The electrical circuit.
In addition to the permanent electrical connections between the coils, resistance and movement, there are three insulated copper wires: one red, one white and one yellow. These fine wires

often break at the point where they are soldered; they should be re-soldered. Pressing or twisting the wires in one way or another is not adequate. Remove the old solder to clear the hole provided for the wire. Soldering irons with a fine bit such as used for radio and television work are much better than the old type of copper bit (often the work of an apprentice) which can cause trouble, since the large mass radiates too much heat within its vicinity. The sketch in Figure **40** shows which wire goes to which connection, and how connection is made to the source of current, the movement, and the contact device. The white wire **B** is connected to one pole of the cell and to the left hand coil; the red wire **R** from the other pole of the cell to a terminal which is solid with the plate. At the same position, is a second terminal, insulated from the first, to which is soldered the yellow wire **G** which conducts the supply from **R** to the contact device of the alarm with its bell or buzzer.



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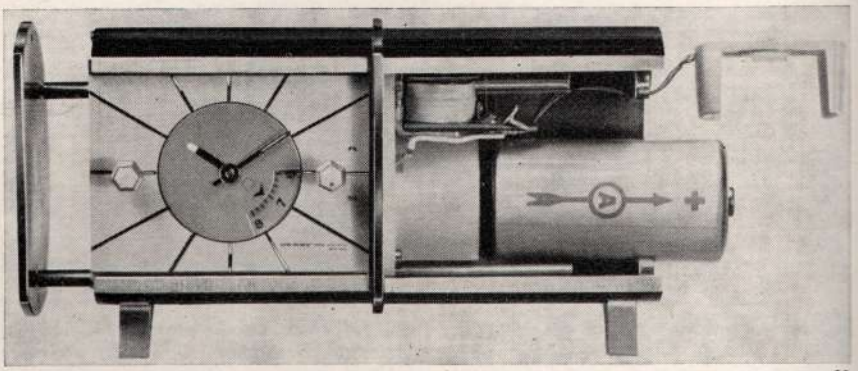
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The Derby-Vox-Electric Movement DAC 262

The ESA 9000 movement operates a battery-electric alarm (Fig. **41**) sold under the name of Derby-Vox-Electric. In the left hand portion of the case is the clock movement with alarm release device described earlier (Fig. **7a**). In the right hand portion of the case is the battery and the alarm buzzer. The yellow wire already mentioned also goes to the buzzer.

The buzzer is a solenoid with a vibrating armature and contact. When connected to a source of current, the armature oscillates as a result of the pulsating attraction produced by the closing and opening of the circuit; it sounds like a tuning fork. By adjusting the distance **C** of the armature (Fig. **42**) the sound can be modified slightly. Contacts **a** and **b** should be cleaned, using a buff with good pressure. The distance between the contacts should be between 1 and 2/10 mm. When replacing the cell, attention should be paid to the indication of polarity. **(Continued)**

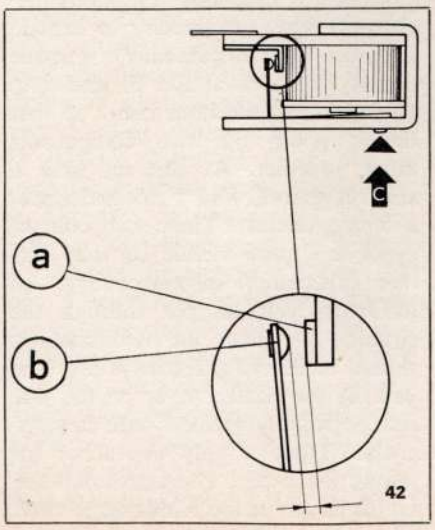

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Fig. 40 Arrangement of connections in ESA movement No. 9000 with electrical contact provision (alarm contact): B white wire; R red wire; G yellow wire. There is a mechanically operated contact between R and G. The two terminals should not touch each other. The terminal to which the red wire is connected is earthed to the movement.

Fig. 41 Derby-Vox-Electric movement DAC 262. A small electric alarm with the Ebauches 9000 movement (Figs. 7a, 38, 39, 40).

Fig. 42. Electric buzzer of the Derby-Vox-Electric battery alarm clock. By bending the blade at **C** the sound can be modified slightly. Contacts **a** and **b** are between 1 and 2/10 mm apart.