COMPLICATED WATCHES AND THEIR REPAIR

Author's additional books

WATCH AND CLOCK ENCYCLOPAEDIA

PRACTICAL WATCH REPAIRING

PRACTICAL CLOCK REPAIRING

WATCHMAKERS' AND CLOCKMAKERS' ENCYCLOPAEDIA

WITH THE WATCHMAKER AT THE BENCH

BRITISH TIME

THE WATCHMAKER'S LATHE AND HOW TO USE IT

PRACTICAL WATCH ADJUSTMENT

CLOCKS AND THEIR VALUE

COMPLICATED WATCHES
and Their Repair

by

DONALD DE CARLE, F.B.H.I.

Medallist British Horological Institute;
Liveryman, Worshipful Company of Clockmakers;
Chairman, British Horological Institute, 1956–7

Illustrations by
E. A. AYRES, F.B.H.I.

BONANZA BOOKS, NEW YORK

First published serially in
HOROLOGICAL JOURNAL
First impression . . 1956
Facsimile reprint . . 1977

This edition is published by Bonanza Books,
a division of Crown Publishers, Inc.,
by arrangement with NAG Press Ltd.
a b c d e f g h
BONANZA 1979 EDITION
Manufactured in the United States of America

Library of Congress Cataloging in Publication Data
De Carle, Donald.
Complicated watches and their repair.
Includes index.
1. Clocks and watches—Repairing and adjusting.
I. Title.
TS547.D373 1979 681'.114'028 79-13897
ISBN: 0-517-29252-1

PREFACE

Complicated watches have always been interesting to the enthusiastic horologist, but now the need to understand some complicated watches at least has become a daily necessity.

With the increasing production of automatic watches, chronographs and, to a lesser extent, calendar watches, the need to understand such work has become vital.

The aim in this book has been to make the work as straightforward as possible with no ambiguity, and to this end all the illustrations are reproductions of specially made pen and ink drawings.

The predominance given to automatic watches in the book is inevitable for two reasons: one, because there is and will be an ever-increasing number of such watches passing through the workshops for servicing, and, secondly, because there are so many different systems. Whereas modern chronographs and repeaters are fundamentally the same, makers of automatics have revelled in being different from one another.

It may be assumed by some that the repair of complicated watches is difficult, when in fact it is not. It is of course essential for the craftsman to have a sound knowledge and some experience of ordinary watches. Other than this, great *care and some thought will ensure success; there are some facts which it is necessary for the beginner in complicated work to be taught and I trust this book will fill that need.*

My sincere thanks are due to Mr. E. A. Ayres for his helpful co-operation with such excellent drawings, and to Dr. D. S. Torrens for so carefully reading the proofs of the book. Messrs. Patek Philippe willingly and courteously placed a number of illustrations at my disposal and thanks are especially due to them for the excellent photographs of their perpetual calendar watch which they had made specially for the publisher in order to guide the artist in preparing the dust cover of this book.

My thanks are also due to the many Swiss and American manufacturers who so kindly helped with illustrations and information.

D. de CARLE.

CONTENTS

INTRODUCTION

COMPLICATED work sounds very difficult, but in fact it is not. There are, of course, different degrees of complication in watches, but with experience and the necessary amount of skill, any repairer who works slowly, methodically, accurately, carefully and gently is bound to succeed.

With any complicated work there is one overriding consideration at the work bench—*care*. Complicated watches need much more careful handling than ordinary time-of-day watches. They cannot be repaired in a hurry ; they will not stand it and will eventually get the better of the repairer. Never did the adage " More haste, less speed " more aptly apply.

To become successful repairers of complicated watches students must be methodical—not that it is unnecessary to be methodical when repairing ordinary watches, far from it—but when dealing with any form of complicated watch it is vital.

Naturally, complicated work should not be the reader's first attempt at watch work and this book is written for the student who is well versed in all ordinary work and knows how to use tools.

The book is concerned with the repair of automatic winding watches ; timers ; chronographs ; split second chronographs ; calendars ; quarter and minute repeaters ; and triple complicated and clock watches. An explanation of the type of watch being dealt with will be given at the beginning of each chapter.

There are numerous versions of the same type of complicated watch. For instance, there are more than 20 different variations of automatic watches and the different types of chronographs must run into dozens. Several different designs or calibres of automatic watch will be considered and one of each of the more popular calibres of chronograph.

Calendar watches (the simple type, and perpetual), repeating watches, and the triple complicated watches which include repeating, chronograph and perpetual calendar mechanisms in the same watch, and clock watches, will receive the attention their importance or popularity calls for.

COMPLICATED WATCHES AND THEIR REPAIR

Section 1

AUTOMATIC WATCHES

This chapter deals with the automatically wound watch with a pedometer form of mechanism. Two types are in common use, one where the rotor makes a complete revolution and the other where the rotor rotates through a segment of a circle and banks on each side upon bumper springs. Of the two systems the one where the rotor makes a complete rotation and winds in both directions is the best. The other system sometimes referred to as the " hammer " type cannot take the fullest advantage of every movement of the wrist of the wearer; further, the constant knocking of the rotor upon the bumper springs can be disturbing to the wearer.

There is little doubt that the automatic watch has come to stay, and the reason is not far to seek. First and foremost is that constant force is supplied by the mainspring during the hours when the watch is worn. Every horologist is conscious of the necessity of a " good action " (i.e., a good arc of vibration of the balance) especially in a watch worn on the wrist. Because of this, the error due to lack of isochronism of the balance is reduced. A good timekeeping rate cannot be expected if the action is poor. By " good rate " is meant a constant error in timekeeping ; for instance, if the rate is, say, 30 seconds per week fast, the watch will not deviate more than a few seconds from that rate either way. It should not suddenly gain or lose, say, 15 seconds on its rate. A watch may keep time to 60 seconds per week but during the week it may be :—

+ 10 the first day ;
+ 30 the second day ;
+ 60 the third day ;
+ 80 the fourth day ;
+ 60 the fifth day ;
+ 40 the sixth day ;
+ 60 the seventh day.

In this case the rate is poor.

A good rate would be + 9 seconds each day. To obtain this condition a watch must reach certain standards—particularly, general good quality in finish, and correct adjustment of the train and the

escapement, including the balance and spring. Thirdly, there must be an equal or almost equal torque of the mainspring at all times.

Winding a Watch

To obtain an almost equal torque of the mainspring, a fusee was introduced many years ago, but this practice is not only costly but cumbersome. The next best practice is to use automatic winding.

To obtain the best result from an ordinary winding watch it is necessary to wind it in the morning—or immediately before it is worn—these observations apply particularly to wrist watches. The reason for winding before wearing is to ensure that the balance shall have an arc of, say, 1¼ turns. Under these conditions the balance is less liable to be influenced by the movements of the wearer.

Tests have been made indicating that with the slipping mainspring used in automatic watches the torque may not be absolutely constant due to an erratic slipping of the mainspring. When the mainspring is fully wound it may slip back, say, half a turn and with continued use and consequent movement of the rotor, build up again to become fully wound, then slipping back, say, for three-quarters of a turn, and so on.

The variation of torque can, comparatively, be only slight and no doubt a device will be found to correct even this slight error. For instance, eight or more slight notches cut into the inside of the wall of the barrel will prevent a good deal of excessive slipping. But even so, taking the broad view, the automatic winding is still the best, and events have proved it to be so.

Good rates can be obtained with ordinary winding watches and if automatic winding is added to movements of the same size, extraordinarily good rates will be obtained. Manufacturers are inclined to use a small size movement for automatics, say, 9¾‴ in a 12‴ case, to accommodate the automatic mechanism, but there is a trend to use larger movements. Eventually there will be the combination of a large movement and controlled slipping mainspring, which, with the progress already made with balance springs of low thermal error, should produce a watch with almost perfect rate.

Makers of Automatics

A trust, Ebauches S.A., has been formed in Switzerland of the ébauche manufacturers, i.e., the factories which make the framework or major portion of the watch. Other factories make the escapement and there are factories which specialise in making dials, hands, cases, etc. Finally, there are the " finishers." A " finisher " is the factory where the movement from the ébauche factory is completed ; the plates, bridges, etc., are plated and finished ; the movement is jewelled ;

escapement fitted ; sprung and timed ; dial and hands fitted and finally the movement cased. There are 17 ébauche factories controlled by Ebauches S.A., but there are dozens of the finishing factories and each of the finishing factories gives the watch it finishes a name, a trade name, and an individuality of its own. In addition there are well over 100 factories in Switzerland that make their own ébauche and finish the movements as well.

Ebauches S.A. factories make three automatic ébauches which are sold to many finishers. The action and repair of these three models are described and also movements of the " complete factories " are dealt with, so that if the reader comes across a movement with a name that is not among the " complete factory " list he will know that it is probably one of the Ebauches movements.

General Notes on Automatics

When winding the watch by the winding button, wind slowly. The automatic winding mechanism terminates in a train of wheels, which are sometimes small with fine pivots, and frequently the wheels are thin and delicate, but quite strong enough for the purpose for which they are normally required. Winding the button vigorously places an undue strain upon these parts mentioned and damage may occur. Some movements are so designed that the train of wheels is not interfered with when winding by the button.

The cost to a manufacturer to tool up and produce a new calibre is enormous, and you may be sure every care has been taken in the design to ensure satisfaction of the finished article. A prototype is made, largely by hand, and thoroughly tested. Each part—wheels, pinions, levers, springs, screws, etc.—is carefully studied as it is in the factory's interest to design and produce the best possible article. Therefore, do not be tempted to alter the design of any part. If you think the fault lies in the malformation of a certain part procure a new piece from the factory that made the movement. It is not advisable to alter the shape of a part or even to repair a damaged part but to fit a new piece as supplied by the manufacturer. It is important to use the mainspring as supplied by the factory. Automatic winding mainsprings are fitted with a special slipping device and although these slipping ends may look simple to make they are not. They are made of a specially-hardened and tempered steel and formed to a required curve. Generally speaking, it is not advisable to remove the mainspring if it looks fresh and clean. Oil the automatic mechanism as indicated. Each manufacturer of the movements described has been approached and the oil and oiling instructions given are those recommended by the actual manufacturer.

About Oil

A few words about oil will not be out of place. The viscosity of the oil used in an ordinary watch is important, but it is even more so when dealing with an automatic watch.

The Swiss recommend certain grades for particular parts and invariably they advise Chronax oil, made by Compagnie Française de Raffinage, Paris, France. If this oil is not available an approximate equivalent may be obtained from the table following.

Ragosine watch and clock oils are manufactured by Rocol Ltd., London and Leeds, and have been approved and recommended by Smith's Clocks and Watches, Ltd., being used in all their products :

Chronax Oil	*Ragosine Oil*
H.H.H. ..	Grade 300 (a heavy oil).
H.	Grade 180 (chronometers and clocks).
C.	Grade 120 (large watches and small clocks).
D.	Grade 120 (large watches and small clocks).
C.B.A. ..	Grade 60 (balance holes and escapements of small watches).

Grease

For lubricating some parts where a grease is required, activated grease is recommended. Activated grease is a combination of mineral grease, i.e. petroleum jelly, with the addition of solid animal fat, e.g. stearine or stearic acid, to prevent spreading. Use nine parts petroleum jelly to one part animal fat, well mixed to a fairly stiff paste. The word " active " in this connection means it has non-spreading qualities. Generally speaking, animal (and vegetable, e.g. olive) oils have non-spreading properties, while mineral oils are deficient in that respect, hence an animal or vegetable oil tends to " stay put " while a mineral oil spreads until it dissipates itself away completely from the place where it was originally put. The activation can be achieved in two ways, one by treating the surface to be oiled (Epilame process) and the other by mixing the active substance (animal oil or stearic acid) with the oil. To summarise :

Epilame.—A solution of stearic acid in toluene or carbon tetrachloride or other pure fat solvent. Benzine is not suitable owing to impurities which in course of time have a bad effect on the oil.

Activated (French " activée ") treated to prevent spreading of oil or other lubricant.

Activated lubricant oil or grease containing animal oil or other active substance (e.g. stearic acid, olive oil, neat's-foot oil, etc.).

Activated surfaces.—Surfaces of pivots, jewel holes, etc., which have been treated to prevent oil spreading.

Activated oils are usually petroleum oils to which a certain quantity of animal or vegetable oil has been added.

Activated grease.—Made from a petroleum base, e.g., petroleum jelly with the addition of a solid animal fat such as stearine or stearic acid, or an active oil such as neatsfoot or olive oil.

It might seem that animal or vegetable oil used alone would solve the watchmaker's problems, but this is not practicable as both these types of oil tend to thicken quickly with age and are also subject to considerable thickening at low temperatures. There is one exception to this rule, the oil made by Kelley's from the jaw of the porpoise.

Mineral oil is less likely to become thick with age, and another point in its favour is that, as it is less difficult to refine, its ultimate cost to the watchmaker is less.

The use of a correct oil for a particular purpose is important. If the parts of the automatic mechanism are not oiled with the correct oil the watch may not wind successfully.

Stoppers

When an automatic watch stops and it is not fitted with an " up-and-down " (reserve power) indicator, it is advisable to discover if it is the automatic mechanism or the watch movement which is at fault. If the movement is fitted with up-and-down work it will at once be seen that if the indicator points to fully wound it must be the watch movement that is at fault ; on the other hand, if the indicator points to run down, then it must be the automatic work.

If no indicator mechanism is fitted, it is better to remove the automatic work (or part of it according to the type of movement) and apply the usual tests to the movement to ascertain if it is fully wound. Should it be fully wound, it will be apparent that the fault is with the movement ; but should it not be wound, then the fault is in the automatic work.

It is generally better to assemble the automatic mechanism on to the movement after the movement proper has been fully assembled, with dial and hands, and fitted into its case. When the automatic work has been fitted, apply the following test. (These remarks refer to all movements where a rotor is employed). Hold the watch, sight high, in a vertical position before the back of the case is in place and with the rotor facing you. Now turn the watch, still vertical, so that the rotor falls to the bottom. Keep turning the watch and the rotor should always remain at the bottom. Reverse the direction, and the rotor should still remain at the bottom. If it is found that

the rotor lifts and is inclined to rotate with the watch then there is an obstruction. Examine carefully to find where the binding occurs and make the necessary adjustments.

Where bumper springs are employed apply the same test and rotate the watch so that the bumper spring on each side makes contact with the rotor. While this test is being carried out observe that the automatic mechanism is winding the watch.

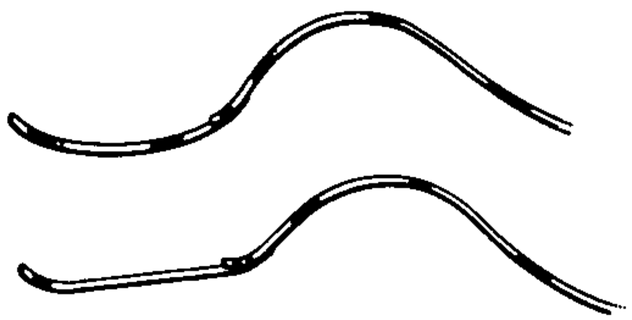
It is of vital importance that the rotor should be absolutely free, so that the fullest advantage is taken of every movement of the wearer's wrist while the watch is being worn.

The Mainspring

Special care must be given to the mainspring of all automatic winding watches. If it is necessary to remove the mainspring because of thickened oil, clean it carefully with a piece of tissue paper dipped in benzine and draw the spring through a fold, keeping the same curvature of the spring. Do not attempt to straighten out the spring.

Clean the slipping spring device and, before replacing it in the barrel, use activated grease or graphite on the inside wall of the barrel to ensure a steady soft slipping. This is important because if the slipping is jerky it is inclined to let the mainspring slip too much and the amount of slipping controls the amount of force the spring exerts. If the spring slips too much, then the curve of the slipping piece must be flattened out. Conversely, if the spring winds up too tightly it is liable to cause the balance to knock the bankings, and the curve of the slipping piece must be more gentle.

The illustrations Figs. 1 and 2 show the mainspring bridle incorrectly curved, not allowing the mainspring to be fully wound, and correctly curved. These illustrations are intended as a general guide and must not be taken as correct for all watches.



Figs. 1 and 2.—*An incorrect mainspring bridle at top and correctly formed one below.*

Fig. 3 is of a special winder for mainsprings with bridles, made by Bergeon. Practically all Swiss manufacturers recommend this winder.

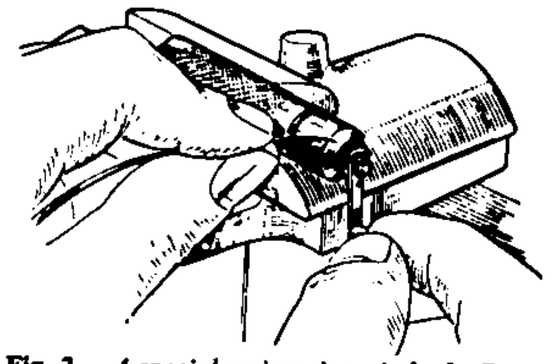
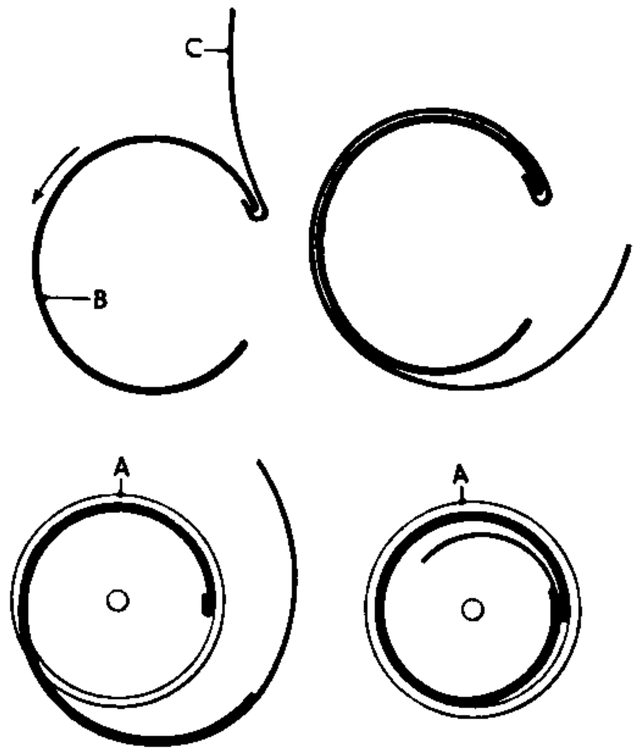


Fig. 3.—*A special mainspring winder by Bergeon for mainsprings with bridles.*

Some manufacturers of automatic winding watches use the bridle as made and patented by Fabrique Suisse de Ressorts S.A., Fig. 4, the manufacturers of the Sirius mainspring. The springs, complete with bridle, are supplied in rings and it is advisable to push the spring into the barrel without removing the ring.



Figs. 4 to 7.—*How a mainspring should be wound by hand.* C *is the spring,* B *the bridle and* A *the barrel.*

If, during repair, it has been necessary to remove the mainspring from the barrel it can be replaced by hand, as shown in the four illustrations Figs. 4 to 7. This method does prevent the risk of damaging the rim of the barrel. If possible, wind the mainspring and bridle into a ring and then present it to and push direct into the barrel. The inside diameter of the ring should be 0.20 to 0.30 mm. larger than the inside diameter of the barrel.

BIDYNATOR (Ebauches, S.A.)

Felsa S.A. Grenchen, Switzerland, make an automatic known as the Bidynator. The size of the movement is $11\frac{1}{2}'''$ = 26 mm., calibre No. 690. The rotor traverses through 360°, winding in both directions,

and there is a centre seconds hand. Fig. 8 shows the movement, and Fig. 9 shows it with the dial removed.

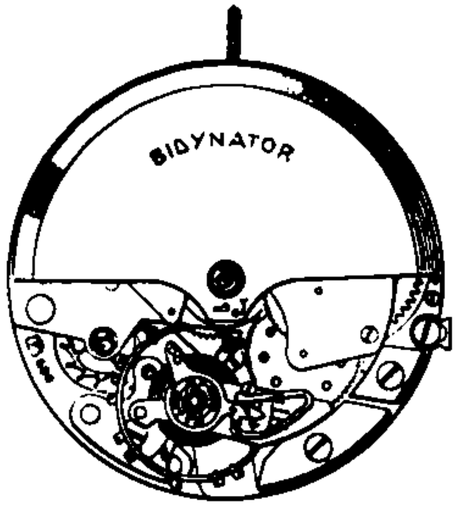


Fig. 8.—*The movement and winding rotor.*

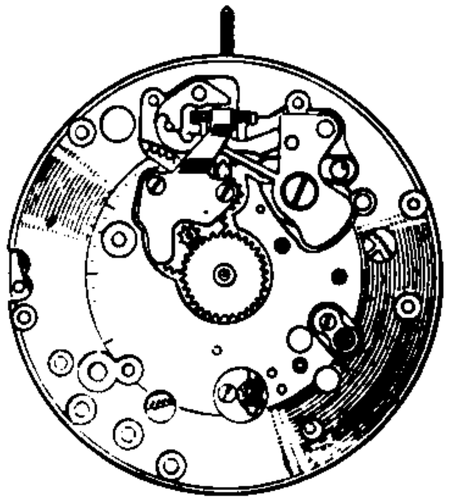


Fig. 9.—*The Bidynator with the dial removed.*

To remove the movement from its case, loosen the two screws, *A* and *B* (Fig. 10), and push back the small bolt pieces. Remove the winding shaft and lift the movement out of the case.

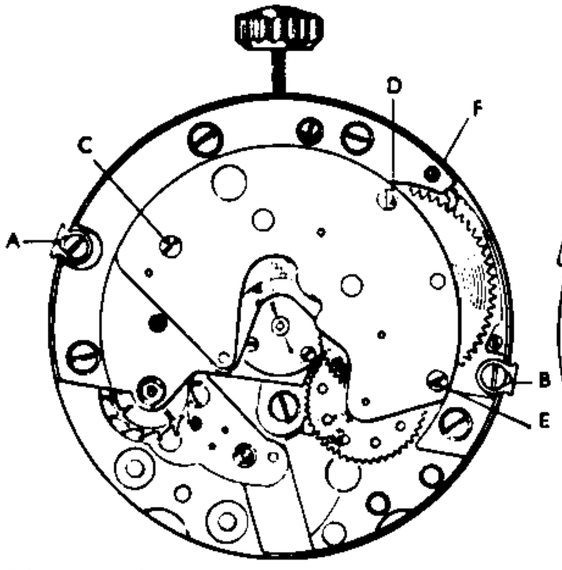


Fig. 10.—*Removing the movement from the case.*

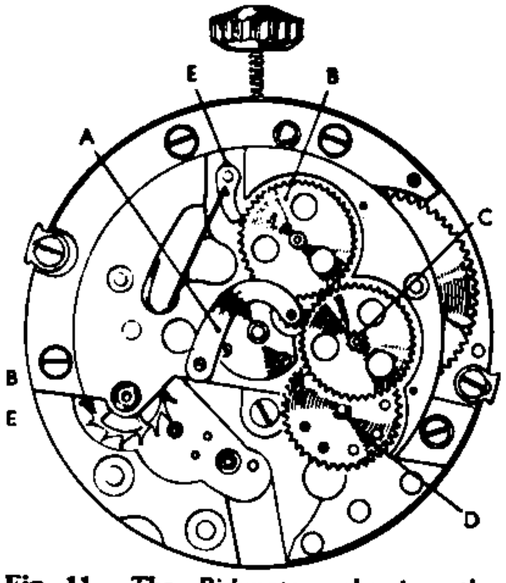


Fig. 11.—*The Bidynator showing the automatic winding mechanism, under the plate.*

To take the automatic mechanism to pieces push down the small bolt piece (Fig. 8) to the left as shown by the arrow engraved on the rotor. Lift the rotor straight up, carefully, and away from the movement. It will be noted that there are two jewel holes in the rotor, one fitting on the lower part of the central post, and the other, a smaller hole, for the pivot at the top of the post. If any undue side

pressure is brought to bear on the central post while removing the rotor there is a risk of breaking one or both jewel holes, so lift the rotor straight up. It is not necessary to remove the rotor fixing bolt during cleaning, but it is advisable to snap it back into its original position to minimise the risk of the spring jumping out.

Replace the winding shaft and let the mainspring down by holding back the click, which has a slot cut in its upper pivot, *F* (Fig. 10). Now remove the three screws, *C*, *D*, and *E* (Fig. 10), and lift off the plate, which is the top plate of the automatic work. This will expose the mechanism as shown in Fig. 11.

The action is as follows : The steel wheel fixed to the rotor gears into the small steel wheel which is riveted to the rocking arm, *A* (Fig. 11), and as the rotor moves, say, to the left, it gears into the steel wheel *B*, and if to the right, into the steel wheel *C*, so that as the rotor rotates either to the left or right the wheel *C* rotates in a clockwise direction. The wheel *C* has riveted to it a pinion which gears into the wheel *D* and this last wheel has a ratchet device fitted to a pinion which gears into the main ratchet wheel of the watch movement. If the watch is wound by the winding button the ratchet attached to the pinion of the wheel *D* rotates backwards so that the train of the automatic mechanism is not reversed.

The click *E* (Fig. 11) holds the mainspring up during even a small movement of the rotor until sufficient movement has been obtained for the click of the main ratchet wheel to take over. Furthermore, the click *E* prevents the train from reversing while the strength of the click spring in the wheel *D* has been overcome during the process of of winding by the button.

Except for the wheel fixed to the rotor, the whole of the automatic work can be taken to pieces for purposes of cleaning. If the rotor needs adjustment because there is too much freedom and a risk of it touching either the inside of the back of the case or the top plate of the movement or there is lack of freedom, thus endangering the winding, it can be corrected by lowering the top jewel hole of the rotor to correct the former fault and by raising it to correct the latter. In either instance it will be necessary to push the hole out and reset it to the required height.

Cut a piece of pegwood so that it fits into the lower hole fairly tightly, then cut the end square so that it will press on the under side of the top jewel hole. Hold the rotor on the pad of the thumb of the left hand and with the pegwood in the right hand slowly and firmly push the top hole out. To reset, use the friction jewel setting tool. (*See* " Practical Watch Repairing," p. 252).

Having cleaned the whole of the movement, reassemble and oil as indicated in the chart (Fig. 12).

Finally apply the tests for freedom of rotor as explained on page 5.