RESTRICTED

OP 1064 A
VOLUME 2

COMPUTER MARK 1 AND MODS.

MAINTENANCE

A BUREAU OF ORDNANCE PUBLICATION

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VOLUME 2

COMPUTER MARK I AND MODS

MAINTENANCE

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NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON 25, D. C.

To all holders of ORDNANCE PAMPHLET 1064A
insert change; write on cover 'Change 1 inserted'
Approved by The Chief of the Bureau of Ordnance

OP 1064A CHANGE 1

5 November 1947

K. H. Noble
Acting Chief of Bureau

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Ordnance Pamphlet 1064A
is changed as follows:

COMPUTER MARK 1 AND MODS - MAINTENANCE

Insert attached pages 578 through 583 in place of corresponding blank pages in OP 1064A.

This is Volume Two with pages from 541 to 697
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Part five

LOCATING CASUALTIES

Introduction

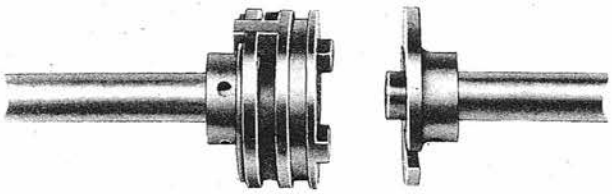
This section deals with various typical casualties, either mechanical or electrical, which may be encountered when the cause of test errors or faulty operation is being traced. The information given here is not intended to be a complete guide for locating all possible sources of trouble, but rather serves as a reference listing of the more common types of trouble. Other information pertaining to trouble analysis is given for various units which are used only in (or with) the Computer Mk 1 and which are not covered elsewhere. This includes a discussion of the special-type follow-ups, disassembly procedure for the range receiver, and the readjustment procedure for the selector drive mechanism.

In order to use this section effectively for locating the source of trouble, it is essential that the maintenance man be thoroughly familiar with the function, construction, and maintenance of all the basic units in OP 1140 and OP 1140A. He will then be able to recognize the units, and typical troubles in the units, as they appear in the computer. Also, after the source of the trouble is located he will be able to decide how to accomplish the actual repair of a casualty.

In general, the method given for locating the source of each type of trouble consists of performing mechanical or electrical checks upon a unit while it is in the instrument until the exact cause of the trouble has been isolated. The nature of the trouble will then determine whether the unit must be removed for repair on the bench.

OLDHAM COUPLINGS

The following list of Oldham couplings, with their values per revolution and their connection in the gear train, may be used in the analysis of test errors. Extreme shock sometimes causes temporary disengagement of Oldham couplings, permitting a line to become out of adjustment any number of *half*-revolutions of the shaft. When a unit or line is found to be improperly positioned in relation to another unit or line, check the Oldham coupling list. If the difference in position is equal to some number of half-revolutions of the coupling in that line, the readjustment may be effected by breaking the coupling and turning the shaft the proper amount, then remaking the coupling.



Although an attempt has been made to list the adjustments which will be affected in the event an Oldham coupling has become temporarily disengaged and repositioned, the gearing diagram should always be consulted to establish the exact location of the coupling and the units affected by it. Never try to analyze a gearing or Oldham coupling casualty by use of the schematic. Only the gearing diagram shows the exact relationship between the various shaft lines and units. Where no adjustment number is listed, no readjustment of that shaft line is necessary.

Oldham Couplings

CONNECTS	TO	VALUE/REV.	ADJ. NO.	SHAFT NO.
Target Angle Dial	Target Component Solver	10°	532 136	43-S108 43-S42
Br	*Br* Dials	1.25°	199	43-S198
Br	*Br* Dials	1.25°	199	43-S226 43-S123
cBr	Local Control Follow-up	1.25°	70	3-S34 43-S220
cBr	Local Control Follow-up	1.25°	70	3-S29 3-S5
cB′r	Local Control Follow-up	2.5°	70	40-B79 12-E6
△*cBr*	Rate Control Section	1°		44-S60
B′r	Deck Tilt Computer and A-199	1.5°	99	14-A21 40-B38
jB′r	D-79 (△*cBr* − *jB′r* = △*cB′r*)	0.5°		3-S28 3-S4
B′ġr or *B′r*	Parallax Computer	2.5°	243	14-A18 3-S14
B′ġr or *B′r*	Parallax Computer	15°	243	3-S16 47-S7
B′ġr	Star Shell Computer	2°	S. S. 17	14-A24
B′ġr	Star Shell Computer	2°	S. S. 17	41-S69 41-S76
B′ġr	Star Shell Computer	2.5°	S. S. 17	14-C7
Bws Dial	Horizontal Wind Component Solver	2.5°	105	49-S2
Co Receiver	*Co* Dials	1.5°	179	44-S61
Dd	D-15 (*B′r* + *Dd* = *B′ġr*)	0.72°	99, 98, 602	40-B50 14-A9
Dip Dial	Sync *E*	1.25°	91	40-E8 41-S54
Dj Dial	L-30	1.5 mils	500, 86	14-A1
Dj Dial	L-30	3 mils	500, 86	14-A3 40-B52
Dj Dial	L-30	6 mils	500, 86	43-S187
Ds Ind. Counter	*Ds* Master Counter	20 mils	89	41-S34 40-A26
Ds Counter	L-28	20 mils	198	43-S200
Ds Counter	L-28	20 mils	198	49-S25

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Oldham Couplings

CONNECTS	TO	VALUE/REV.	ADJ. NO.	SHAFT NO.
E	*dH* Component Solver	22.5°	123	43-S93 43-S102
E Dials	L-12	1.25°	116	3-S30 3-S25
E	D-73 ($E + V = E2$)	1.25°	180	49-S29
E	Sec *E* Cam and A-180	1.25°	260	44-S64
Sync *E* CENTER Position Gear	*E*	1.25°		40-E6 41-S44
Sync *E* Dials	D-12	1.25°	90	41-S47 40-E4
E2 Intermittent Drive	Ballistic Computers	1.5°	71, 72, 73, 84, 85	48-S27 7-D2
E2 Matching Counter	*E2* Master Counter	1.5°	183	49-S30
$E2 + L$	Parallax Computer	5°	3, 227	40-D11 47-S8
$\triangle cE$	Rate Control	20 min.		44-S58
Eb	L-11	2°	50, 51	40-D31 14-B8
$Eb + Vs$	Trunnion Tilt Computer	2°	61 32	40-D37 40-E18
$E'\dot{g}$	Star Shell Computer	150 min.	231	14-B25
$E'\dot{g}$	Star Shell Computer	150 min.	231	14-C6
F Ind. Counter	*F* Master Counter	1 sec.	77	3-S27
F Ind. Counter	*F* Master Counter	1 sec.	77	40-B56 41-S30
$F - Tf$ (Ser. Nos. 781 and higher)	D-89 ($T\dot{g} + F - Tf$)	2 sec.	262	45-B21 45-D16
$L + \frac{Zd}{30}$	$L + \frac{Zd}{30}$	3°		44-S65
cR	Height Computer	388.9 yds.	138	43-S96 43-S97
cR	L-10	200 yds.	196	49-S12
cR	*cR* Intermittent Drive	200 yds.	233	44-S63
$1/cR$	$1/cR$ Integrator		149	44-S44 44-S45
dR Follow-up	Range Integrator and *dR* Dial	5.5π kn.	163, 171 132, 181	43-S143 43-S142

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Oldham Couplings

CONNECTS	TO	VALUE/REV.	ADJ. NO.	SHAFT NO.
dR	*dRs*	20π kn.	181, 132	49-S17
dR (Ser. Nos. 780 and lower)	Dead Time Prediction Multiplier	20π kn.	132	7-D23 45-A27
dRs	Range Prediction Multiplier (all) Dead Time Prediction Multiplier (Ser. Nos. 781 and higher)	19π kn.	135 132	45-A28 46-A36
R2	Ballistic Computers except Fuze	600 yds.	74, 75 76	46-B22 48-S26
R2	*R2* in Rear Units	600 yds.	156	3-S33
R2	*R2* Ind. Counter *R2* to Star Shell	600 yds.	92 S. S. 18	3-S12 14-A8
R2	*R2* Ind. Counter *R2* to Star Shell	800 yds.	92 S. S. 18	14-A4
R2	Star Shell	800 yds.	S. S. 18	41-S63
R2	Star Shell	400 yds.	S. S. 18	14-G4
R2	Parallax	550 yds.	156, 92, S. S. 18	47-S5 3-S13
Rj	L-29	33⅓ yds.	234, 235, 88	41-S23 40-B53
Rj	L-29	33⅓ yds.	234, 235, 88	43-S189
Rj	L-29	60 yds.	234, 235, 88	49-S16
RdBs	Range Rate Corrector	20π kn.	109	49-S19
RdBs	Bearing Integrator	20π kn.	139	49-S28
RdE	Range Rate Corrector	20π kn.	108	49-S18
RdE	Elevation Integrator	20π kn.	154	44-S59
So Receiver	*So* Dial	2 kn.	212	41-S60 40-E22
So Receiver	*So* Dial	2.25 kn.	212	43-S238
Sw Dial	Horizontal Wind Component Solver	3 kn.	157	49-S4
Sec *E*	Sec *E* Integrator		147	44-S42 44-S43
Tf (Ser. Nos.781 and higher)	D-90 ($F - Tf$)	1.25 sec.	262	45-B20 48-S32
$Tg + F - Tf$	Dead Time Prediction Multiplier	5 sec.	188	49-S27 45-D15

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Oldham Couplings

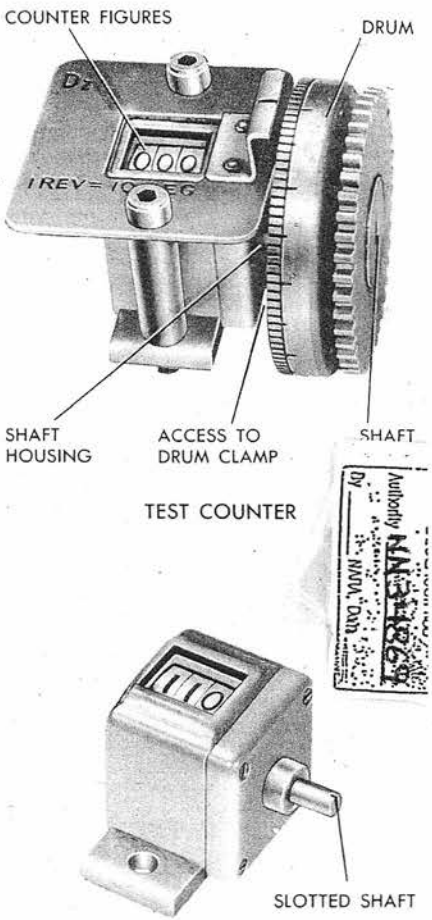
CONNECTS	TO	VALUE/REV.	ADJ. NO.	SHAFT NO.
Time	Time	1216.67 rpm		44-S62
Vj	L-31	1.5 mils	501 87	41-S14 40-B61
Vj Dials	L-31	6 mils	501, 87	49-S9
Vj Dials	L-31	6 mils	501, 87	43-S196
Vs Counter	L-37	30 min.	184	49-S31
Vs Counter	L-37	30 min.	184	44-S47 44-S48
Vs Counter	L-37	30 min.	184	44-S46 40-D58
Vs Ind. Counter	*Vs* Master Counter	30 min.	55	40-E10 41-S43
Vs Ind. Counter	*Vs* Master Counter	30 min.	184, 55, 51	40-D35 14-B4
Vz Dials	L-34	25/8°	29 51	L-34 40-B77
Vz Dials	L-34	25/8°	29 51	40-B78 40-D62
Vz Dials	*E'g* Dials	2°	51	40-D61 14-B6
S. S. Defl. Counter	S. S. Defl. Follow-up	20π kn.	230	45-A32 49-S34
S. S. Defl. Follow-up	Star Shell Computer	5π kn.	230	3-S42
S. S. Defl. Follow-up	Star Shell Computer	5π kn.	230	40-B82 41-S71
S. S. Defl. Follow-up	Star Shell Computer	5π kn.	230	14-C5
Xo	D-53 ($Xo + Xwg = WrD$)	8π kn.	131	49-S22
Yo	D-54 ($Yo + Ywg = Ywgr$)	4π kn.	101	49-S21
Ywgr	Elevation Wind Component Solver	1.25 kn.	100	49-S3
Zd Dials	Trunnion Tilt Computer	3°	112	40-B22 40-C18
Zd Dials	Deck Tilt Computer	1.5°	111	40-C8 40-D19
Zd^2	*jDd* Computer	8.75°	34	40-C5 40-B4

COUNTERS

The small test counters used in the instrument may freeze. Usually, they will bind first and thus cause sluggishness in the associated line. If the binding is allowed to continue so that the counter shaft freezes in its housing, the counter drum clamp will slip, the shaft will break, or the line will stall. In any case the counter will remain at a fixed value.

A binding counter may be detected by feeling the counter drum shaft for end play. If the end play is not perfectly free, or if none can be felt, the counter shaft is probably binding.

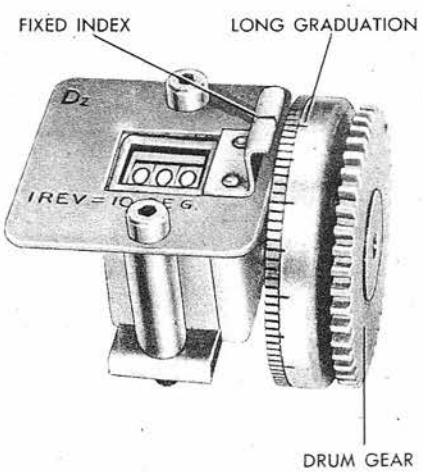
When a faulty counter is replaced, it is usually necessary only to readjust the new counter to the line, using the adjustment clamp adjacent to the counter. In some cases, however, no adjustment clamp is available, so the counter gear mesh must be used for adjustment.



TEST COUNTER

Before installing a new counter, the counter drum should first be set on the shaft of the new counter so that one of the longest graduations matches the fixed index when the counter figures are centered. While the drum is held the figures may be centered by turning the slotted shaft of the counter with a small screw driver. Then the clamp on the drum hub should be tightened. The drum must clear the fixed index plate.

When the gear mesh must be used for readjustment, special precautions will save trouble. First, set the line on a whole number value so that a long drum graduation matches the fixed index of the counter. Mark this graduation, and mark the drum gear mesh. Remove the counter. Install the drum on the new counter. Using the marked drum graduation, set the new counter at the established value of the line. Replace the counter so that the marked gear teeth are matched.

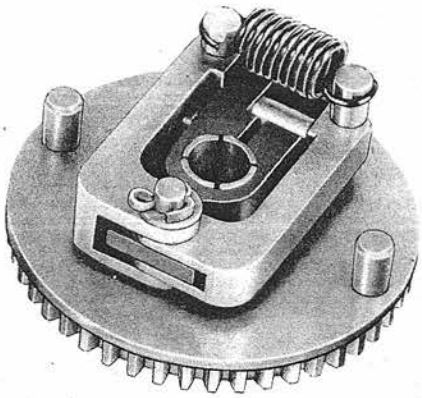


Whenever a counter is re-installed in the computer, make sure that its gear mesh has sufficient play. The small counter shaft cannot withstand side-loading due to a tight gear mesh.

The binding or freezing of a counter may have caused a clamp in the line to slip, thereby upsetting the adjustment of other units. This possibility should always be considered, and reference made to the schematic diagram to analyze the effects.

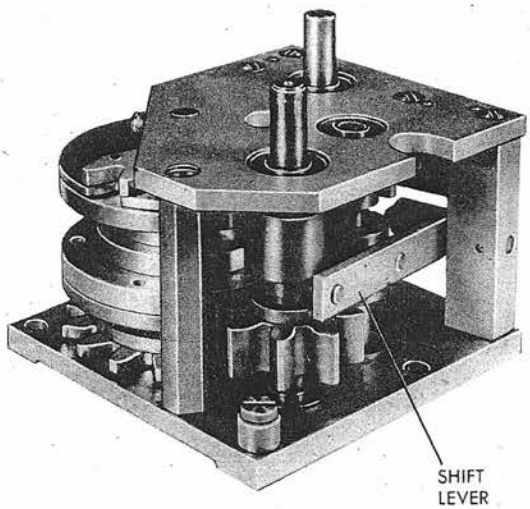
INTERMITTENT DRIVES

Intermittent drives occasionally cause trouble in the computer. Possible casualties are binding of the shock-absorber assembly and jamming at the cut-out point.



SHOCK-ABSORBER ASSEMBLY

If the output of an intermittent drive does not agree with the input value when the drive is cut in, check the shock-absorber assembly. Try turning the output line in the direction toward agreement with the input value. If the line "gives" and falls into agreement, the indication is that the shock-absorber assembly had stuck open. Hold the input and turn the output to open the shock-absorber assembly in either direction. Releasing the output line should permit the shock absorber to close. If it fails to close, the binding may be in either the shock-absorber assembly itself or in the output line. Open the clamps in the output line to isolate the binding. If opening a clamp frees the shock absorber, the trouble is beyond the point opened. If the binding persists, it is in the shock-absorber assembly.



If a line jams, and the line has an intermittent drive, the cause may be that the drive has jammed at a cut-out point. Check whether the line is at a cut-out value. If it is, the intermittent drive is probably causing the trouble. Check whether pushing on the shift lever releases the jamming. If it does, the shift mechanism is out of adjustment.

If the shock absorber binds or if the drive jams at the cut-out point, remove the faulty unit; see the chapters on *Removal of Mechanisms* in this OP. See OP 1140A for repair of the unit.

SOLENOID LOCKS AND CLUTCHES

Solenoid locks and clutches are used in the rate control section of the computer. The locks hold lines which are not used during SEMI-AUTO and LOCAL control. If a lock fails to hold, part of the generated quantity may back out through that line. The clutches connect the AUTO rate control lines to the rate control computing mechanism. If a clutch fails, the AUTO rate correction is not fed into the rate control mechanism.

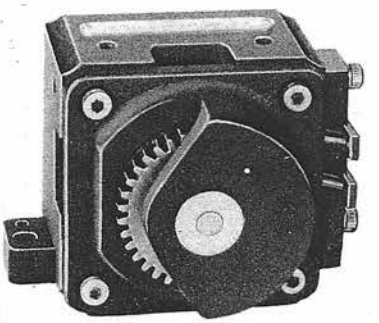
Although a noisy lock or clutch is not desirable, it is not strictly a casualty unless the chatter is sufficient to cause the connecting teeth to disengage partially.

A lock may fail to close or the holding pin in the lock may shear off. If a lock is not holding, the solution indicator will turn during B tests. If the lock fails to close, the solution indicator will turn freely. If the pin has sheared, the solution indicator may turn only occasionally during a high rate B test problem. See *Removal of Mechanisms*, pages 613 and 616, for instructions on removing the unit and see OP 1140A for its repair.

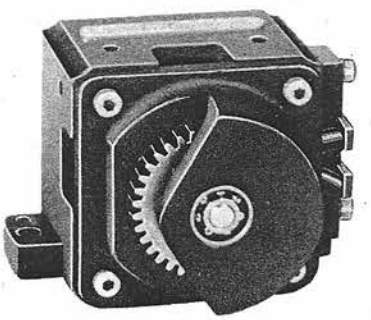
A lock which fails to hold has no effect on satisfactory operation of the computer in AUTO control.

If a lock should fail to open, that is, stick closed after being de-energized, AUTO rate control would not function. However, the torque on the line usually will cause the lock to disengage so that normal operation is not hindered. If a lock is suspected of sticking, shift the control switch between AUTO and SEMI-AUTO several times. The lock should be heard to engage every time the switch is turned to SEMI-AUTO. This check should be repeated with cover 1 removed to make sure that the lock is faulty before removing the unit.

SOLENOID LOCK



SOLENOID CLUTCH



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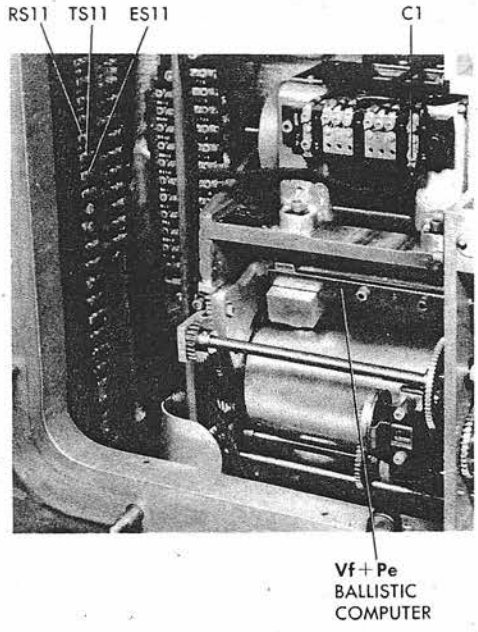
The clutches are energized by signal keys in the director when the control switch is at AUTO. Remember that range has a separate control switch. When the switch is at AUTO, the range clutch is energized by the range signal from the director; when the switch is at MANUAL, the clutch is energized by the RANGE RATE CONTROL MANUAL push-button. The closing of a clutch may be heard as its signal key is closed. Placing the ear against the computer case near a clutch will make its closing more easily heard. The signal key circuit may be by-passed by using a jumper as follows:



1. Remove cover 4.
2. Secure one end of a two-foot jumper to terminal C1 of the *Vf* + *Pe* ballistic computer. NOTE: Care should be exercised in handling the other, exposed, end of the jumper.
3. Touch the other end of the jumper to the terminal of the circuit in question—
   RS11 for the range signal
   TS11 for the train signal
   ES11 for the elevation signal
4. The corresponding clutch should be heard to close each time the jumper is touched to the terminal.
5. Remove the jumper when the check is completed.

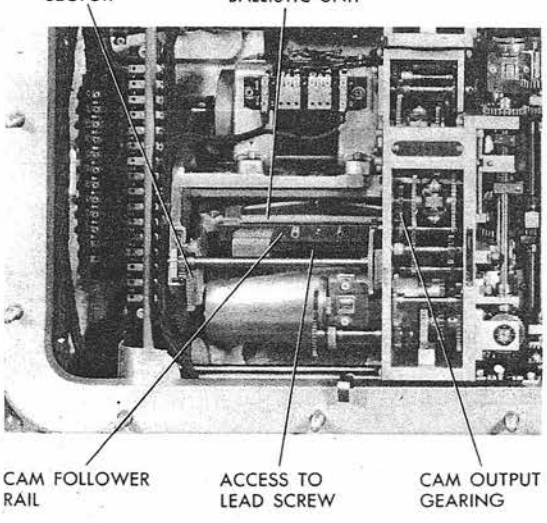
If a clutch is not heard to close when the circuit is completed, remove cover 1 and repeat the check to make sure that the clutch is inoperative before removing it.

While testing a clutch, it may stay closed after the circuit is broken. Usually, a slight pressure on the line, as in normal operation, will release the clutch. If the clutch sticks, however, it should be removed and repaired. See OP 1140A and *Removal of Mechanisms* in this OP.

BALLISTIC COMPUTERS

The four ballistic computer units are similar in construction and operation, and are subject, therefore, to similar types of casualties.

Since each unit contains three test counters which may operate at relatively high speed, the chance of a counter casualty occurring in these units is increased. The *E2* counters in particular, since they rotate rapidly every time the *E* line is slewed by the director, may become casualties due to binding or freezing. This will result in sluggish operation of the *E2* line, and in some cases the *Eb* receiver motors will be stalled. Therefore, if any of the lines in the ballistic computers are sluggish or excessively heavy, the counters should be checked for casualties. Refer to page 551.



Since *E2* also drives the lead screw of each ballistic computer, any binding of the lead screw will also overload the *E2* and *Eb* lines. Binding may be detected by opening the clamp which connects the main *E2* line with a particular ballistic unit, and then turning the lead-screw input gear through its full travel. Binding may be caused by a combination of dirt and lack of lubrication on the lead screw. In such a case, the screw may be cleaned with approved solvent and re-lubricated without removing the unit. If the binding still exists, or if the lead-screw threads are damaged, the unit should be removed and repaired. Refer to *Removal of Mechanisms* in this OP and to OP 1140A.

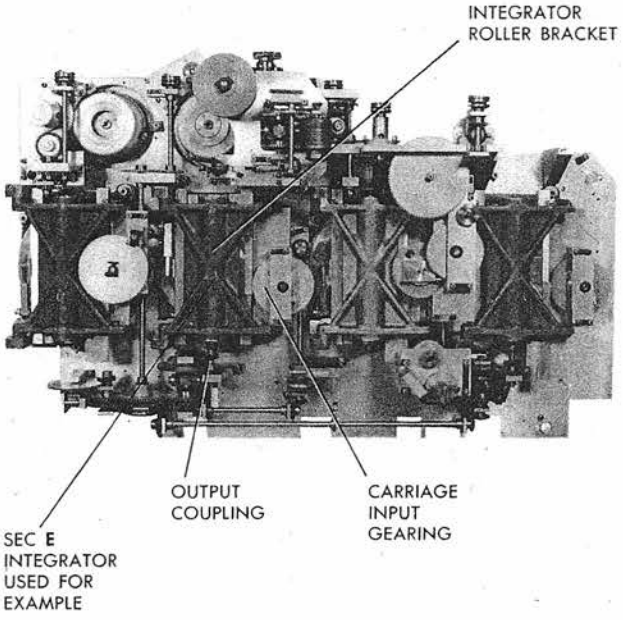
Each ballistic cam output is mechanically amplified by gearing before it reaches its follow-up control. This means that the cam follower works at a mechanical disadvantage with respect to the follow-up control gearing. Therefore, the entire gear train between cam follower and follow-up must be kept perfectly free. Otherwise, the cam follower will be greatly overloaded by a slight stick in the gearing. As a consequence, the *E2* line would be overloaded in trying to move the cam follower. This condition would show up as a sluggish *E2* line; or, in the course of running tests, the cam follower might "hang up" to such an extent that the cam-follower springs could no longer hold the follower rail against the follower ball, resulting in large test errors. This load condition is particularly likely in the $Vf + Pe$ ballistic computer, which has a very large gear ratio between the cam follower and follow-up. It should be noted that the lever-arm spring in the $Vf + Pe$ follow-up is made very light in order to reduce the load on the cam follower.

To check the cam output gearing for excessive load or sticks, move the follower sector gear so as to lift the follower rail from the ball, with the ballistic computer follow-up energized. The line should feel perfectly free and should drive the follow-up smoothly. Gently lower the follower rail until it touches the ball. It should return to position easily and positively. If any excessive load, roughness, or sticking exists, the trouble may be in the cam output gearing or shaft lines, or in the follow-up control. For repair of these parts, refer to *The Ballistic Computer* and *The Follow-up* in OP 1140A.

INTEGRATORS

The existence of integrator trouble is usually indicated by an analysis of test errors or by unit check tests performed on the generating mechanism. If an integrator is suspected of giving an erratic, rough, or inconsistent output, certain checks may be made with the unit in place.

INTEGRATOR UNIT
REMOVED FROM COMPUTER



The integrator being checked should first be isolated from the load of its output line by disconnecting its output gear or coupling. Then, position the carriage input so that the integrator output is zero. Observe the output while the plate is rotated. If the zero point is not maintained, the eccentric stud which supports the integrator plate may be loose. This casualty may be repaired only after the entire integrator has been removed.

Check the freeness of the carriage travel by lifting the carriage manually as far as the lost motion of the line will permit. When the carriage is released, it should return to the exact position it had previously. The zero point may be used initially for this check. The check should then be repeated at several other positions of the carriage on both sides of the zero point. To check the exact repositioning of the carriage at points other than zero, connect the integrator output temporarily and run either a B test or an integrator timing test several times at the selected position. Consistent results in a test will indicate that the carriage is returning to the same position each time it is raised and released.

If the carriage does not return properly, there may be sticking or binding in the carriage itself, or in its input line. The carriage may be isolated from the line by removing the carriage input gearing. The carriage should then be checked for sticking or binding throughout its entire travel.

Check the freeness of the output roller by turning it manually with the integrator roller bracket slightly raised against the spring tension. If any sticks are felt, the roller supporting bearings are probably dirty.

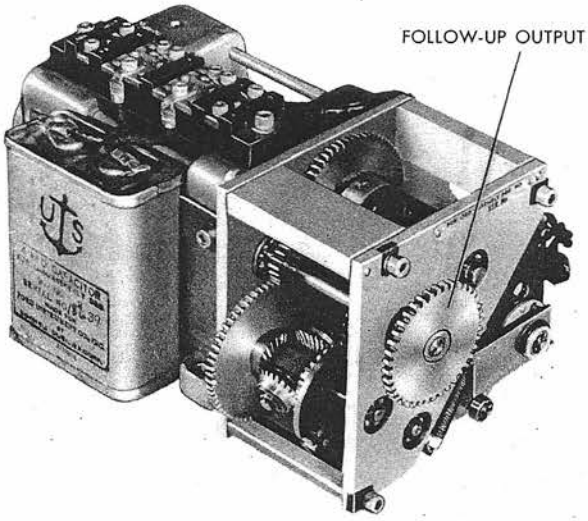
Check the surface of the plate, balls, and output roller for dirt, nicks, or rust. Any of these may cause rough or erratic output.

If dirt or chips are found in the unit, the parts should be cleaned with an approved solvent, and re-lubricated. If this does not eliminate the sticking or binding, the integrator should be removed and overhauled. Refer to *Removal of Mechanisms* in this OP and to OP 1140A.

FOLLOW-UPS

Whenever a line is in error the follow-up involved should be checked. The follow-up output should be observed as it drives to synchronization from either direction, and the point of synchronization should be noted each time. If the line has a handcrank, the follow-up may be driven off synchronization by turning the handcrank in the IN position. Other follow-ups may be driven off manually with computer power OFF.

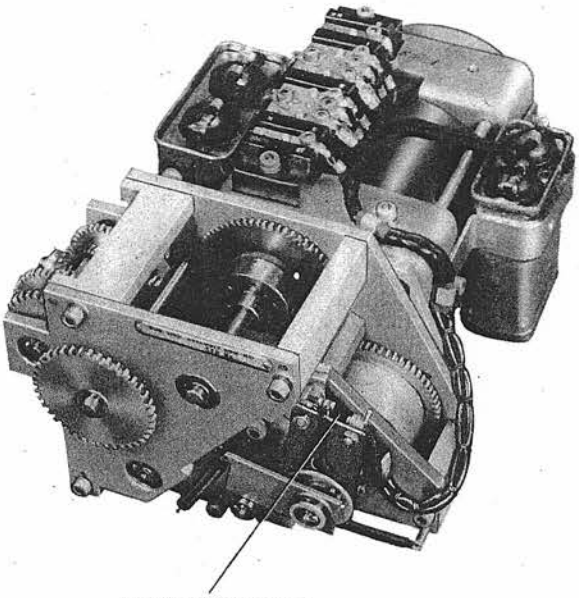
TYPICAL FOLLOW-UP

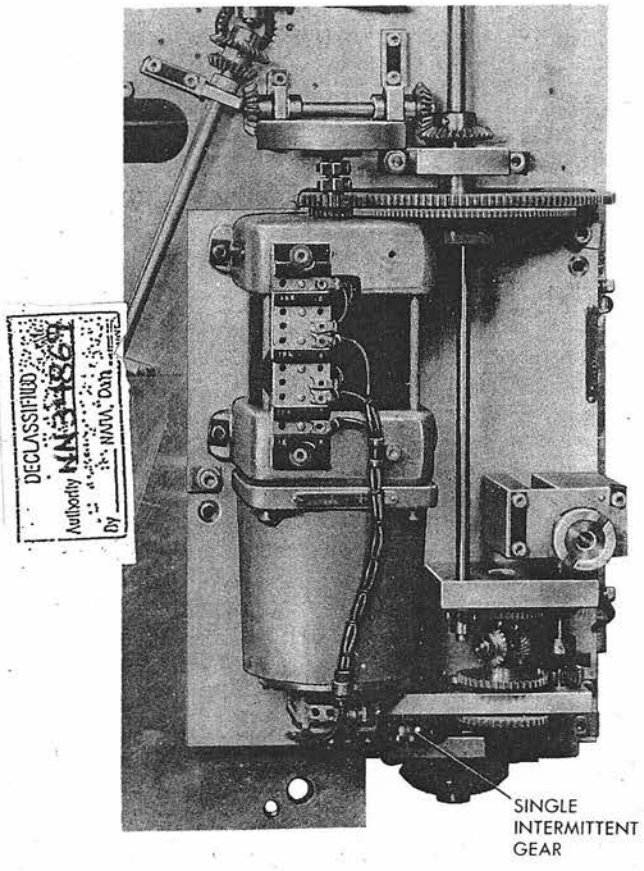


The synchronization point is usually read on a dial or counter. The follow-ups which do not drive a dial or counter may be checked by placing matching pencil marks on an output gear and an adjacent plate. If the follow-up is operating satisfactorily, it should return to the same synchronization point, with the same action, from either direction of offset. If the synchronization point is broad, or the action is sluggish in either direction, the follow-up should be carefully checked to locate the source of trouble.

The various troubles and casualties pertaining to follow-ups are discussed in OP 1140A.

COARSE FOLLOW-UP





cB′r FOLLOW-UP

The input lines to follow-ups usually contain lost motion. Where the lost motion is considerable, take-up springs are used. Any restriction in the input line will cause this lost motion to "hang up," causing an output error. The freeness of the line may be checked by manually offsetting the follow-up input gear in either direction. The follow-up should resynchronize to the original output reading when the line is released. A common source of trouble is a tight mesh between the follow-up input gear and the mating gear on the input line. Most follow-ups are mounted by screws in the motor feet. If these screws are not sufficiently tight, severe shock may move the unit and cause it to be incorrectly aligned for a proper gear mesh. During normal operation, the follow-up affected would produce a rough output; during static tests it would show an error in the output due to "hanging-up" of the input line.

Follow-ups used in the Computer Mk 1 which differ from the standard type discussed in OP1140A are:

The *jE* and *jBr* (coarse) follow-ups

The *cB′r* (local control) follow-up

The *Sh* and *Ct* (limited) follow-ups

The *jE* and the *jBr* follow-ups are of a special type and are energized only during automatic rate control. They differ in two respects from a standard follow-up. The contacts are widely spaced, and the intermittent gearing has only one locking disk. The wide contact gap causes about 15 min. total dead space in the *jBr* follow-up output and about 8 min. in *jE*.

The *cB′r* follow-up differs from the standard compensated type in its intermittent gearing. It has only one intermittent gear instead of the usual two.

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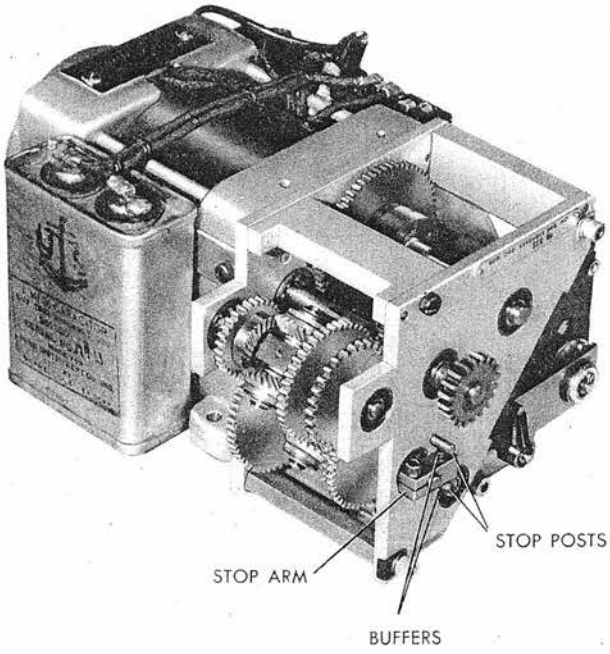
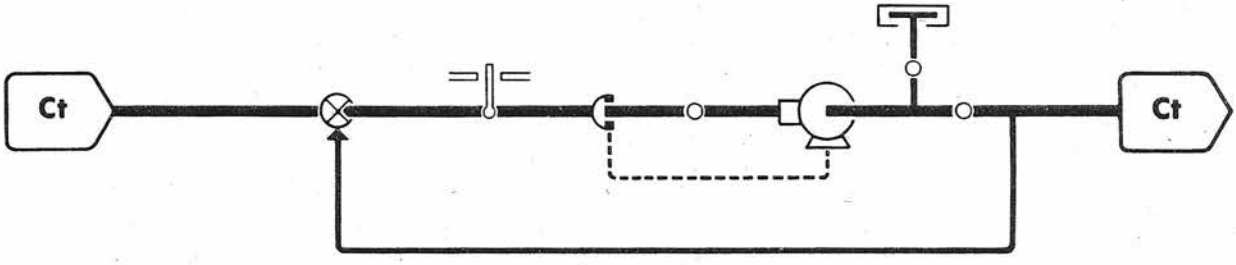
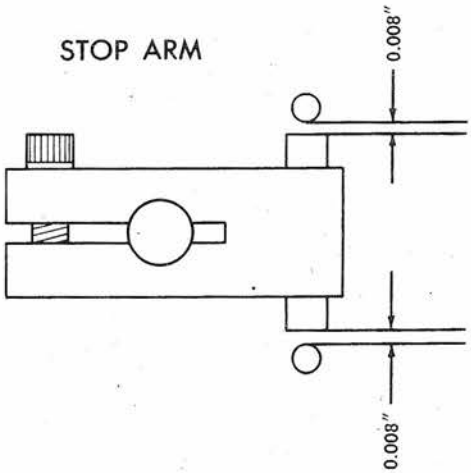
LIMITED FOLLOW-UP



The *Sh* and *Ct* follow-ups are the limited type. They differ from the standard velocity-lag follow-up in that they have no intermittent gearing in which to store up a large error or difference between input and output. Also, the contact movement is limited to small amounts by a stop arm and post assembly. A neoprene buffer on either side of the arm bears against a stop post when either limit is reached.



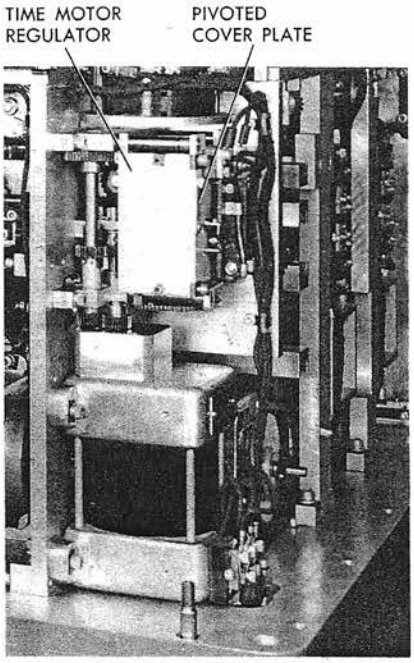
The space between each buffer and its stop post should be about 0.008 inch when the follow-up is synchronized. If the space is too small, the follow-up will drive too slowly. If the total space between the buffers and the stop posts is 0.016 inch, but the space is not centered when the follow-up is synchronized, the indication is that the center contact arm is bent. If the buffer spacing and centering is correct, but the follow-up contact gap is too large, the effect will again be to reduce the maximum motor speed. The total contact gap should be 0.008 inch to 0.010 inch.



THE TIME MOTOR REGULATOR

The functional description and operation of the time motor regulator are covered in OP 1140.

If the results of the time motor regulator test indicate excessive errors, an attempt should be made to adjust the regulator in place. Remove cover 1, or on later instruments remove the plate at the right front of cover 1, to gain access to the regulator. Near the contact arms is a small pivoted cover plate. Loosen the screw at the top, and swing the plate toward the front. Access may then be had to the regulator lever. Move the lever slightly toward F if the time line was running too slowly, or toward S if the time line was running too fast.

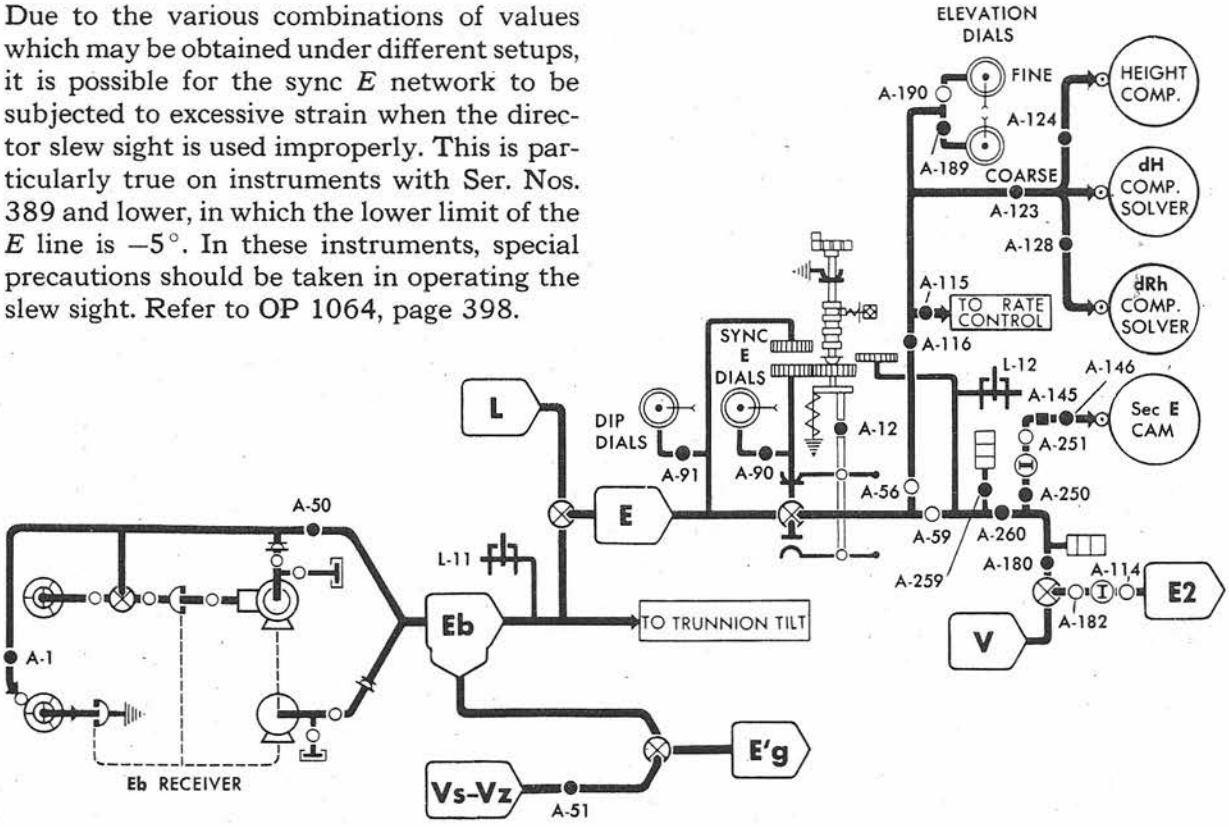


Run the test again. If the error is still excessive repeat the adjustment as necessary.

If moving the lever to the limit of its travel in either direction does not produce the desired results, and the voltage and frequency have been maintained within specified limits, then the trouble may be in some part of the regulator, in the time motor, or in the time shaft lines. If the time line is running excessively fast, the trouble is usually in the regulator. Try adjusting the main spring. See OP 1140, page 216. If this is not successful, remove the regulator from the instrument. See page 603 in this OP. Replace the escapement mechanism. See OP 1140A. If no replacement is available, it may be possible for an experienced man to adjust the hairspring tension in order to make the regulator lever operative. See OP 1140, page 217. If the time line is running excessively slow, the trouble may be due to sticking or binding in the time motor reduction gear or the time shaft lines. Refer to pages 92 and 432 in OP 1140A for the procedure used in checking and repairing these parts.

SYNCHRONIZE ELEVATION NETWORK

Due to the various combinations of values which may be obtained under different setups, it is possible for the sync *E* network to be subjected to excessive strain when the director slew sight is used improperly. This is particularly true on instruments with Ser. Nos. 389 and lower, in which the lower limit of the *E* line is −5°. In these instruments, special precautions should be taken in operating the slew sight. Refer to OP 1064, page 398.



The usual cause of excessive strain is slewing the *E* line into either limit of L-12. Since there are several units on the *E* line which have considerable inertia, the sudden stop may cause slippage at adjustment or assembly clamps, or it may cause a casualty in the gear train.

If the sync *E* network has been subjected to extreme shock, the entire network should always be given a systematic check as follows:

Put the sync *E* handcrank IN and match the sync *E* dials at the fixed index.

Set *L* and *Vs* at 2000′, and *Vz* at 0′. Transmit a value of *Eb* from the director.

The readings of the *E* dials and the *E′g* dials should agree with the value being transmitted. To convert degrees of *Eb* to minutes of *E′g*, multiply by 60 and add 2000.

If both dial readings are in error by an equal amount, either A-50 has slipped, or there is a casualty in that part of the gear train.

If only the *E* dials are in error, either A-116 or A-56 has slipped, or there is a casualty in the *E* line to the control unit. On instruments with Ser. Nos. 291 and higher, A-56 and A-59 are of a type which will not slip when properly assembled.

If the *E* dials read correctly, put the sync *E* handcrank at CENTER and check the values of L-12. If they are incorrect, either A-59 or a gear in the line has slipped.

If the values of L-12 are correct, check the vector gear positions of the *dH* and *dRh* component solvers, and the height computer. Refer to *Unit Check Tests,* pages 192 and 197. If all three vector gears are in error by the same amount, either A-123 or a gear in the line has slipped.

The lines which have intermittent drives rarely cause trouble by slippage. If they do, the intermittent-drive shock absorber is probably faulty. On instruments with Ser. Nos. 389 and lower, there is no intermittent drive on the *E* line to the sec *E* cam. This line, therefore, is susceptible to shock. A-210 may slip and upset the sec *E* cam. Refer to the check of A-210. See *Readjustment Procedure,* page 443.

If any part of the sync *E* network is found in error after sudden shock, no readjustment should be made until the line involved is carefully checked to make sure it is free from casualties. Possible casualties are a sheared taper pin in a gear or coupling hub, slippage of a gear on its inserted hub, or a damaged limit stop. If no casualties are found, check each adjustment on the line in accordance with *Readjustment Procedure.*

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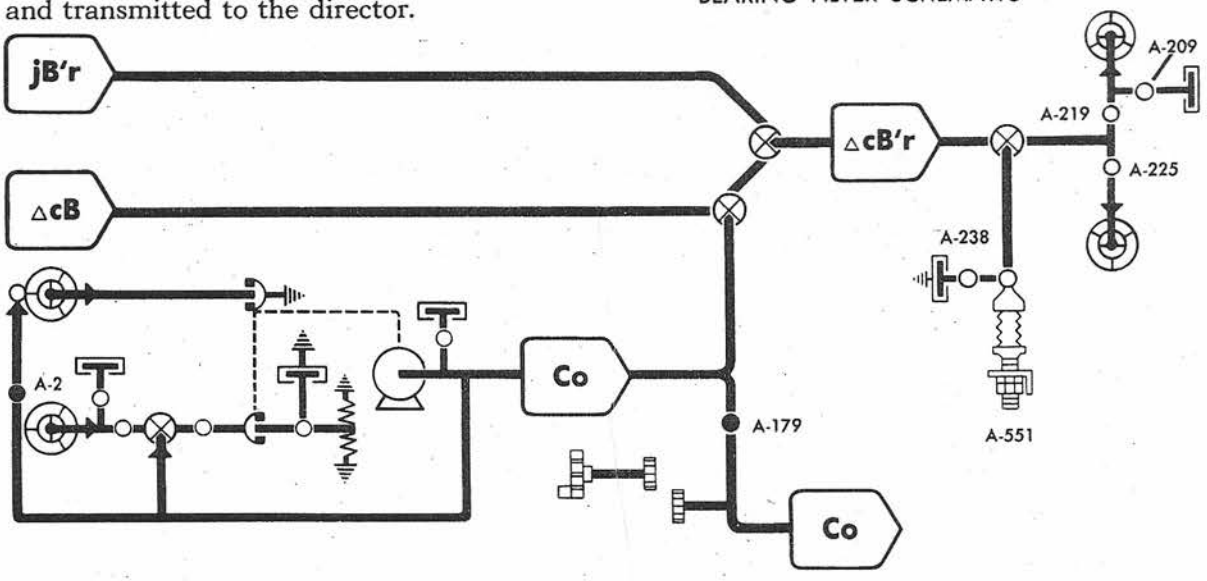
BEARING FILTER

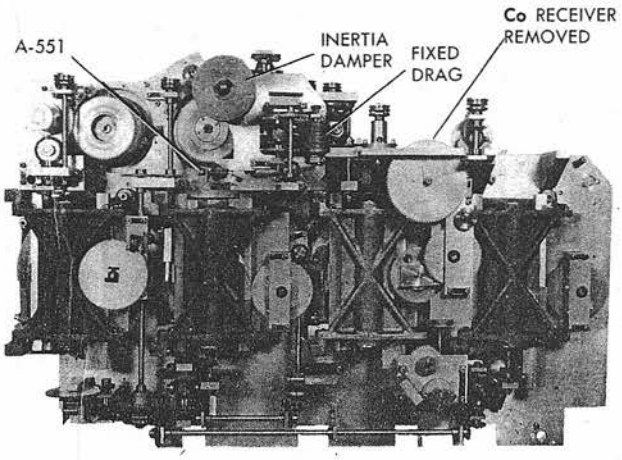
The purpose of the bearing filter in Computer Mk 1 is to prevent roughness or oscillations in the *Co* input signal from being amplified and transmitted to the director.

BEARING FILTER SCHEMATIC



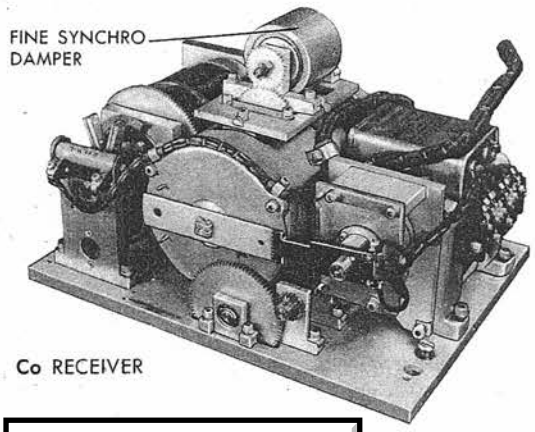
Co RECEIVER

If the △*cB'r* output from the computer seems excessively rough, or contains excessive oscillation, the trouble may be in the bearing filter. The generated bearing line, however, should be checked first. Put the *Co* handcrank IN. Set up the computer to generate a slow bearing rate, and observe the generated bearing output. If it is rough, the trouble may be due to tightness, dirt, or sticking in the integrators or shaft lines associated with generated bearing. Refer to OP 1140A for instructions on checking these parts.



INTEGRATOR UNIT (REMOVED FROM COMPUTER)

If the trouble still exists, the bearing filter system may be at fault. Check the spring tension adjustment, A-551. Check the fixed magnetic drag, the large inertia damper, and the fine synchro damper on top of the *Co* receiver to see that these units have not been demagnetized and that they are free from internal sticks. Check the *Co* receiver itself. Refer to *Magnetic Dampers,* and *Synchro Receivers,* OP 1140A. Check the △*cB'r* and *Co* lines, to make sure that they are free from tight gear meshes, binding shafts, or sticky bearings.



Co RECEIVER

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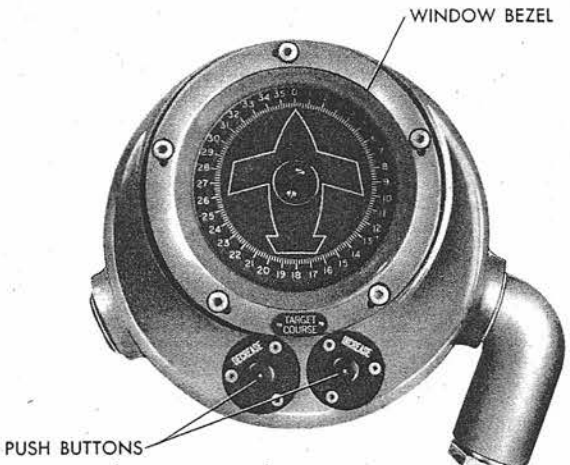
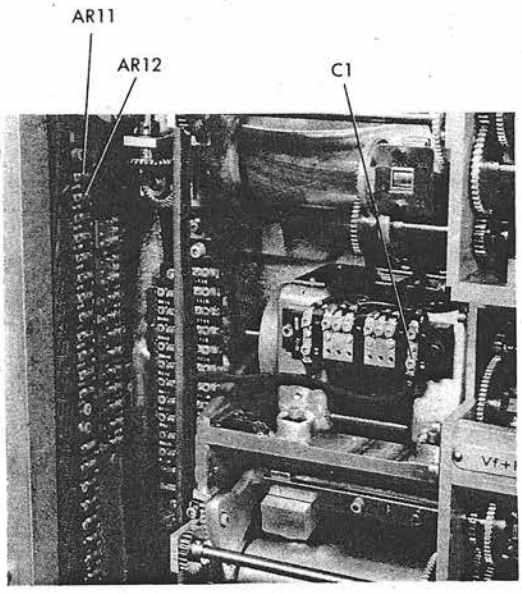
TARGET COURSE CONTROL



Ct INDICATOR

The *Ct* transmitter under cover 1 and the *Ct* indicator on the end of the star shell computer are energized whenever the computer power switch is ON. If the *Ct* indicator does not follow when the target angle handcrank is turned, refer to *Transmission Test Analysis,* page 180.

If the *Ct* indicator dial moves in jumps as the target angle handcrank is turned smoothly, the dial may be rubbing on the dial mask. Remove the window on the indicator and check the dial clearance.

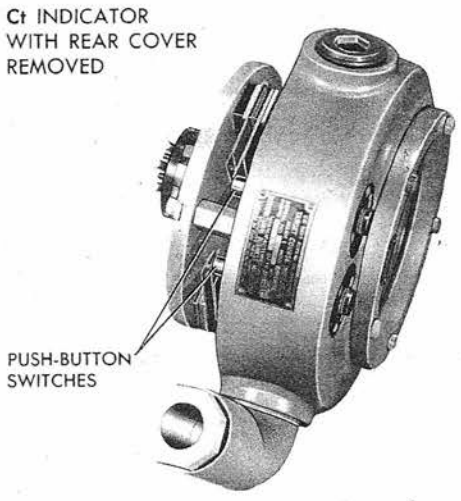


Vf+Pe BALLISTIC COMPUTER

When the *Sh* and *A* handcranks are at AUTO, the *Ct* motor may be controlled by the indicator push-buttons. If *Ct* does not drive when either push-button is depressed, remove cover 5 and check the operation of the relays.

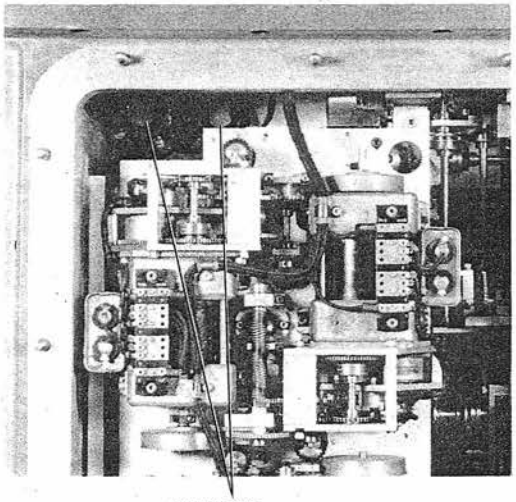
If a relay does not operate when its controlling push-button is depressed, the trouble may be in either the relay itself, or the push-button circuit. Remove cover 4 and connect one end of a test jumper to terminal C1 of the *Vf + Pe* ballistic computer. Connect the other end of the jumper to terminal AR11 to energize the DECREASE relay, or to terminal AR12 to energize the INCREASE relay. If the relay then operates properly, the trouble is in the push-button circuit.

Remove the *Ct* indicator from the end of the star shell computer. Take out the eight screws holding the rear cover of the indicator, and remove the cover. Check the push-button switches, and the wiring from the indicator to the Computer Mk 1.



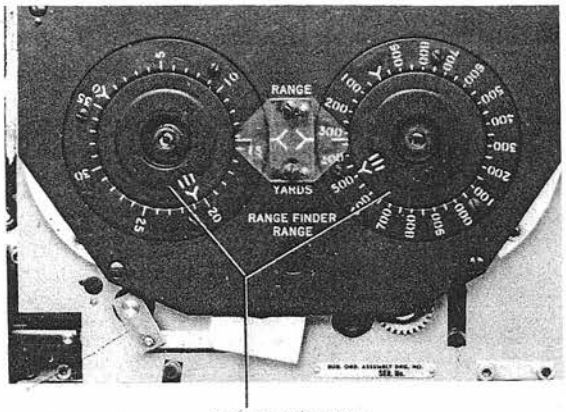
If a relay does not operate when the test jumper is connected, remove it and check the coil. For removal, see page 689.

If the *Ct* motor does not drive when either relay operates, but it does drive during rate control, the normally open relay contacts are probably faulty. Remove the unit and inspect these contacts.



The normally closed contacts on both relays are used to supply the *Ct* follow-up center contact. If they are faulty, the *Ct* follow-up will be inoperative during rate control.

THE RANGE RECEIVER



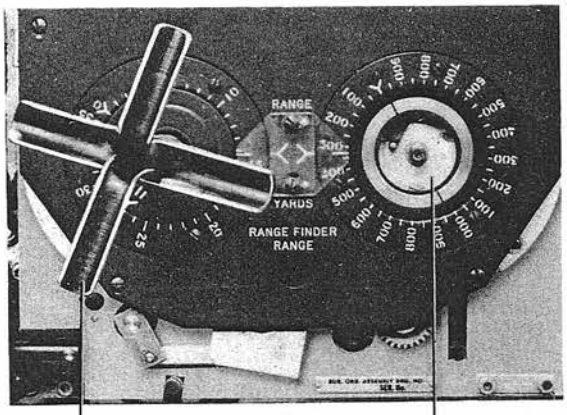
RANGE RECEIVER

The range receiver in Computer Mk 1 is a special type of double-speed receiver. Its function and normal operation are fully discussed in OP 1064.

The following symptoms of trouble may occur in the range receiver:

No operation
Sluggish or erratic operation
Operation in one direction only
Oscillation

No operation



DIAL WRENCH

FINE SYNCHRO DIAL REMOVED

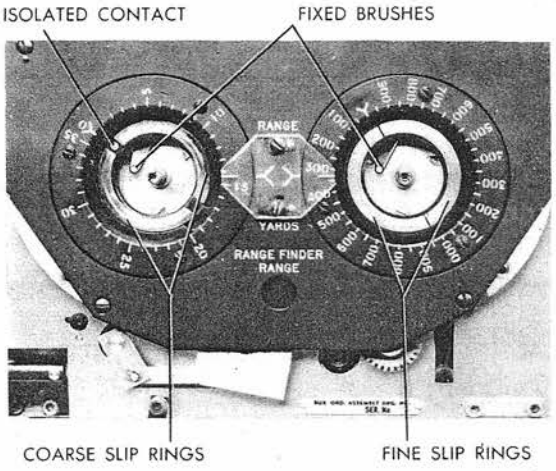
If the range receiver fails to operate at all, either the servo motor is overloaded or else the follow-up control circuit is open.

The servo motor may be overloaded by too much friction on the *jdR* line, or by tightness and sticks in the gearing. With the power OFF, use the generated range crank in the IN position to turn *jdR*. The *jdR* line, the *jRc* integrator, the *cR* line, and the *cR* dials should turn smoothly and easily.

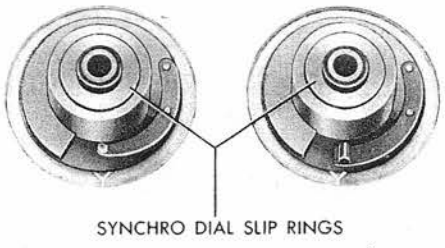
If the line feels tight or sticky, remove cover 1 and check frictions A-164 and A-240. If these frictions cannot be adjusted to act smoothly, refer to *Shaft Line Devices,* OP 1140A. Check the associated gearing for tightness and sticks. See *Shaft Lines,* OP 1140A.

If the gearing is free, and the frictions properly adjusted, but the range receiver still does not operate, remove the coarse and fine synchro dials from their synchro shafts. Use a dial wrench for this purpose.

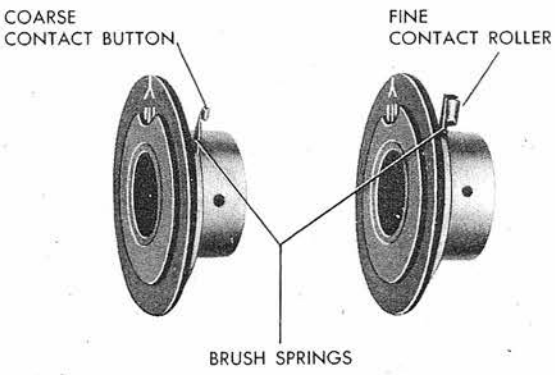
Inspect the contact surfaces and make sure that they are smooth and free from any oil, dirt, or other foreign matter. These contact surfaces include both slip rings and the isolated contact on the coarse dial assembly; both slip rings on the fine dial assembly; the slip ring on the bottom of each synchro dial, together with its corresponding fixed brush; and the coarse contact button and fine contact roller on their respective synchro dials.



Check that the brush springs on both the coarse and fine synchro dials are bent sufficiently to make *light contact* with the slip rings. Check that the fixed brush below each synchro dial is bent upwards sufficiently to make *light contact* with the synchro dial slip ring.

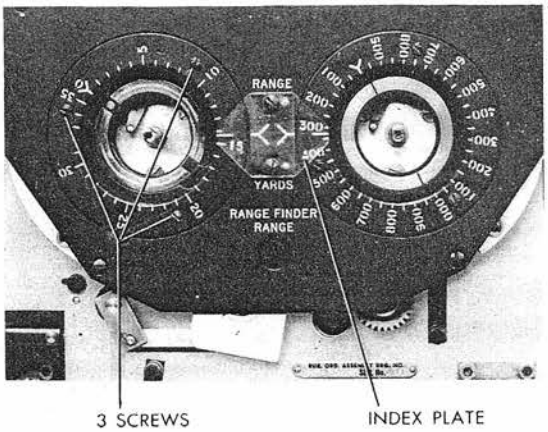


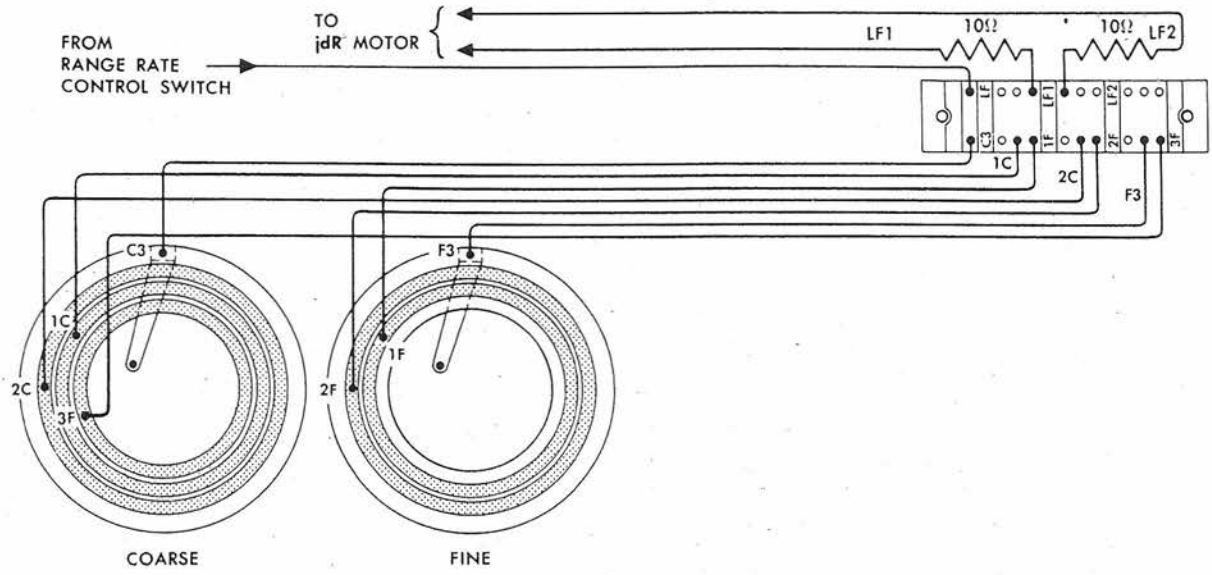
The proper bend for all four brush springs may be checked by measurement. Each brush spring should be deflected by its slip ring approximately 1/32 inch when the synchro dials are seated on the synchro shafts.



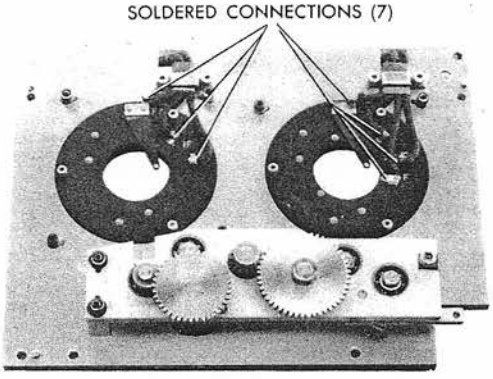
If the above parts have been checked and adjusted, but the range receiver still does not operate, it will be necessary to further disassemble the unit.

Remove the two screws holding the index plate, and lift the plate off. Remove the three screws holding the coarse ring dial in place, and remove the dial. Before removing the slotted ring and triangular clamp ring below the dial, mark both pieces in two places, on their adjacent inner diameters. Then remove the three flat-head screws and both rings. Next, remove the three screws holding the slip-ring plate. Do not mix these screws with the dial screws. Lift the plate out. Check the lower slip rings and their corresponding brushes for proper condition and proper contact. Follow the same instructions given for checking the upper slip rings and brushes.





FIXED SLIP RING CIRCUIT



Follow the same procedure in disassembling and checking the fine dial assembly. Make sure that the parts of the fine and coarse dial assemblies are kept separate while they are out of the instrument in order to avoid interchange.

Use a circuit tester to check for continuity from the fixed slip rings and brushes to the receiver terminal block at the right of the range dials. If any of these circuits are found to be open, remove the remainder of the receiver from the instrument. See *Removal of Mechanisms,* page 621. Check the soldered connections on the bottom of the lower slip rings, and the wiring to the terminal block. Check each of the 10-ohm resistors on the terminal block.

Check the range servo motor and capacitor. See *Servo Motors,* OP 1140A.

Sluggish or erratic operation

If the range receiver runs too slowly, check frictions A-164 and A-240. Check the associated gearing and shaft lines. Follow the disassembly procedure given above and check all contact surfaces.

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If the receiver will not synchronize to exact correspondence, or if it follows a smooth signal erratically, the fine control circuit is probably inoperative. Disassemble and check the entire slip-ring and brush assembly. Note that the fine control circuit is completed by the coarse synchro dial brush when the brush touches the isolated coarse contact. Therefore, both follow-up assemblies are involved in fine control.

Operation in one direction only

If the receiver will synchronize from a large displacement in one direction only, check the entire coarse control circuit for the direction of no operation.

If the receiver, when synchronized, will not follow a change of signal in one direction, and tends to overrun a signal change in the opposite direction, one of the fine slip ring circuits is open. Check the entire circuit from the inoperative slip ring to the receiver terminal block.

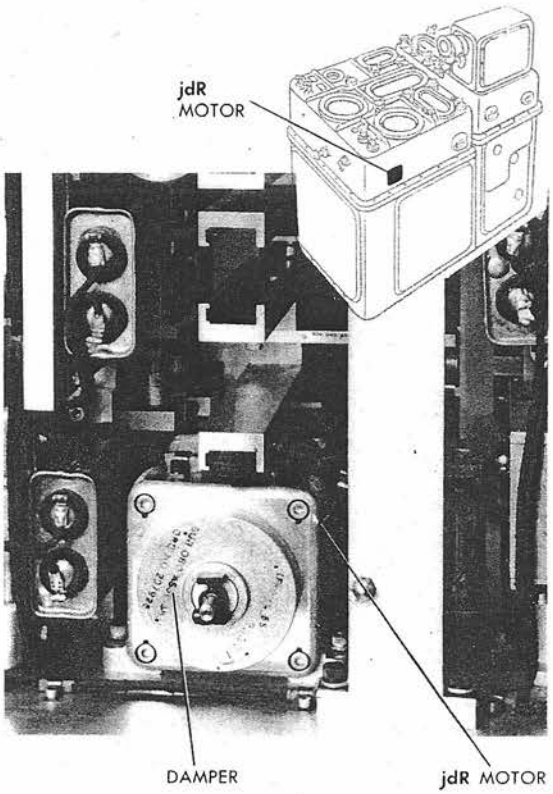
Oscillation

The commonest type of oscillation trouble occurs when the receiver is nearly synchronized, all circuits are properly energized, and the *Rrr* knob is set at 5. In this case, any oscillation existing will be rapid and of small amplitude, and can very often be stopped by turning the *Rrr* knob to a lower ratio. If any oscillation exists, however, it should be eliminated.

The oscillation may be caused by an inoperative magnetic damper on the *jdR* motor, by insufficient friction on the *jdR* line, or by improper action of the fine follow-up roller contact.

Check that the damper on the *jdR* motor is securely clamped to the motor shaft. Check the damper itself. See OP 1140A, page 440.

Check A-164. This friction may be increased in order to stop oscillation, provided that the synchronizing time of the receiver is not thereby made excessive.



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Check the fine follow-up roller contact. It should be positioned by its supporting spring so that the roller lies flat on the slip rings when the inner dial is in place. When it is at the synchronized position, the roller should make good contact with both slip rings at the same time.

Reassembling the range receiver

Replace the receiver-unit plate assembly. See *Removal of Mechanisms,* page 623.

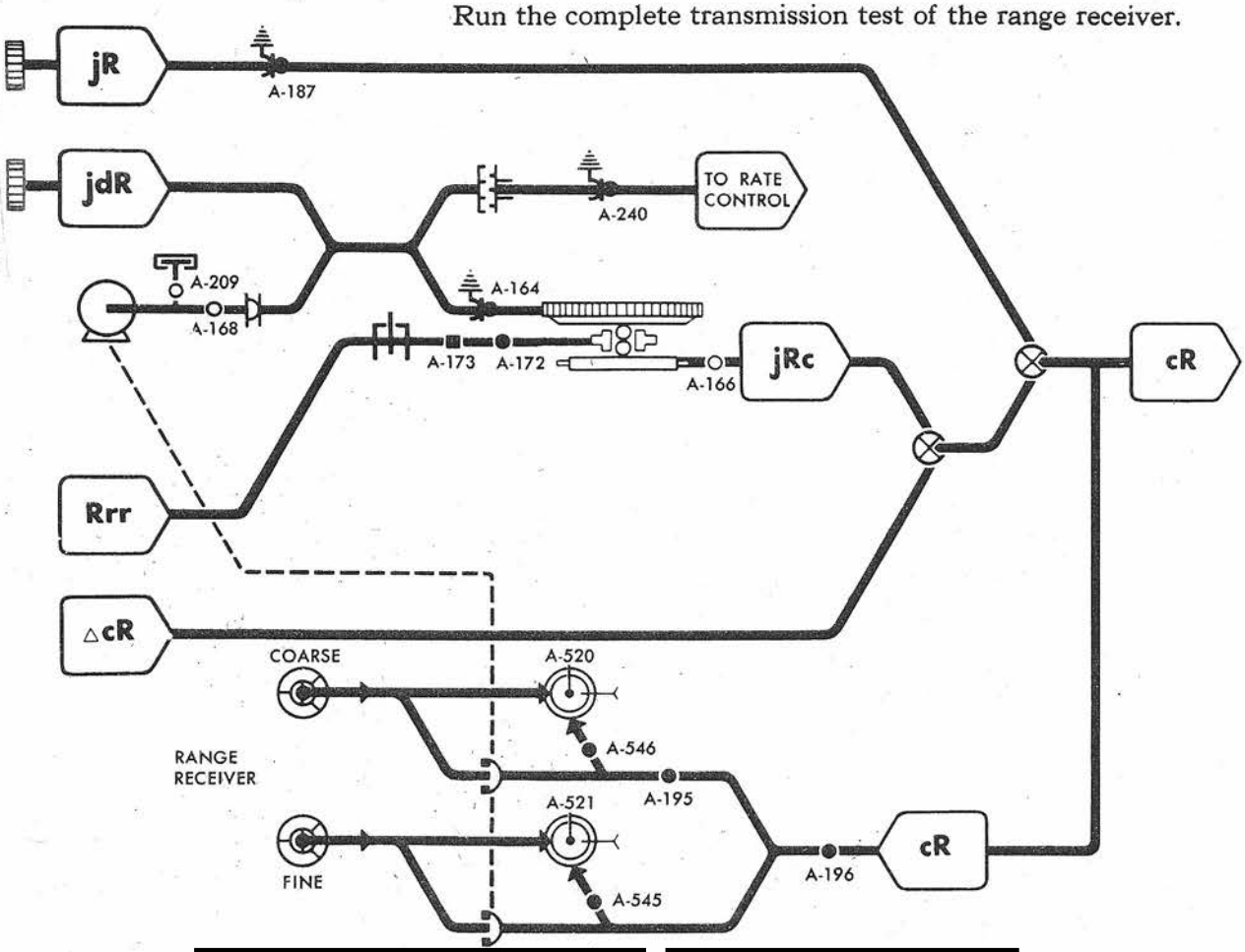
Replace the slip ring plate, then the clamp ring and the slotted ring, on both the coarse and fine dial assemblies. Make sure that the rings are replaced with the marks matched, and that no interchange of these parts has been made between fine and coarse.

Replace both ring dials, the index plate, and the coarse synchro dial.

Readjust A-546, A-545, A-195, A-196, A-520, and A-521, in the order given. See *Factory Adjustment Procedure,* page 827.

Check A-233, A-151, A-104, and A-138. See *Readjustment Procedure.*

Run the complete transmission test of the range receiver.



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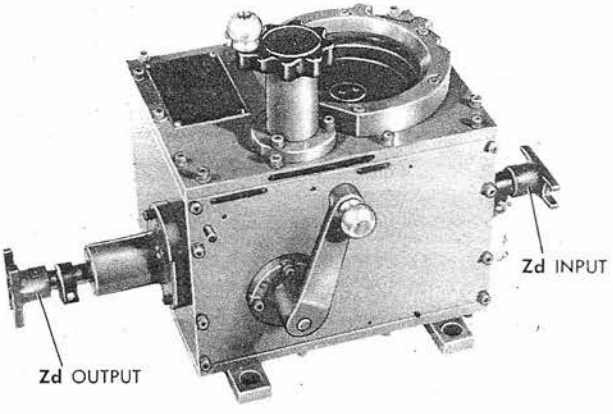
SELECTOR DRIVE

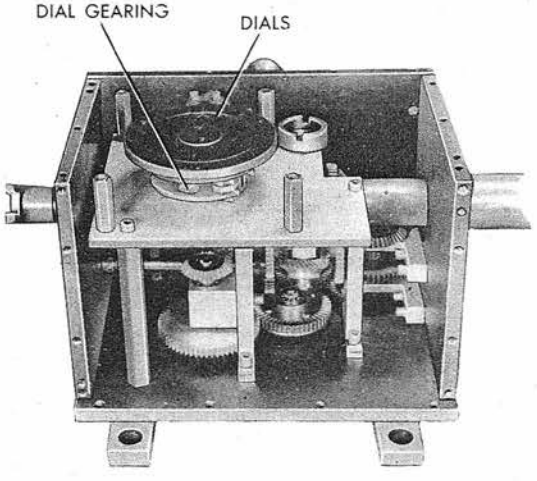
The operation and functional description of the Selector Drive Mk 1 are fully discussed in OP 1064. This section covers typical troubles in the unit, together with the readjustment procedure to be used in case of disassembly.



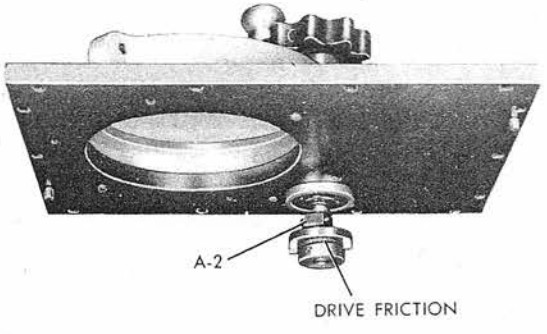
SELECTOR DRIVE MK 1

When the selector lever is at the DISCONNECT position, values of *Zd* from the stable element should merely rotate the dials in the selector drive. The *Zd* line in the computer may be set at any selected value by means of the selector drive handcrank. If the selected value drifts off when the stable element is driving, one or more of the following troubles may exist:

The dials or dial gearing may be binding, causing the *Zd* input to back out the computer *Zd* line. Remove the top cover of the selector drive and check the dial clearance and planetary gearing. Refer to *Dial Assemblies and Counters,* OP 1140A.

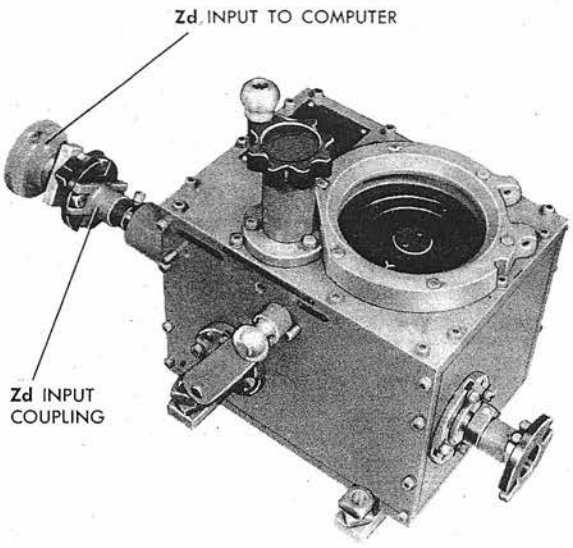


The handcrank holding friction or the handcrank drive friction may be too loose to hold the setting. Remove the handcrank from the top cover and check both friction adjustments. Refer to the readjustment procedure at the end of this section.

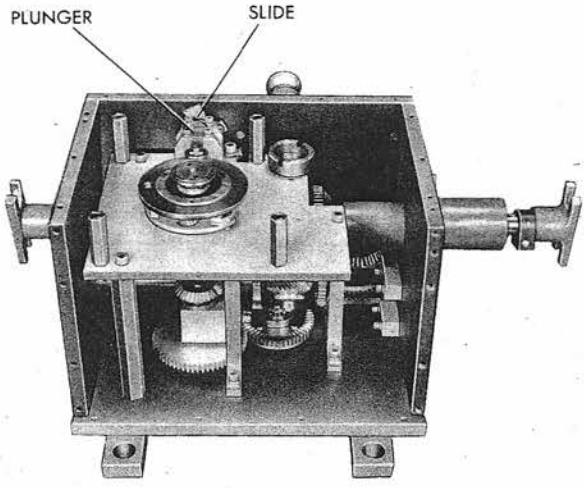


If handcrank inputs are ineffective when the selector lever is at the DISCONNECT or the CONNECT position, the cause may be that:

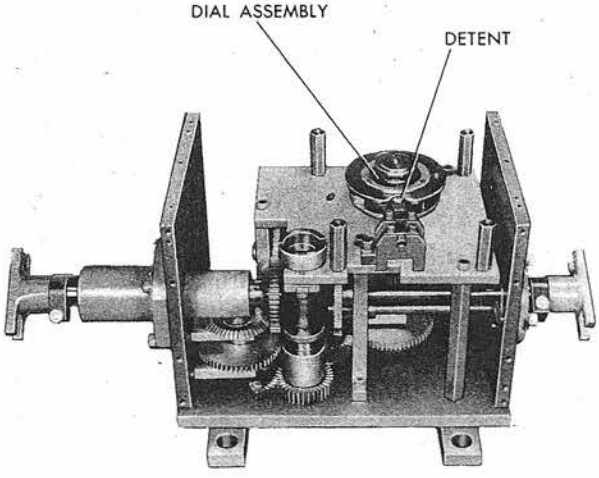
The handcrank drive friction is too loose. Refer to the readjustment procedure for A-2.



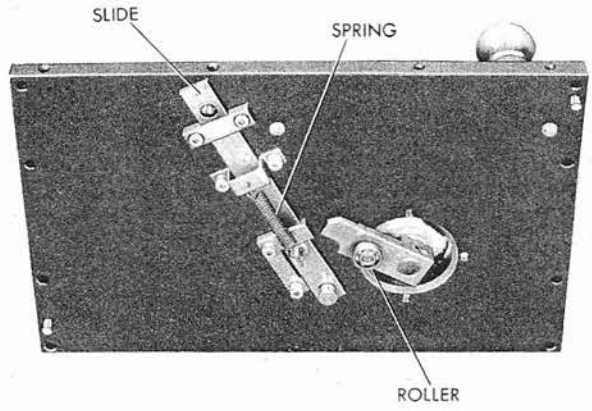
The gearing is binding. Disconnect the coupling on the *Zd* input to the computer and check whether the binding is in the computer or in the selector drive. Refer to *Shaft Lines,* OP 1140A.



Binding in the selector drive in the DISCONNECT or the CONNECT position may be caused by the coarse interlock mechanism. See OP 1064, page 375, for a detailed description of the coarse interlock. If the coarse interlock slide binds, the spring may not lift it up to the position where the hole is in position to receive the plunger. If the plunger binds, it may lock the dial assembly at the synchronized position. In either case, the plunger would be unable to back out of the detent and the dials could not turn. In such case, when the handcrank is turned, the drive friction should slip. However, if the friction is too tight, clamp A-1 may become upset.

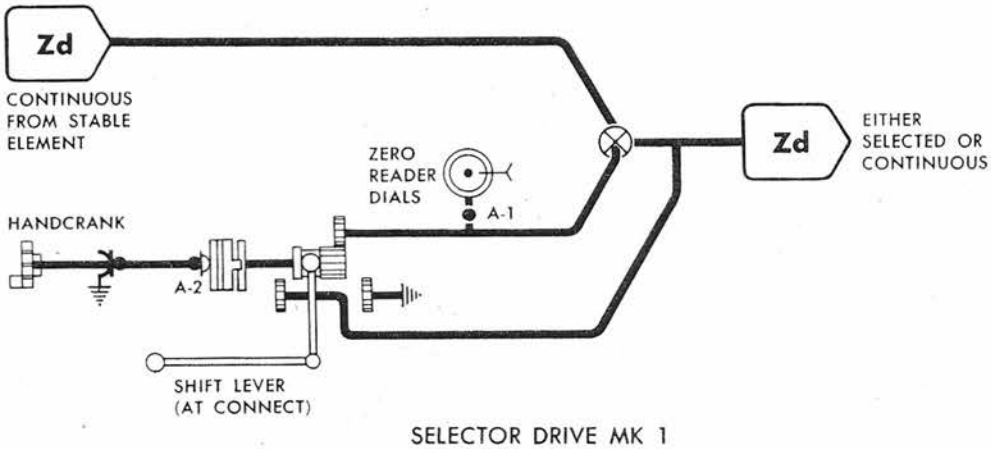


Remove the top cover and the dial mask, and shift the selector lever between LOCK and DISCONNECT to check operation of the interlock slide and plunger. If the slide binds, remove the side cover on which it is mounted to locate the cause of binding. Both the slide and the plunger should be free enough to be moved easily by their respective springs. When replacing this side cover, make sure that the selector-lever roller position matches the position of the recess in the sliding gear.



Readjusting the selector drive

If the selector drive has been disassembled or is out of adjustment for any other reason, it should be completely checked and re-adjusted. In order to cover all adjustments, the following procedure should be used:



SELECTOR DRIVE MK 1

Remove the top cover plate and the dial mask.

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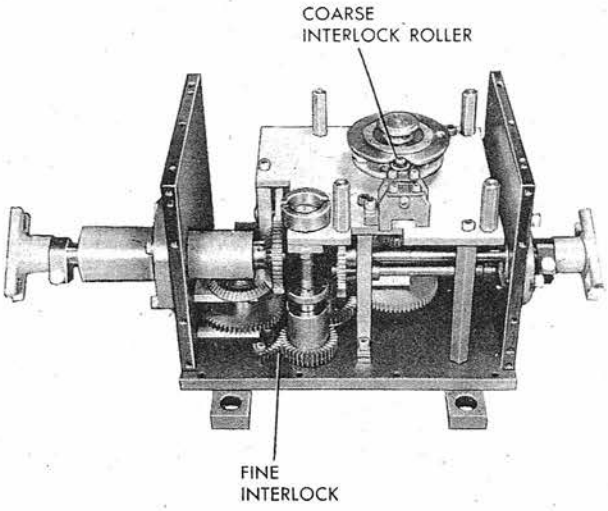
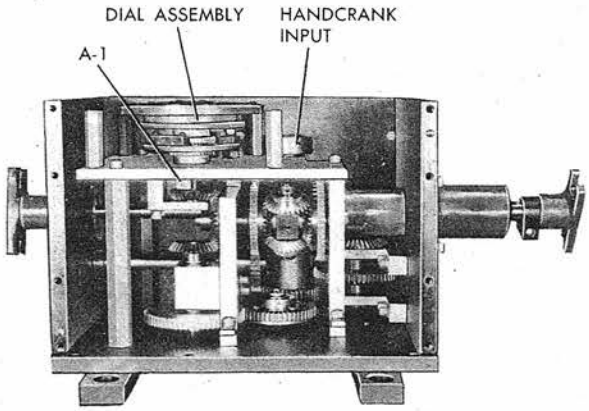
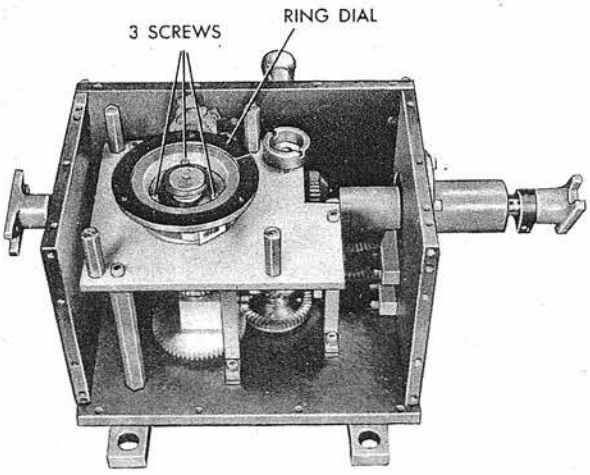


A-1. When the coarse interlock roller is in the detent, the fine interlock should be in correct position to permit the selector lever to be shifted to the LOCK position. See OP 1064, page 375, for a detailed description of the fine interlock.

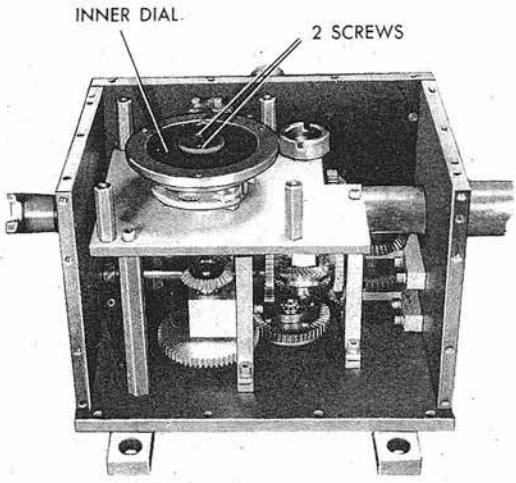


If the lever does not shift to LOCK, remove the side plate opposite the lever and loosen A-1. Hold the dial assembly to keep the coarse interlock in position and turn the handcrank input line until the fine interlock lines up. Shift the lever to the LOCK position. Tighten A-1. Replace the dial mask.

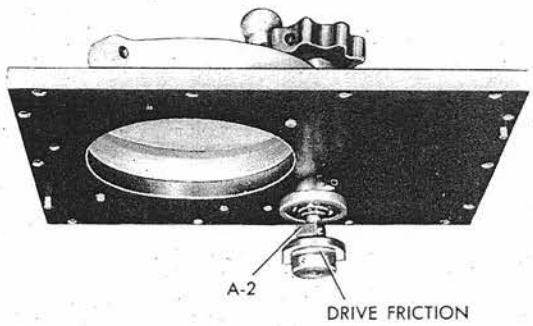


THE RING DIAL. With the interlock set and the lever in the LOCK position, the ring dial index should match the fixed index. If it does not match, remove the inner dial and loosen the three screws underneath. Slip the ring dial to match the fixed index and tighten the three screws. Replace the inner dial.

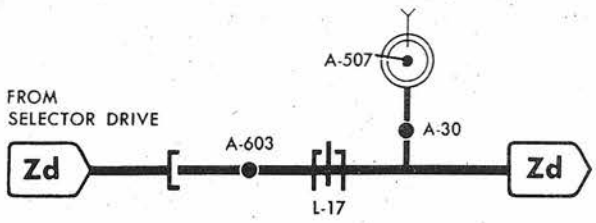
THE INNER DIAL. With the interlock set and the lever in the LOCK position, the inner dial index should match the ring dial index at the fixed index. If the inner dial does not match, loosen the two center screws. Slip the dial to the matched position and tighten the two screws.



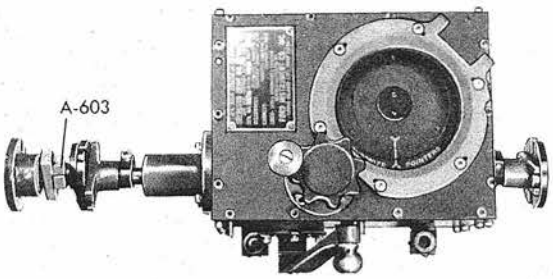
DRIVE FRICTION, A-2. Set the top plate in place temporarily and engage the handcrank coupling. The handcrank drive friction should be tight enough to drive the line when the handcrank is turned, with the selector lever in either the CONNECT or the DISCONNECT position. It should be loose enough, however, to slip when L-17 in the computer is reached, or when the selector lever is in the LOCK position. If necessary, loosen A-2 and turn the threaded clamp to increase or decrease the friction as required. Tighten A-2. Replace and secure the side plate and the top plate.



HOLDING FRICTION. The handcrank holding friction should be sufficient to prevent the *Zd* input from backing out through the handcrank when the shift lever is in the CONNECT position except when the limit of L-17 in the computer is reached. If necessary, remove the handcrank and adjust the holding friction. Refer to OP 1140, page 166.



Check A-603. Refer to *Readjustment Procedure*, page 499.



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Part 6
LUBRICATION

The Computer Mk 1 is clean and is thoroughly lubricated when it leaves the factory. Thereafter, it should be cleaned and lubricated at regular intervals depending upon the amount of use. The information given here concerns routine lubrication, but does not pertain to lubrication which necessitates the removal or disassembly of mechanisms. However, routine lubrication does require the removal of covers for access to the mechanisms to be lubricated. Therefore, lubrication should not be attempted when there is danger of dirt or excessive moisture entering the computer.

General Instructions

Before the instrument is lubricated, it must be cleaned of all metal chips, dirt, dust, and lint. Cleaning should be done with a vacuum cleaner and with a lint-free cloth or brush dipped in an approved solvent. The use of compressed air within the instrument is prohibited since it is liable to blow any loose dirt into bearings and onto gears. Lubricants, containers, and applicators must be kept clean and free from dirt and chip contamination.

Before applying fresh grease, remove the old grease with a lint-free cloth or brush dipped in an approved solvent. Fresh grease should be applied immediately after cleaning, to avoid any possibility of corrosion. It should be applied uniformly and in small quantities. After lubrication, any excess grease should be removed. Too much grease increases friction. Therefore, the least amount needed to produce a uniform coating should be applied.

The use of oil, especially on ball bearings and rollers, is principally to prevent corrosion. Consequently, oil should be used sparingly; preferably being applied a drop at a time by means of soft copper wire.

CAUTION

Care must be exercised to avoid getting oil or grease on synchro slip rings, follow-up control contacts, and parts made of natural rubber.

Lubricants

Oil

Where oil is specified, use Instrument Oil, BuOrd Specification 14-O-20(Ord), Standard Stock No. 14-O-975-25.

Grease

Where grease is specified, use Instrument Grease, BuOrd Specification 14-G-8(Ord), Standard Stock No. 14-G-980-800. If this is not available, use Bearing Grease, BuOrd Specification 14-G-10(Ord), Stan

Lubrication of Basic Mechanisms

Instructions for the routine lubrication of basic mechanisms used in the Computer Mk 1 are given below. These instructions are followed by a Lubrication Schedule in which the frequency of lubrication is specified.

Flat Cams

Where possible, clean all parts with solvent. Apply a thin coating of grease to cam grooves. Apply a film of oil to guide rails of cam follower, and 3 to 5 drops of oil to groove of each guide roller and to each bearing.

Component Solvers

Where possible, clean slides, guides, and other parts with clean brush or lint-free cloth dipped in solvent.

Apply 3 to 5 drops of oil to each bearing, roller groove, and pivot point.

Apply a thin coating of grease to grooves of spiral cams, or to lead screws, and to slots of vector gears and output racks.

Ballistic Computers

Thoroughly clean cam surfaces, guide rods, lead screws, and other parts with solvent. Make sure that cam surfaces are absolutely free from metal chips or dirt.

Apply a thin coating of grease to guide rods, lead screws, limit stops, and gearing.

Apply 3 to 5 drops of oil to each bearing.

Multipliers

Where possible, clean all parts with solvent.

Apply a thin coating of grease to lead screws, racks, and slots.

Apply 3 to 5 drops of oil to guide rails, rollers, pivots, and bearings.

Integrators

Thoroughly clean rollers, balls, and discs, using lint-free cloth or clean brush dipped in solvent. Be sure to remove any fine chips that may have been rolled flat on discs, balls, or rollers by rubbing with clean cloth or brush.

Lightly coat rollers, balls, discs, and working surfaces of carriage guide rails with grease.

Apply 3 to 5 drops of oil to all bearings except those that support discs. The latter should be lubricated with grease whenever integrators are disassembled.

Limit Stops

Clean threaded shafts with solvent. Apply a thin coating of grease to threads and run traveling nuts full length of shafts several times to distribute the grease uniformly.

Differentials

In differentials having spider shafts less than ¼ inch in diameter (such as those in follow-ups), lubricate gears and bearings with oil. In differentials having spider shafts ¼ inch or more in diameter, apply a thin coating of grease to all gearing. Apply sufficient oil to each bearing to form a protective film.

Jewelled differentials in double-speed receivers require no care since they are totally enclosed.

Gears

On low speed spur and bevel gears (gears that rotate less than 300 rpm), apply sufficient oil to gear teeth to form a protective film.
On high speed spur and bevel gears (such as those driven by the time motor), apply a thin coating of grease to gear teeth and rotate shafts several times to insure uniform distribution. Wipe off any excess, where possible, from sides of gears.

Bearings

Apply 3 to 5 drops of oil to all bearings.

Couplings

Apply a thin coating of grease to all pressure contact surfaces.

Worms and Worm Wheels

Clean with solvent and apply a thin coating of grease to teeth of worms and worm wheels.

Lubrication Schedule

The lubrication schedule is separated into four parts, each part covering a major unit of the computer. These units are: the control unit, the computer unit, the indicator unit, and the corrector unit. A lubrication schedule for the Star Shell Computer Mk 1 is also included.

The frequency of lubrication is based both upon hours of operation and upon time periods. If the hours of operation exceed 150 in one month or 500 in three months, the frequency of lubrication is governed by the hours of operation. Otherwise, the instrument should be lubricated at regular time periods.

The term "high speed" in reference to shafts and gears refers to those whose maximum speed exceeds 300 rpm. All others are low speed. Small differentials have spider shafts less than ¼ inch in diameter, such as those in follow-ups. All others are denoted as large differentials.

Control Unit

The control unit is located under cover No. 1.
LUBRICATE EVERY 150 HOURS OR MONTHLY.

Component Solvers

Lubricate guide rails, rollers, and pivots with oil. Lubricate cam grooves, slides, slots, and screws with grease.

Disc Integrators

Lubricate all bearings with oil.

Component Integrators

Lubricate all bearings with oil.

High Speed Gearing

Time line; first two pairs of gears connecting each servo motor; output of range integrator.

Lubricate all bearings with oil. Lubricate all gears with grease.

Limit Stops

Lubricate all limit stops with grease.
LUBRICATE EVERY 500 HOURS OR 3 MONTHS.

Disc Integrators

Lubricate rollers, balls, discs, working surfaces of carriage guide rails, and gears with grease.

Component Integrators

Lubricate rollers, balls, and gears with grease.

Low Speed Gearing

All gearing except that classified previously as high speed gearing.
Lubricate all bearings, all low speed spur and bevel gears, and all small differentials with oil. Lubricate all large differentials with grease.

Worms and Worm Wheels

Lubricate all worms and worm wheels with grease.

Couplings

Lubricate all oldham couplings with grease.

Computer Unit

Access to the computer unit is obtained by removing covers Nos. 3, 4, and 5.
LUBRICATE EVERY 150 HOURS OR MONTHLY.

Ballistic Computers

Lubricate guide rods, lead screws, limit stops, and gears with grease.
Lubricate all bearings with oil.

Disc Integrators

Lubricate all bearings with oil.

Component Solvers

Lubricate guide rails, rollers, and pivots with oil.
Lubricate cam grooves, slides, slots, and screws with grease.

Multipliers

Lubricate guide rails, rollers, and pivots with oil.
Lubricate slides, slots, and screws with grease.

High Speed Gearing

Time line; integrator gearing connecting discs and rollers; first two pairs of gears connecting each servo motor.
Lubricate all bearings with oil. Lubricate all gears with grease.

Limit Stops

Lubricate all limit stops with grease.
LUBRICATE EVERY 500 HOURS OR 3 MONTHS.

Disc Integrators

Lubricate rollers, balls, discs, working surfaces of carriage guide rails, and gears with grease.

Flat Cams
Lubricate cam grooves with grease. Lubricate guide rails of cam followers, guide rollers, and bearings with oil.

Complementary Error Corrector
Lubricate cam grooves, slides, and slots with grease. Lubricate rollers, pivots, and bearings with oil.

Low Speed Gearing
All gearing except that classified previously as high speed gearing. Lubricate all bearings, all low speed spur and bevel gears, and all small differentials with oil. Lubricate all large differentials with grease.

Worms and Worm Wheels
Lubricate all worms and worm wheels with grease.

Intermittent Drives
Lubricate cams, followers, sliding couplings, and gears with grease. Lubricate bearings with oil.

Couplings
Lubricate pressure contact surfaces of oldham couplings with grease.

Indicator Unit
The indicator unit is located under cover No. 2. The star shell computer must be removed before cover No. 2 can be removed. Monthly lubrication of the mechanism in the indicator unit is not specified because this gearing is subject to little wear and because the star shell computer must be removed to obtain access.
LUBRICATE EVERY 500 HOURS OR 3 MONTHS.

High Speed Gearing
B'gr line; *E'g* line; first two pairs of gears connecting each servo motor. Lubricate all bearings with oil. Lubricate all gears with grease.

Low Speed Gearing
Other gearing not specified above.
Lubricate all bearings, all low speed spur and bevel gears, and all small differentials with oil. Lubricate all large differentials with grease.

Intermittent Drives
Lubricate cams, followers, sliding couplings, and gears with grease. Lubricate bearings with oil.

Couplings
Lubricate pressure contact surfaces of oldham couplings with grease.

Corrector Unit
Access to the corrector unit is obtained by removing covers Nos. 6, 7, and 8.
LUBRICATE EVERY 150 HOURS OR MONTHLY.

Component Solvers
Lubr[illegible]iv[illegible]cam

grooves, slides, and slots with grease.

Multipliers

Lubricate guide rails, rollers, and pivots with oil. Lubricate slides, slots, cam grooves, and screws with grease.

Computers

Lubricate guide rails, rollers, and pivots with oil. Lubricate cam grooves, slides, and slots with grease.

High Speed Gearing

B'gr line; *L* line; *E'g* line; *Zd* line; first two pairs of gears connecting each servo motor.
Lubricate all bearings with oil. Lubricate all gears with grease.

Limit Stops

Lubricate all limit stops with grease.
LUBRICATE EVERY 500 HOURS OR 3 MONTHS.

Low Speed Gearing

All gearing except that classified previously as high speed gearing. Lubricate all bearings, all low speed spur and bevel gears, and all small differentials with oil.
Lubricate all large differentials with grease.

Worms and Worm Wheels

Lubricate all worms and worm wheels with grease.

Intermittent Drives

Lubricate cams, followers, sliding couplings, and gears with grease. Lubricate bearings with oil.

Couplings

Lubricate pressure contact surfaces of oldham couplings with grease.

Star Shell Computer

Access to the mechanisms of the star shell computer is obtained by removing the front and rear covers of the star shell computer case.
LUBRICATE EVERY 150 HOURS OR MONTHLY.

Multipliers

Lubricate guide rails, rollers, and pivots with oil.
Lubricate slides, slots, and screws with grease.

High Speed Gearing

Lubricate all bearings with oil.
Lubricate all gears with grease.

Limit Stops

Lubricate all limit stops with grease.
LUBRICATE EVERY 500 HOURS OR 3 MONTHS.

Low Speed Gearing

All gearing except that classified previously as high speed gearing. Lubricate all bearings and all low speed spur and bevel gears with oil.

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Part seven

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REMOVAL OF MECHANISMS

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Introduction

This section of the book is intended for use when it is necessary to remove any part of the mechanism for repair or replacement. It is presented mainly as a pictorial guide with a minimum of accompanying text. The procedures given here agree with sound and established practices for dealing with complicated mechanisms. Therefore, it is advisable for all maintenance personnel to adhere closely to the given instructions and to check each operation against the illustrations.

Before removing any mechanism, a careful check should be made to determine the cause of trouble. If it is of a simple nature, such as a poor gear mesh, the trouble can very often be corrected without taking the mechanism apart.

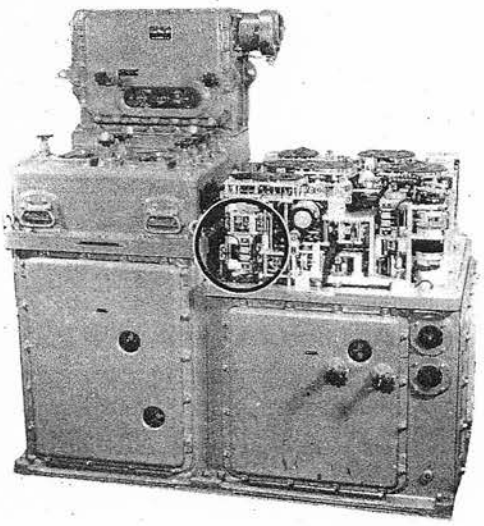
In the following chapters the location of each mechanism is shown and information on how to remove it follows in simple steps. In cases where it is necessary to remove other units to reach the desired mechanism, the interfering units are listed immediately after the mechanism title and in the order in which they should be removed. As the various screws are removed, their size and length should be noted, so they can be replaced in their proper positions. This is especially important where several different lengths of the same size screw are used near each other. Any unit which is located with dowel pins should first be worked back and forth carefully to free them. Where a taper pin is removed, it should always be replaced in its original hole. While removing mechanisms from the computer, care should be taken to avoid damaging gears, contact arms, springs, and other small parts. The removed mechanisms should be carefully placed aside until ready for reassembly. It is advisable to loosen all adjustments that are upset by the removal of mechanisms so that the possibility of damage to other parts is reduced.

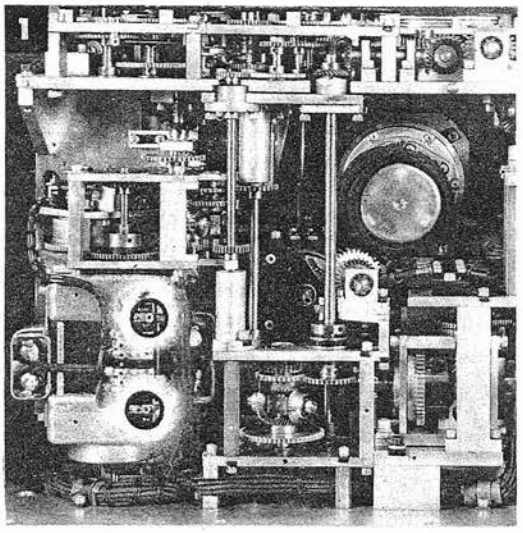
In order to repair a mechanism, reference should be made to the methods and checks given in OP 1140A. All mechanisms should be cleaned, inspected, and relubricated before they are reinstalled. The electromechanical assemblies (follow-ups, clutches, locks, receivers, etc.) should be bench checked before they are reinstalled.

Reassembly of the removed parts is the reverse of the removal procedure. For some mechanisms, special notes are given to assist in reassembly. The requirements given below apply to the reassembly of all mechanisms. Shafts should have proper end-play and freedom. Bearings must be absolutely clean so that the shafts can run smoothly. Gear meshes must be free, yet have a minimum amount of lost motion. Electrical wiring should be checked to see that all wires are connected to proper terminals. The cables should clear all sharp corners and gears.

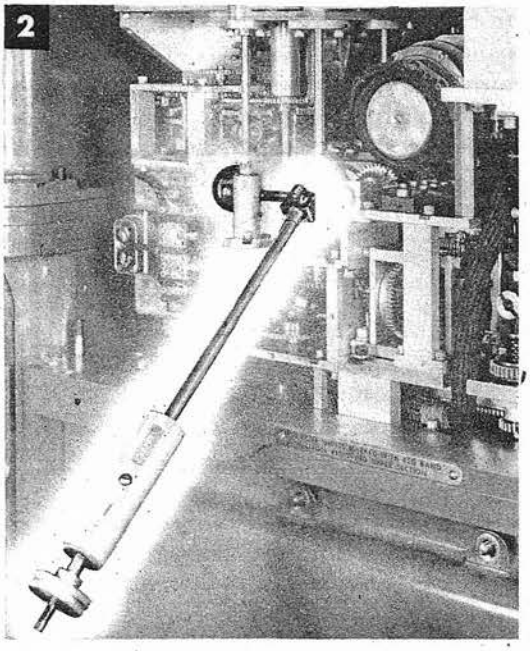
Removal and reinstallation of mechanisms will upset the relationship between the parts which were removed and those that remained in the computer. For each mechanism, the numbers of the points at which adjustments must be made to reestablish the correct relationships are listed in the sequence in which they should be made. Detailed information for making each adjustment can be found in *Readjustment Procedure,* page 232. The computer must be completely reassembled before readjustment is begun. If a large number of mechanisms were removed, so that extensive readjustment is necessary, it is advisable to follow the instructions given under *Factory Adjustment Procedure,* page 815.

jE FOLLOW-UP

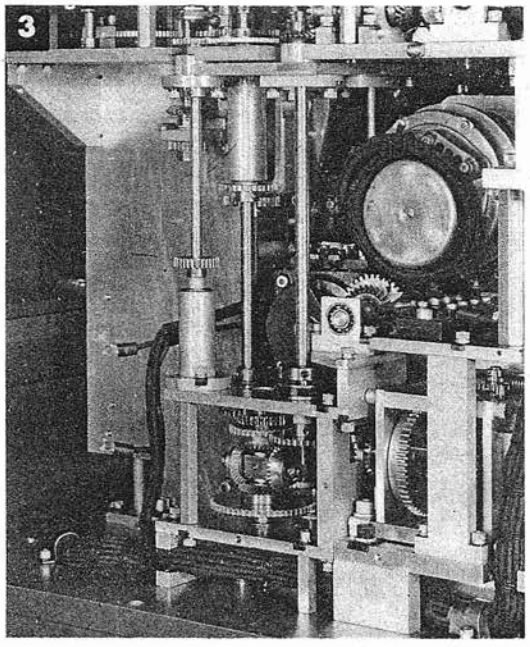




1 Remove the two screws connecting cable leads N and NN to the servo-motor terminal block.



2 Using an angle screw driver, remove the screw securing the cable clamp above the capacitor. Free the cable.

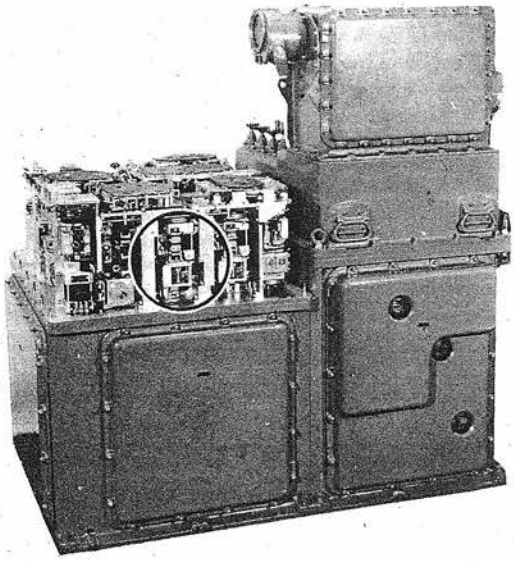


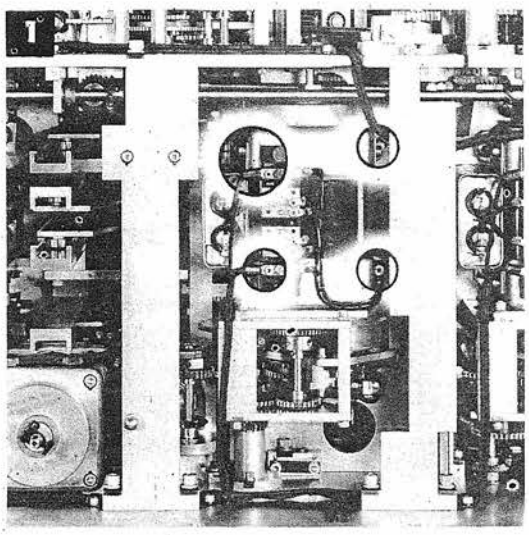
3 Remove the four screws securing the motor to the mounting plate. Remove the follow-up.

To reinstall the *jE* follow-up, reverse the removal procedure.

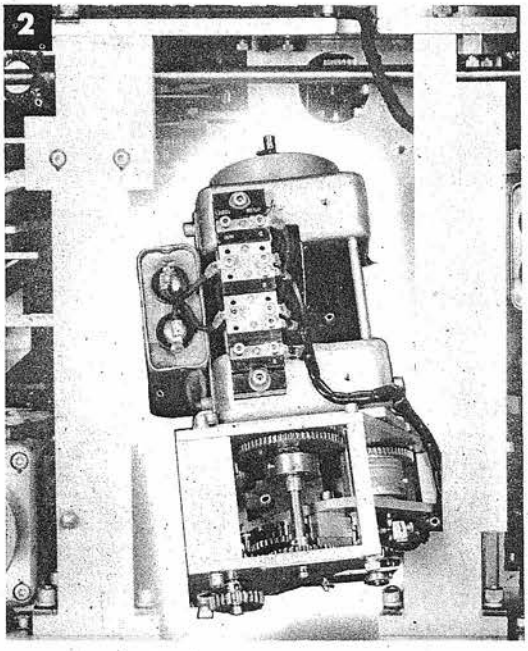
Readjust clamp A-529.

RdBs FOLLOW-UP

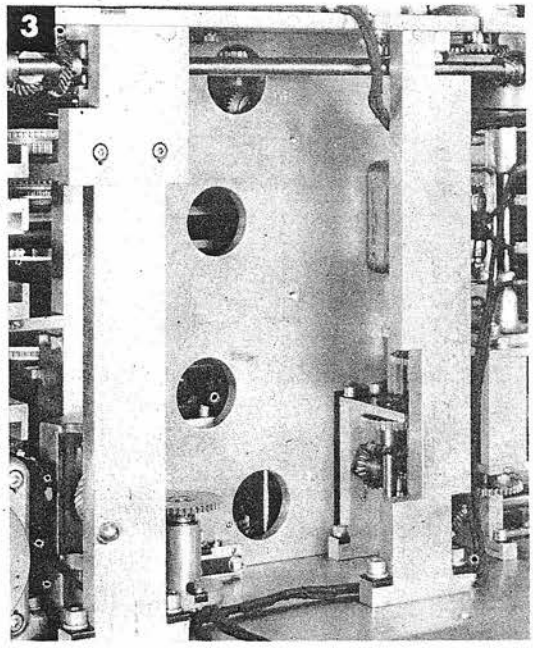




1 Remove the two screws connecting cable leads M and MM to the servo-motor terminal block. Remove the four screws securing the follow-up to the mounting plate.



2 Tilt the lower end of the follow-up outward to clear the shaft above it.



3 Remove the follow-up.

To reinstall the *RdBs* follow-up, reverse the removal procedure.

Readjust clamp A-121.

Run tests.

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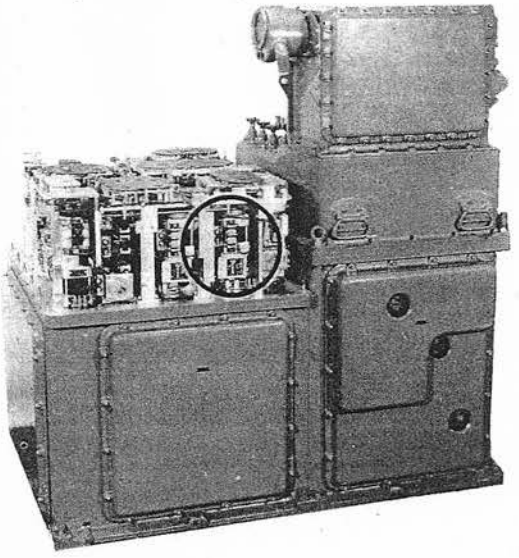
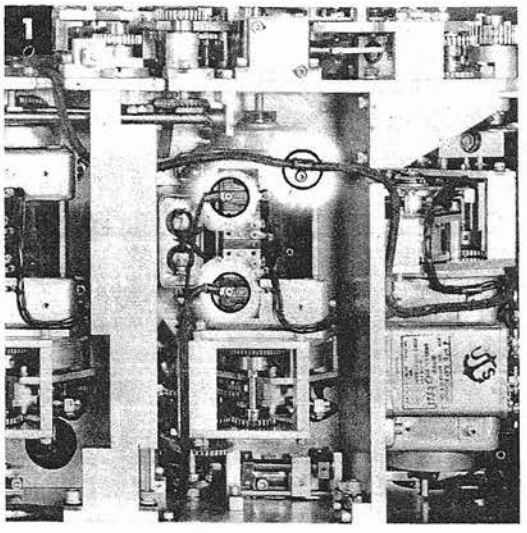
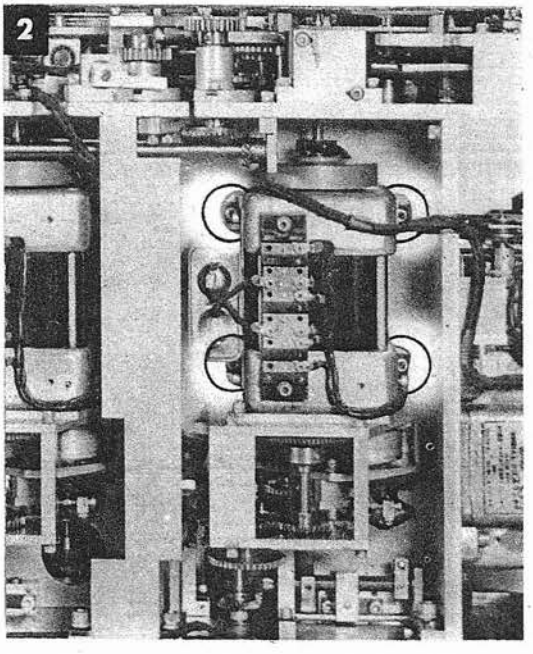
dRh FOLLOW-UP

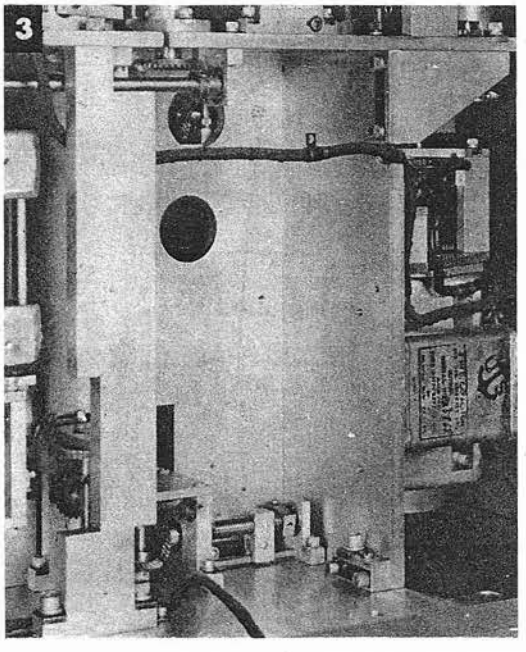




1 Remove the two screws connecting cable leads P and PP to the servo-motor terminal block. Remove the screw securing the cable clamp to the upper end of the motor case. Free the cable.



2 Remove the four screws securing the motor to the mounting plate.



3 Remove the follow-up.

To reinstall the *dRh* follow-up, reverse the removal procedure.

Readjust clamp A-119.

Run tests.

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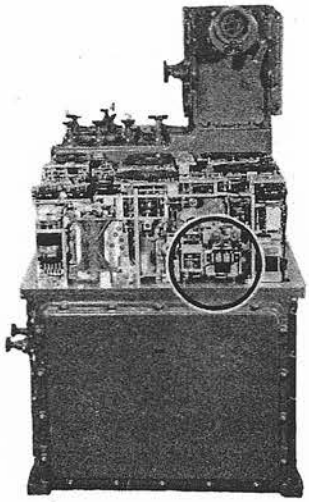
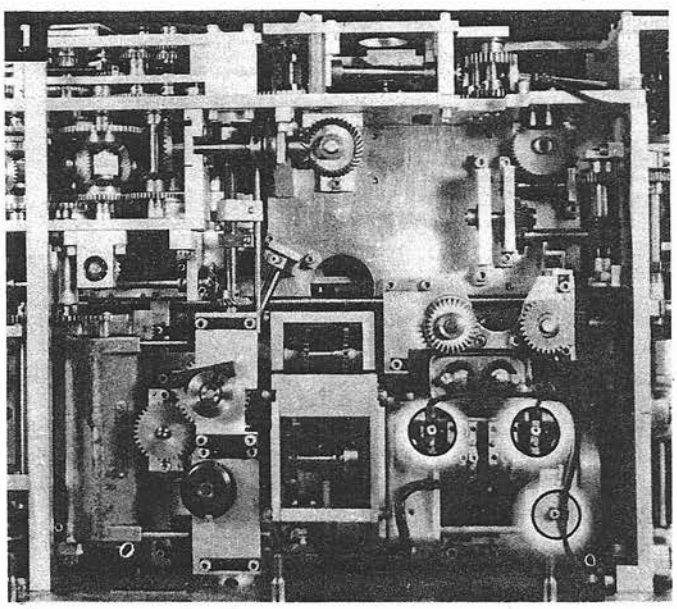
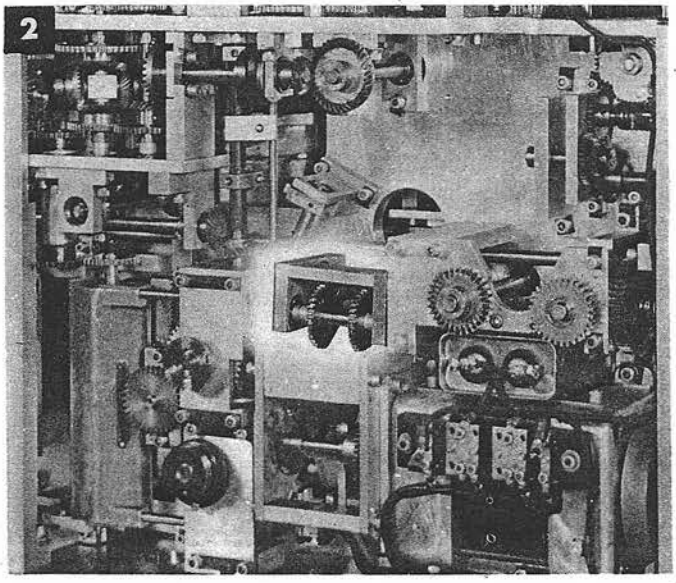
dR FOLLOW-UP





1 Remove the two screws connecting cable leads E and EE to the servo-motor terminal block. Remove the screw securing the cable clamp to the servo motor. Free the cable.



2 Remove the two screws securing the gearing directly above the follow-up to the mounting plate. Now the gearing can be shifted.

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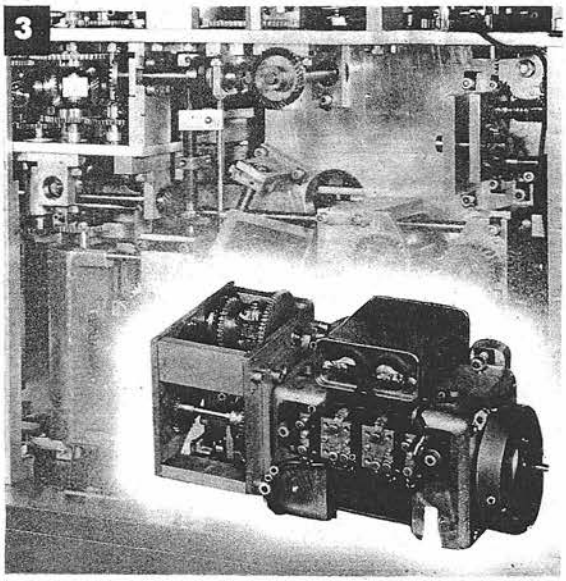
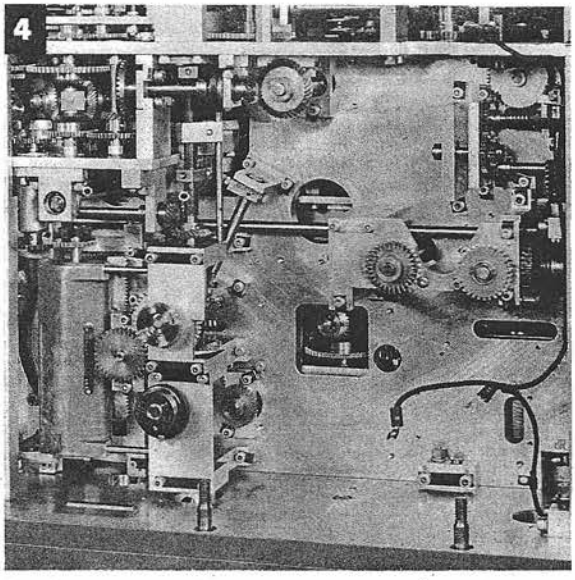


3 Remove the four screws securing the motor to the mounting plate. Lift the loosened gearing and tilt the follow-up downward to gain clearance.



4 Remove the follow-up and the gearing assembly.

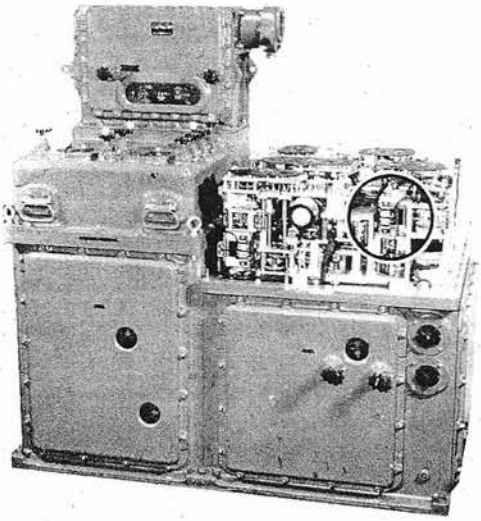
To reinstall the *dR* follow-up, reverse the removal procedure.

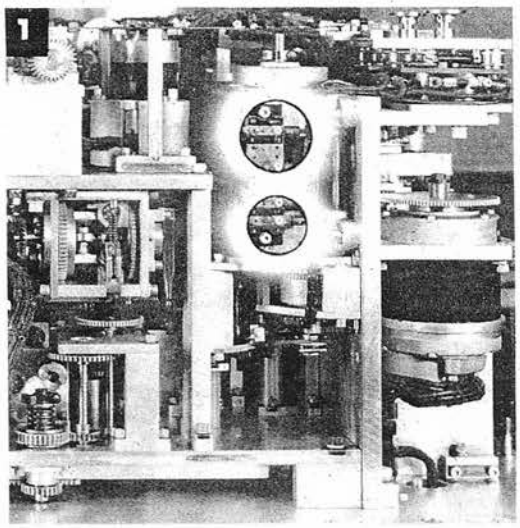
Place both the gearing assembly and the follow-up in their approximate positions before inserting holding screws.

Before tightening the screws, position the gearing assembly to obtain the proper gear meshes.

Readjust clamp A-163.

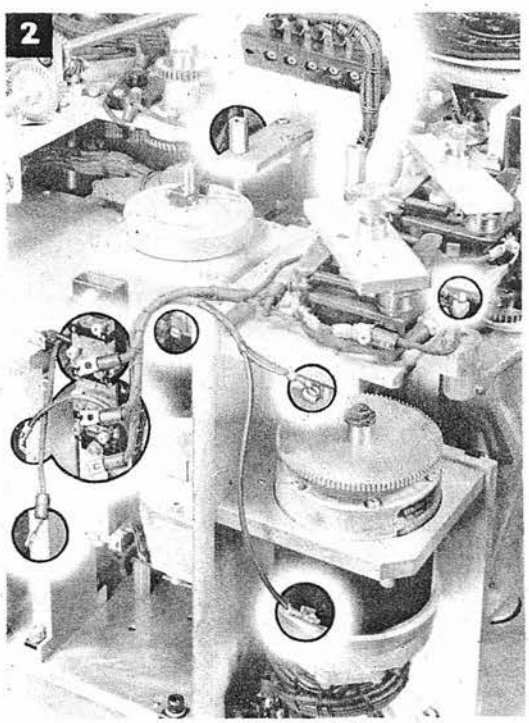
Sh FOLLOW-UP

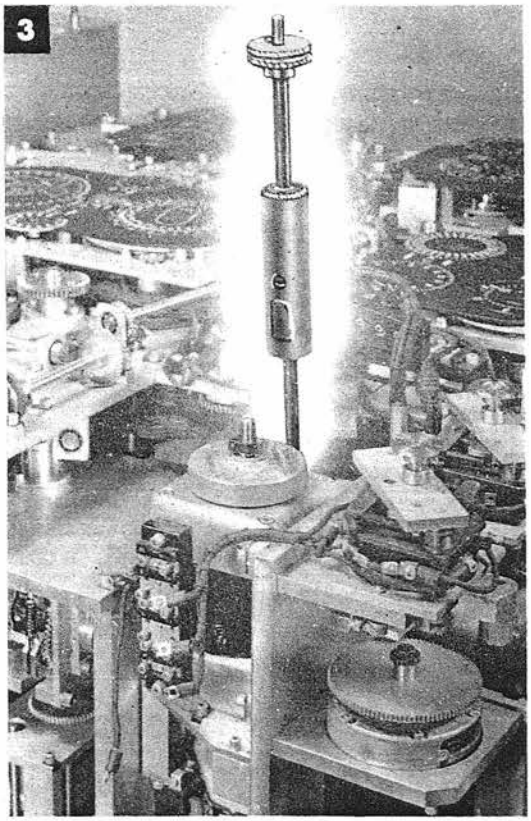




1 Remove the four screws connecting cable leads K, KK, K7 and K2 to the servo-motor terminal block. Loosen the two screws securing the terminal block to the servo motor. Free the K lead.

2 Remove the two screws connecting the capacitor leads to the terminal block.
Remove the screw connecting the lead from the contact assembly to the terminal block.
Remove the two screws connecting leads 1K and 2K to the range rate control switch assembly.
Remove the two screws securing the terminal block which is next to the *Sh* follow-up. Lay the block back, out of the way.
Remove the screw holding the cable clamp to the upper end of the servo motor case. Free the cable.

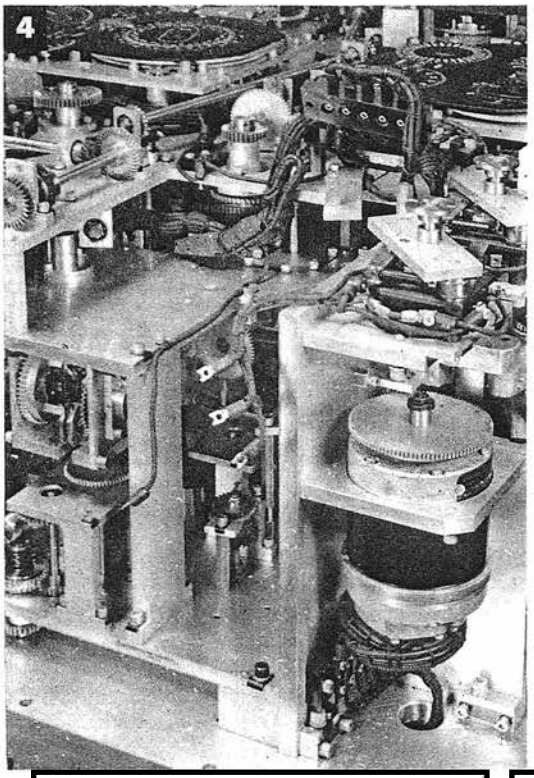




3 Remove the screw securing the cable clamp and the upper capacitor bracket to the servo motor.

Using an angle screw driver, remove the lower screw securing the capacitor. Remove the capacitor.

Remove the four screws securing the servo motor to the mounting plate. Use an angle screw driver to remove the two back screws.



4 Remove the follow-up.

To reinstall the *Sh* follow-up, reverse the removal procedure.

Readjust A-137.

Run rate control tests.

Ct (A) FOLLOW-UP

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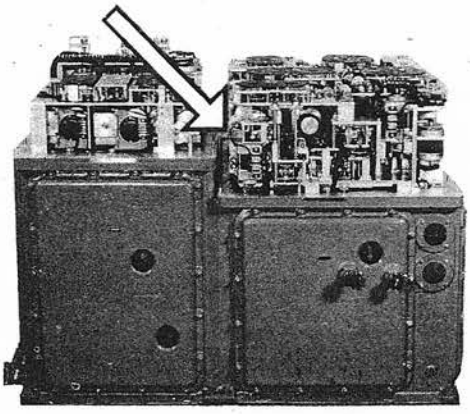
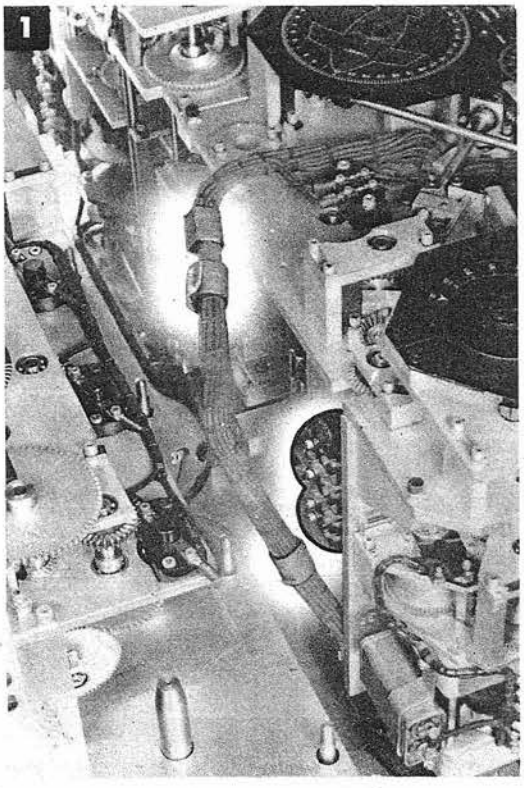
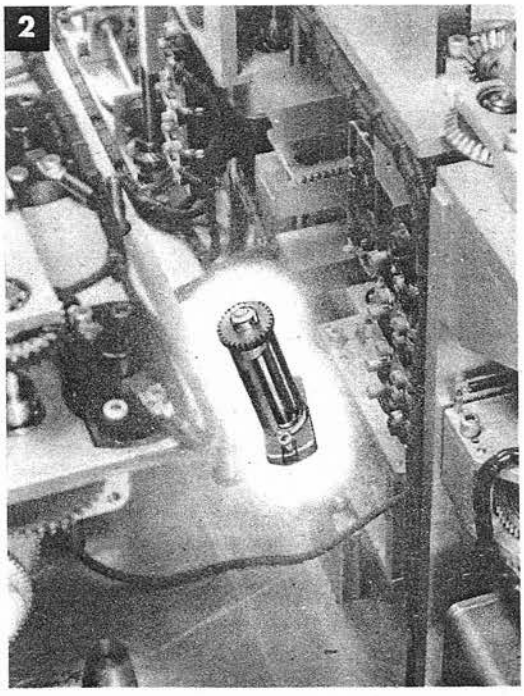
Cover 2, page 238

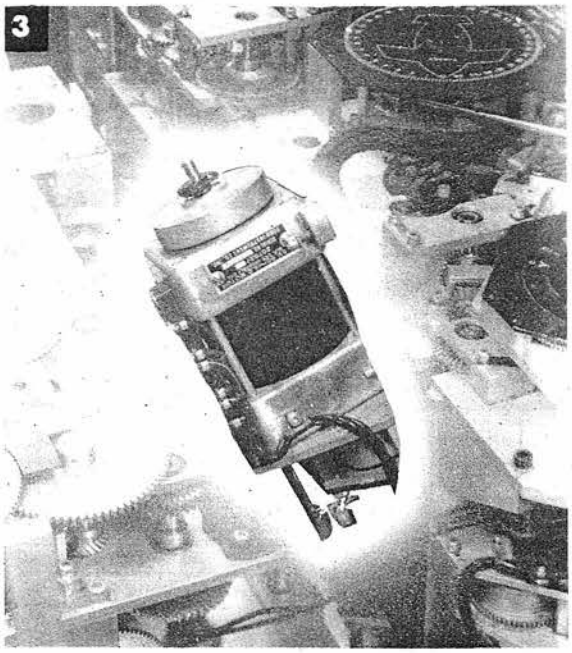




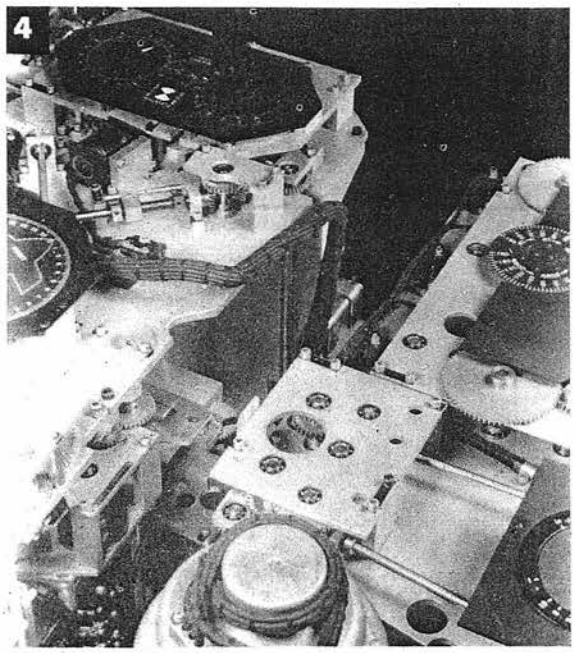
1 Remove the four screws connecting cable leads RR, TA2, TA1 and R1 to the servo terminal block.
Remove the three screws securing the clamps on the cable around the *Ct* follow-up. Free the cable.



2 Remove the two screws securing the shaft assembly adapter to the base plate located near the *Ct* follow-up.
Remove the adapter and shaft assembly.



3 Remove the four screws securing the servo motor to the mounting plate. Push the cable to one side. Turn the motor to free it from the meshing gears.



4 Remove the follow-up.

To reinstall the *Ct* follow-up, reverse the removal procedure.

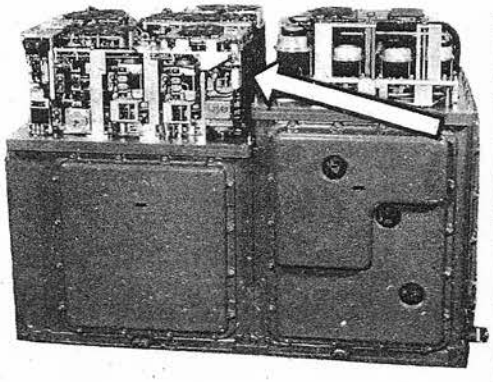
Readjust A-136, A-137, and A-258.

Run rate control tests, and the transmission test of the *Ct* indicator.

Replace the rear cover and the star shell computer.

Readjust the star shell computer to the instrument.

RdE FOLLOW-UP



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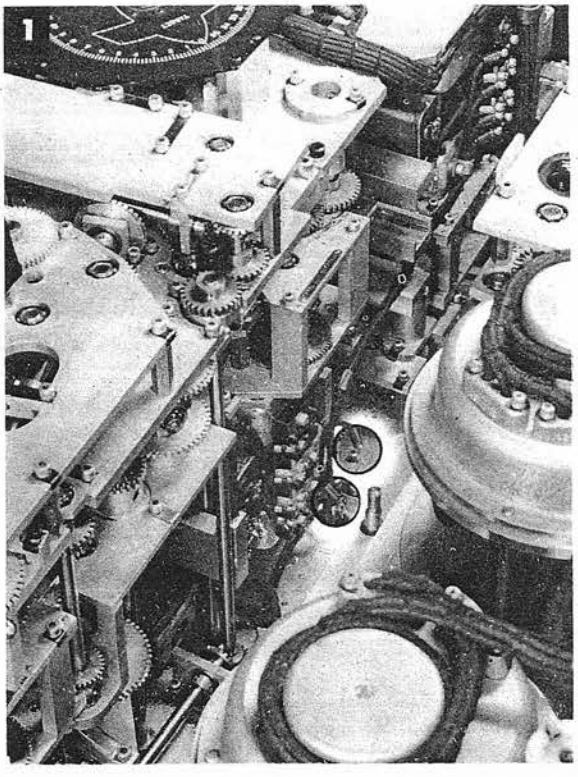
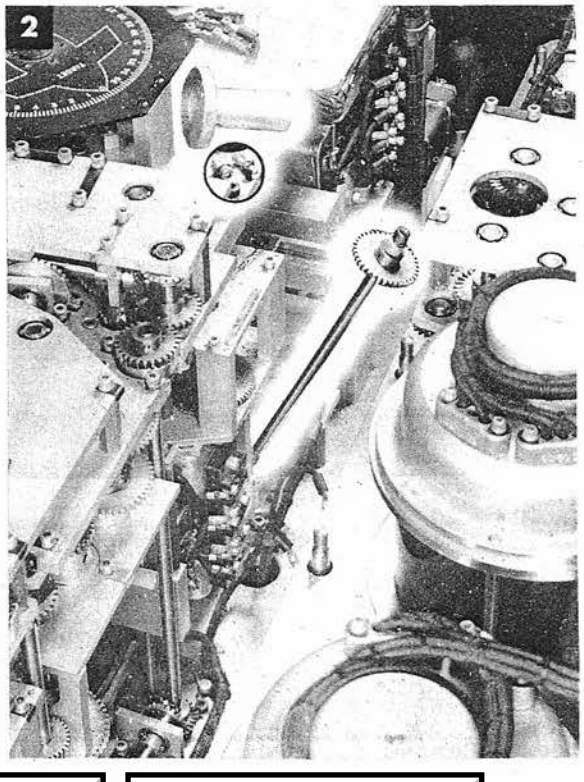
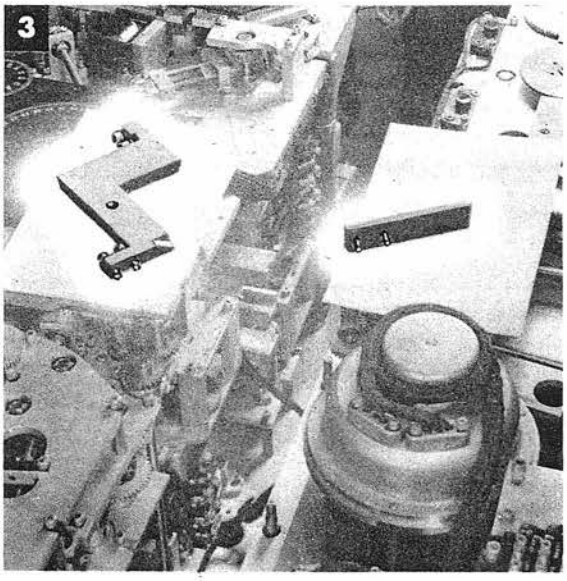


1 Remove the two screws connecting cable leads S and SS to the servo terminal block.

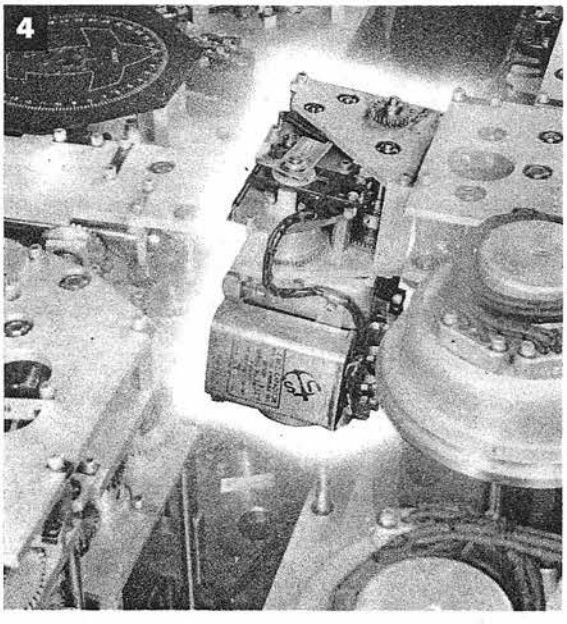


2 Remove the two screws securing the adapter and shaft assembly beside the *RdE* follow-up.
Remove the adapter and shaft assembly.

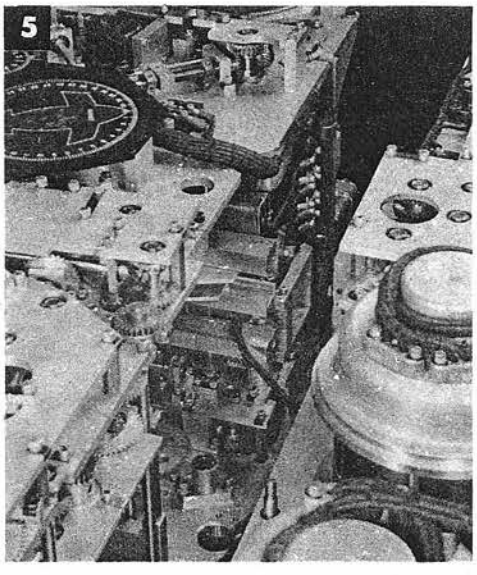


3 Remove the two screws securing the guide post to the top plate of the rear unit. Remove the guide post.
Remove the three screws securing the supporting bracket located near the lower end of the *RdE* follow-up. Remove the bracket.

4 Remove the four screws securing the motor to the mounting plate. Slide the follow-up out, and lift it straight up.



5 Remove the follow-up.



To reinstall the *RdE* follow-up, reverse the removal procedure.

Readjust clamp A-118.

Run tests.

Replace the rear cover and the star shell computer.

Adjust the star shell computer to the instrument.

jBr FOLLOW-UP

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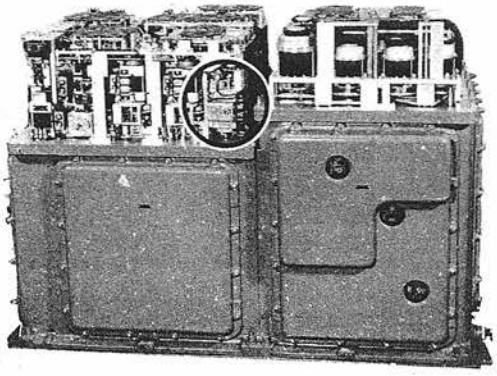
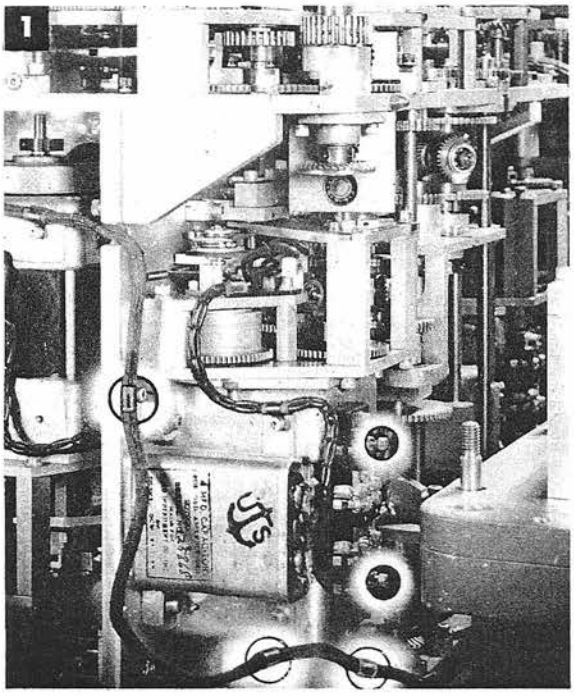
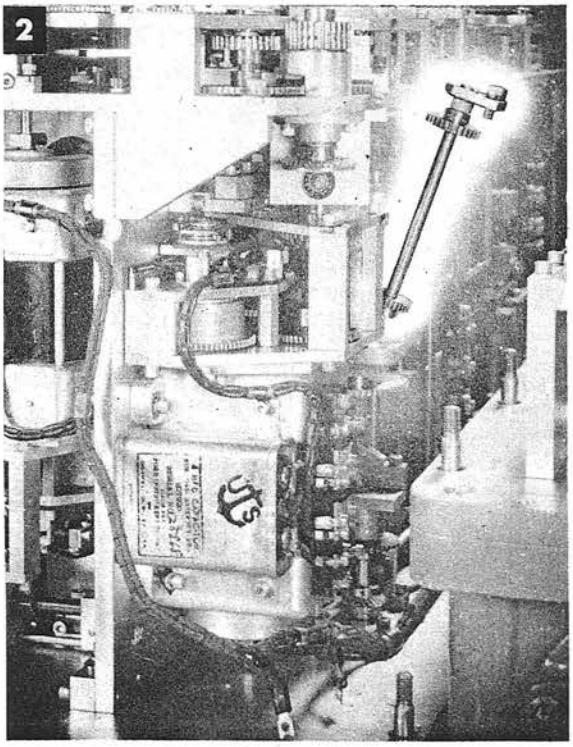
Cover 2, page 238





1 Remove the two screws connecting cable leads T and TT to the servo-motor terminal block.
Remove the three screws securing the cable clamps near the follow-up.
Free the cable.



2 Remove the two screws securing the hanger to the top plate beside the *jBr* follow-up.
Remove the shaft assembly and hanger.

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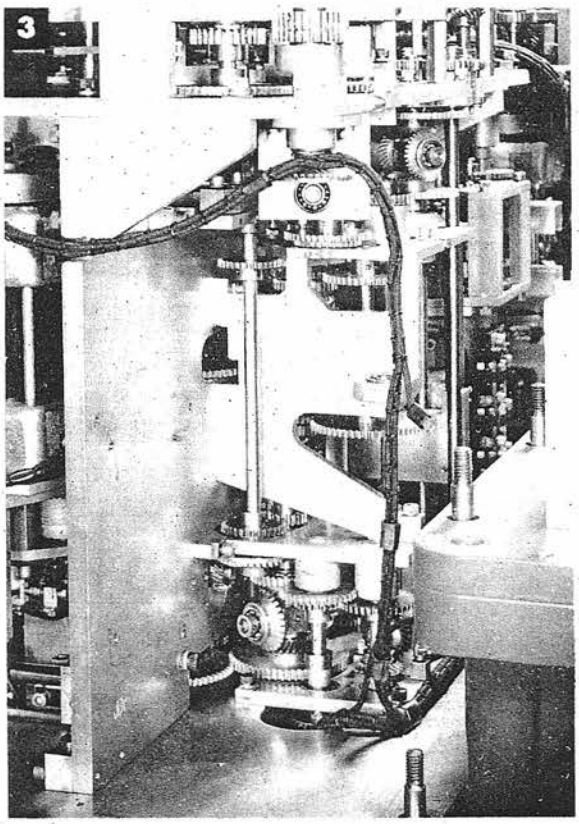


3 Using an angle screw driver, remove the four screws securing the motor to the mounting plate. Remove the follow-up.

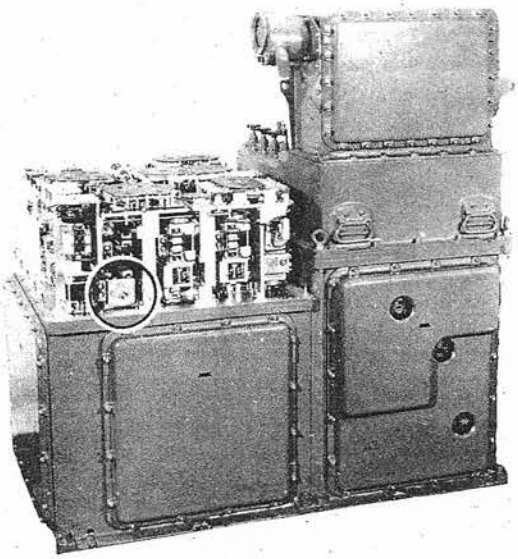
To reinstall the *jBr* follow-up, reverse the removal procedure.

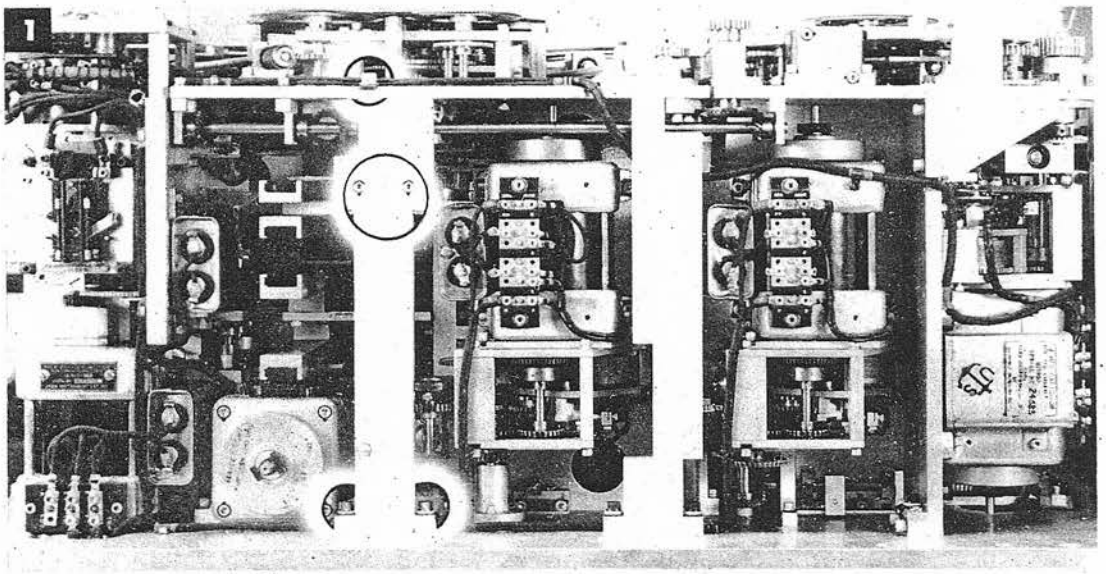
Readjust clamp A-533.

Replace the rear cover and the star shell computer.

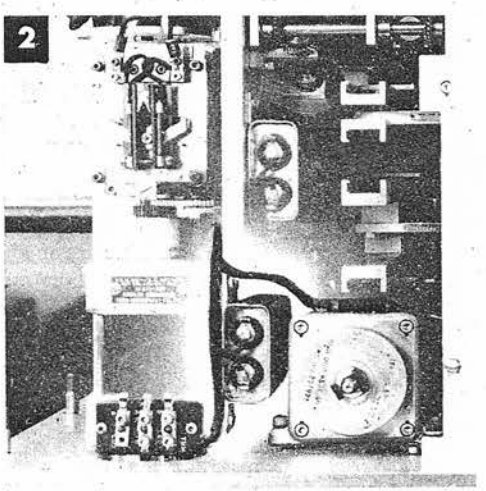
Readjust the star shell computer to the instrument.

RANGE MOTOR





1 Remove the five screws securing the supporting post beside the range motor.



2 Remove the two screws securing the capacitor brackets to the time motor.

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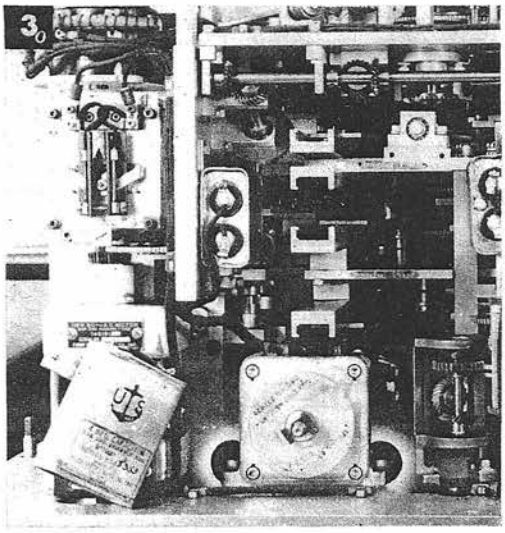
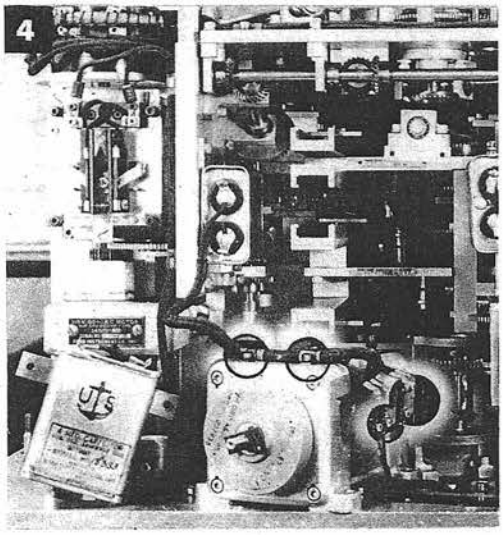
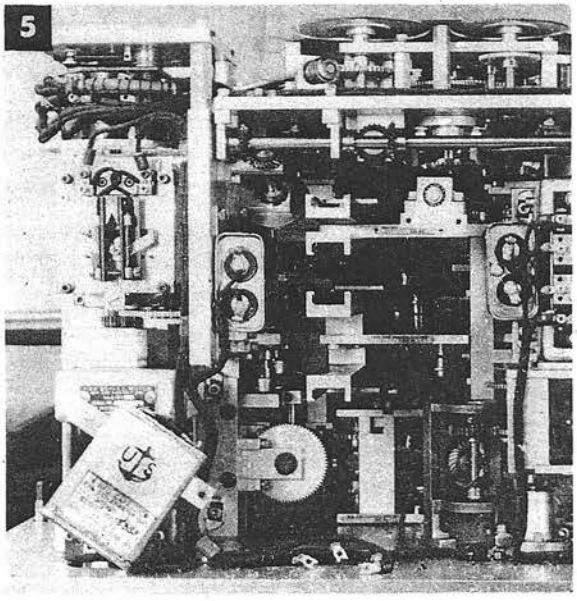


3 Remove the four screws securing the range motor to the base plate.



4 Lift the range motor over the cable in front of it.
Remove the screws connecting the external leads to the terminal block.
Remove the two screws securing the terminal block. Free the leads.
Remove the screws from the two cable clamps on the motor. Free the cable.

5 Remove the motor.

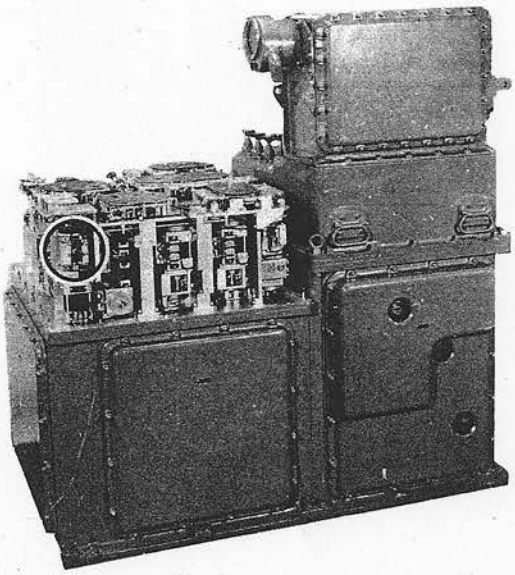


To reinstall the range motor, reverse the removal procedure.

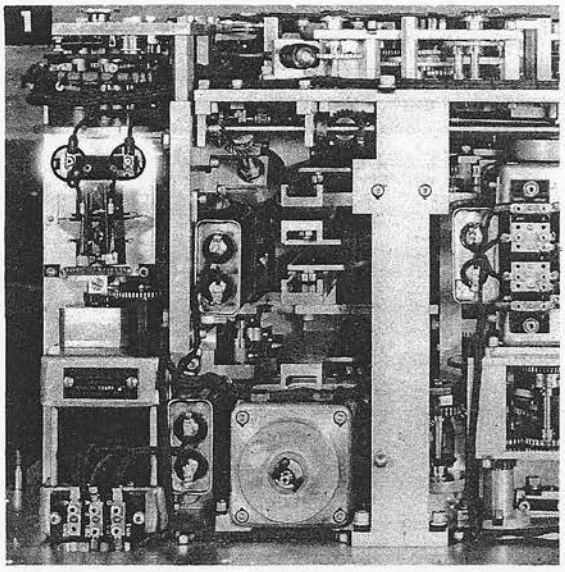
CAUTION: Tighten clamp A-168 on the motor shaft. It cannot be reached after the motor is installed.

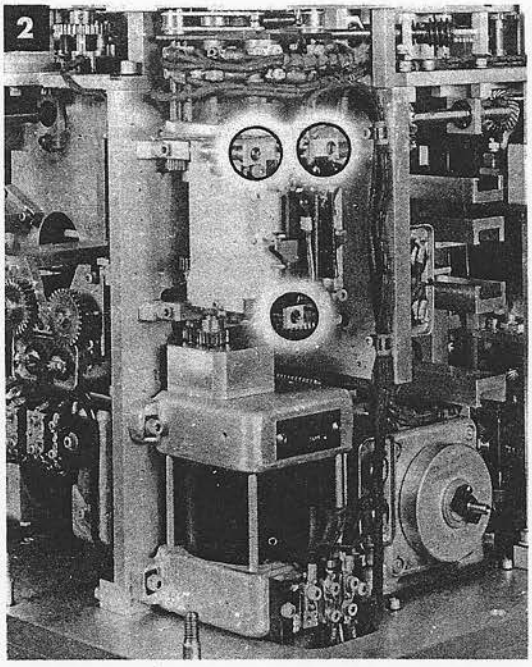
Check the operation of the range receiver.

TIME MOTOR REGULATOR

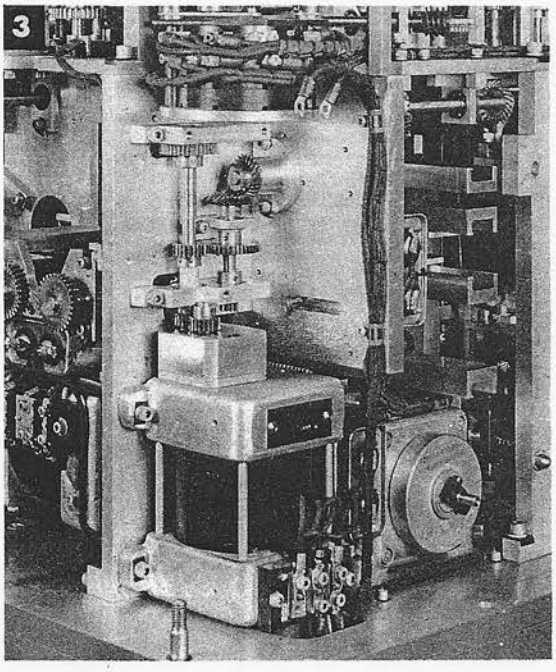


1 Remove the two screws connecting cable leads TMR and TM2 to the terminal block on the time motor regulator.





2 Loosen the three camera screws securing the regulator to the mounting brackets.
Tilt the gear end of the regulator out of mesh.

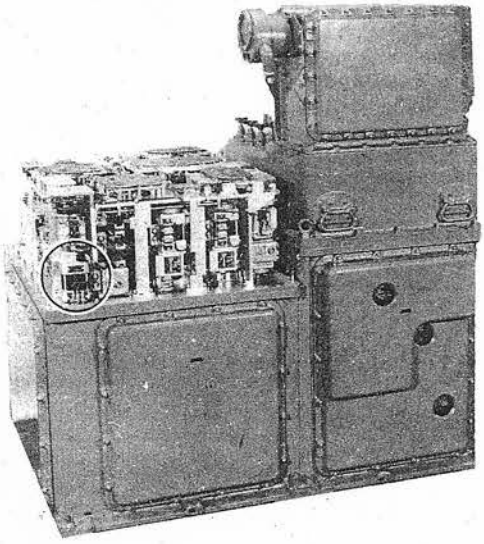


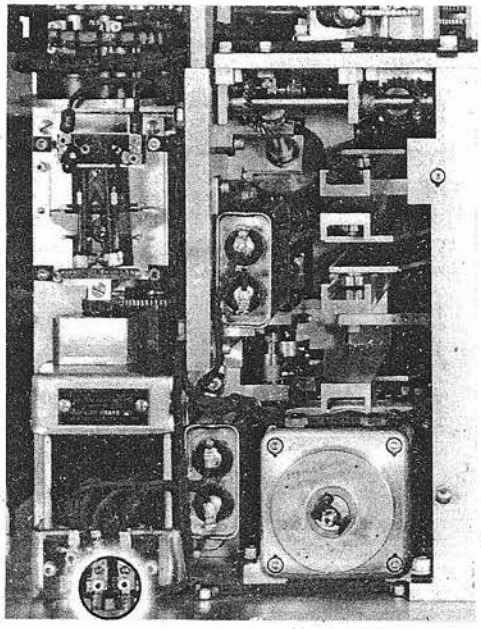
3 Remove the regulator.

To reinstall the time motor regulator, reverse the removal procedure.

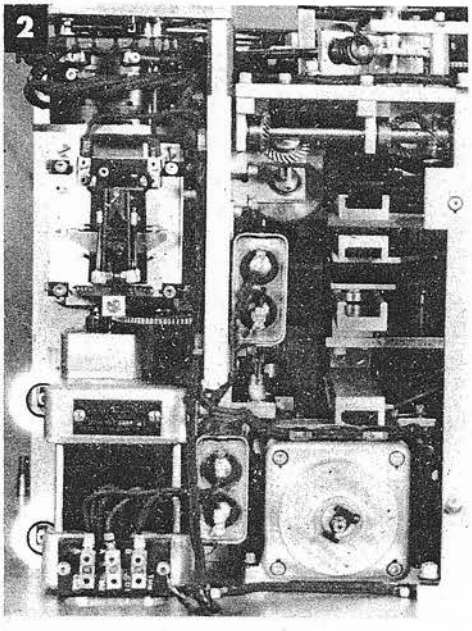
Position the gear on the regulator for sufficient clearance.

TIME MOTOR

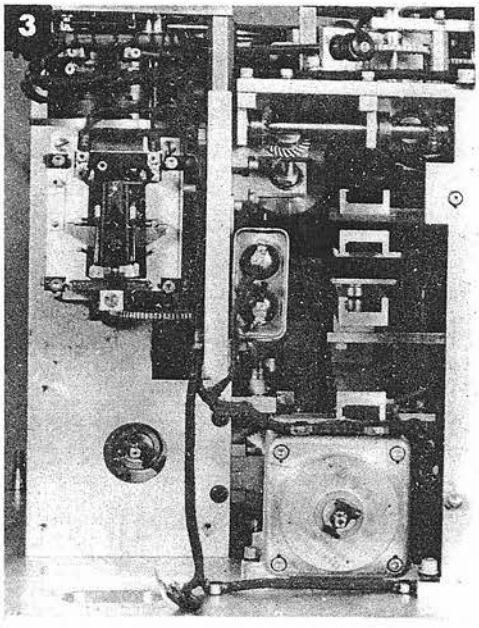




1 Remove the two screws connecting cable leads TMM and TM2 to the servo-motor terminal block.

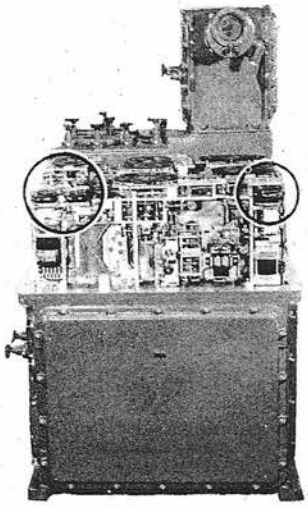


2 Remove the four screws securing the motor to the mounting plate.

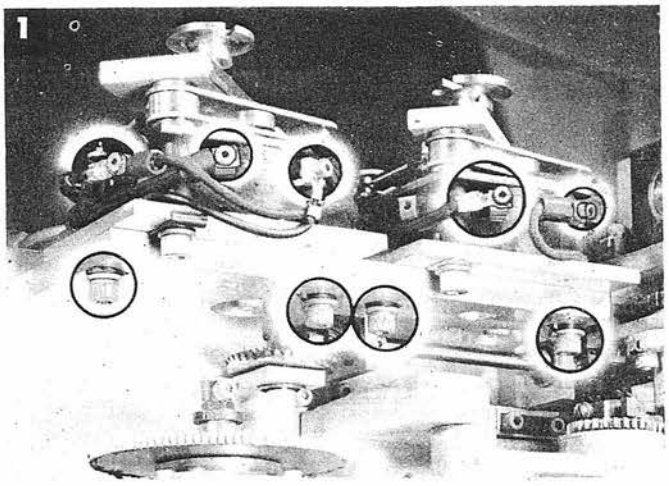


3 Remove the motor.

To reinstall the time motor, reverse the removal procedure.

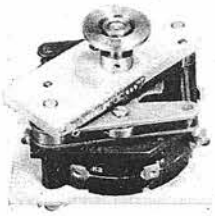


TARGET SPEED, RANGE RATE CONTROL, AND CONTROL SWITCHES

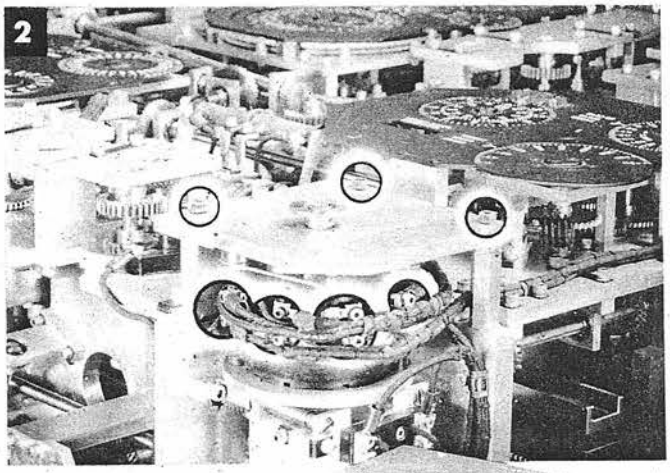


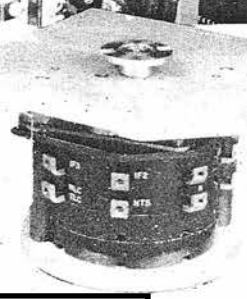
NOTE:
Label any unflagged cable leads so that they can be correctly reconnected.

1 To remove the target speed or the range rate control switch, remove the two screws securing the switch to the mounting plate. Remove all the screws connecting the cable leads to the switch. Remove the switch.



2 To remove the control switch, remove the three screws securing the mounting plate to the instrument.
Remove all the screws connecting cable leads to the switch. (See note above.) Remove the switch.





To reinstall a switch, reverse the removal procedure.

Check all cable connections before turning the power on.

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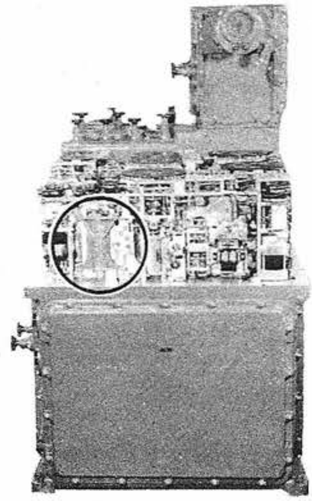
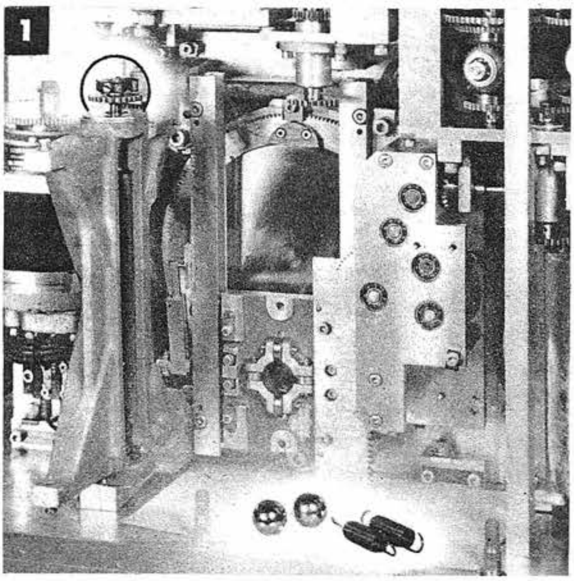
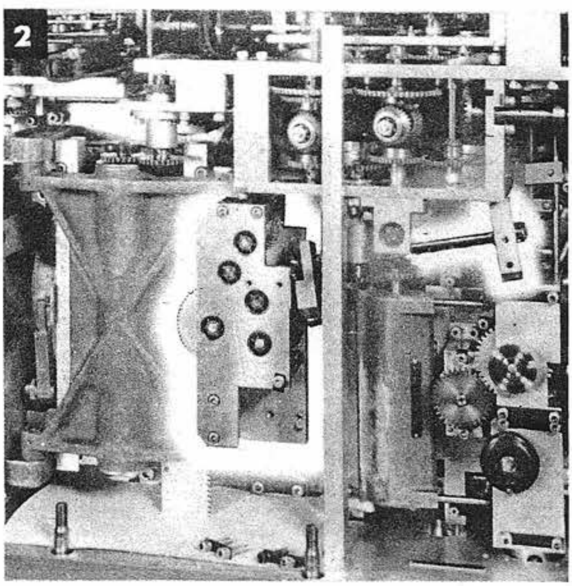
RANGE RATE INTEGRATOR

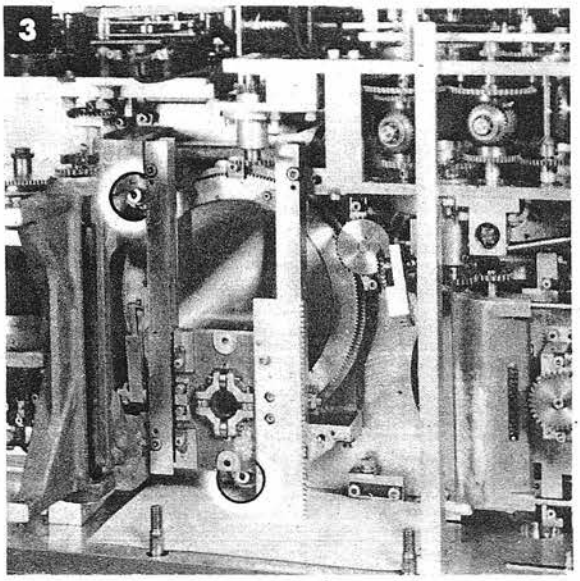




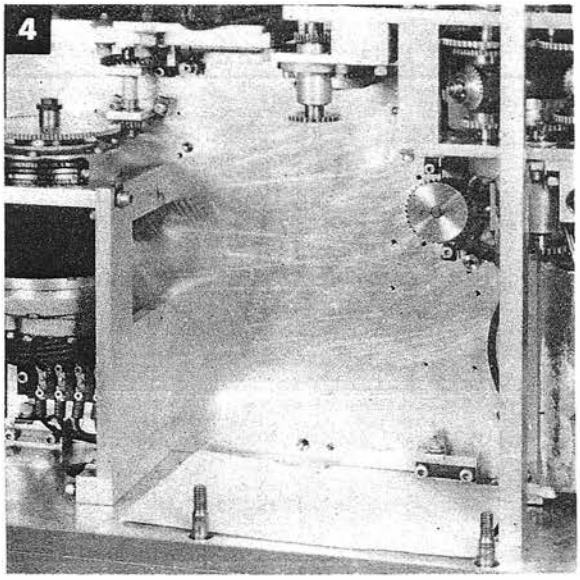
1 Loosen clamp A-167 and slip the gear out of mesh. Remove the two springs. Open the integrator. Be careful not to drop the balls. Remove both balls from the retaining rollers.



2 Remove the four screws securing the horizontal shaft assembly above the range rate ratio integrator. It is not necessary to remove this shaft assembly.
Remove the three rear screws securing the gearing at the right of the range rate integrator. Remove the gearing group.



3 Remove the three screws securing the integrator to the plate. Work the dowels free.



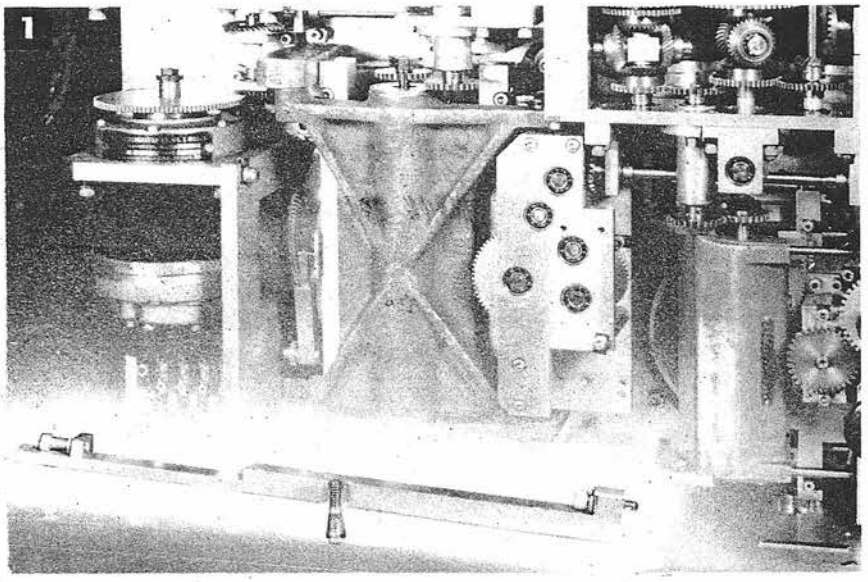
4 Remove the range rate integrator.

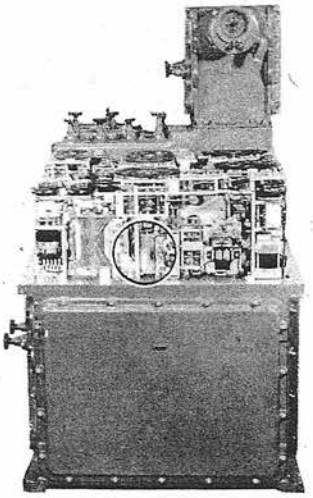
To reinstall the range rate integrator, reverse the removal procedure.

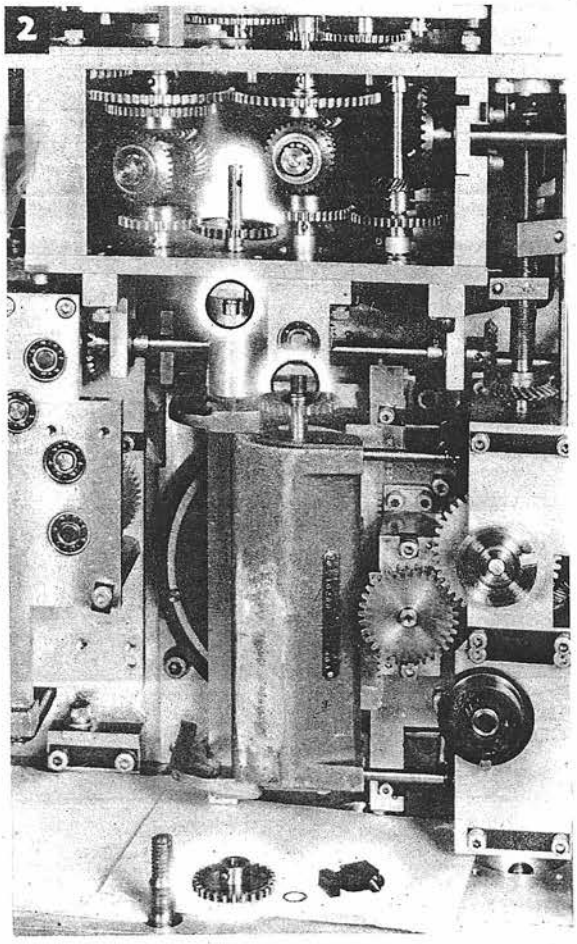
Readjust clamps A-170 and A-171.

Run tests.

RANGE RATE RATIO INTEGRATOR







1 Remove the two screws securing the supporting post in front of the integrator. Remove the post.
Place paper over the holes in the plate below the integrator to prevent parts from falling through.

2 Unpin the two gears on the shaft assembly to the left of the integrator output. Push the shaft up through the gears and adapter until the lower of the two gears can be removed. Loosen, but do not remove, the two screws securing the adapter.
Remove clamp A-166.

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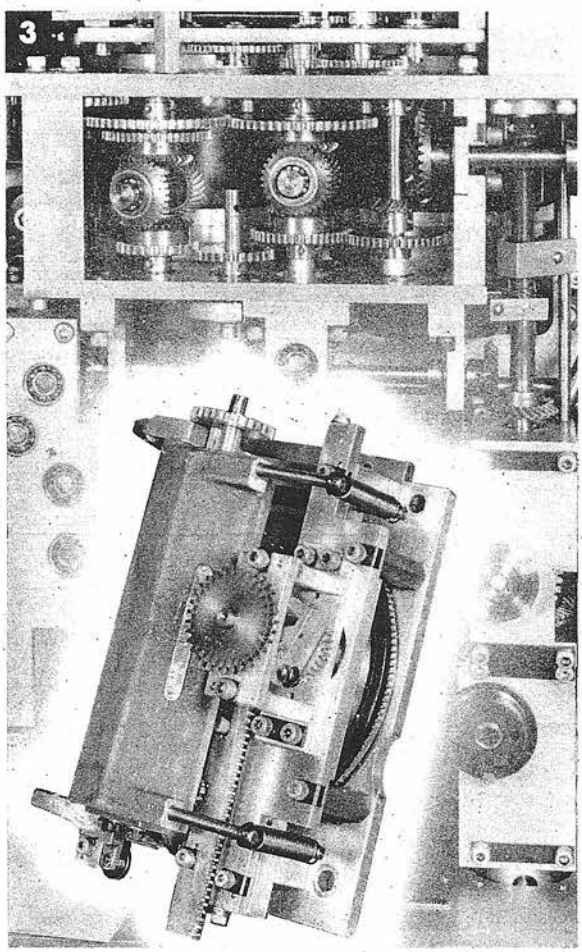
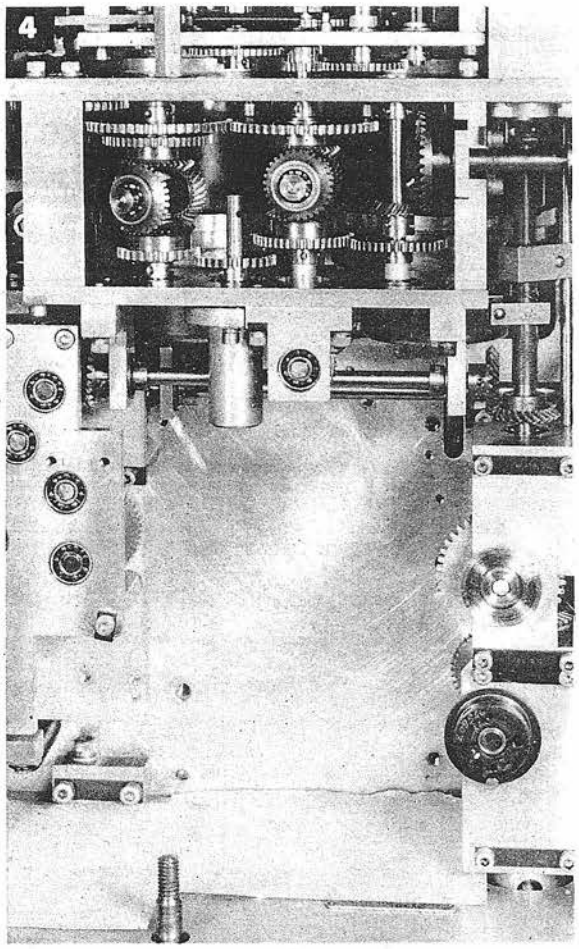


3 Remove the three screws securing the integrator to the plate. Work the dowels free. Tilt the integrator to clear the gearing.



4 Remove the range rate ratio integrator.

To reinstall the range rate ratio integrator, reverse the removal procedure.

Readjust clamps A-172 and A-173.

Run rate control tests.

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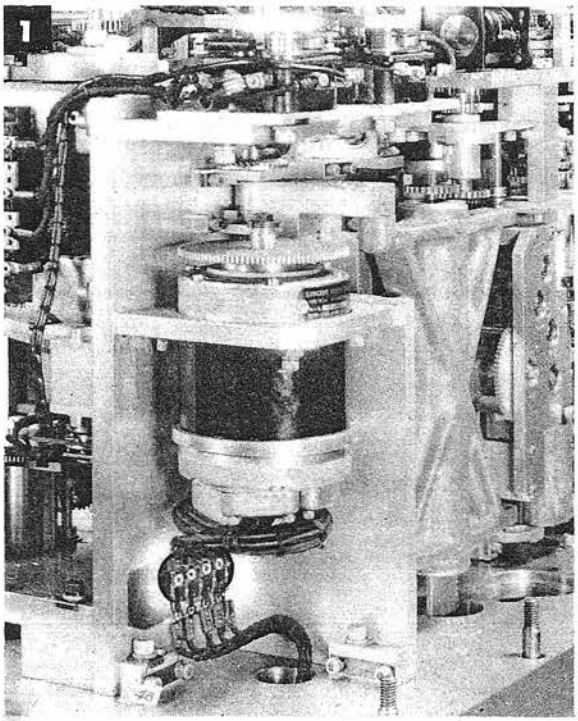
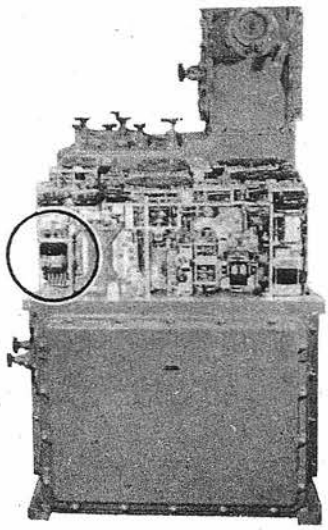
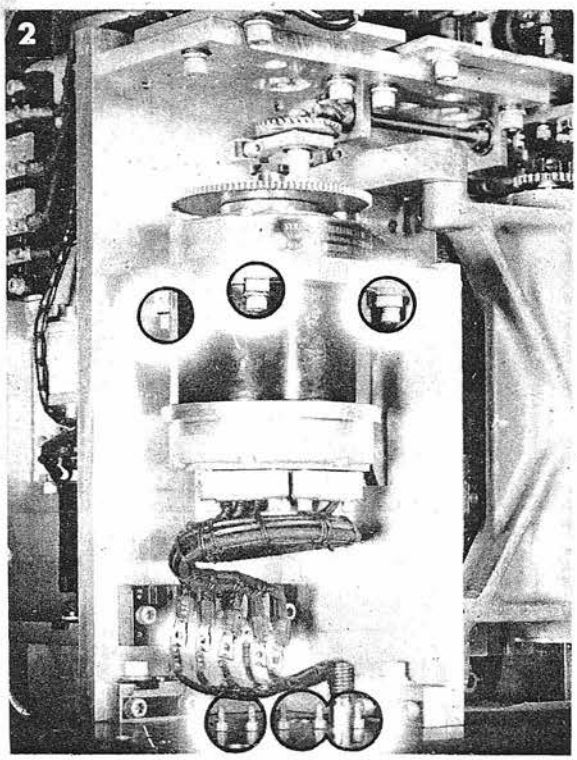
△cR TRANSMITTER





1 Remove the five screws connecting the transmitter leads to the terminal block.

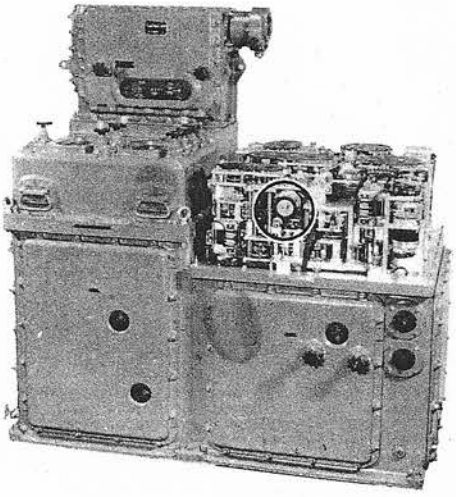


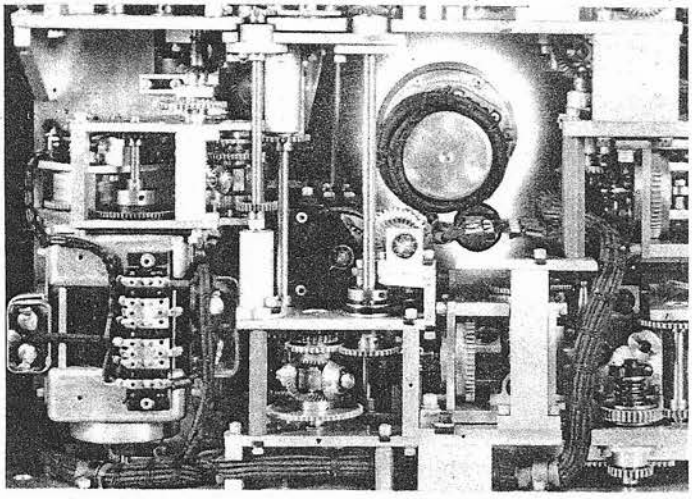
2 Remove the three screws and locking blocks securing the transmitter. Remove the transmitter.

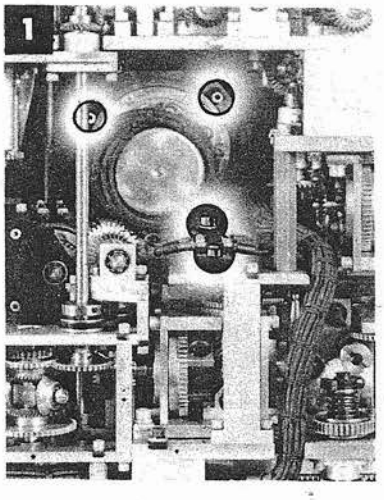
To reinstall the △cR transmitter, reverse the removal procedure.

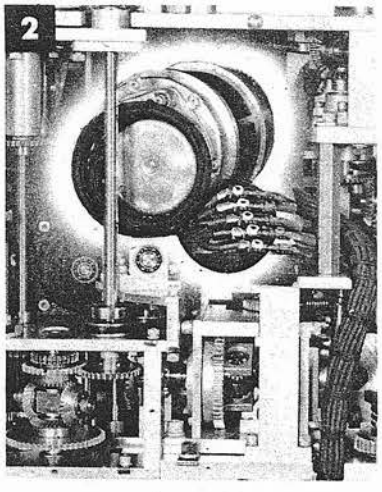
Run transmission tests.

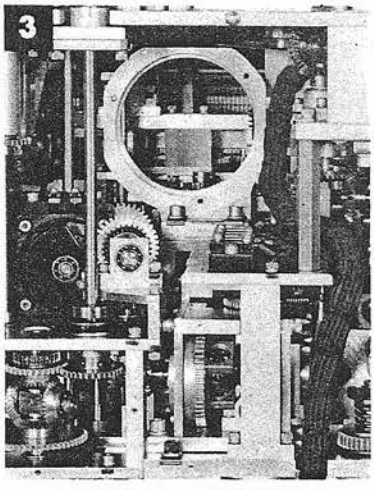
Ct TRANSMITTER











1 Remove the three screws and locking blocks securing the transmitter.
Remove the two screws securing the terminal block.

2 Remove the five screws connecting the transmitter leads to the terminal block.

3 Remove the transmitter.

To reinstall the *Ct* transmitter, reverse the removal procedure.

Readjust clamp A-258.

Run transmission tests.

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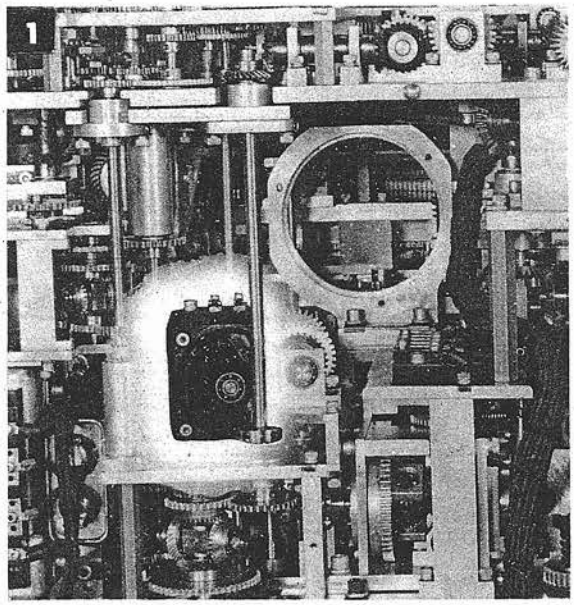
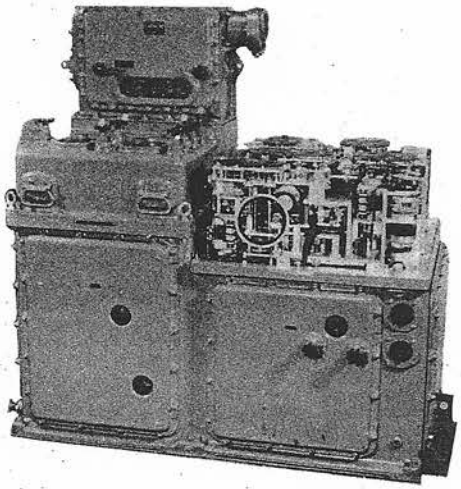
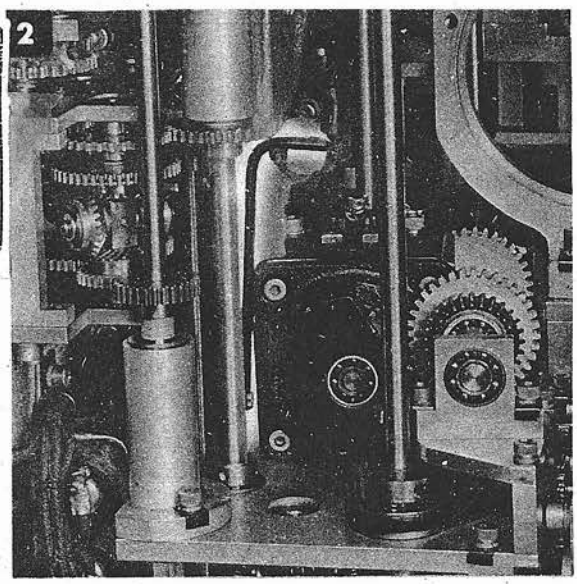
jdR CLUTCH

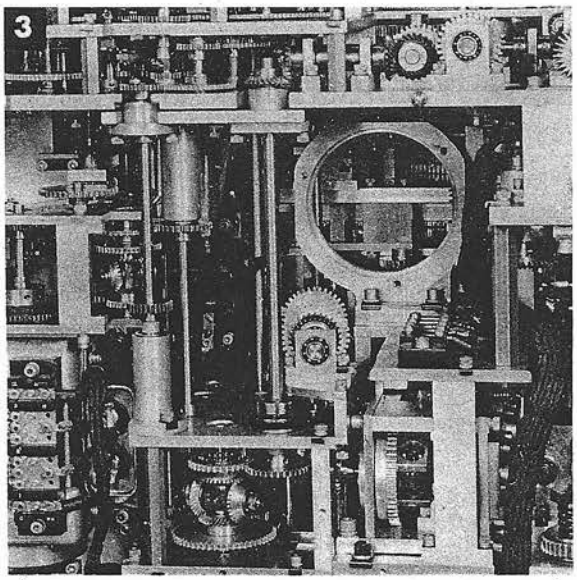
Ct Transmitter, page 611





1 Remove the two screws connecting the cable leads jRR and jR1 to the clutch terminal block.





2 Remove the two screws securing the clutch.

3 Turn the clutch to clear the gearing. Remove the *jdR* clutch.

To reinstall the *jdR* clutch, reverse the removal procedure.

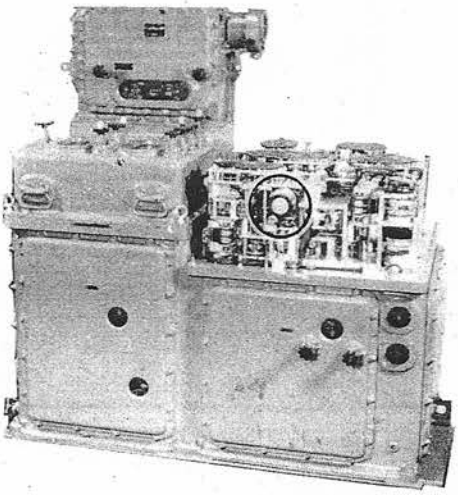
Reinstall the *Ct* transmitter.

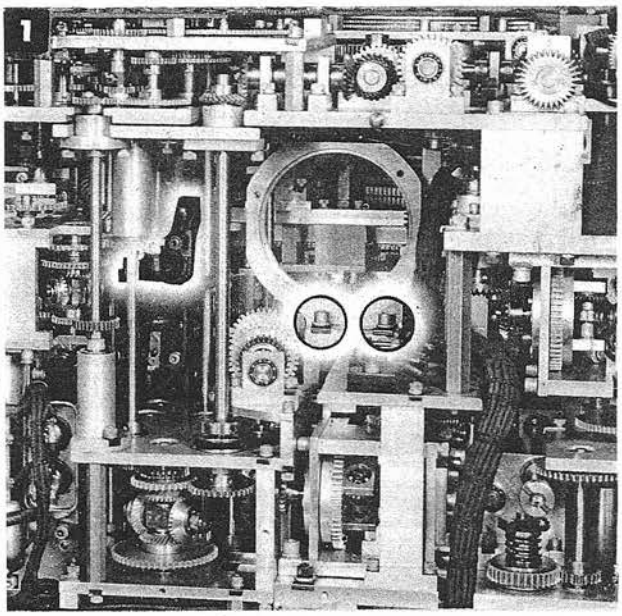
Readjust clamp A-258.

Check rate control and transmission tests.

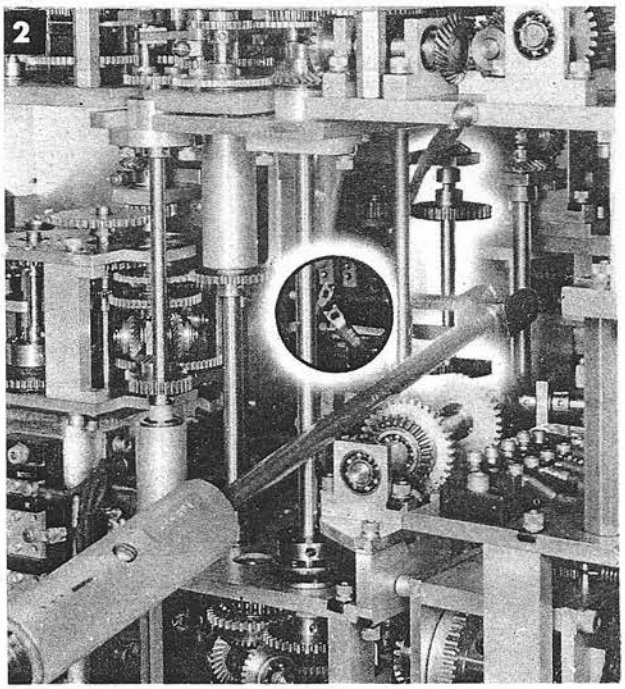
jE LOCK

Ct Transmitter, page 611
jdR Clutch, page 612

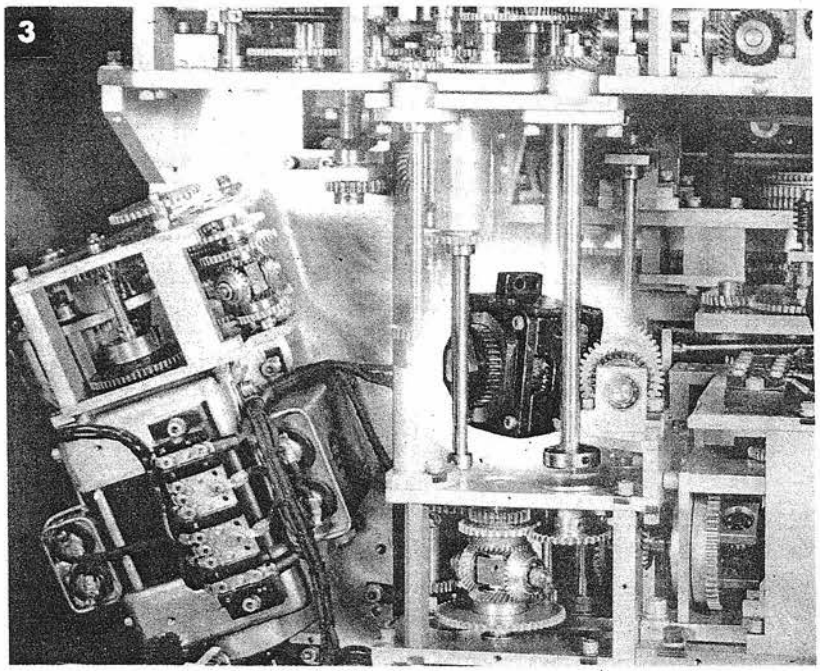




1 Remove the two screws securing the mounting bracket for the *Ct* transmitter. Remove the bracket.
Remove the two screws connecting cables NLC and NLCC to the terminal block of the lock.



2 Remove the four screws securing the shaft assembly between the lock and the *jE* clutch below the lock. Remove the assembly.
Remove the two screws securing the lock.



3 Remove the four screws securing the *jE* servo motor to the mounting plate. Tilt the follow-up out of the way. Turn the lock to clear the surrounding gearing. Remove the lock.

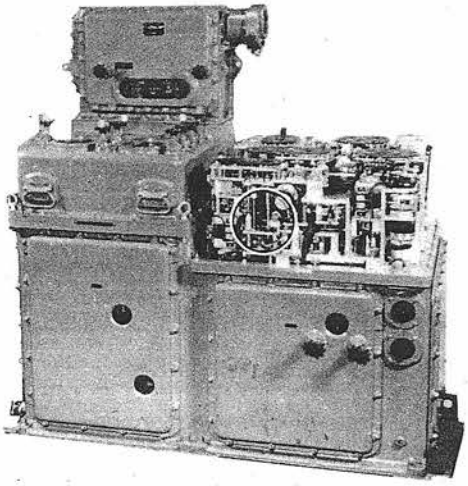
To reinstall the *jE* lock, reverse the removal procedure.

Reinstall the *jdR* clutch and the *Ct* transmitter.

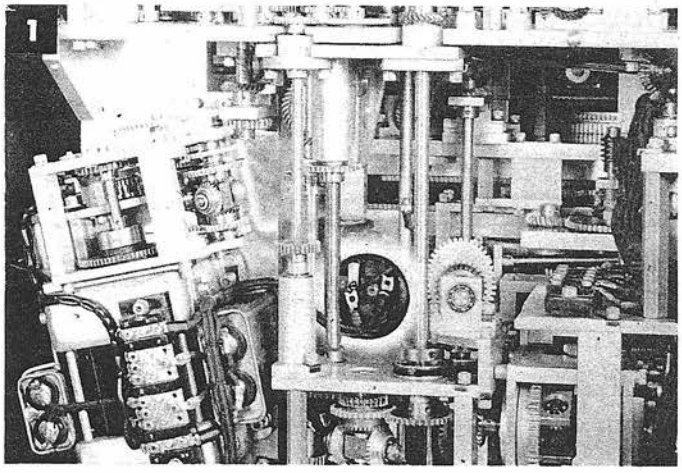
Readjust clamps A-258 and A-259. Run rate control and transmission tests.

jE CLUTCH

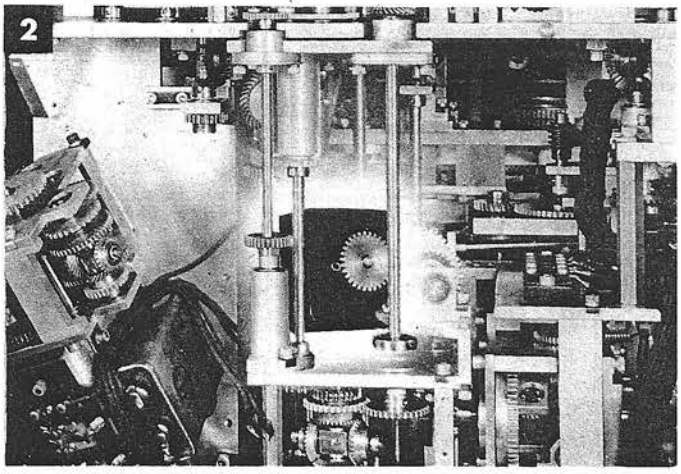
Ct Transmitter, page 611
jdR Clutch, page 612
jE Lock, page 613



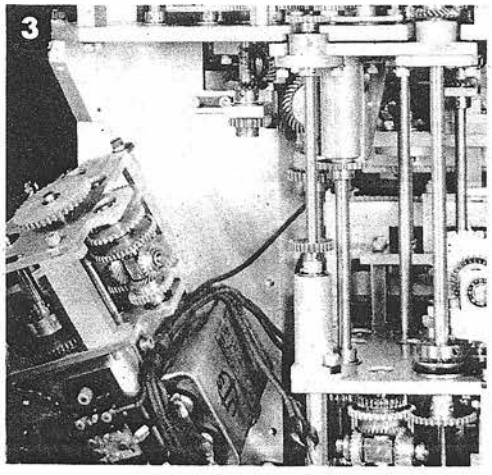
1 Remove the two screws connecting cable leads NC and NCC to the terminal block. Remove the two screws securing the clutch to the mounting plate.



2 Turn the clutch almost completely around to clear the gearing.



3 Remove the *jE* clutch.



To reinstall the *jE* clutch, reverse the removal procedure.

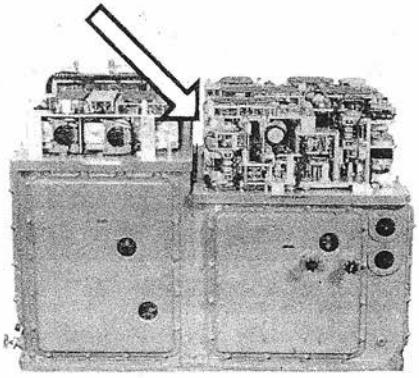
Reinstall the *jE* lock, the *jdR* clutch, and the *Ct* transmitter.

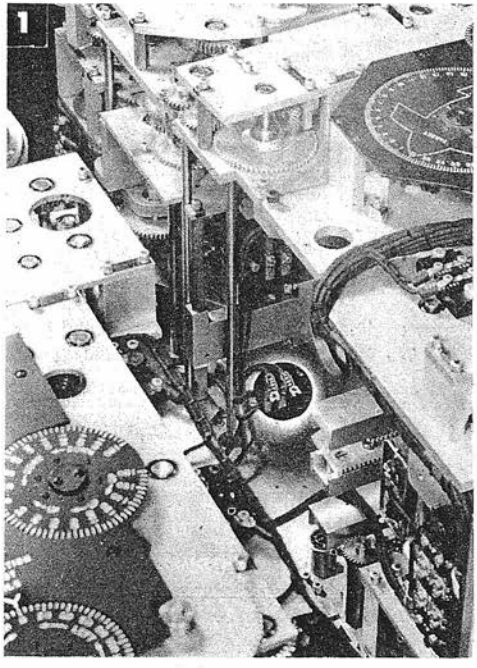
Readjust clamps A-258 and A-529.

Run tests.

jBr LOCK

RdE Follow-up, page 597

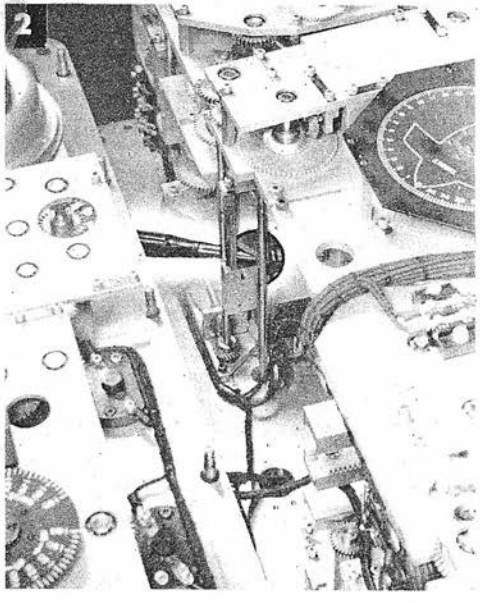


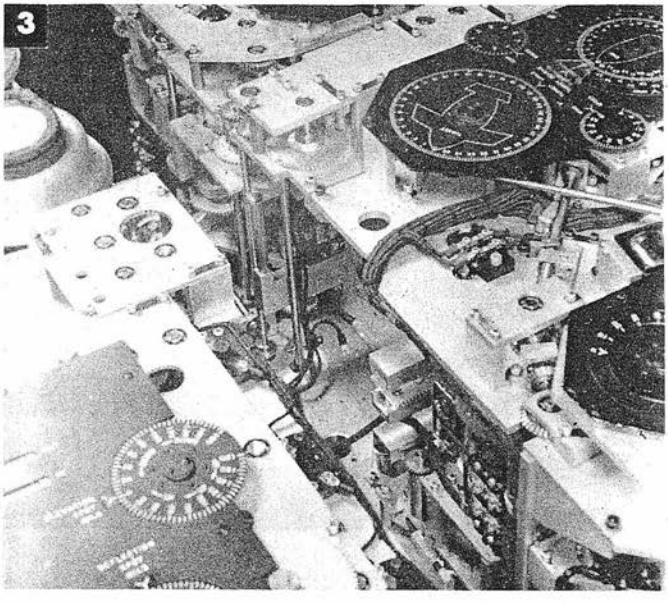


1 Remove the two screws connecting cable leads TLC and TLCC to the terminal block. Remove the screw from the cable clamp on the lock. Free the cable.

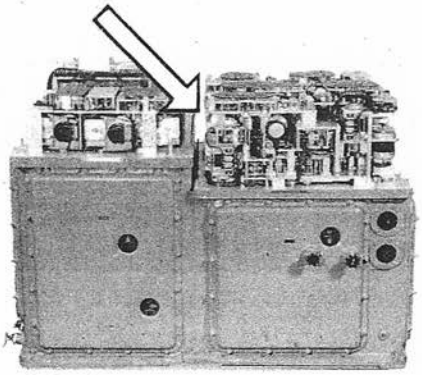
2 Remove the two screws securing the lock. The screw at the right is always a fillister type screw.

3 Remove the *jBr* lock.



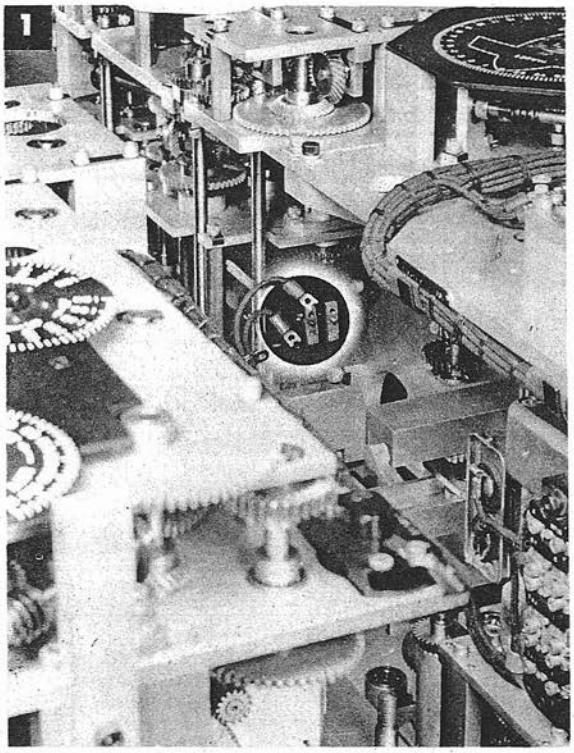


616

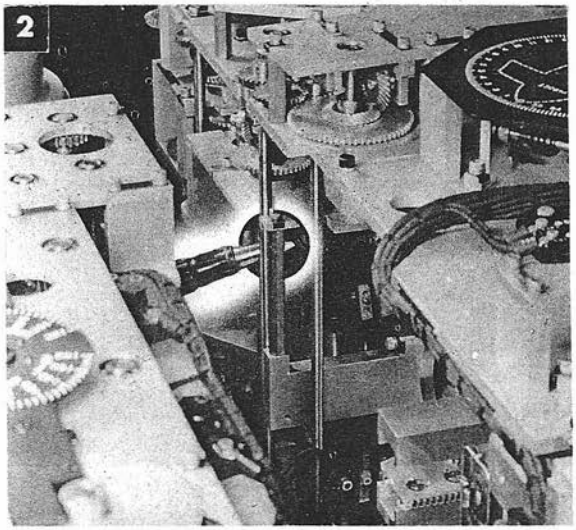


¡Br CLUTCH

RdE Follow-up, page 597

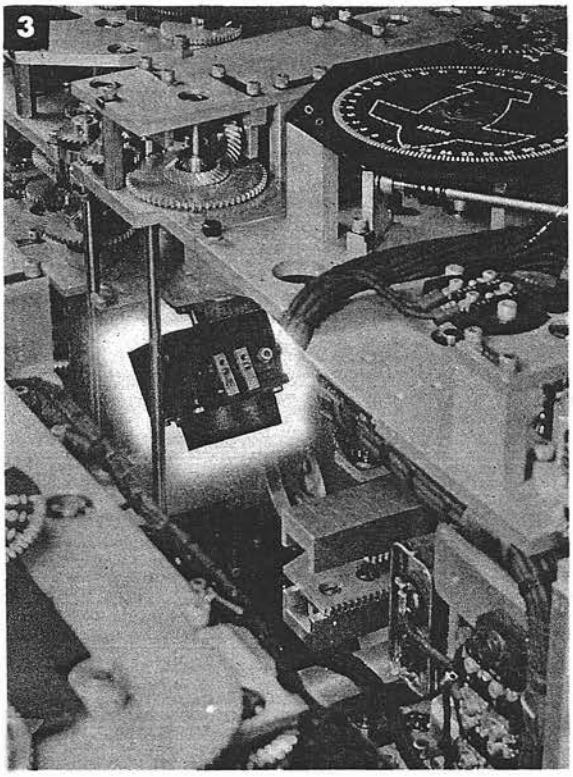


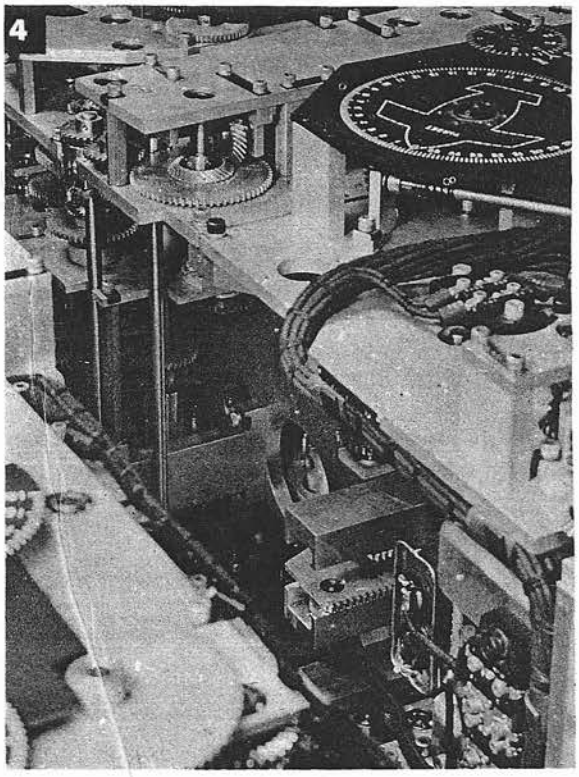
1 Remove the two screws connecting cable leads TC and TCC to the terminal block.
Remove the screw securing the cable clamp to the clutch. Free the cable.



2 Remove the two screws securing the clutch. The screw at the right is always a fillister type screw.

617





3 Loosen clamp A-207. Slip the gear up out of mesh as far as it will go. Tilt the clutch to clear the shafts.

4 Remove the *jBr* clutch.

To reinstall the *jBr* clutch, reverse the removal procedure.

Reinstall the *RdE* follow-up.

Readjust clamp A-118.

Run tests.

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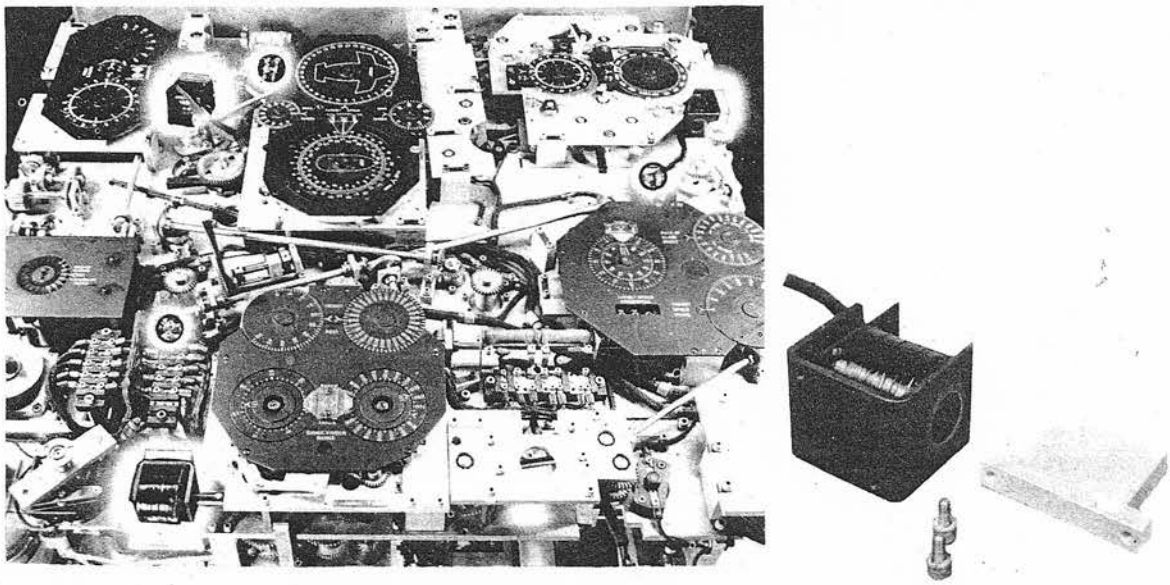
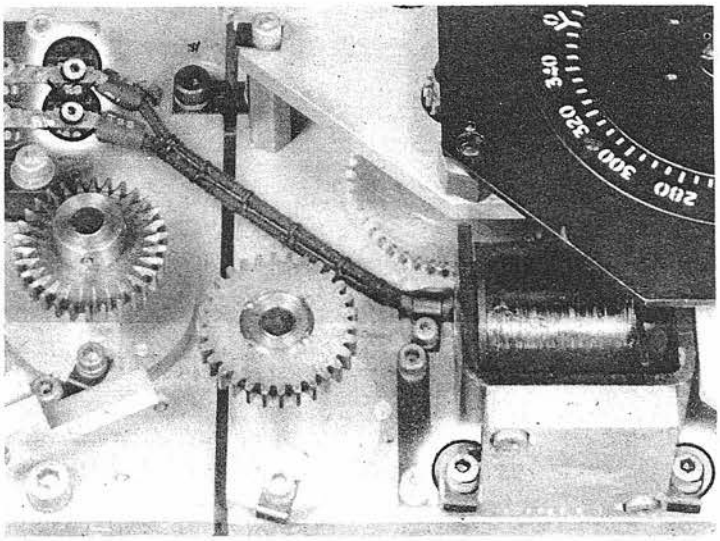
RANGE FINDER'S, POINTER'S, AND TRAINER'S SIGNAL SOLENOIDS



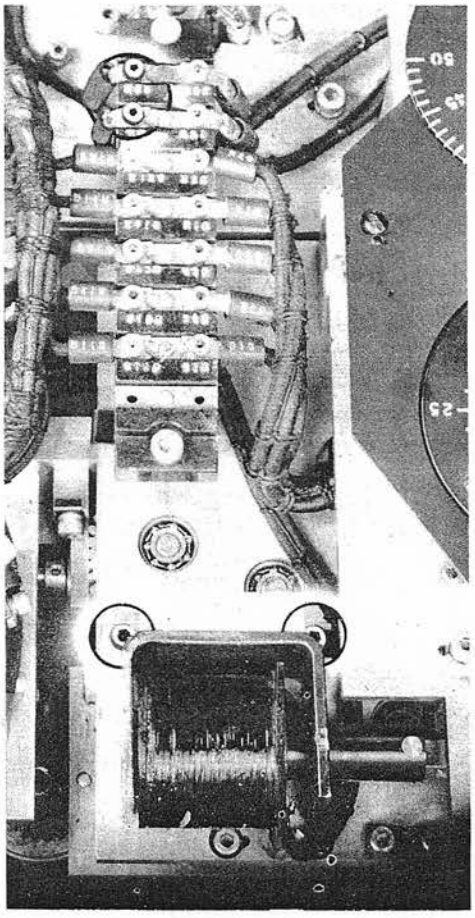
To remove any one of the signal solenoids, remove the two screws connecting its cable leads to the terminal block. Also remove the two screws securing the coil hanger to the top plate of the computer. Tilt the coil to disengage the plunger.

TRAINER'S SIGNAL

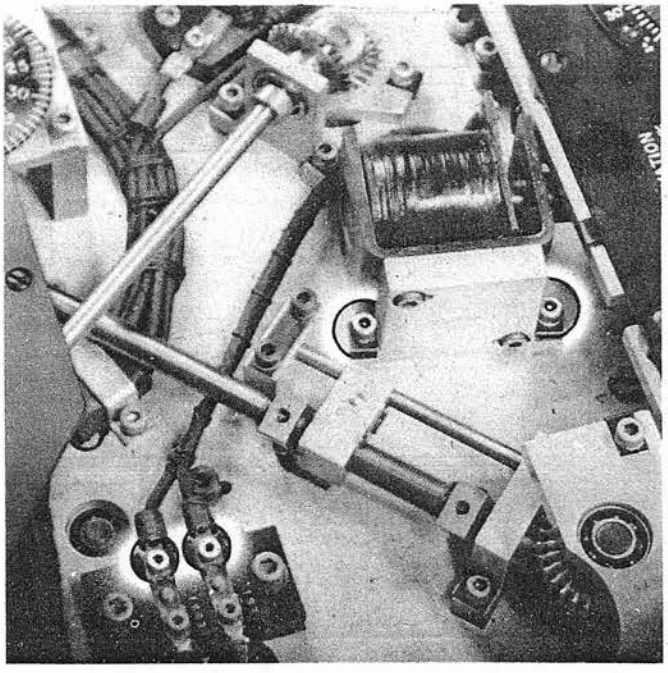
Disconnect leads TS and TSS.



RANGE FINDER'S SIGNAL



Disconnect leads RS and RSS.

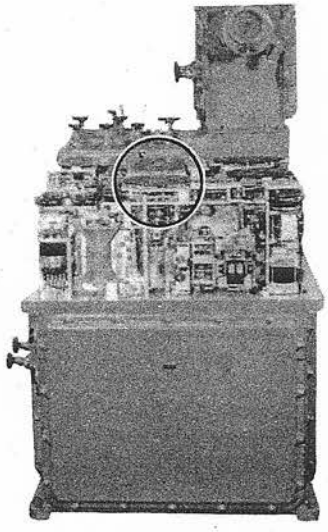


POINTER'S SIGNAL

Disconnect leads ES and ESS.

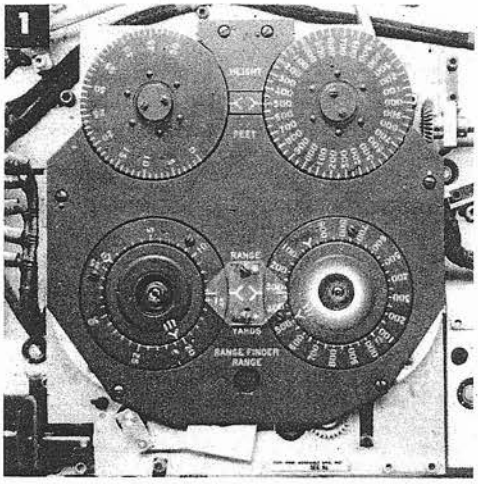
To reinstall a signal solenoid, reverse the removal procedure. Before tightening the screws firmly, energize the solenoid and position the coil so that the plunger does not hum or vibrate within the coil.

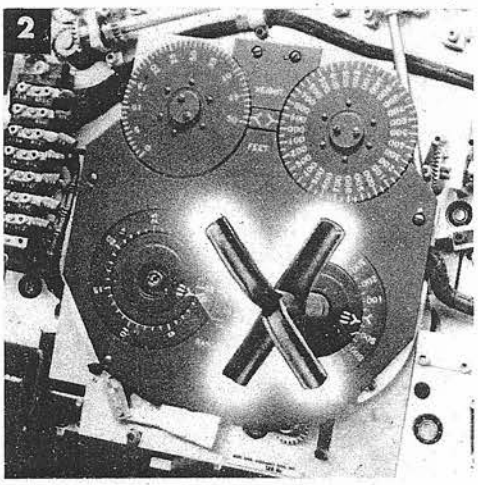
RANGE RECEIVER



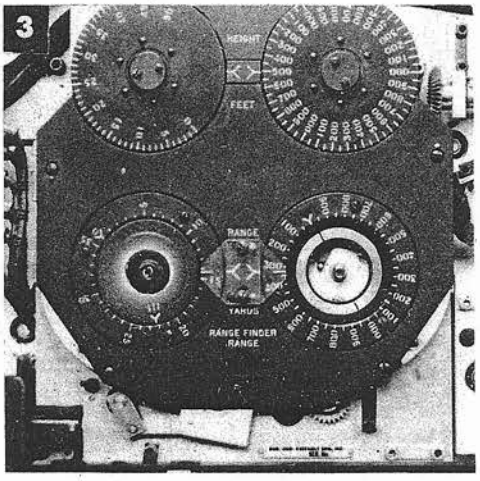
1 Loosen the nut securing the fine inner range dial to the rotor shaft.

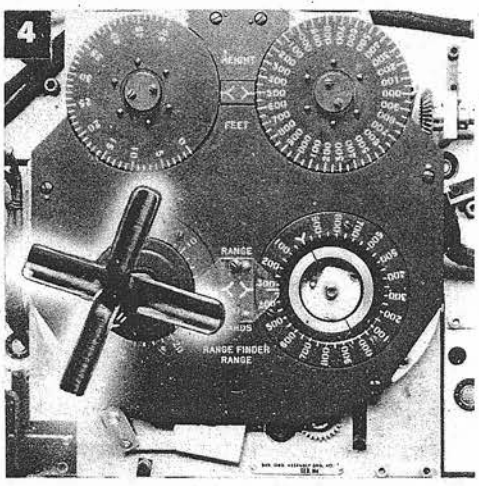
2 Using a special dial wrench, remove the nut and washer. Remove the dial.

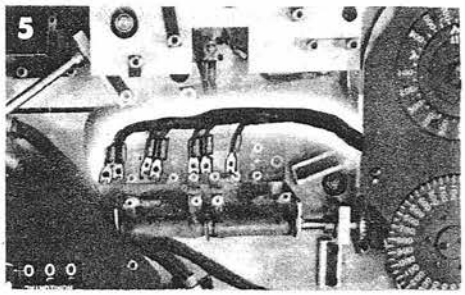




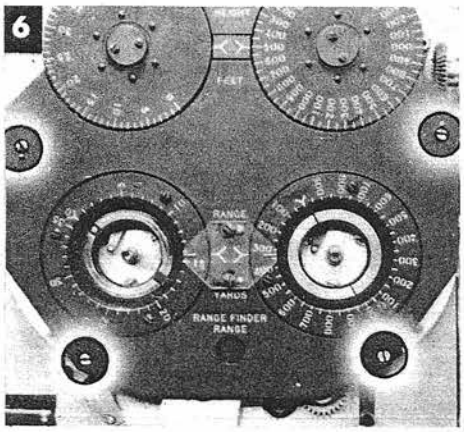
3 In the same manner, remove the coarse inner range dial.



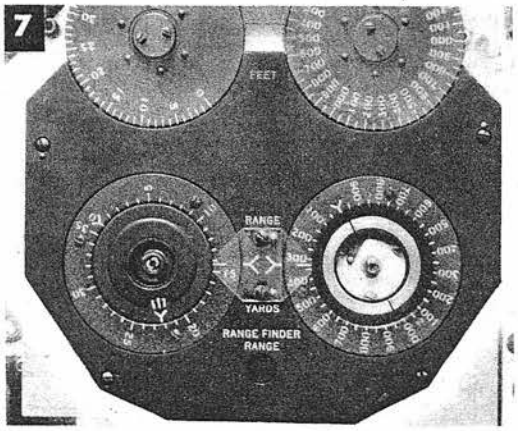




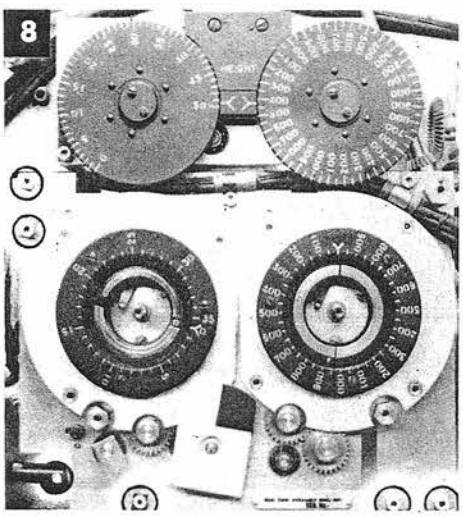
5 Remove the seven screws connecting cable leads to the terminal block at the right of the range receiver.



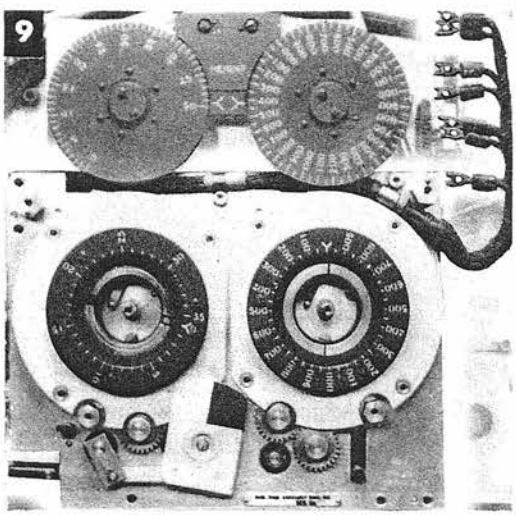
6 Remove the four screws securing the mask over the range receiver.



7 Remove the mask. Do not damage the dowels.

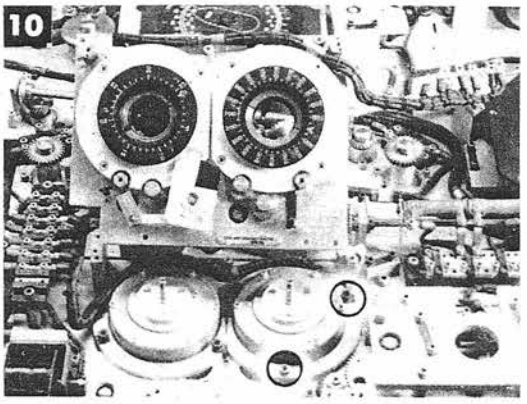


8 Remove the six screws securing the range receiver gearing. One screw is hidden below the cable at the upper right.
Remove the cotter pin from the pivot stud at the end of the solenoid plunger. Free the plunger arm.

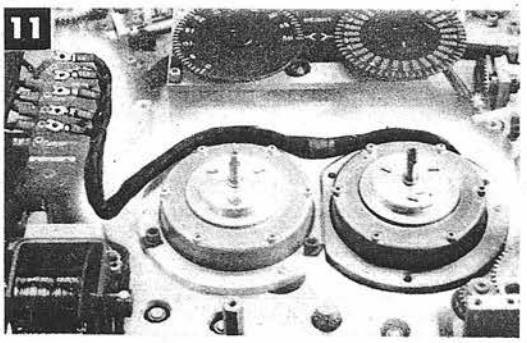


9 Work the unit dowels free. To avoid bending the height dials, lift the front edge of this assembly first.
Remove the assembly.

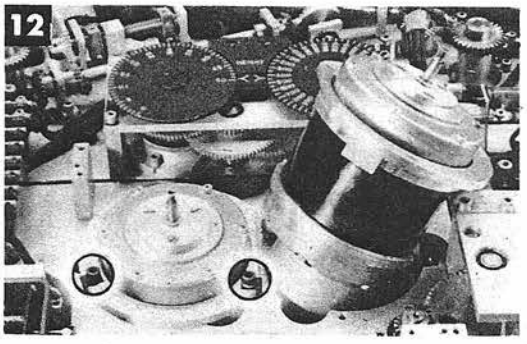
10 To remove the fine synchro, remove the three screws securing the flange to the plate.

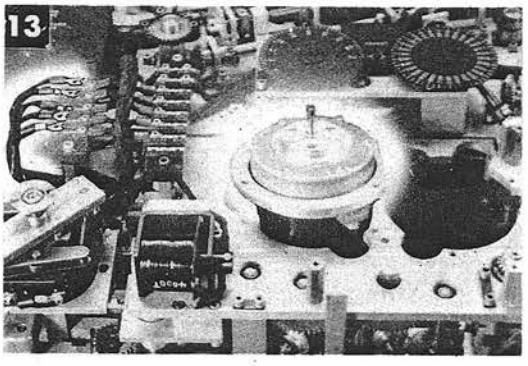


11 Remove the five screws connecting cable leads to the terminal block at the left.
Remove the cable clamp behind the synchros. Remove the fine synchro.



12 To remove the coarse synchro, remove the three screws securing the flange to the plate.





13 Remove the five screws connecting leads to the terminal block at the left.
Remove the synchro. Pull the cable through.

To reinstall the range receiver, reverse the removal procedure.

NOTE:
The dial with the roller contact is the fine dial.
Readjust clamp A-546, A-545, A-195, A-196, A-520, and A-521.
Check clamp A-240, A-164, A-187 and A-138.
Run tests.
Check range transmission.

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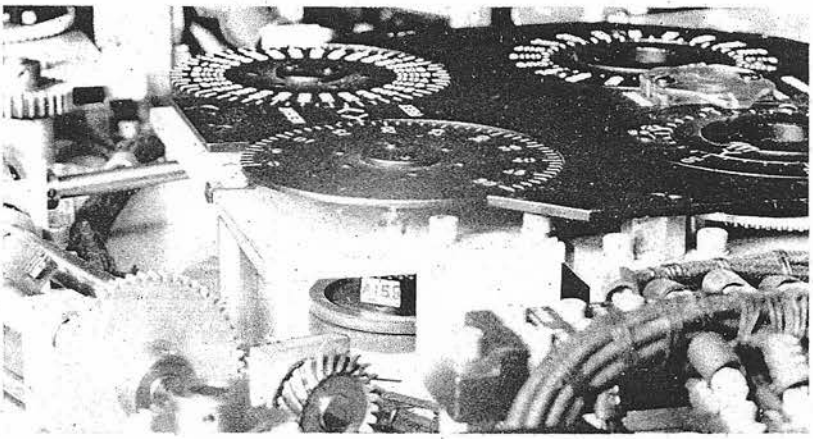
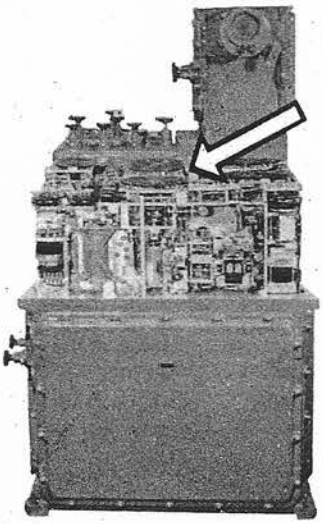
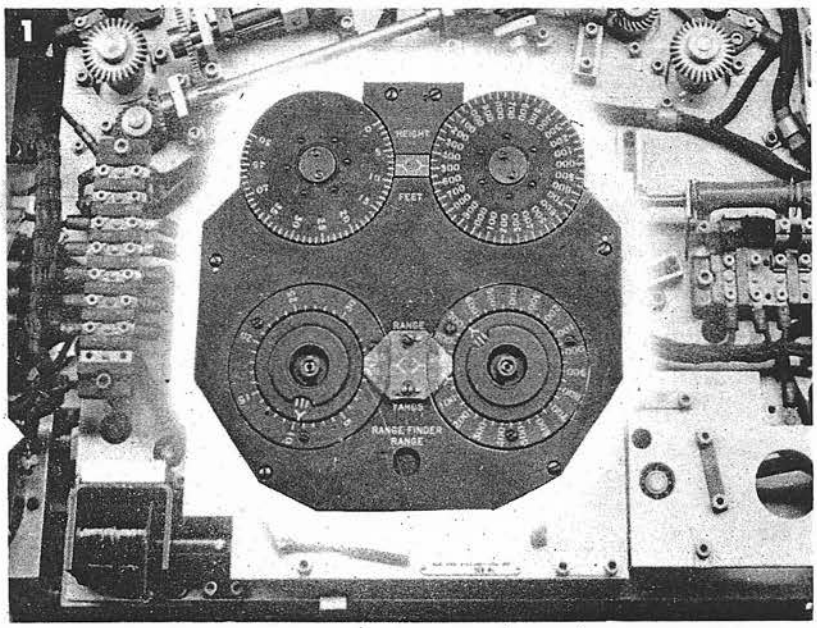
HEIGHT SPRING ASSEMBLY

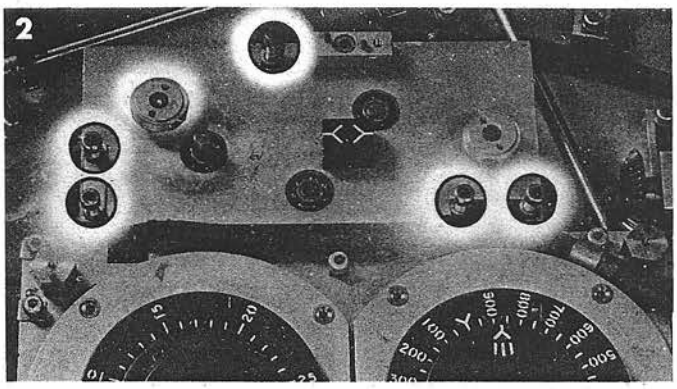




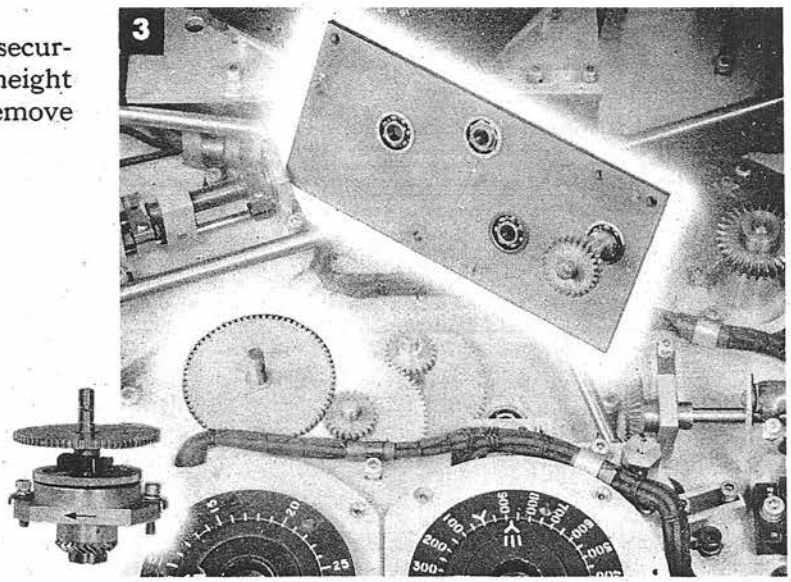


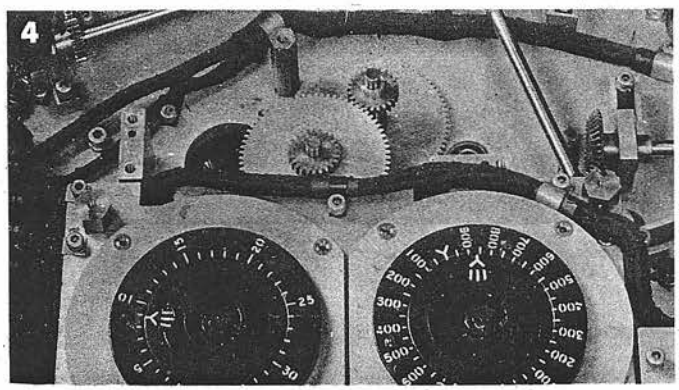
1 Remove the six screws securing the two sections of the masks. Remove both sections.
Remove the dial clamps on the height dials. Remove the dials.

2 Unpin the coarse dial hub. Remove the hub.
Remove the five screws securing the plate.



3 Remove the plate.
Remove the two screws securing the adapter for the height spring shaft assembly. Remove the assembly.





To reinstall the height spring assembly, reverse the removal procedure.

Readjust clamps A-138, A-124, A-158, A-522 and A-523.

Run tests.

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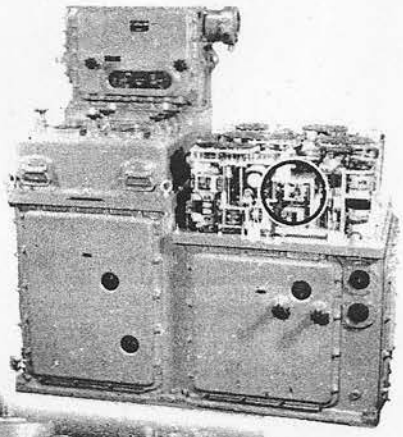
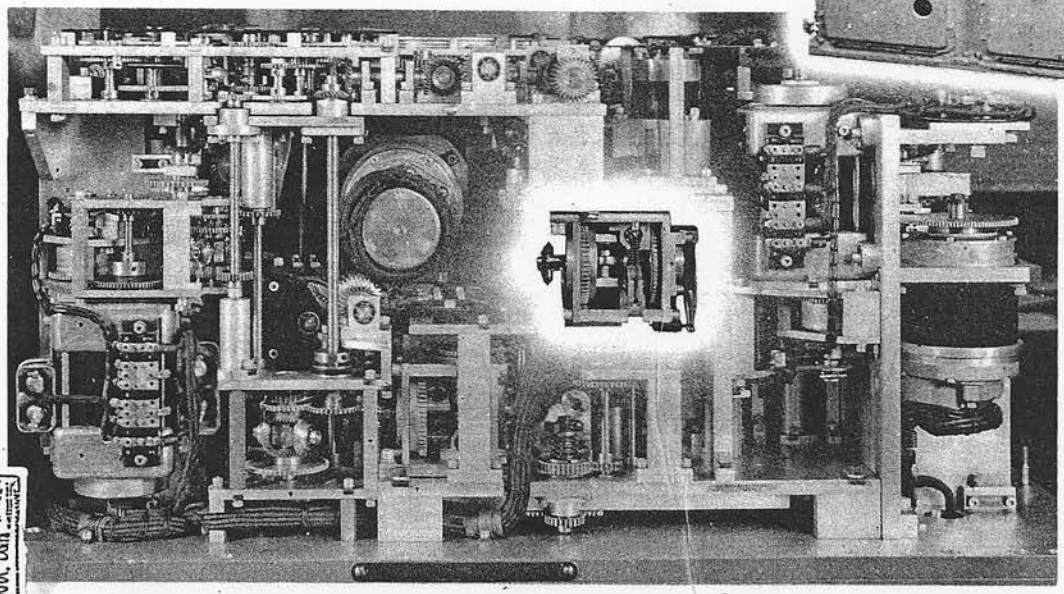
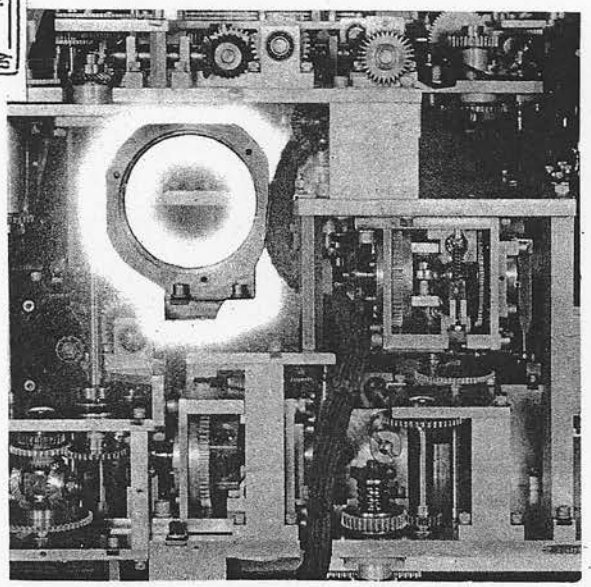
BEARING COMPONENT INTEGRATOR

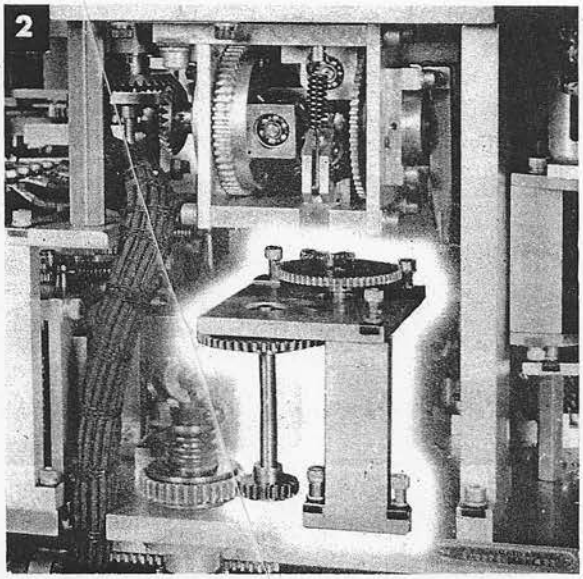
Ct Transmitter, page 611







1 Remove the two screws securing the supporting bracket for the *Ct* transmitter.
Remove the bracket.



2 Remove the three screws securing the upper plate of the gearing group below the integrator.
Remove the two screws securing the front supporting post.

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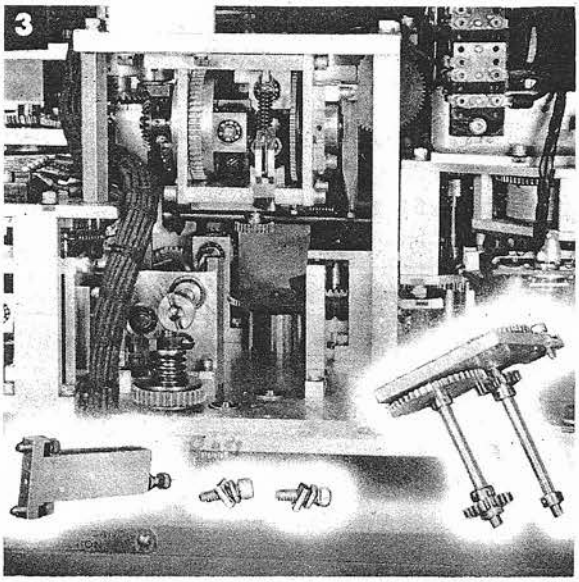
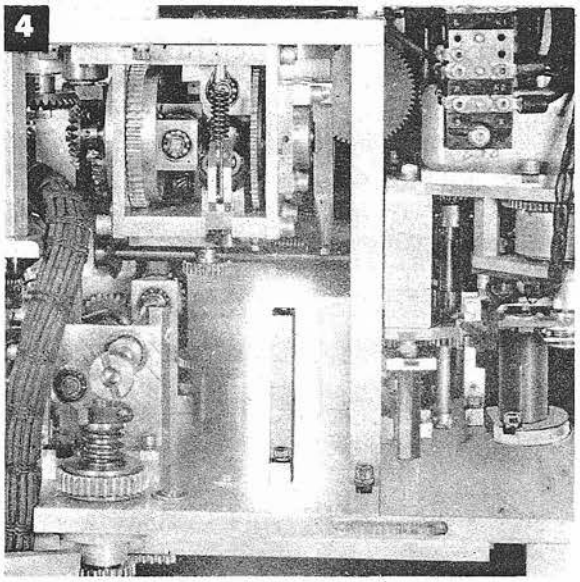
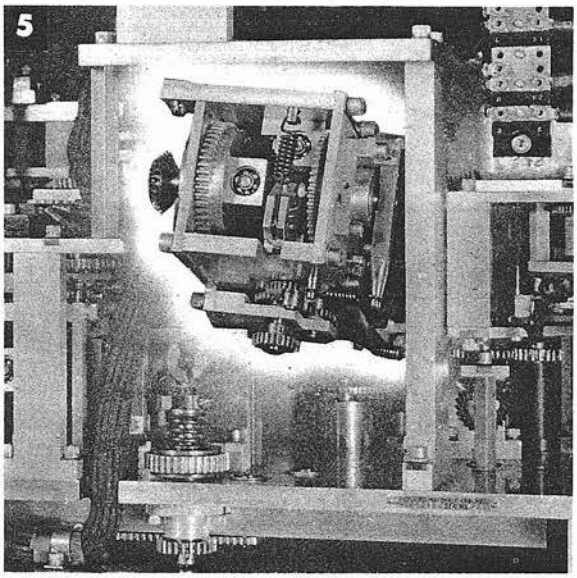


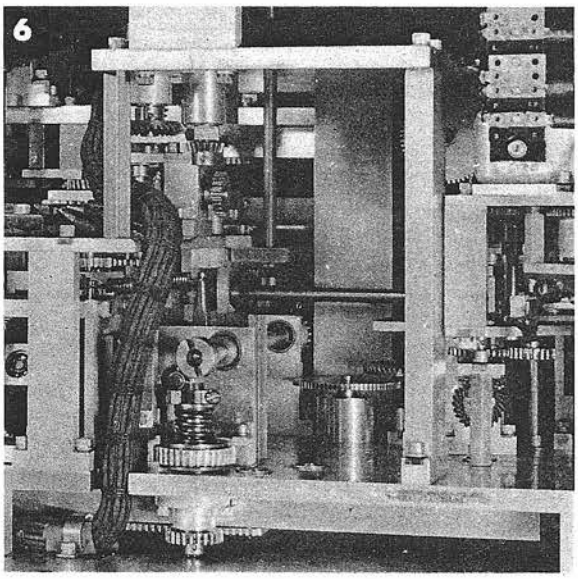
3 Remove the plate, associated shaft assemblies, and the post.



4 Remove the two screws and the rear supporting post for the plate just removed.



5 Back out the two screw dowels at the corners of the integrator toward the rear of the computer. Remove the three screws securing the unit. Support the integrator while removing the last screw. Tilt the integrator to clear the surrounding gearing.



6 Remove the integrator.

To reinstall the mechanism, reverse the removal procedure.

Reinstall the *Ct* transmitter.

Readjust clamps A-117 and A-258.

Run rate control and transmission tests.

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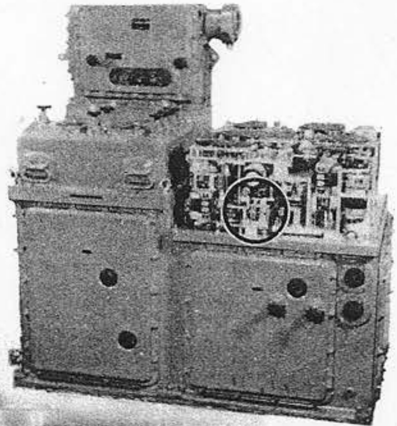
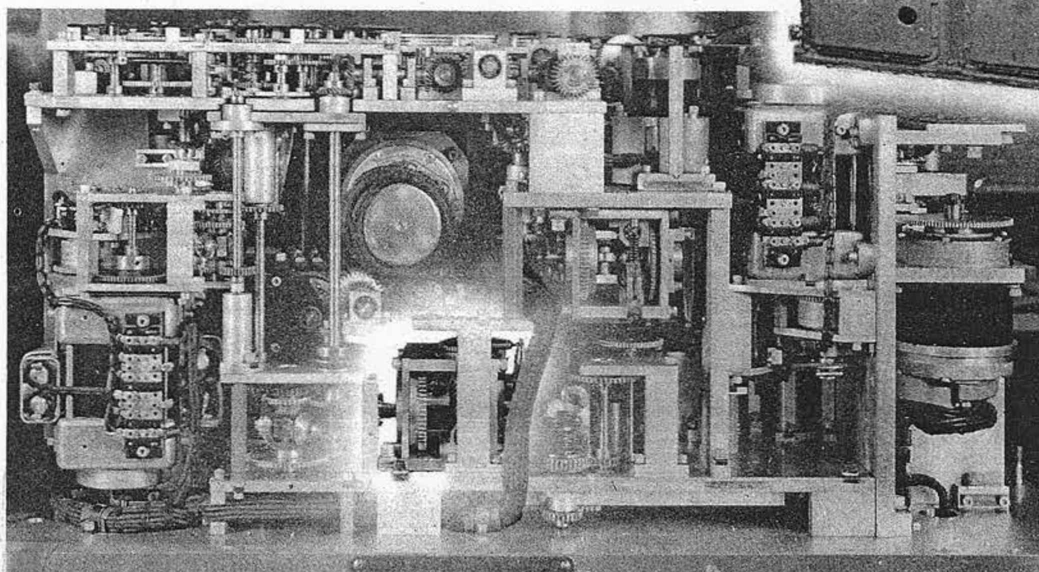
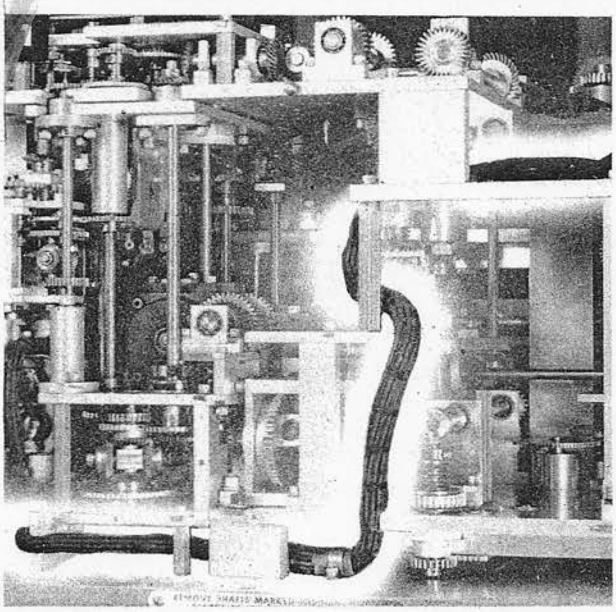
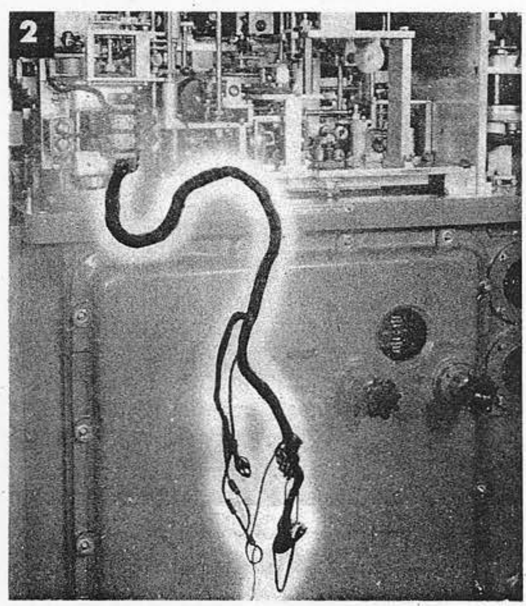
ELEVATION COMPONENT INTEGRATOR

Ct Transmitter, page 611
Bearing Component Integrator, page 626
Sh Follow-up, page 593









1 Remove the screws from the terminal connections of the section of the A cable not disconnected during removal of the *Sh* follow-up. Loosen the screws securing the cable clamps.

2 Free the cable back to the point where it emerges near the *jE* follow-up.

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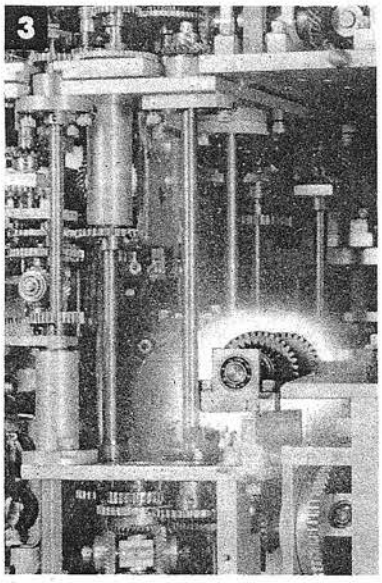
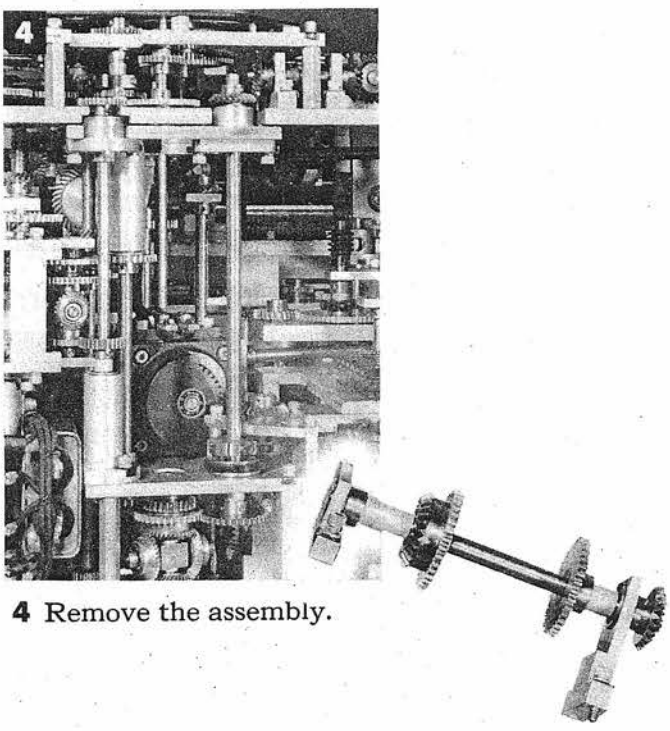
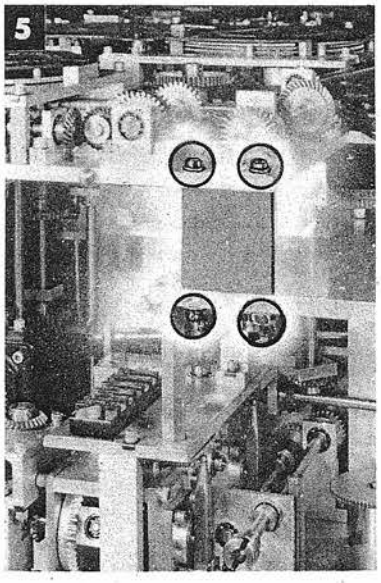


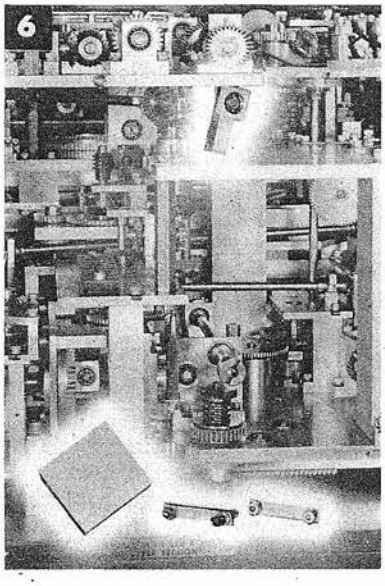
3 Remove the four screws securing the shaft assembly connecting with the *jdR* clutch.



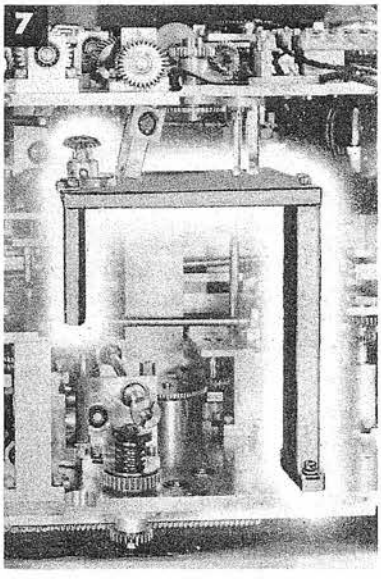
4 Remove the assembly.



5 Remove the four screws securing the supporting plate below the top computer plate.



6 Remove the supporting plate.
Remove the two screws holding a worm shaft assembly to the top plate of the computer.



7 Remove all the screws securing the plate below the top computer plate. Remove the two screws securing the supporting post to the lower plate. Remove the post, the upper plate, and the hexagonal post that supports the upper plate.

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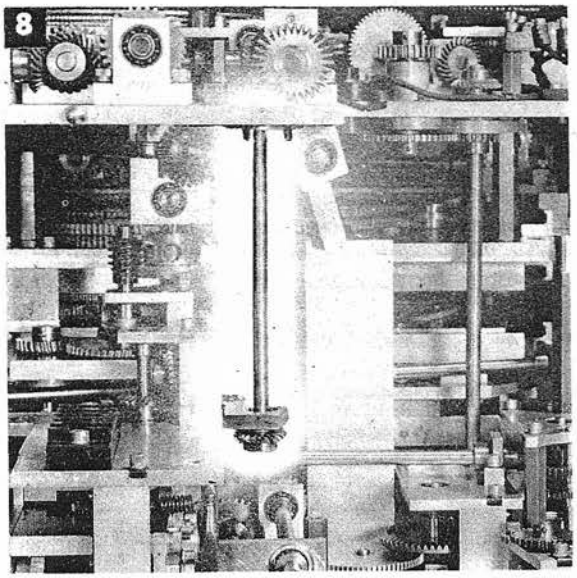
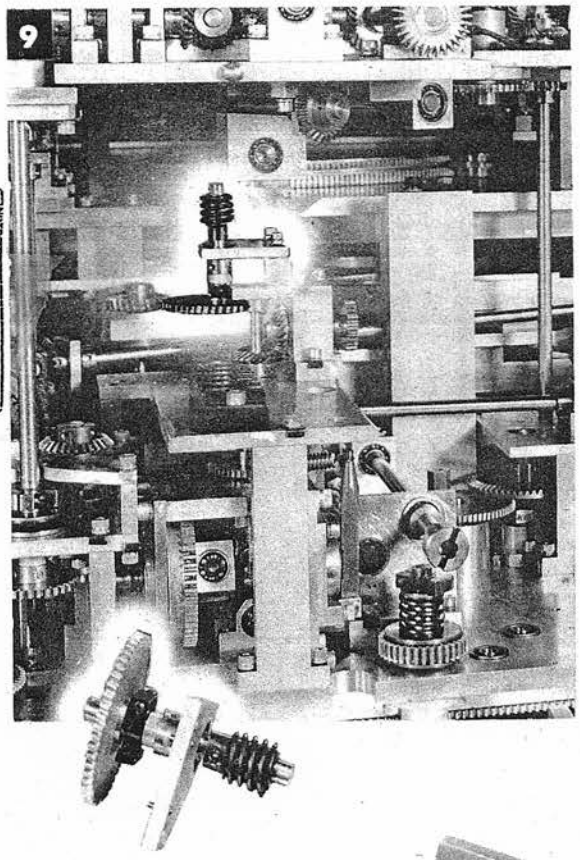
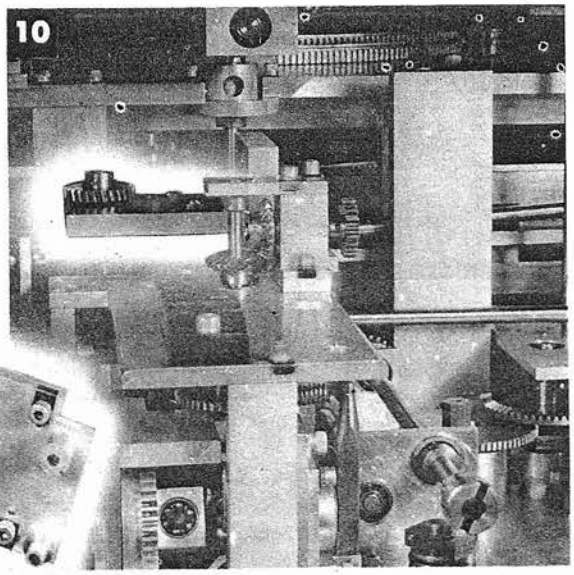


8 Remove the four screws securing the vertical shaft assembly above the inner end of the elevation component integrator. Remove the shaft assembly.

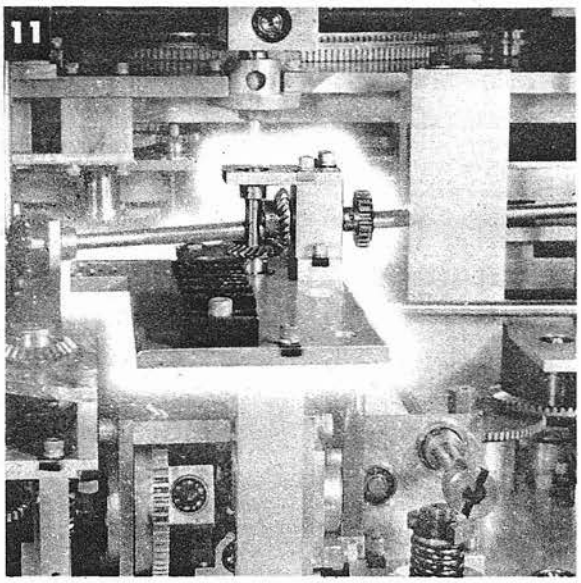


9 Remove the two screws securing the worm shaft assembly on which clamp A-258 is mounted. Remove the shaft assembly.

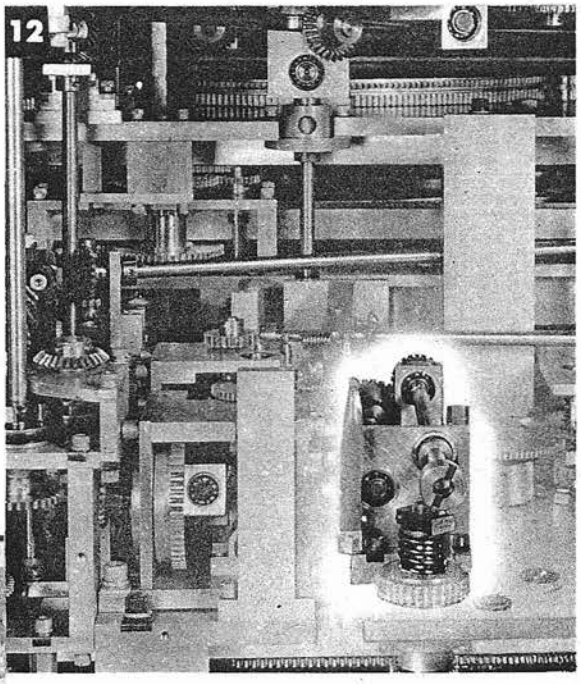
10 Remove the three screws securing the plate below the shaft assembly just removed. Remove the plate with associated gearing.



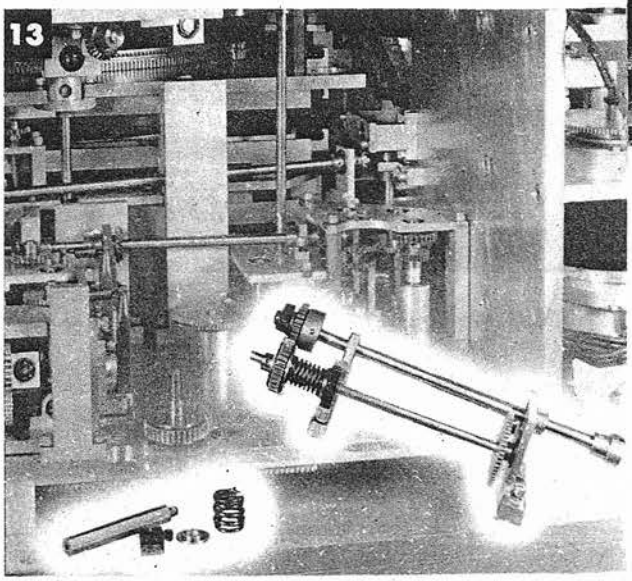
11 Remove the screws securing the plate on which the *Ct* terminal block is mounted, directly above the elevation component integrator. Remove the plate.

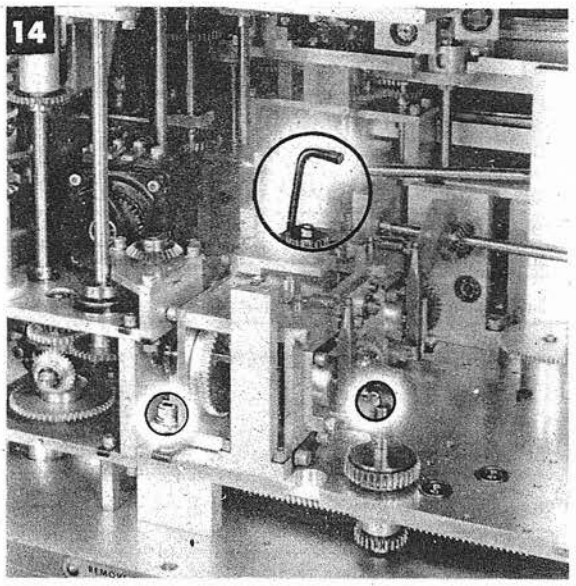


12 Remove clamp A-205, the washer and spring below it, and the hexagonal post just behind the *dH* input coupling.

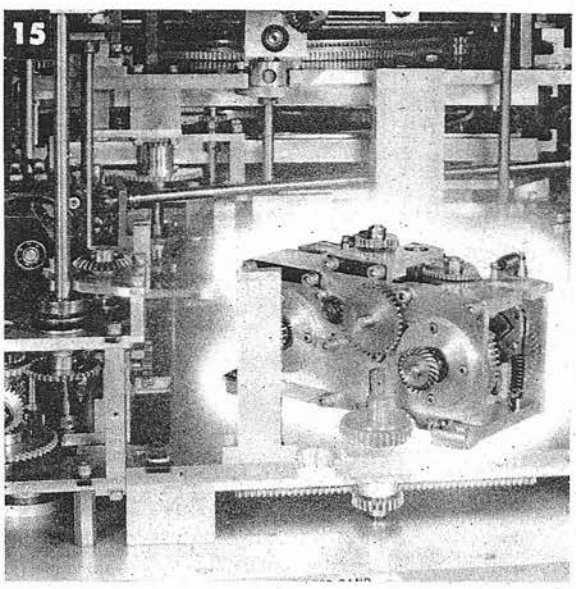


13 Remove the four screws from the *dH* input shaft hangers. Remove the shaft assembly.

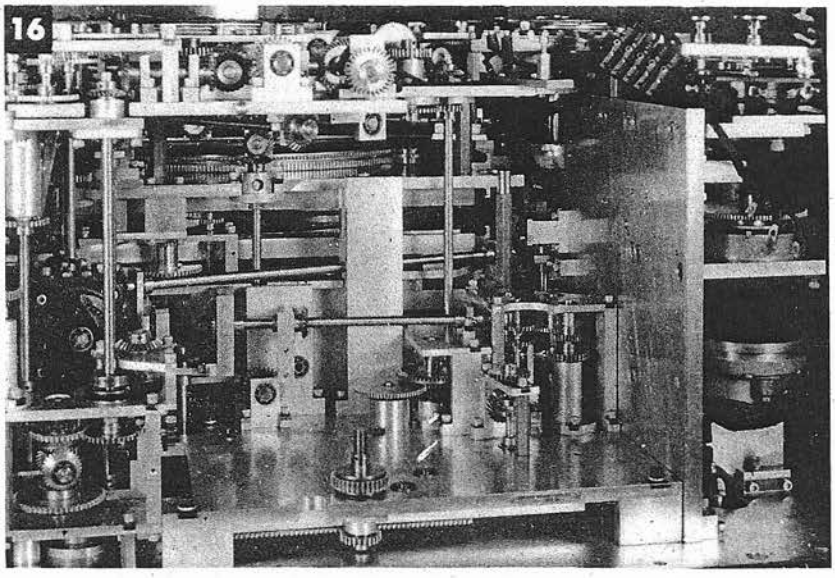




14 Back out the two screw dowels and remove the three screws securing the integrator. To reach the back screw, turn the integrator toward the front of the computer.



15 Turn the integrator to clear the gearing.



16 Remove the integrator.

To reinstall the mechanism, reverse the removal procedure.

Reinstall all the units removed.

Loosen clamps A-136 and A-137.

Readjust clamp A-126.

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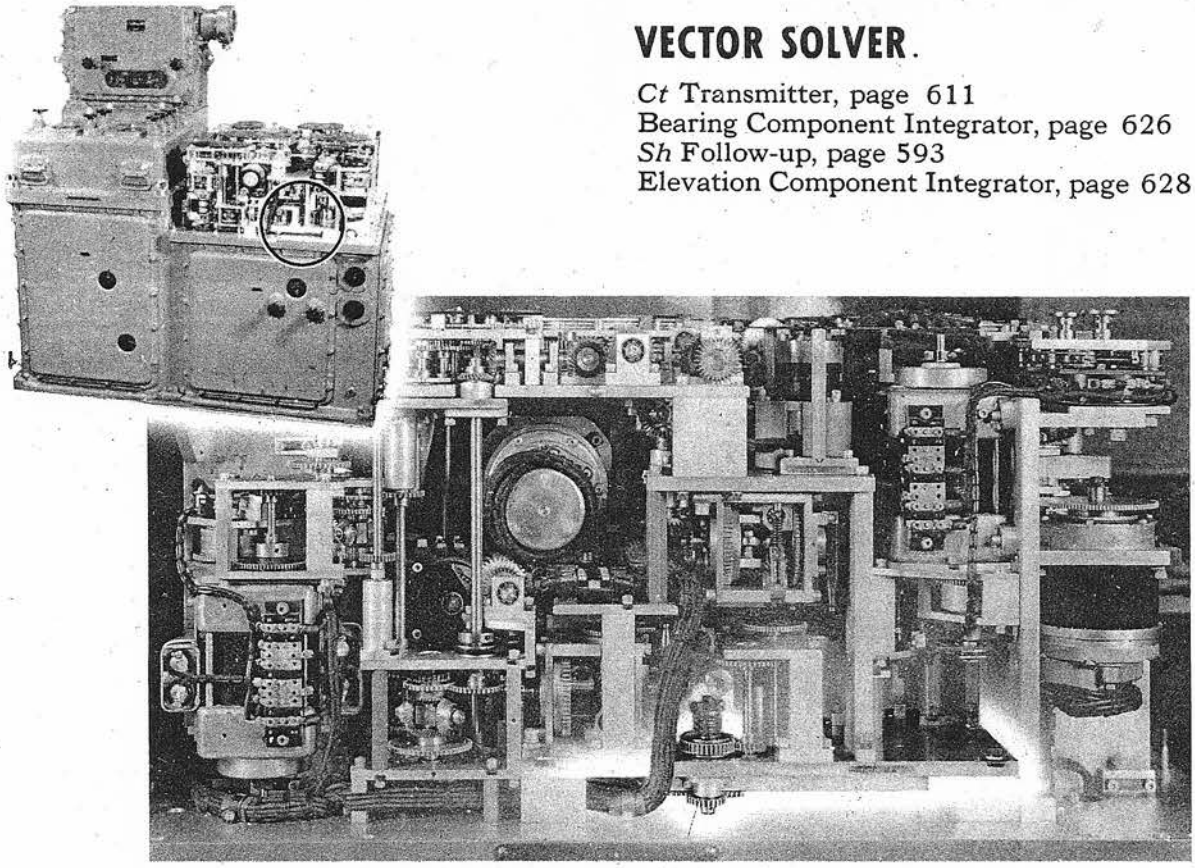
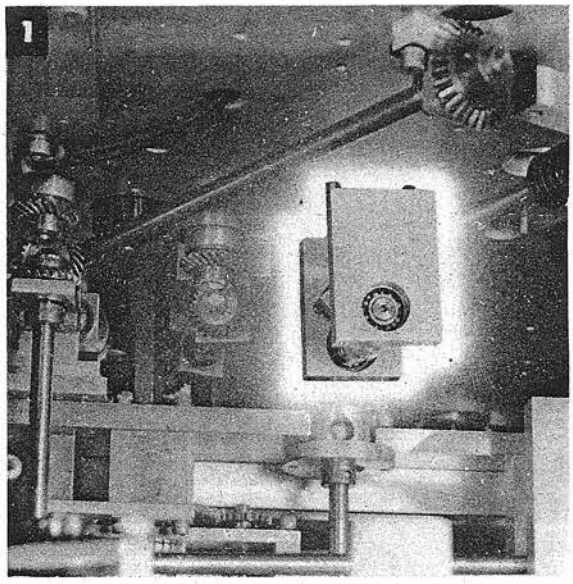
VECTOR SOLVER.

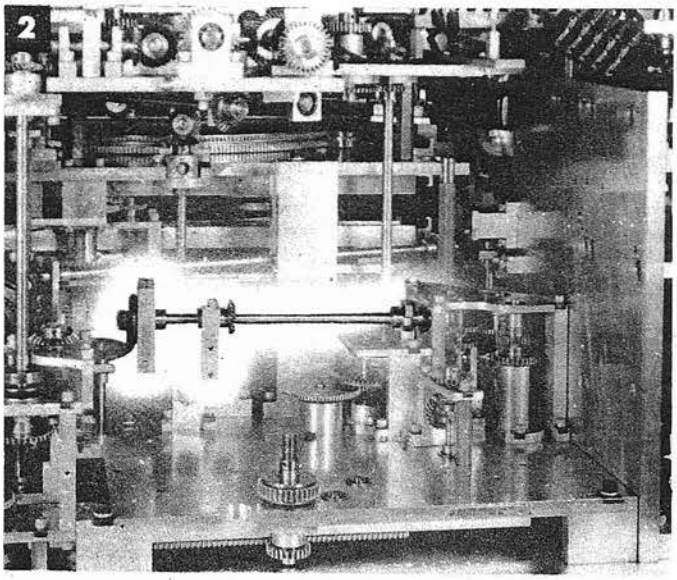
Ct Transmitter, page 611
Bearing Component Integrator, page 626
Sh Follow-up, page 593
Elevation Component Integrator, page 628

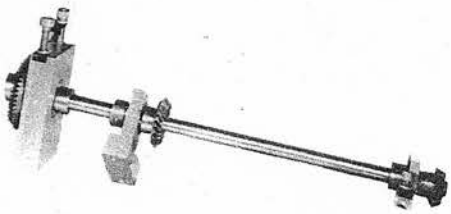




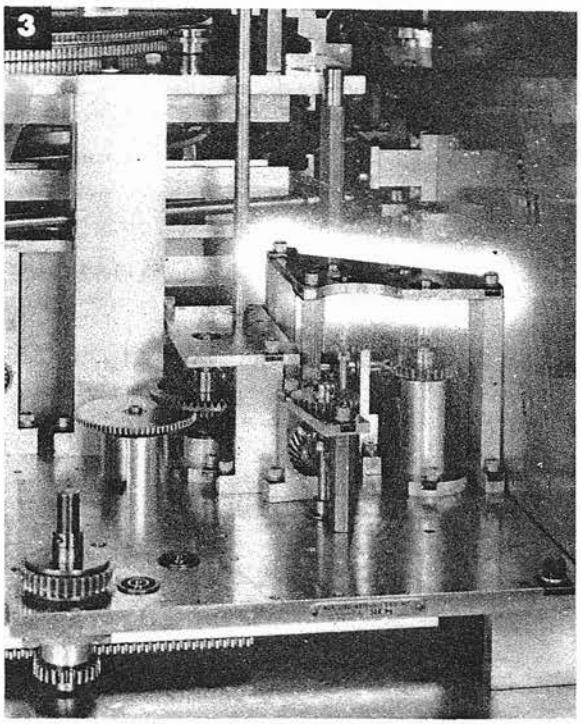
1 Loosen clamps A-136 and A-137.

From the top plate of the computer, remove the four screws suspending the *dH* limit stop (L-4) over the vector solver.
Remove the limit stop.

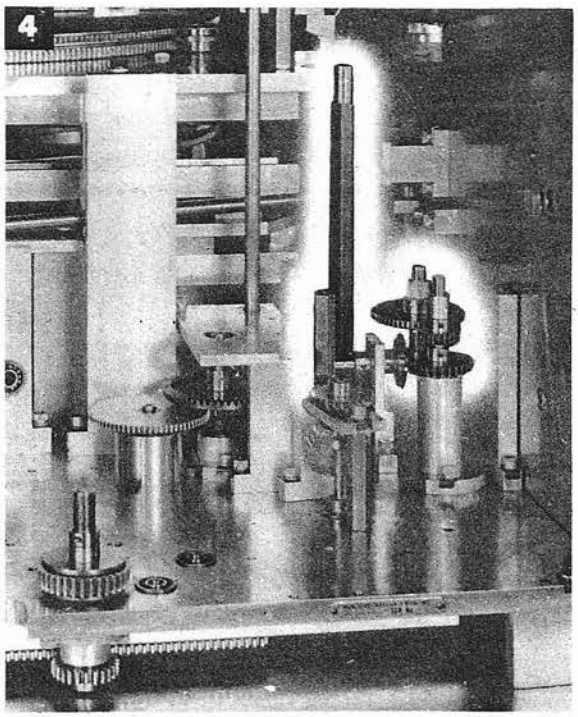




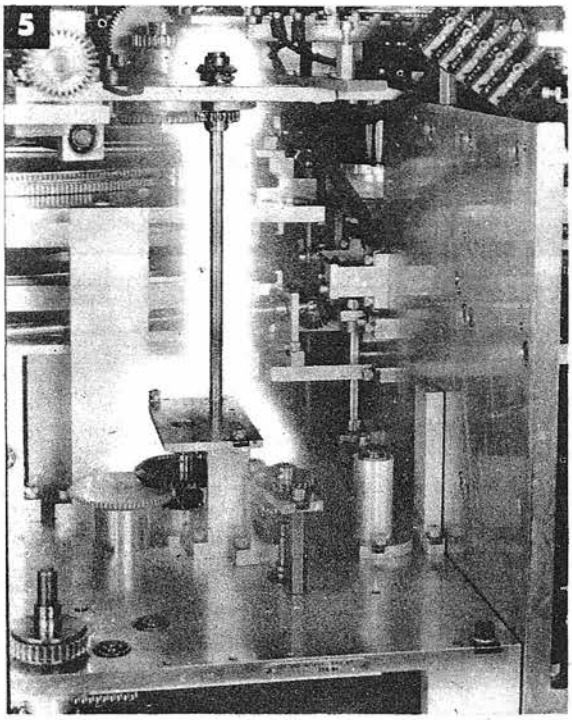
2 Remove the four screws securing the horizontal shaft assembly above the inner edge of the vector solver.
Remove the shaft assembly.
Remove the two screws securing the hanger to the small plate.



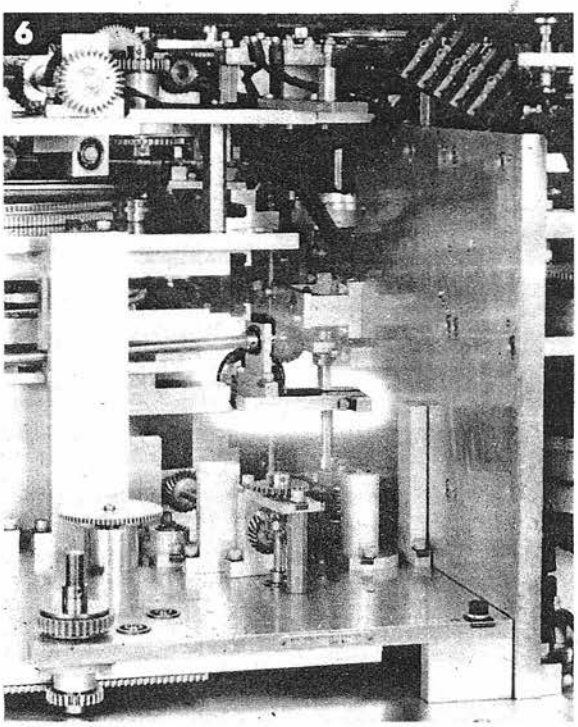
3 Remove the three screws securing the upper plate on the *Sh* input gearing.
Remove the plate.



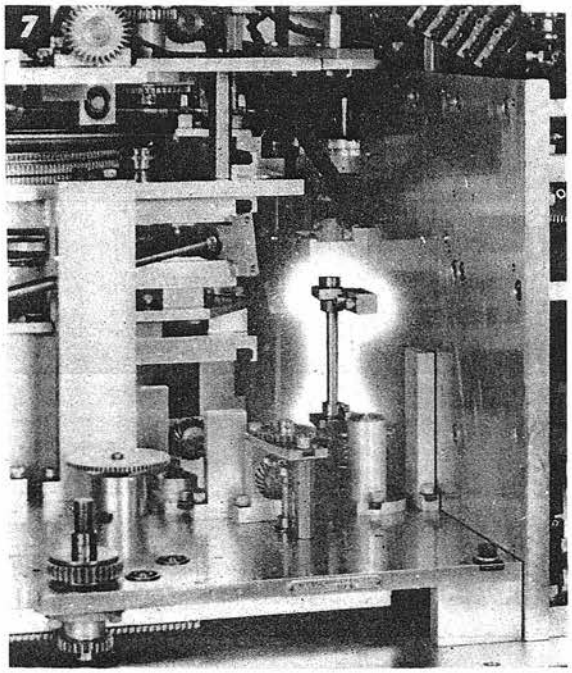
4 Lift out the two shaft assemblies below the removed plate.
Remove the two hexagonal posts.



5 Remove the two screws securing the plate directly above clamp A-137.
Remove the two screws securing the adapter for the shaft that rises from this plate to the top plate of the computer.
Remove the small plate and the shaft assemblies.



6 Remove the screws securing the horizontal shaft assembly mounted on a bracket attached to the front plate of the computer. Lay the shaft back, out of the way.
Remove the two screws securing the bracket.
Remove the bracket.



7 Remove the four screws securing the short vertical shaft assembly toward the back of the front plate. Remove the assembly.

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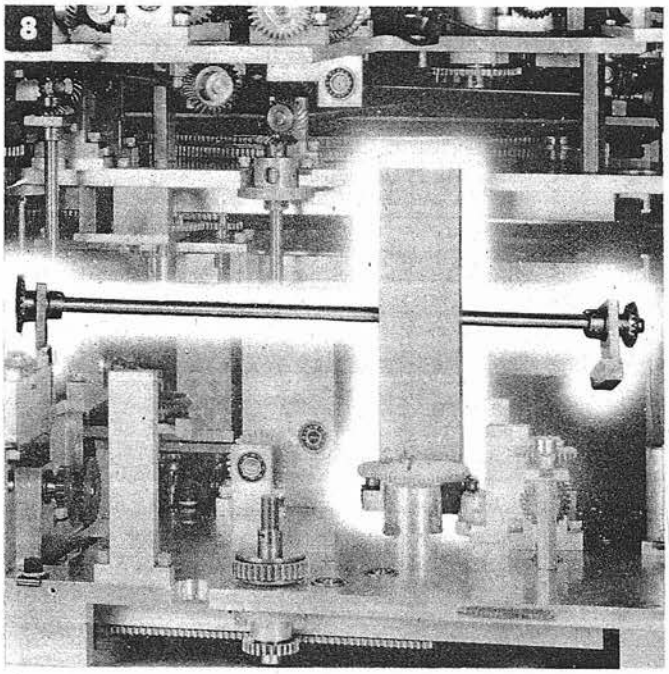
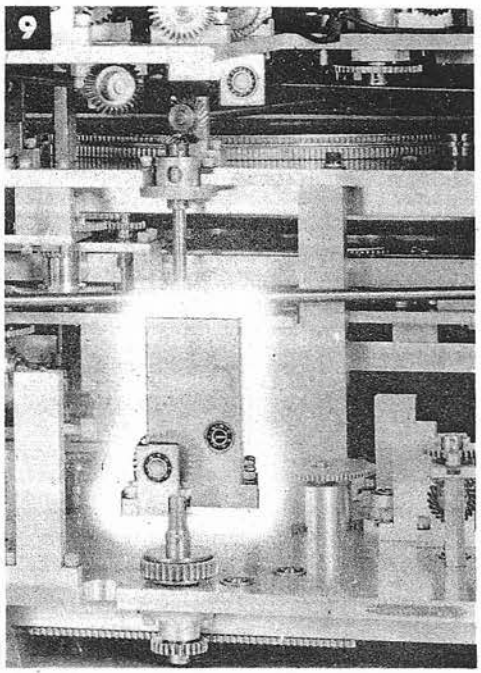
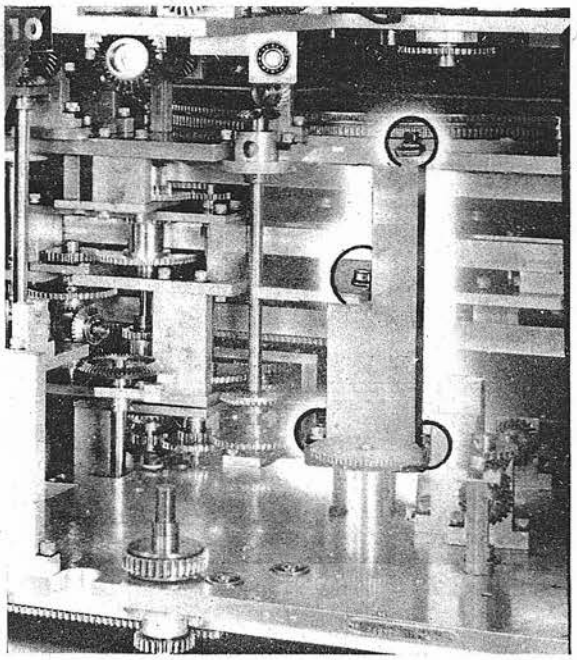


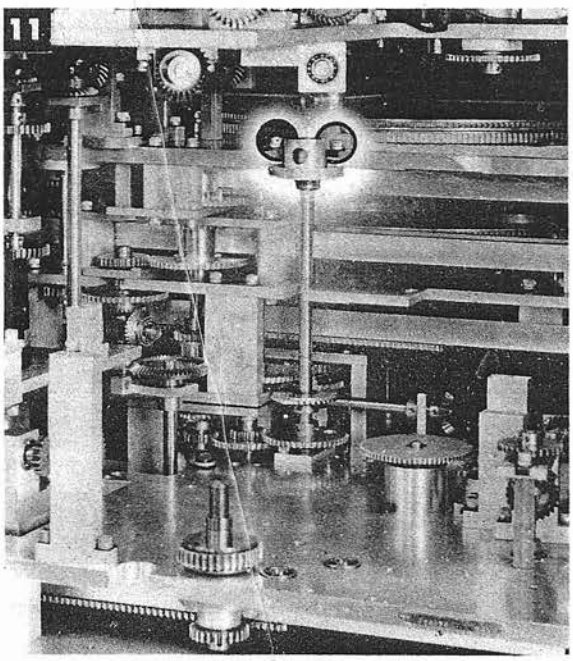
8 Remove the two screws securing the large post toward the rear of the vector solver. Remove the post.
Remove the loose shaft assembly behind this post.



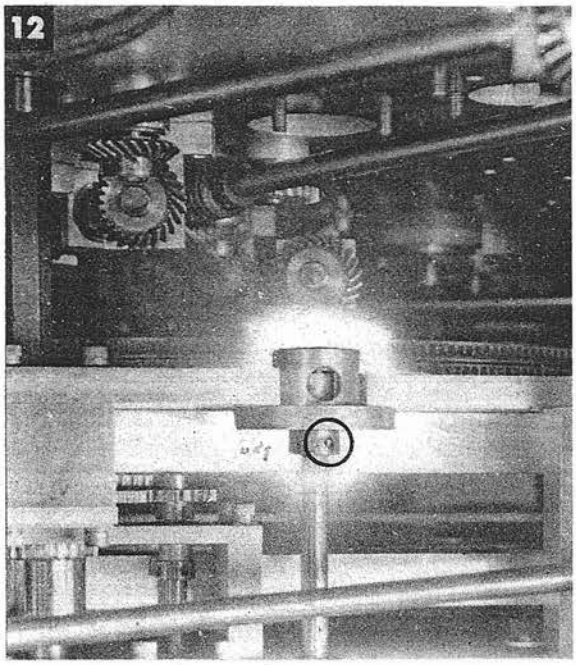
9 Remove the screws securing the rear hangers of the *dH* input shafts.
Remove the two hangers and the short shaft between them.



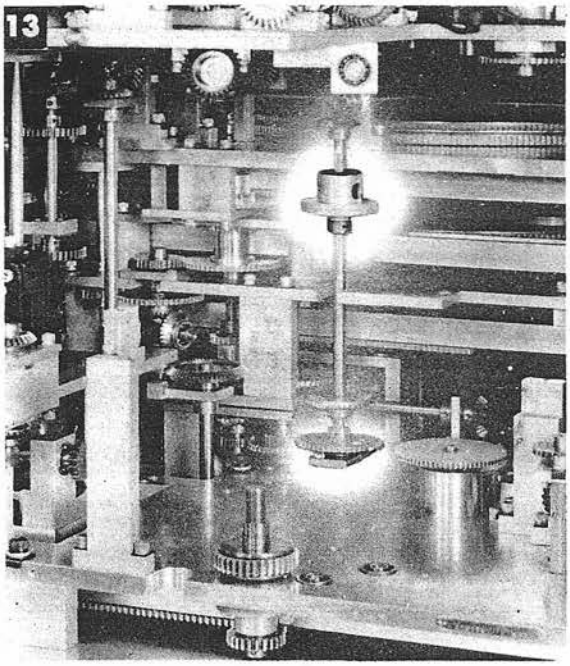
10 Remove the four screws securing the L-shaped supporting post for the component solvers. Remove the post.



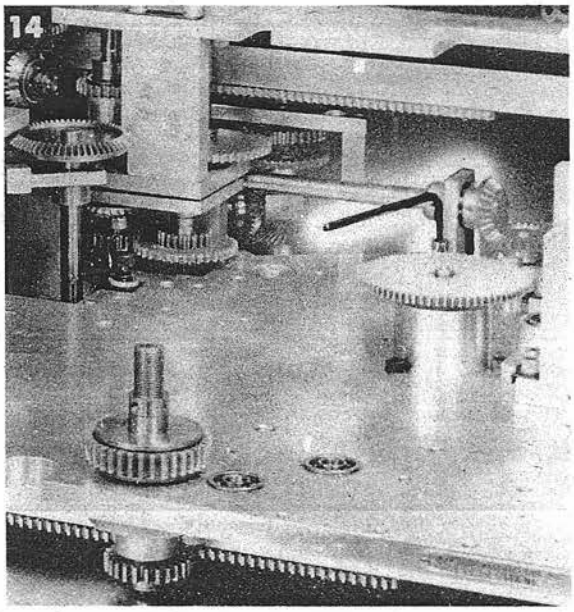
11 Remove the two screws securing the adapter to the plate of the height computer.



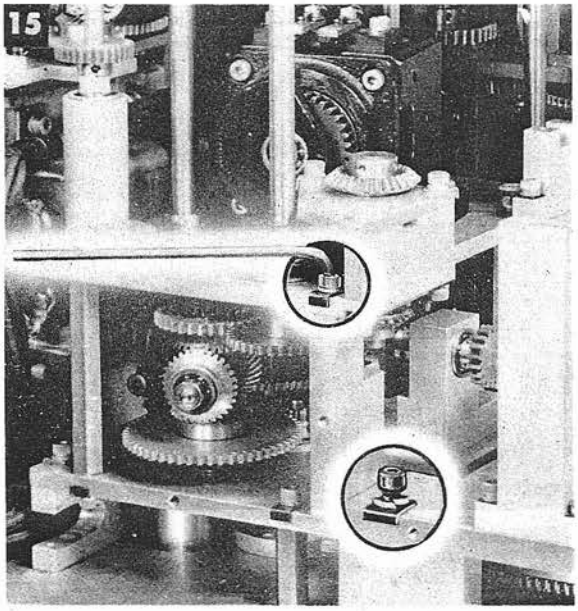
12 Unpin the collar below the adapter.



13 Slide the collar and the adapter down. Through the access holes in the gear, remove the two screws securing the hanger at the base of the shaft.
Remove the shaft assembly.



14 Remove the two screws securing the hanger to the vector solver plate. It is not necessary to remove this shaft assembly.



15 Remove the screw securing the post near the *jdR* clutch.
Remove all the screws securing the vector solver mounting plate to the computer.

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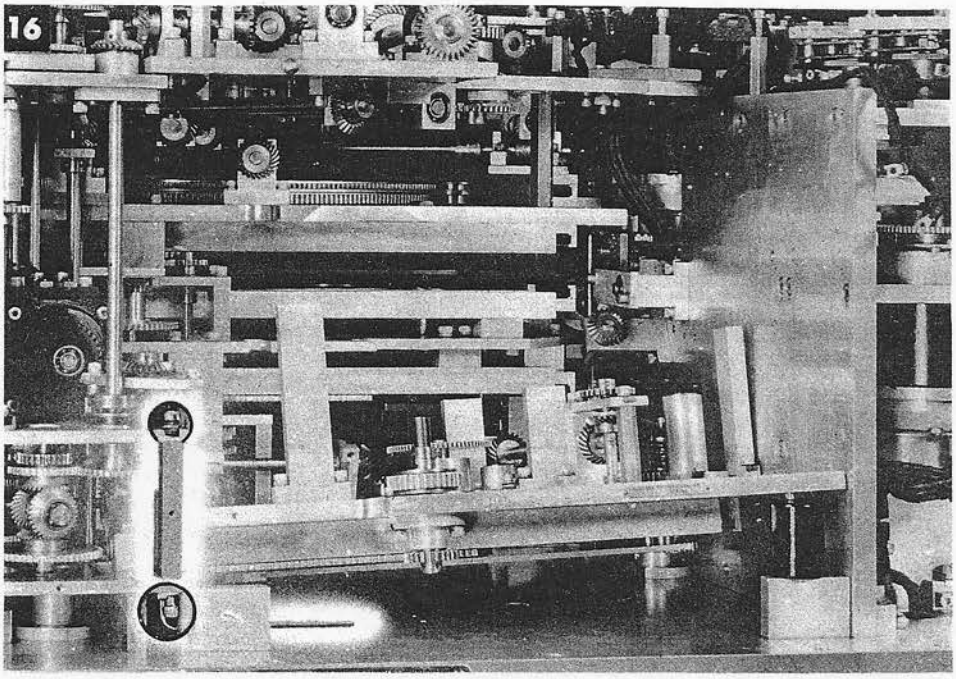
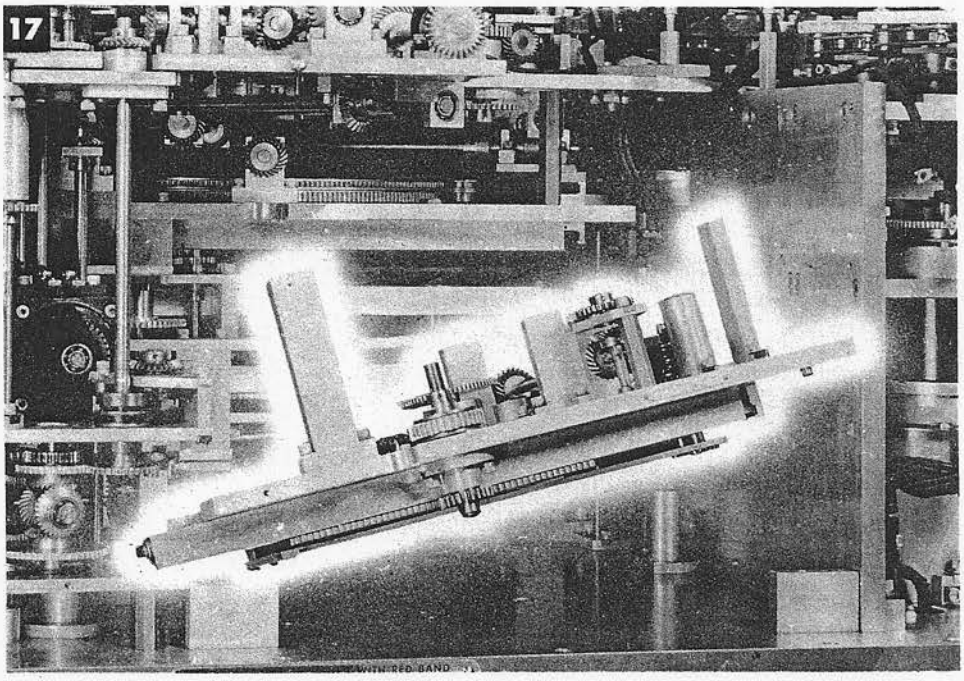
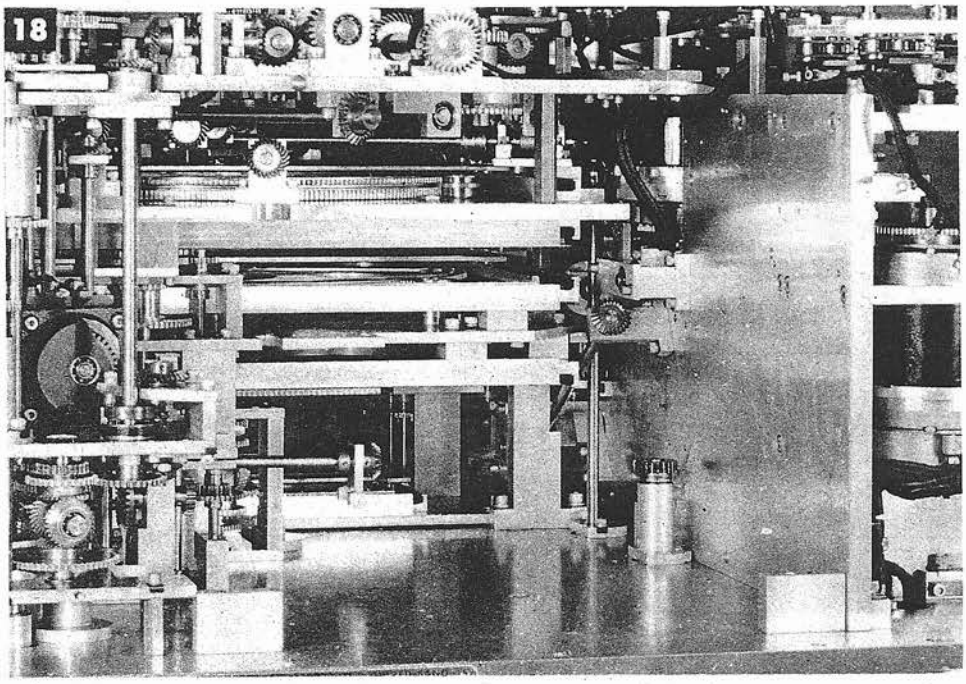


16 Lift the vector solver slightly to gain access to the lower two screws securing the supporting post.
Remove the screws and the post.



17 Tilt the front edge of the vector solver up, to clear an adapter and shaft of the time line.



18 Remove the vector solver.

To reinstall the mechanism, reverse the removal procedure.

Reinstall all the mechanisms removed.

Loosen clamp A-126.

Readjust clamps A-525 and A-192.

Check clamps A-119 and A-121.

Readjust clamp A-126.

Check clamps A-163 and A-118.

Readjust clamps A-115, A-117, A-136, A-137, and A-258.

Run tests.

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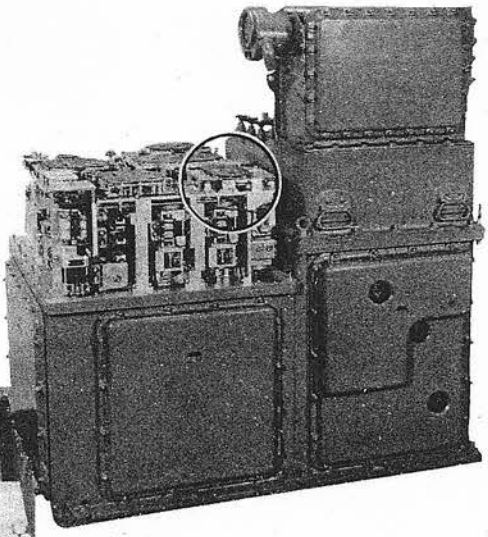
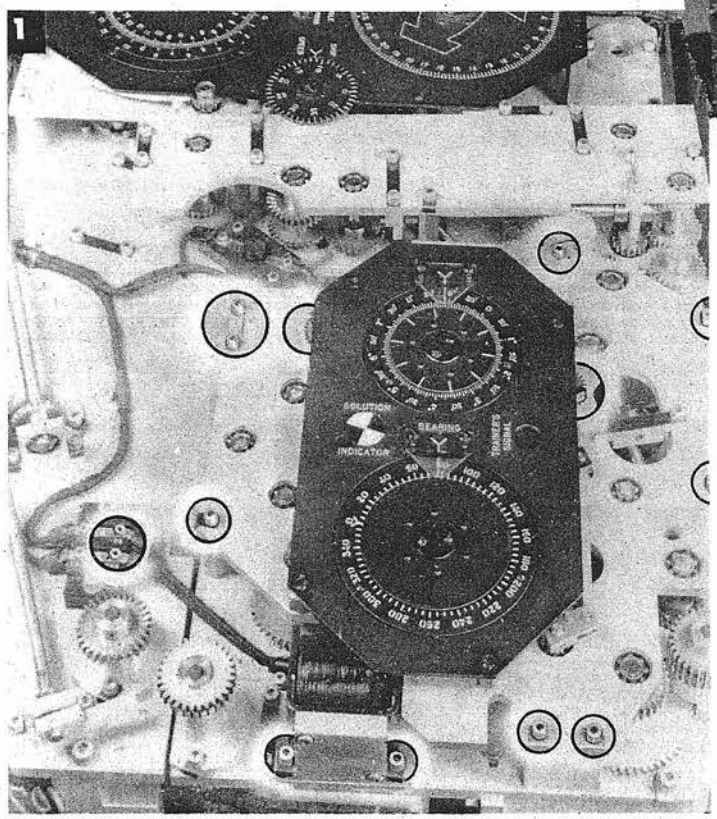
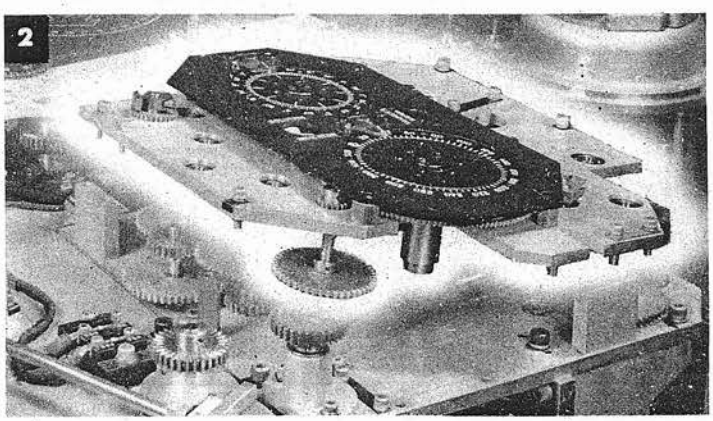
BEARING GEARING AND DIAL ASSEMBLY





1 Remove the eight screws securing the upper plate.
Loosen clamps A-194 and A-197.
Remove the screws connecting cable leads TS and TSS to the terminal block.
Remove the two screws securing the solenoid hanger to the plate. Remove the solenoid.



2 Remove the plate with shafts attached.
Remove the gears on which A-197 and A-194 are mounted.
Remove the spacer below A-194.

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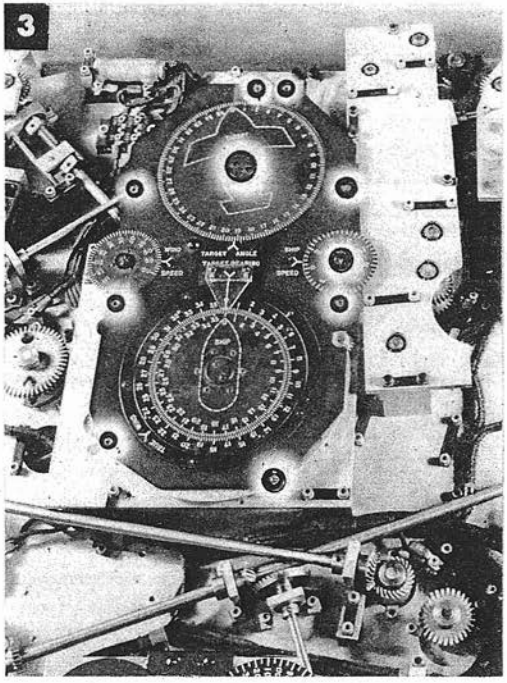
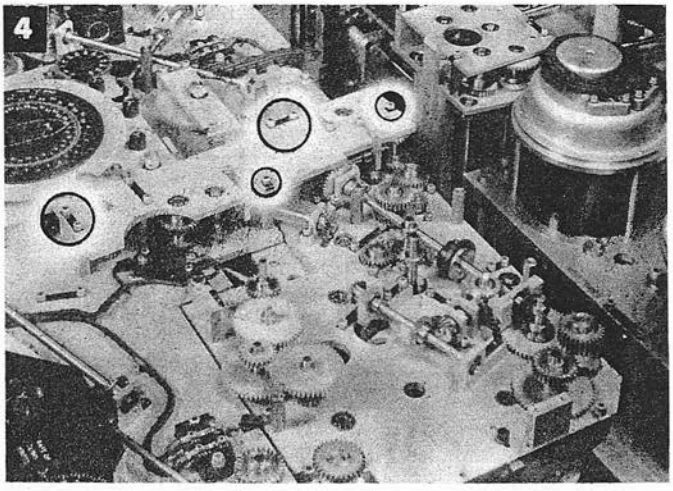


3 Remove the eight screws securing the mask.
Remove the mask.
Remove the dial clamps from the target dial and the ship speed dial.
Remove the two dials.

4 Remove the six screws securing the plate located next to the bearing gearing.



5 Lift out the plate.

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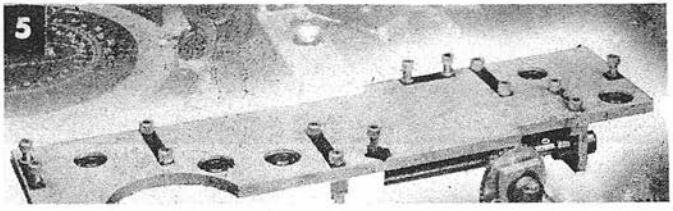
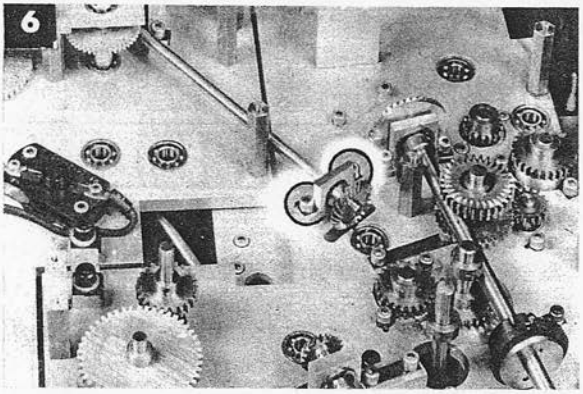
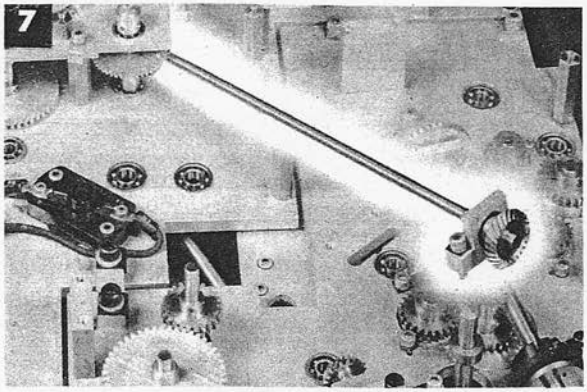
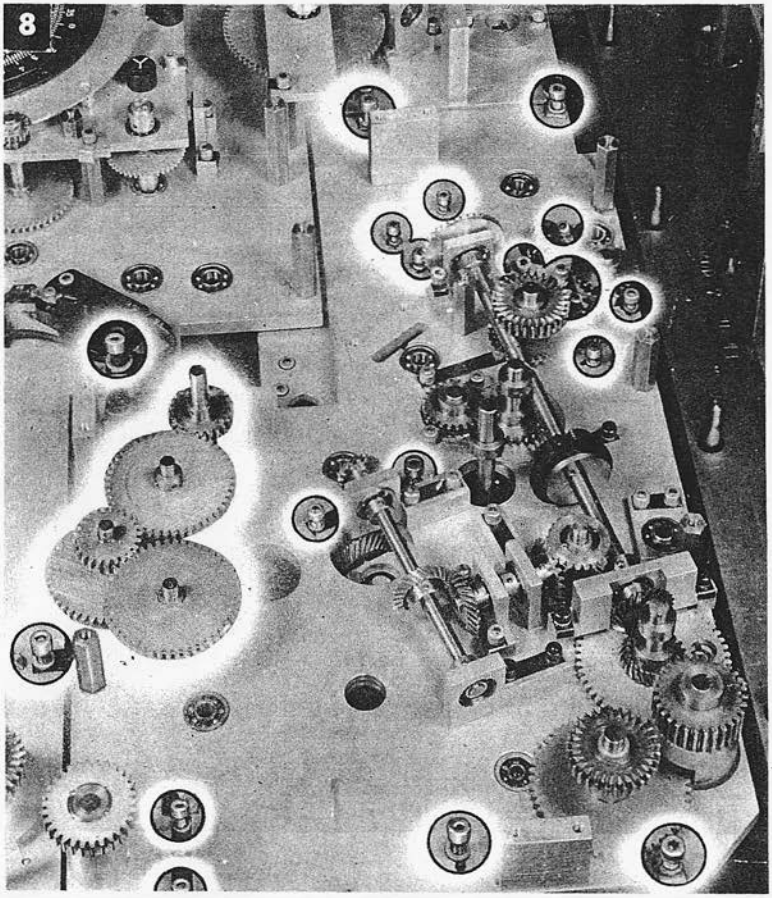


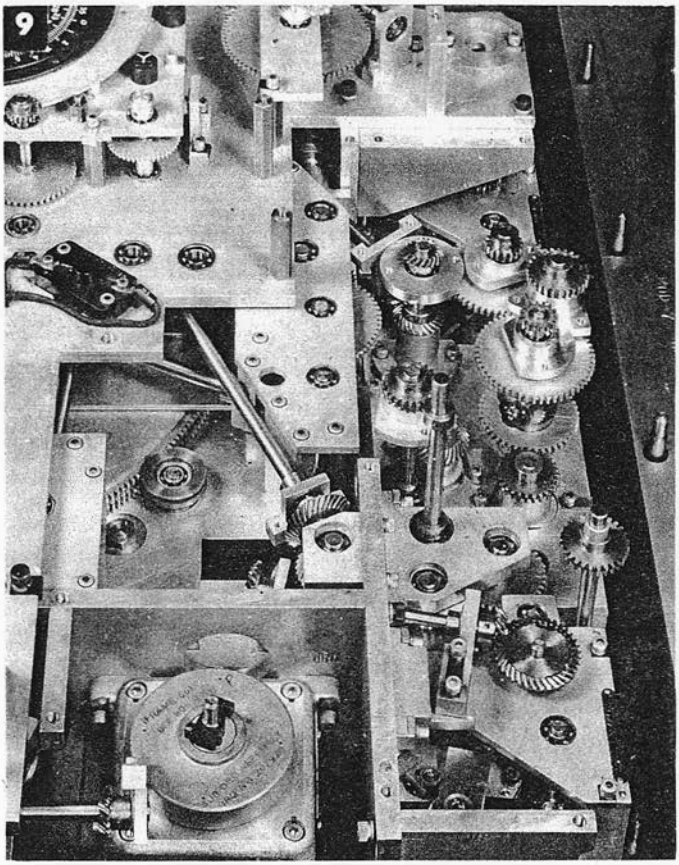


6 Remove the two screws securing the shaft assembly that connects with the *A* dial.



7 Remove the shaft assembly.





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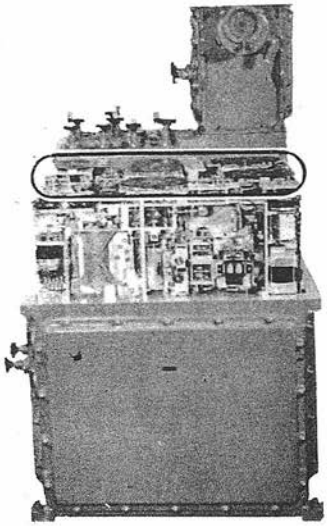
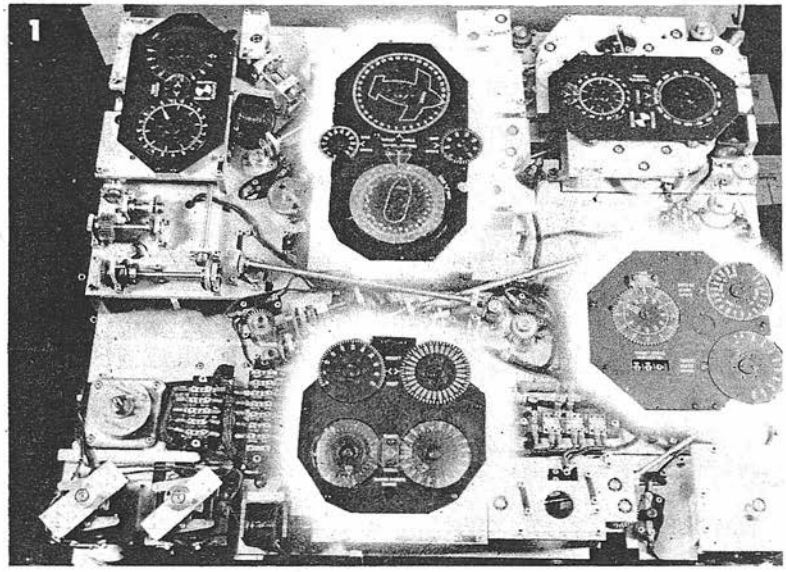
9 Remove the plate.

TOP PLATE OF CONTROL UNIT

Bearing Dials and Gearing, page 640
Ct Transmitter, page 611





1 Remove the dial clamps on the *So*, *Sw*, *dH*, *dR*, *H*, and *A* dials.
Remove the dials.

2 Remove the screws securing the masks around the time, range, and target dial groups.
Remove the masks.

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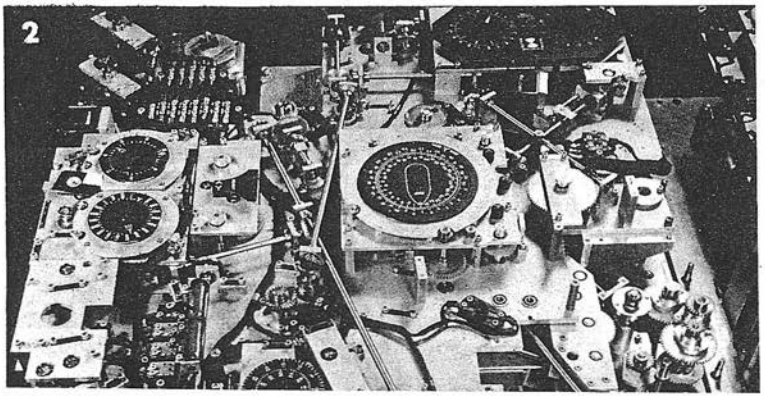
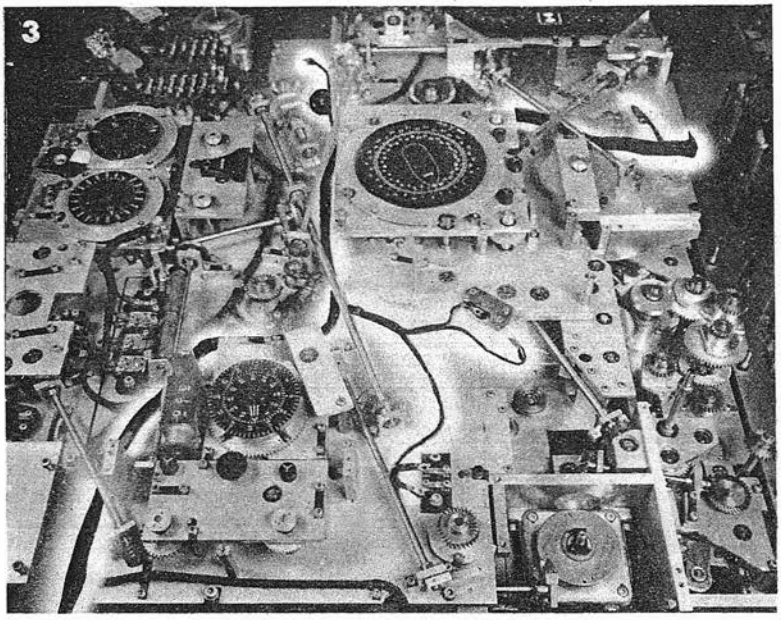
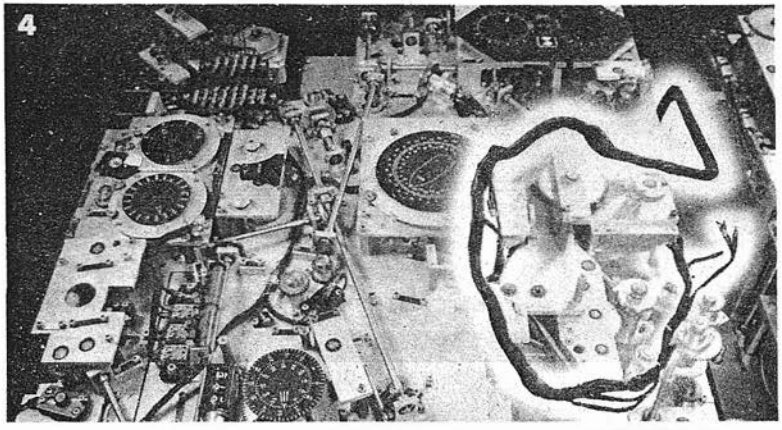


There are two sections of cable, A and B, connected to terminals on the top plate. Remove all the terminal connection screws. Remove the cable clamps. Free the cable from the clamps, shafts, and other obstructions. Lay the cable aside, out of the way.

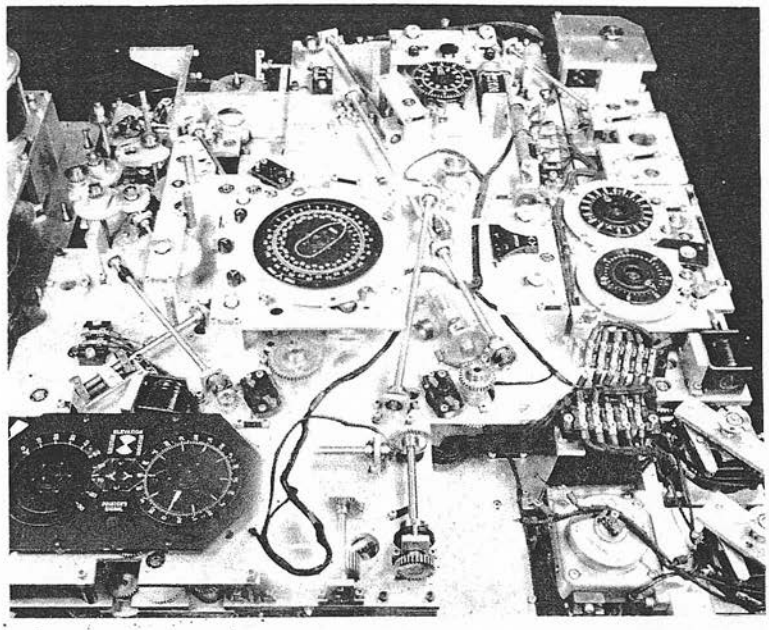


3 Cable A

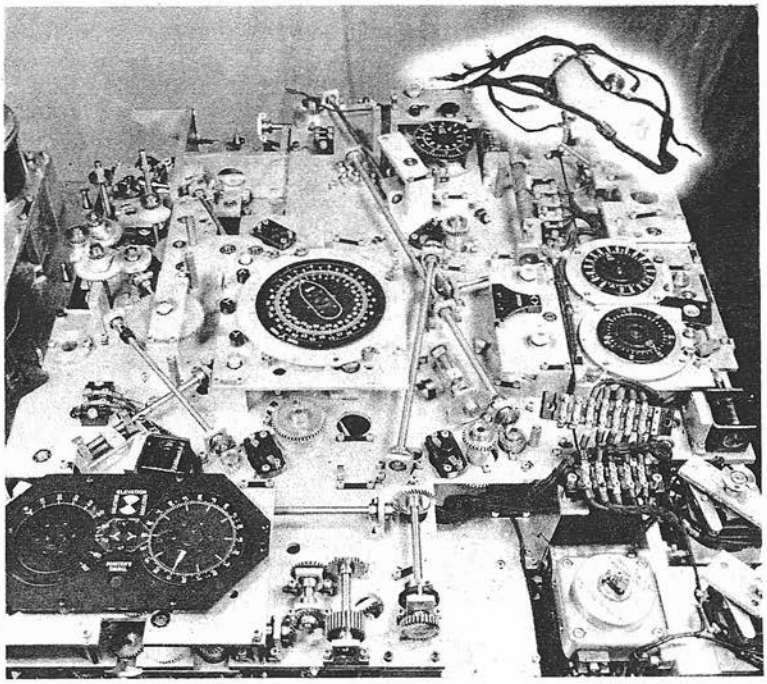


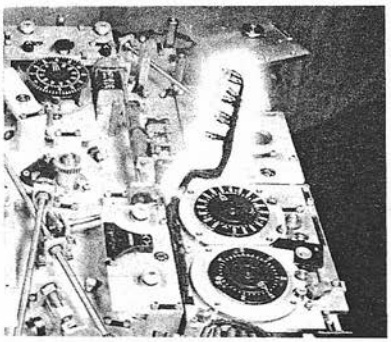
6 45

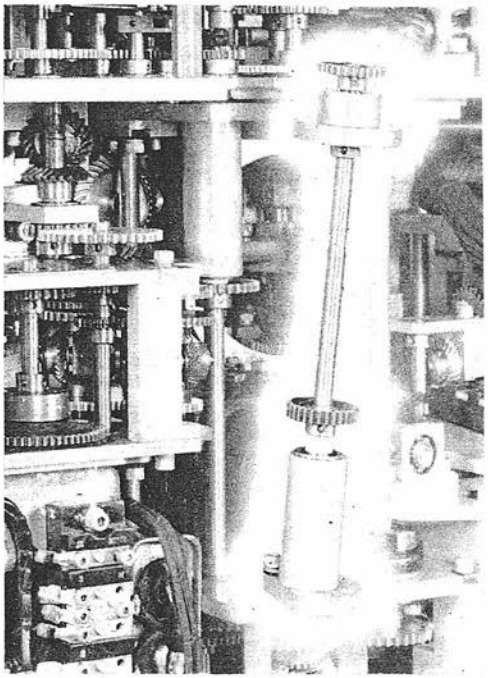
5 Cable B

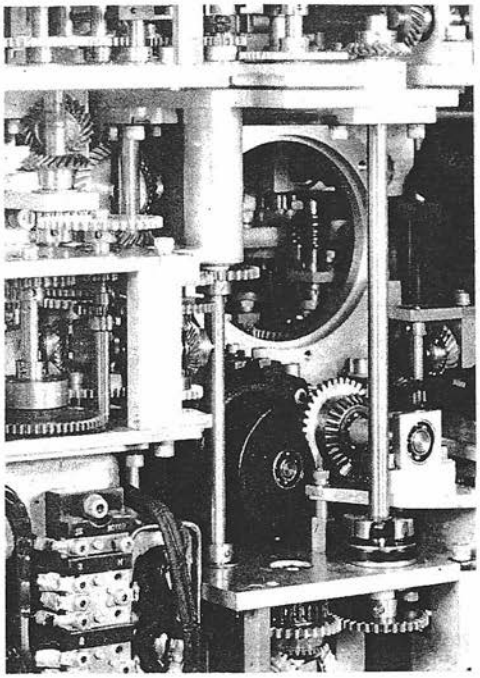


NOTE:
There are cable clamps on the under side of the top plate near the *Ct* transmitter.







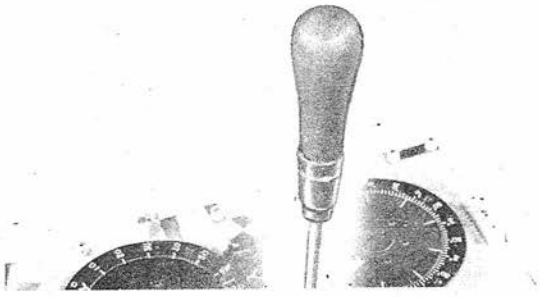


8 Remove the four screws securing the vertical shaft assembly next to the *jE* follow-up.

9 Remove the assembly.

10 Remove the pointer's signal solenoid. See page 620
Remove the mask around the elevation dials.

11 Remove three screws securing the top plate.



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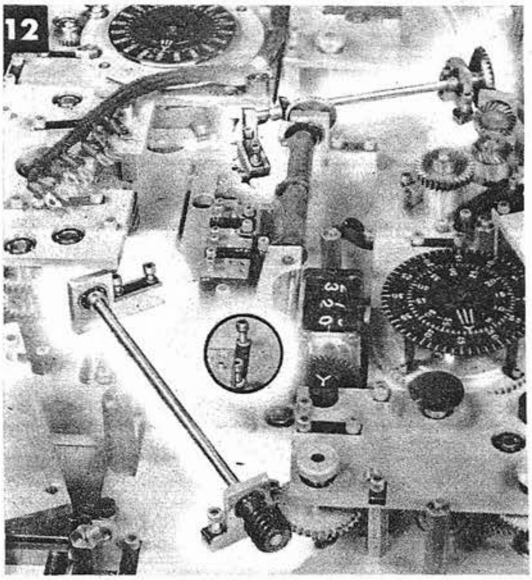
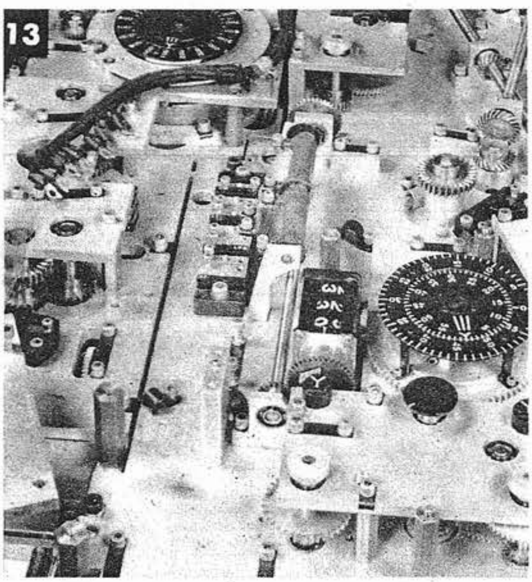
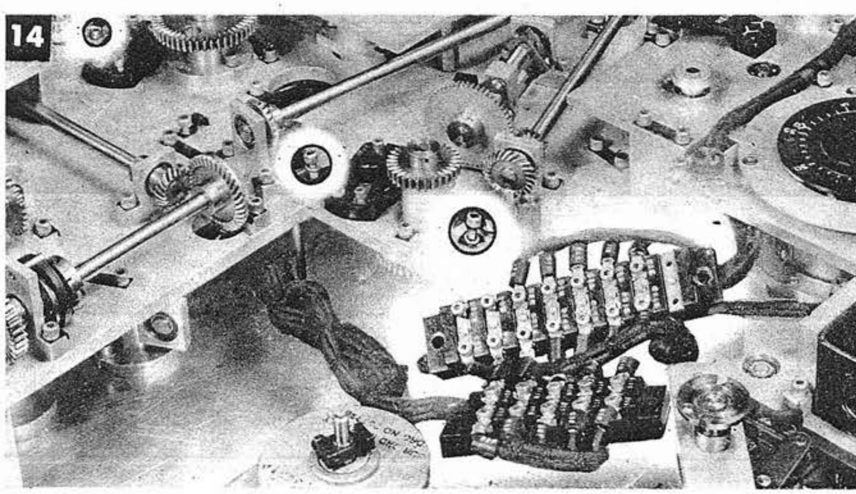


12 Remove the four screws securing the two shaft assemblies that cross over from the top plate to the plate near the range receiver.
Loosen the two screws in front of the *Sh* counter.



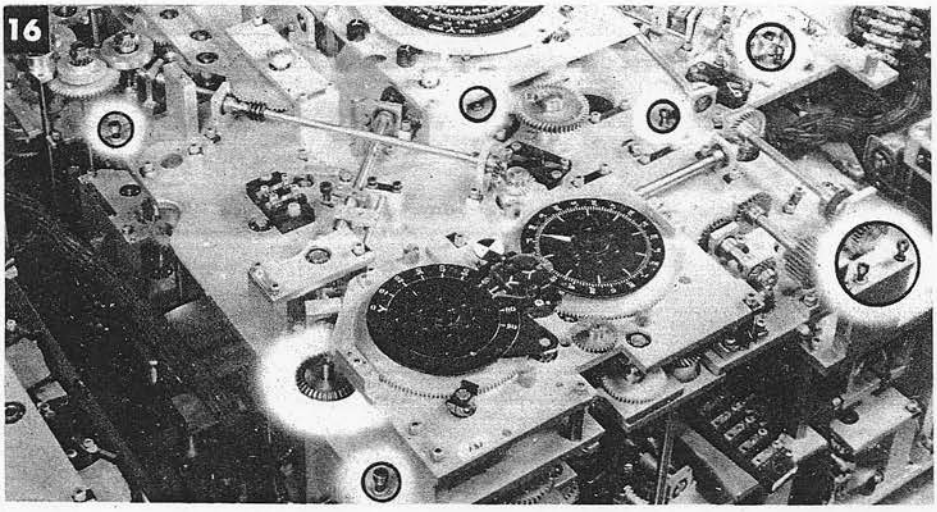
13 Remove the two shaft assemblies.

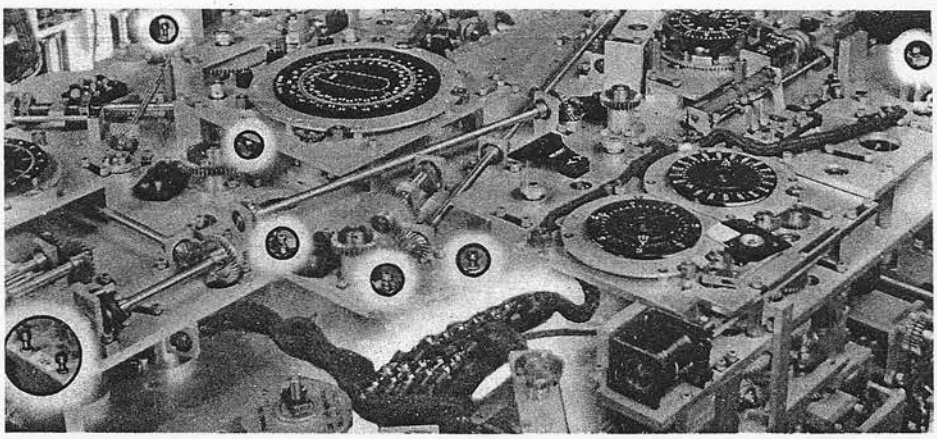
14 Remove the four screws securing the two terminal blocks next to the range receiver. Push the blocks aside.
Remove the six screws securing adapters to the top plate on the corner near the terminal blocks.

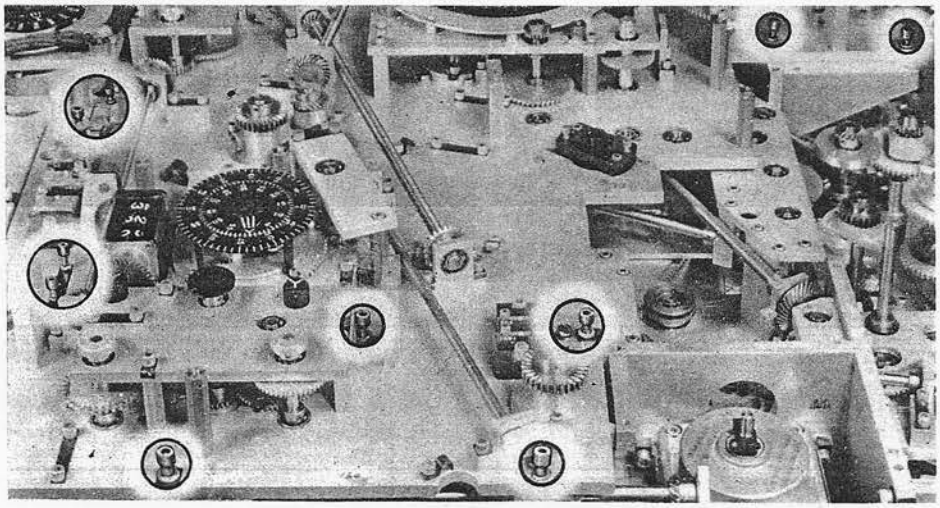


15 Remove the two screws securing the adapter for the shaft assembly near the elevation dials. Remove the shaft assembly.

16 Remove the screws securing the top plate.







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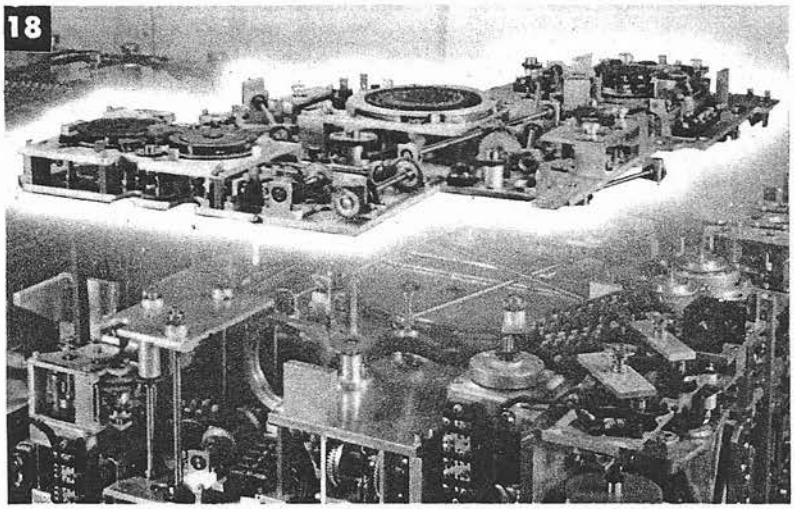
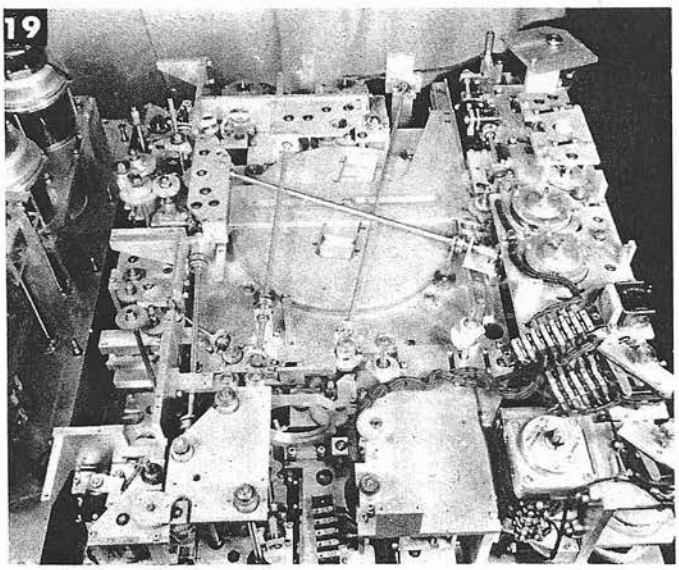
17 Remove the range receiver gearing unit. See page 621.

18 Back out the three screw dowels. Lift the plate straight up to free the gear meshes.



19 Remove the plate.



To reinstall the top plate, reverse the removal procedure.

Reinstall the bearing gearing and dial assembly, the range receiver, and the *Ct* transmitter.

Tighten clamp A-190.

Disconnect the power leads from all follow-ups in the control unit.

Loosen the following adjustments.

A-527	A-118	A-521
A-197	A-121	A-240
A-531	A-204	A-164
A-194	A-529	A-124
A-127	A-201	A-158
A-193	A-533	A-522
A-532	A-136	A-523
A-192	A-137	A-138
A-528	A-115	A-116
A-524	A-117	A-122
A-525	A-222	A-200
A-119	A-223	A-258
A-189	A-205	A-105
A-123	A-206	A-157
A-126	A-187	A-129
A-128	A-195	A-199
A-125	A-196	A-70
A-163	A-520	A-179

Readjust the clamps in the order listed above. Refer to *Factory Adjustment Procedure,* page 815.

Run all tests.

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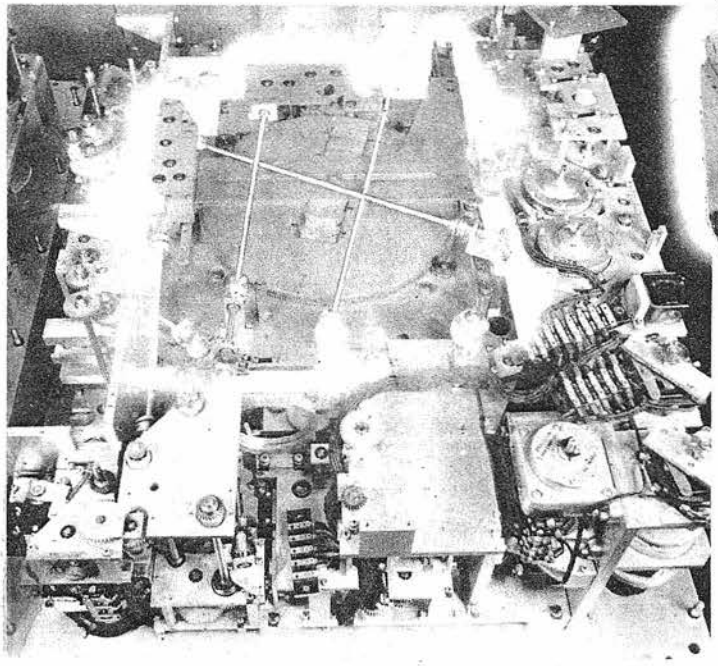
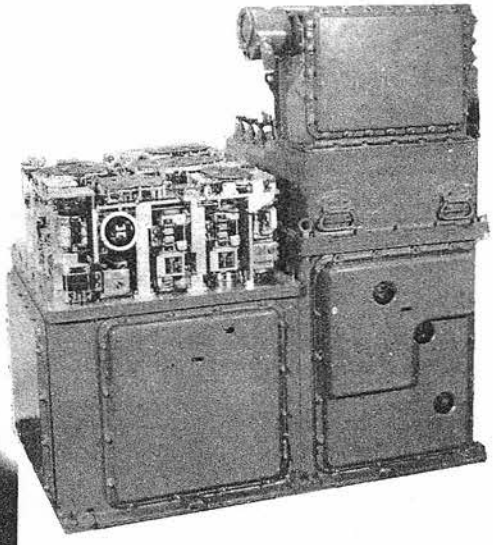
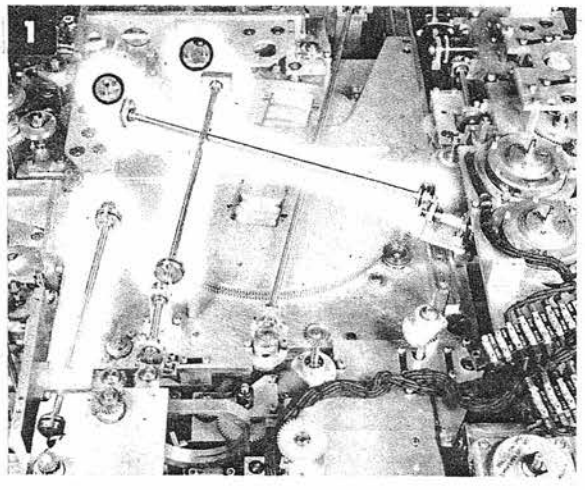
HEIGHT COMPUTER, TARGET COMPONENT SOLVER

Top Plate of the Control Unit, page 644

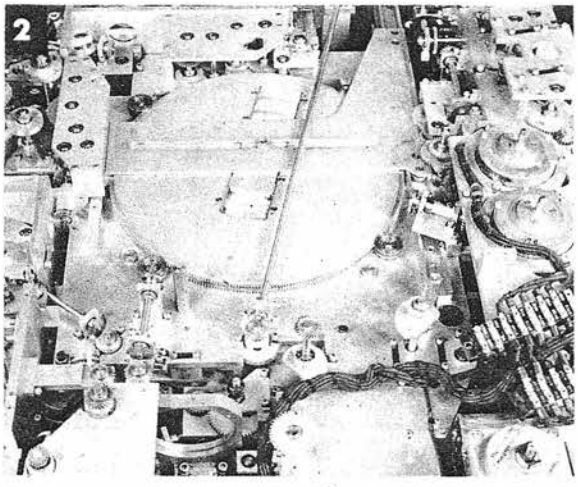




NOTE:
The height computer may be worked on without removal from the instrument, after removal of the top plate and overlying shafts.



1 Remove the two screws from each of the two crossing shaft assemblies. Remove the locking spring from the coupling end of each assembly. Remove the assemblies.
Remove the locking springs from the couplings at each end of the third shaft.



2 Slide the coupling shaft through the gearing, out of the way.

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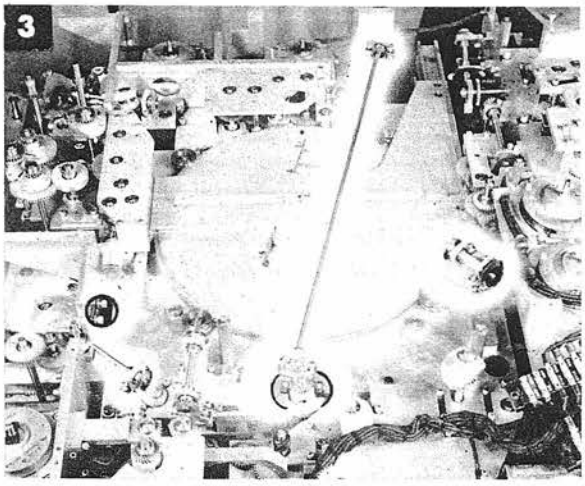
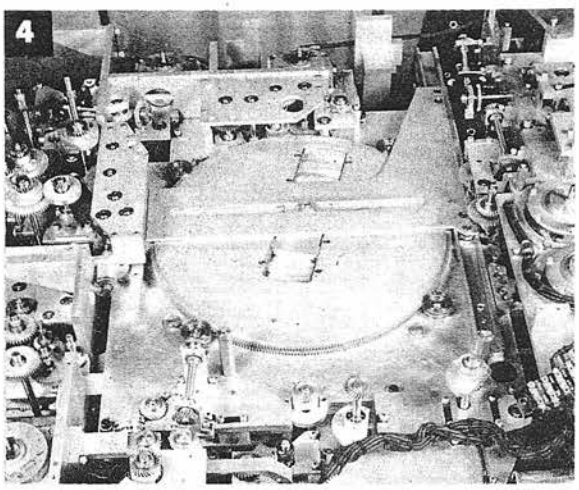
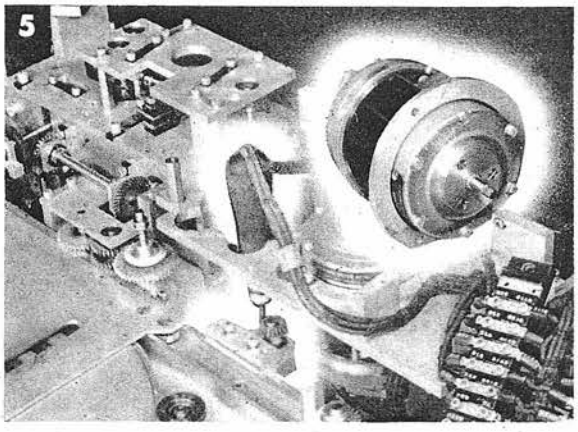


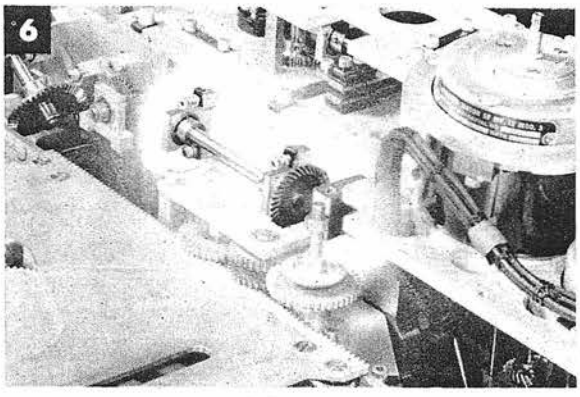
3 Remove the screws securing the three shaft assemblies indicated.



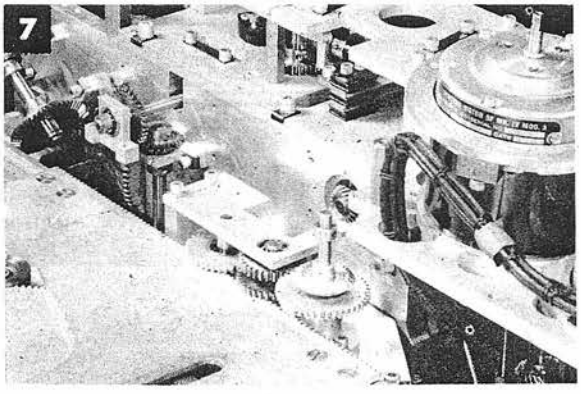
4 Remove the assemblies.

5 Remove the three screws securing the fine synchro of the range receiver. Lift the synchro out, but do not remove it.
Remove the six screws securing the vertical shaft assembly beneath the synchro bracket. This shaft assembly is attached to the edge of the height computer plate. Remove the shaft assembly. Replace the synchro.

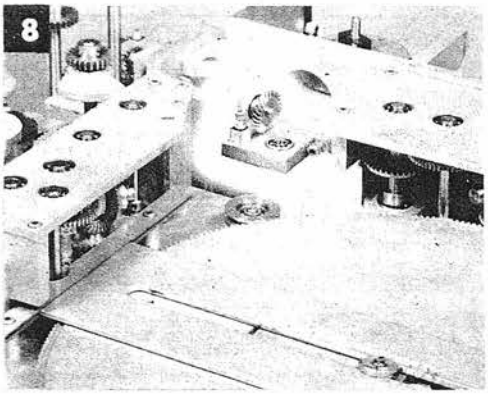




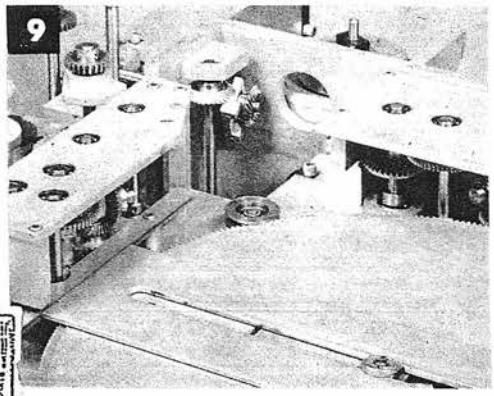
6 Remove the four screws securing the short horizontal shaft assembly near the synchros.



7 Remove the shaft assembly.

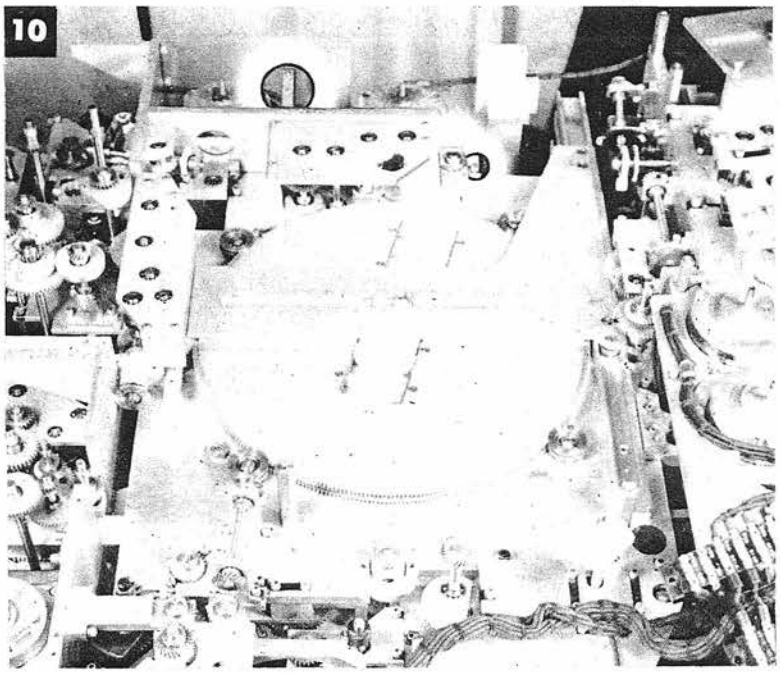


8 Remove the two screws from the hanger for a short shaft assembly near the *dRh* follow-up. Remove the two screws securing the bracket to which this hanger was attached.

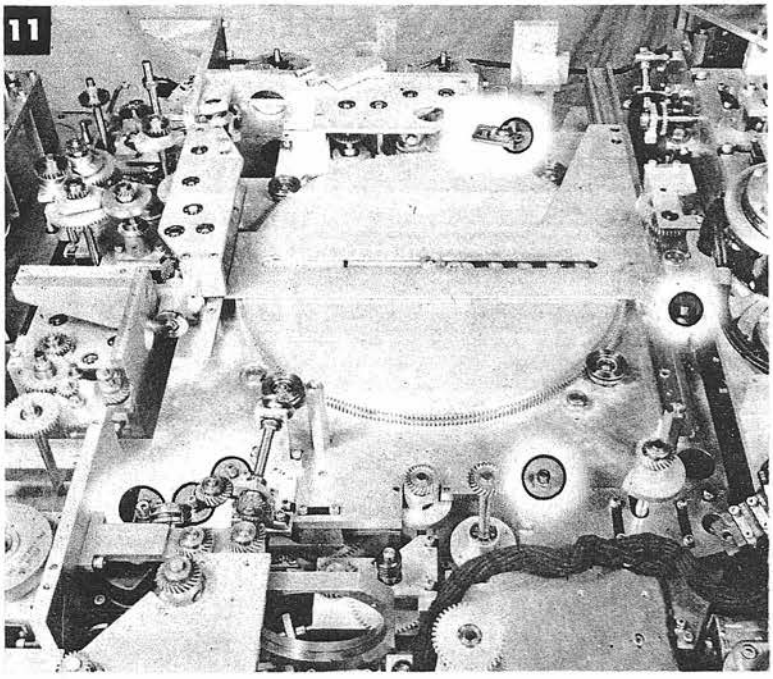


9 Remove the bracket. Push the assembly out of the way.

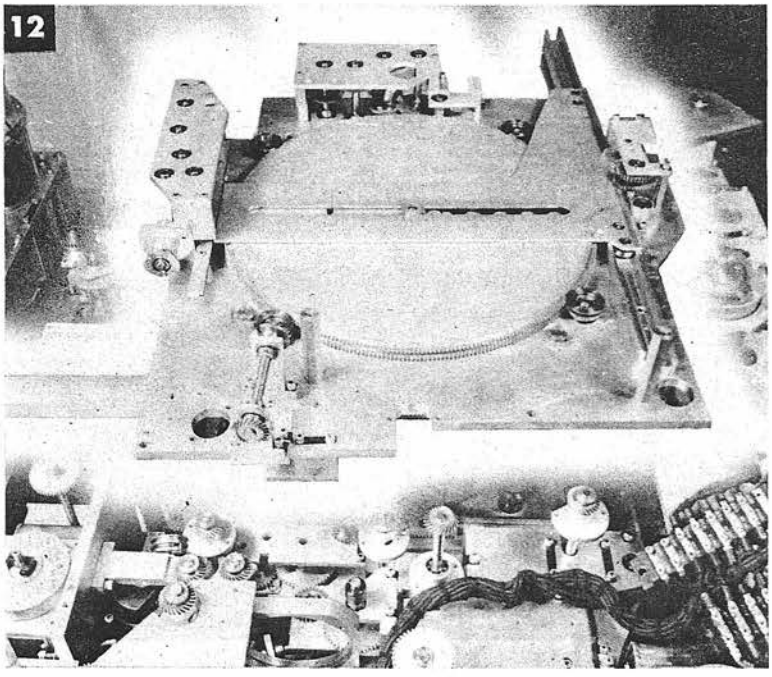
10 Remove the two screws securing the bracket between the *dRh* and *RdBs* follow-ups. Remove the bracket.
Unpin the collar of the bevel gear indicated. Remove the gear.
Remove the screws securing the bevel gear hanger.
Remove the hanger.



11 Remove the two screws securing an adapter to the under side of the height computer plate. Remove the screws securing the plate to the instrument.



12 Lift the plate straight up and remove the mechanism.

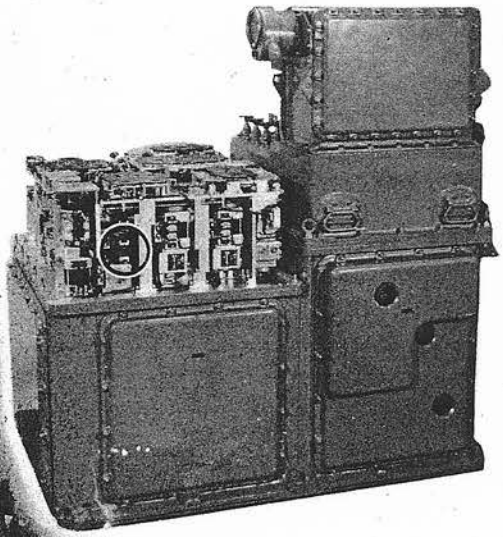


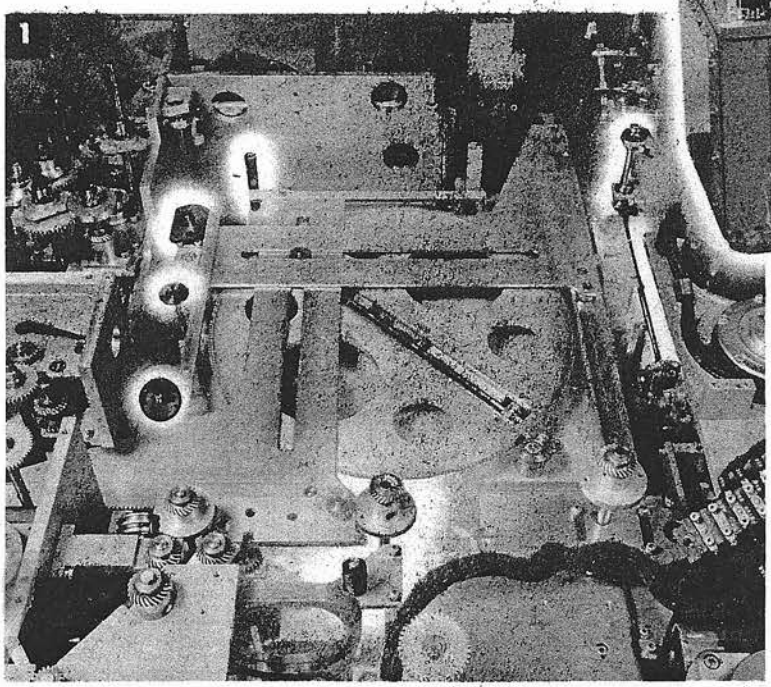
To reinstall the mechanism, reverse the removal procedure.

For readjustment procedure, follow the directions given for the reinstallation of the top plate, page 644 to 651, and run tests accordingly.

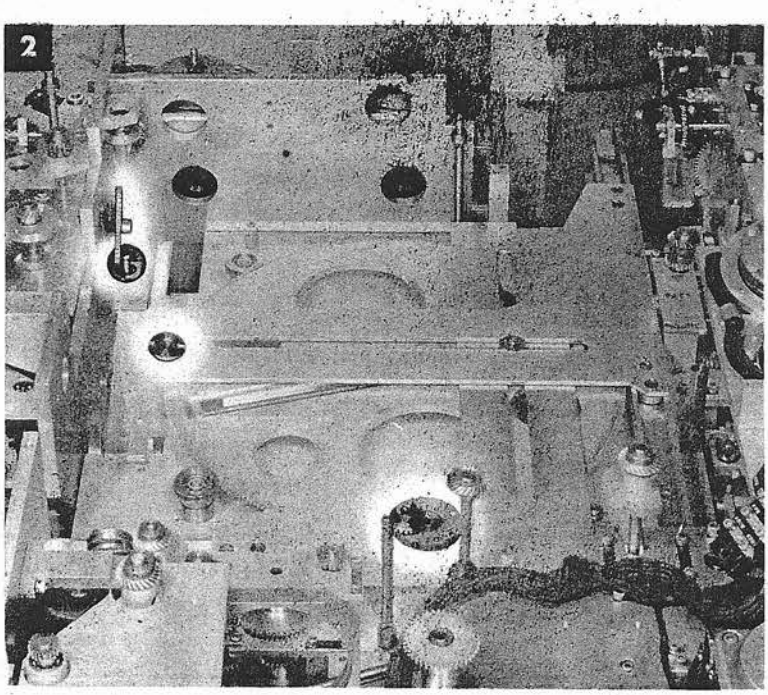
dH, dRh COMPONENT SOLVERS

Top Plate of the Control Unit, page 644
Target Solver, page 652
Height Solver, page 652
dR Follow-up, page 591

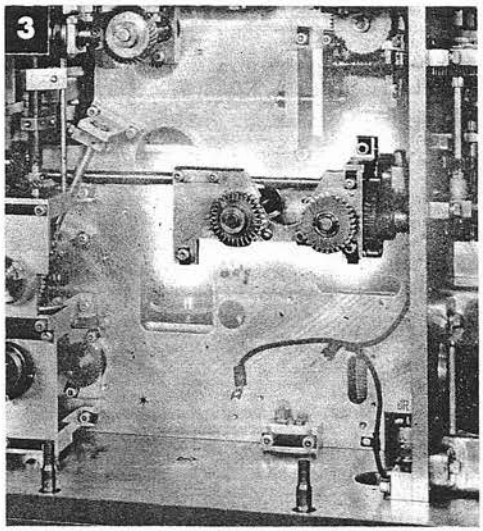




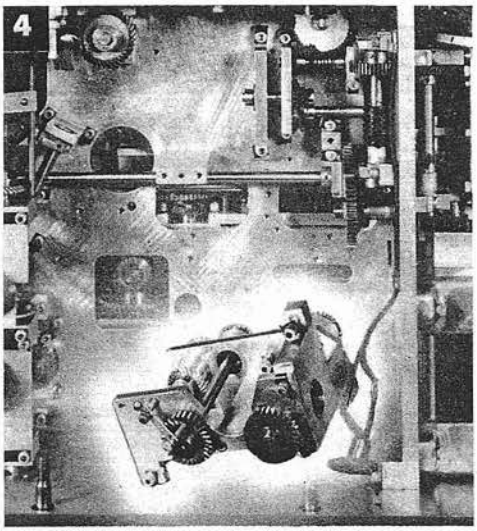
1 Remove the eight screws securing two shaft assemblies to the back of the front plate of the control unit. Remove the assemblies.
Remove the hexagonal post at the left rear corner of the plate.
Remove the two screws securing the hanger for the *Ct* transmitter worm shaft. Remove the shaft assembly.
Unpin the collars of the two gears and the coupling indicated.



2 Remove these three parts and the adapter below the bevel gear.

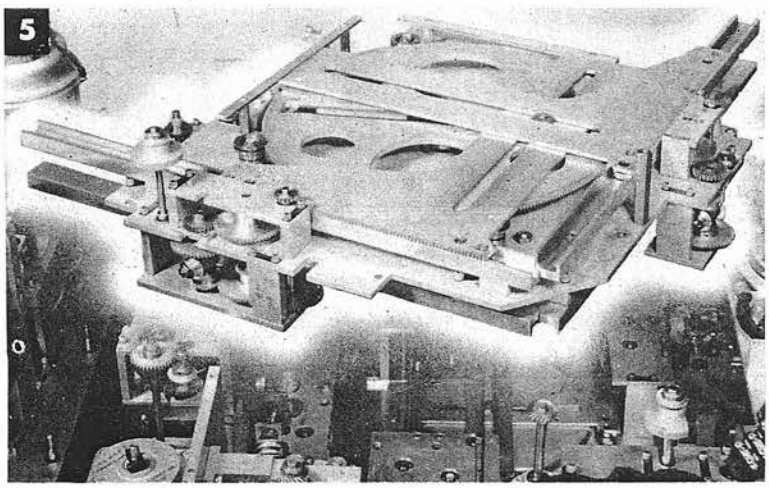


3 Remove the four screws securing the range input gearing group to the front plate of the instrument.



4 Remove the gearing group.

5 Remove the screws securing the *dH, dRh* plate. Lift out the plate with the rear edge tilted upward.



To reinstall the component solvers, reverse the removal procedure.
Reinstall the other mechanisms removed.
For the readjustment procedure, follow the directions given for the reinstallation of the top plate, page 651, and run tests accordingly.

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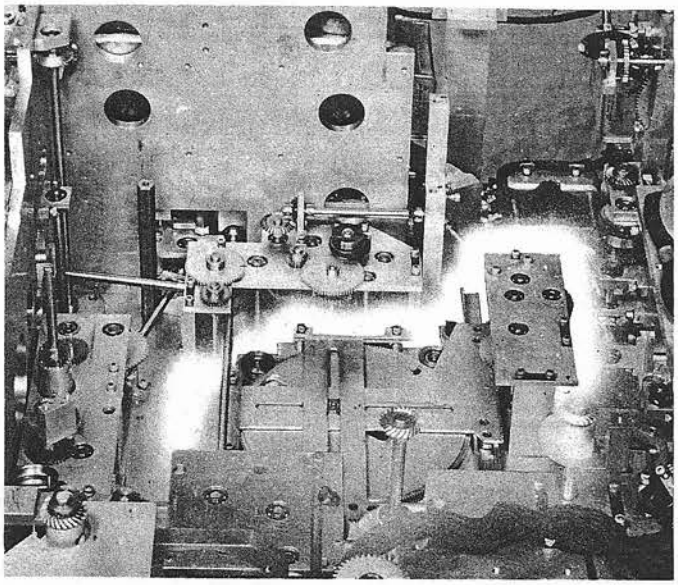
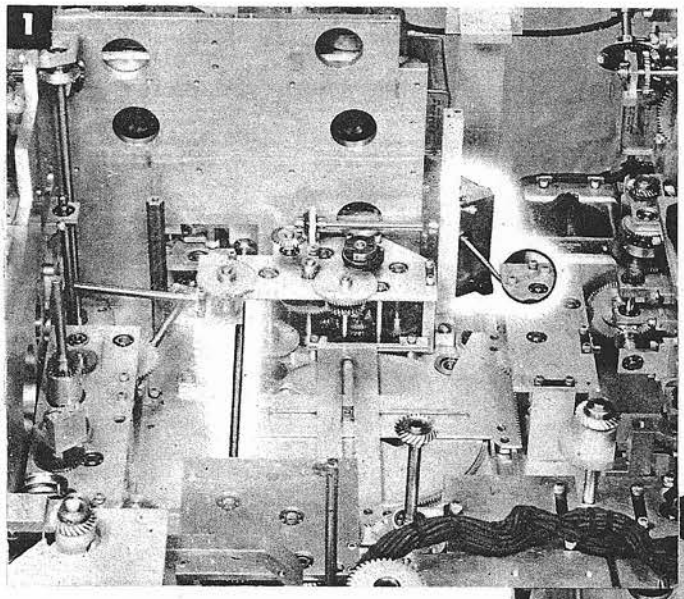
SHIP COMPONENT SOLVER

Top Plate of the Control Unit, page 644

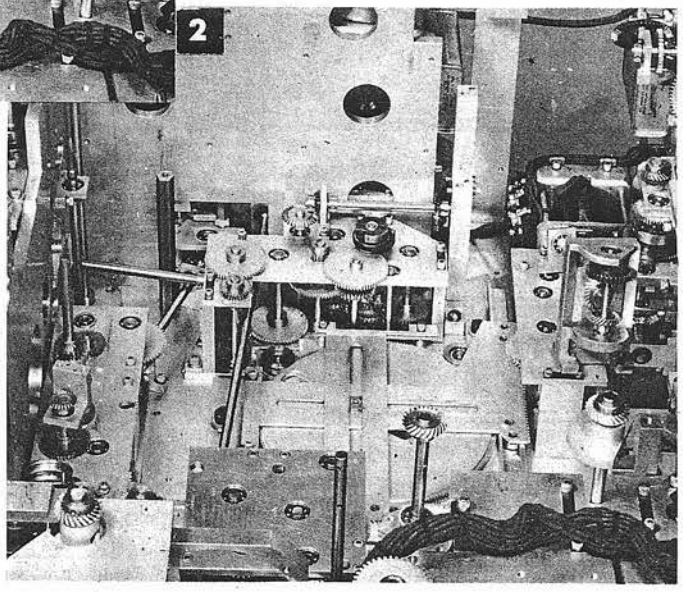
Height Solver, page 652
Target Solver, page 652
dH, dRh Solvers, page 656





1 Remove the four screws securing a long shaft assembly at the rear of the ship component solver. Move the shaft assembly to the rear as far as possible.

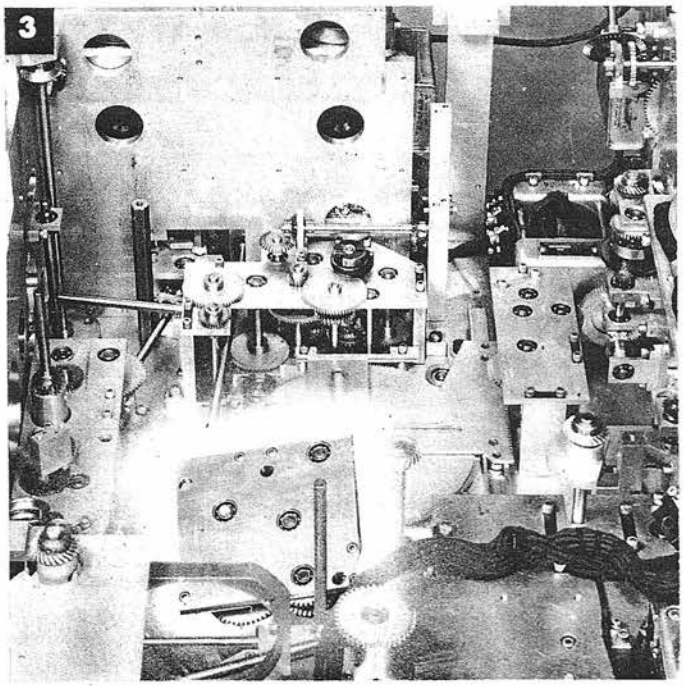
Remove the four screws securing a shaft assembly near the *RdBs* follow-up.



2 Remove the assembly.

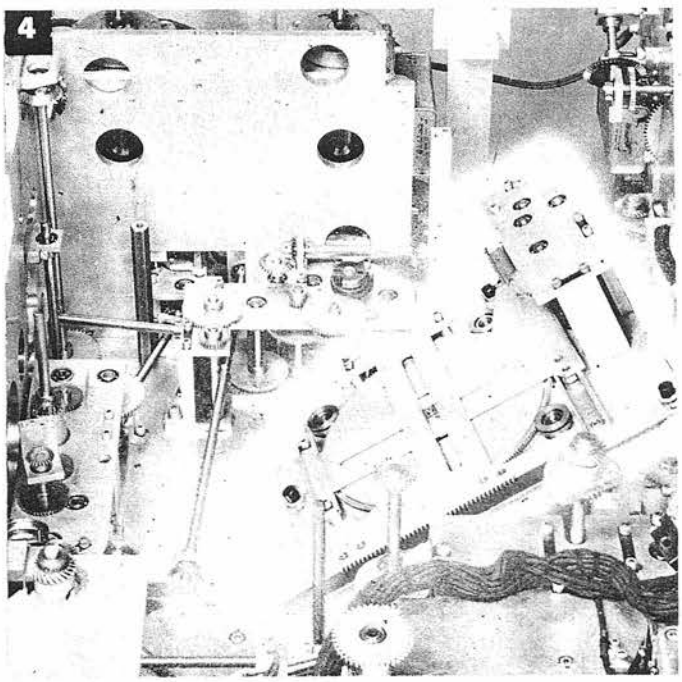
3 Remove the four screws securing a small square gearing mechanism next to the ship component solver. Remove the screws from the lower plate by reaching through the access holes in the top plate.

Remove the mechanism.



4 Remove the screws securing the ship component solver mounting plate to the base of the control unit. Work the dowels free.

Tilt the unit to clear.



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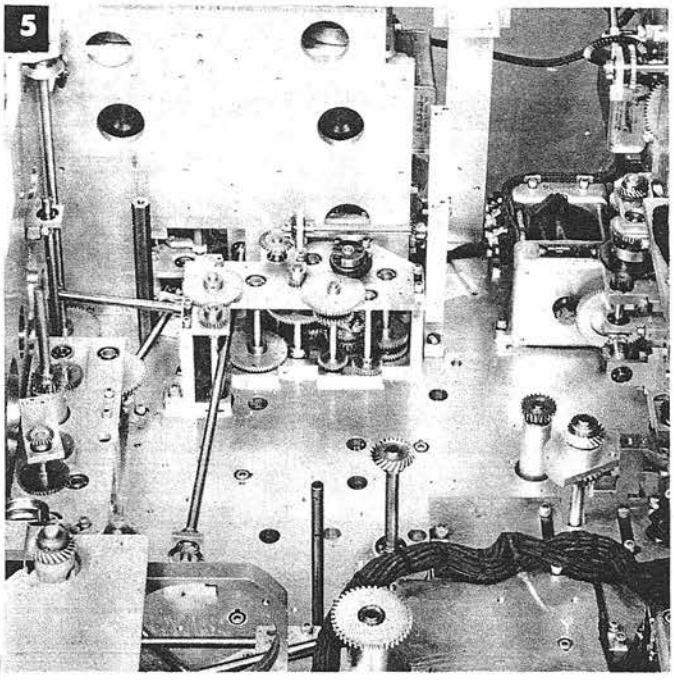

5 Remove the mechanism.

To reinstall the ship component solver, reverse the removal procedure.

Reinstall the *dH*, *dRh* component solvers, the height and target component solvers, the top plate, and associated mechanisms.

Follow the readjustment procedure for the reinstallation of the top plate, page 651, and run tests accordingly.

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Computer Unit

This unit includes the four ballistic computer units, the integrator group, the prediction section, the *Co* receiver, and the $\triangle cB'r$ and $\triangle cEb$ transmitters.

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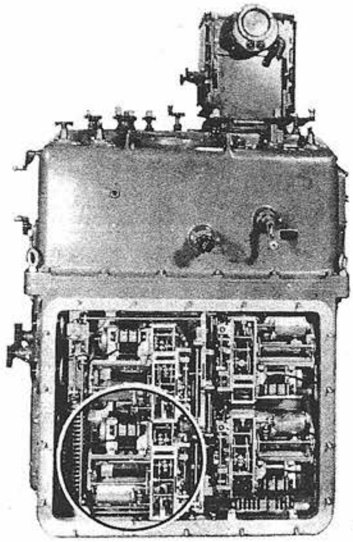
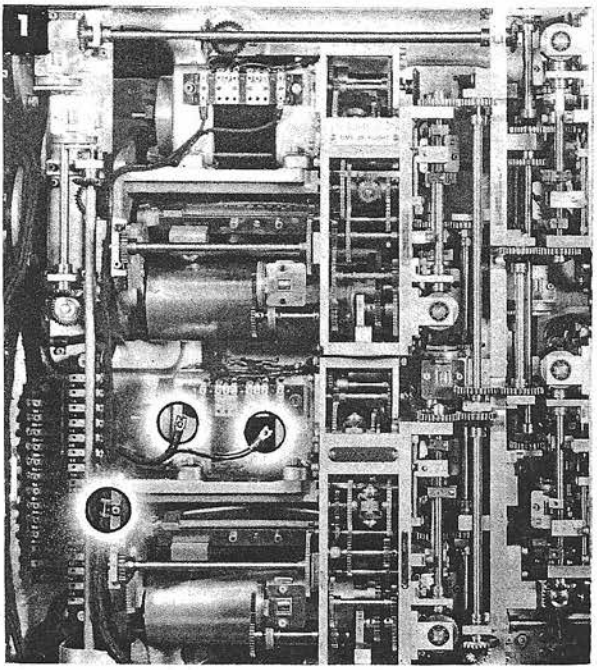
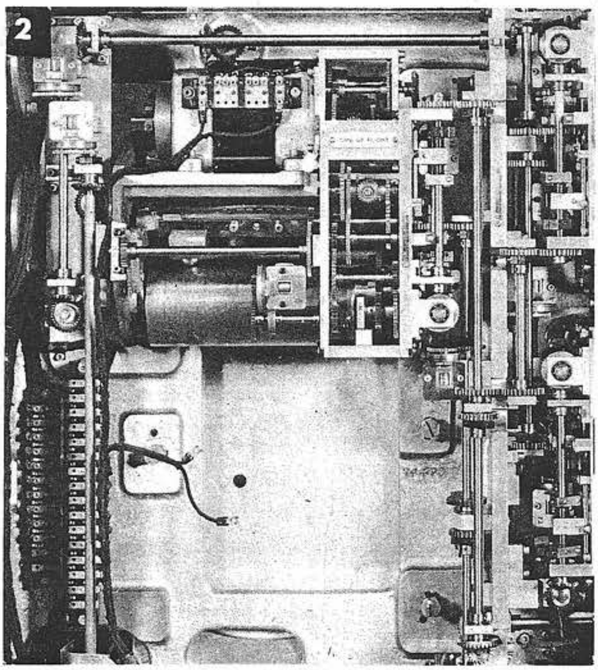
Vf + Pe BALLISTIC COMPUTER





1 Remove the two screws connecting cable leads C and CC to the servo terminal block.
Loosen the screw securing the cable clamp to the side of the mechanism.
Free the cable.



2 Remove the three large screws securing the ballistic computer and remove it.

To reinstall the *Vf* + *Pe* ballistic computer, position the mechanism by means of the dowels and reverse the removal procedure.

Readjust clamps A-85, A-82 and A-75.

Run tests.

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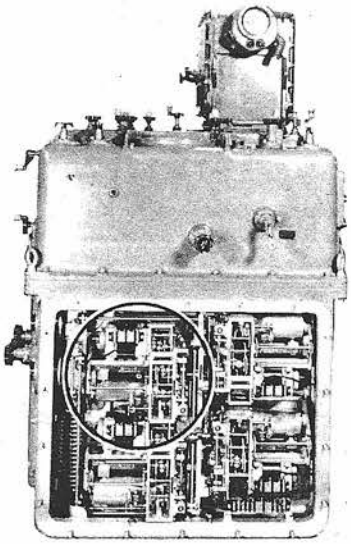
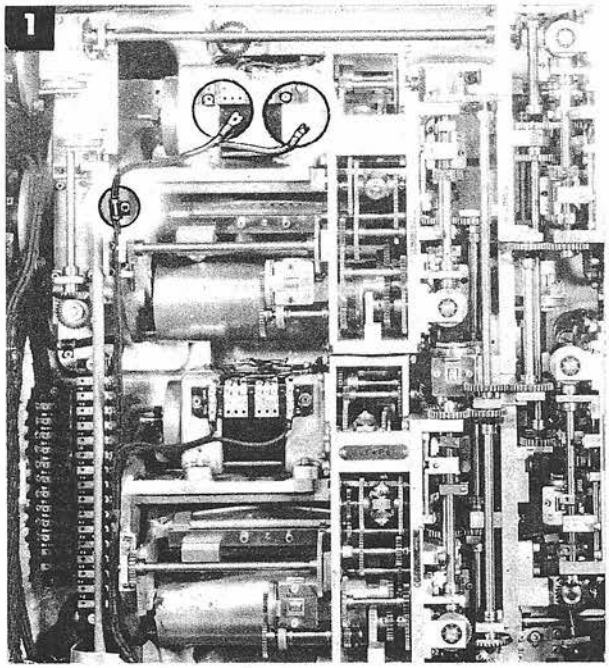
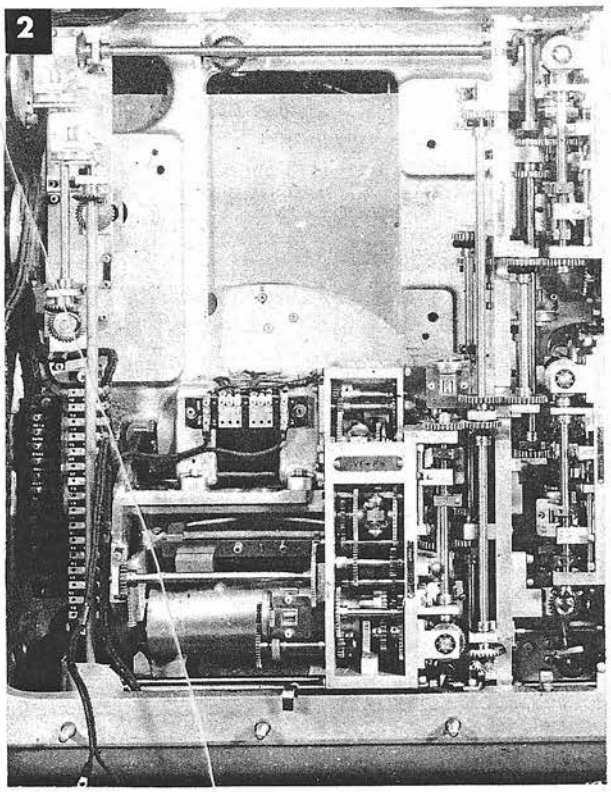
Tf BALLISTIC COMPUTER





1 Remove the two screws connecting cable leads A and AA to the servo terminal block.
Loosen the screw securing the cable clamp to the side of the ballistic computer. Free the cable.



2 Remove the three screws securing the mechanism and remove it.

To reinstall the *Tf* ballistic computer, position the mechanism by means of the dowels and reverse the removal procedure.

Readjust clamps A-84, A-74, and A-80.

Run tests.

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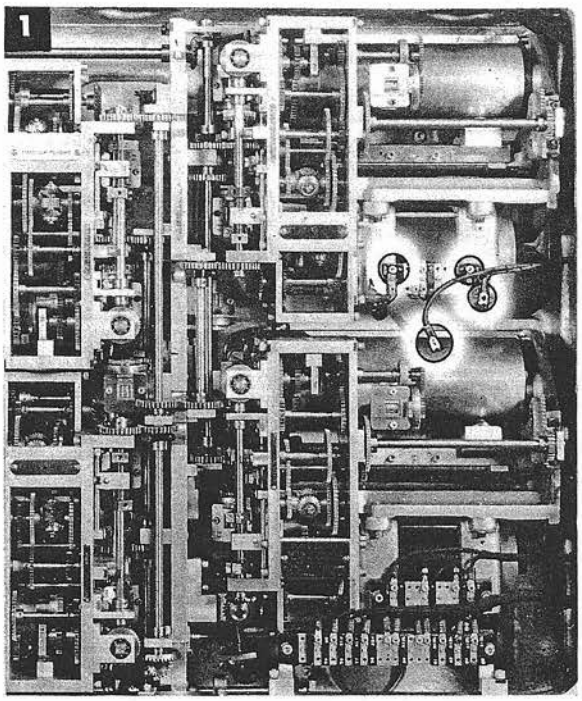
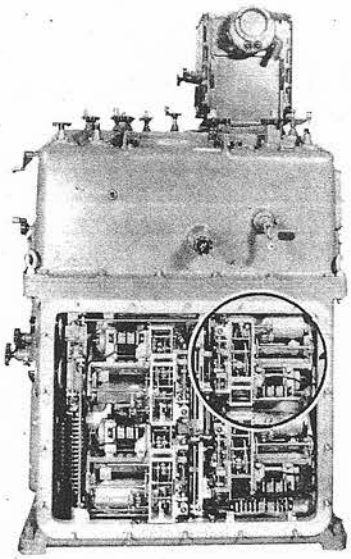
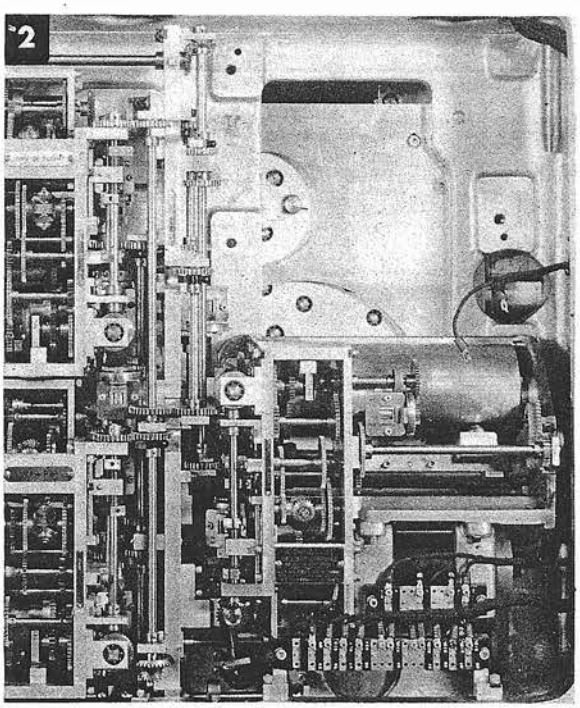
Tf/R2 BALLISTIC COMPUTER





1 Remove the two screws connecting cable leads B and BB to the servo terminal block.



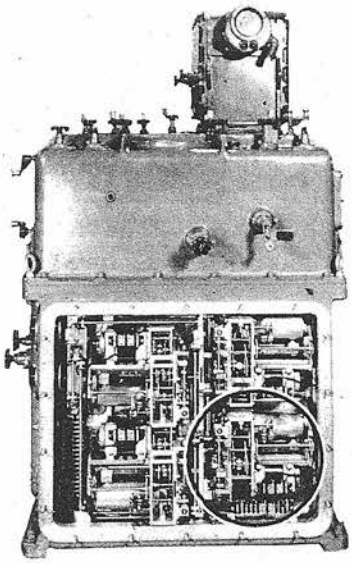
2 Remove the three screws securing the mechanism and remove it.

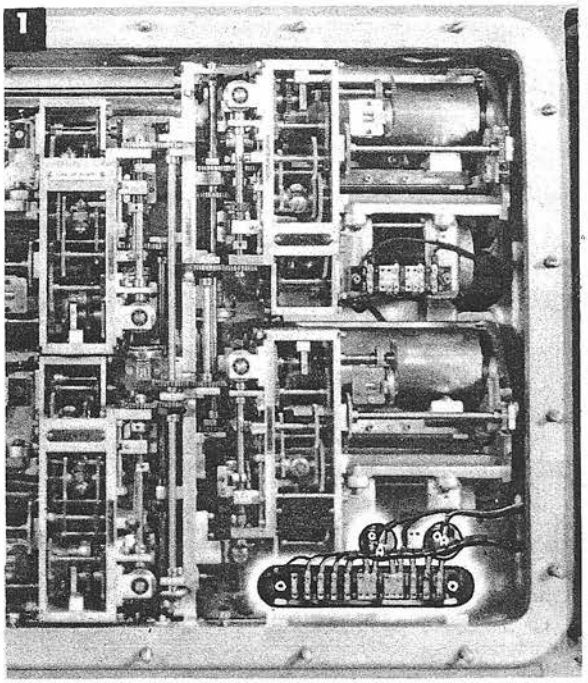
To reinstall the *Tf/R2* ballistic computer, position the mechanism by means of the dowels and reverse the removal procedure.

Readjust clamps A-76, A-71, and A-78.

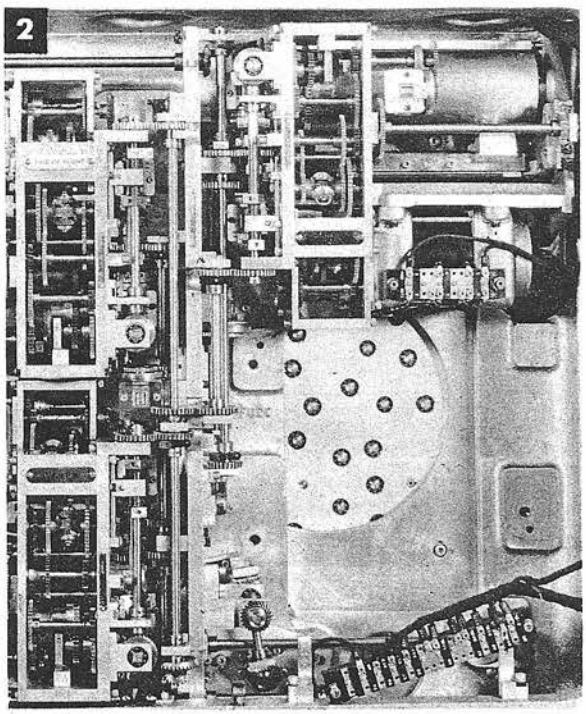
Run tests.

FUZE BALLISTIC COMPUTER





1 Remove the two screws connecting cable leads D and DD to the servo terminal block.
Remove the two screws securing the terminal block just below the fuze ballistic computer. Move the terminal block out of the way.



2 Remove the three screws securing the mechanism and remove it.

To reinstall the fuze ballistic computer, position the mechanism by means of the dowels and reverse the removal procedure.

Readjust clamps A-73, A-203, and A-77.

Run tests.

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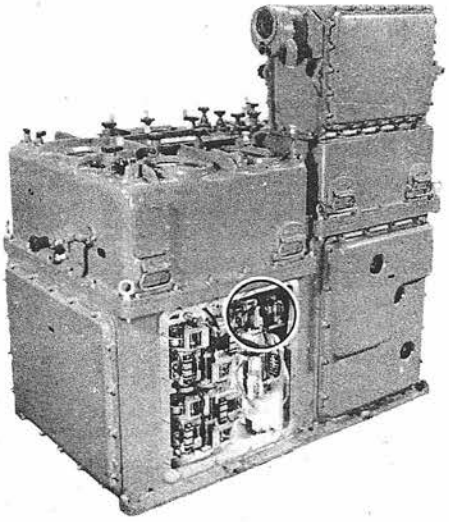
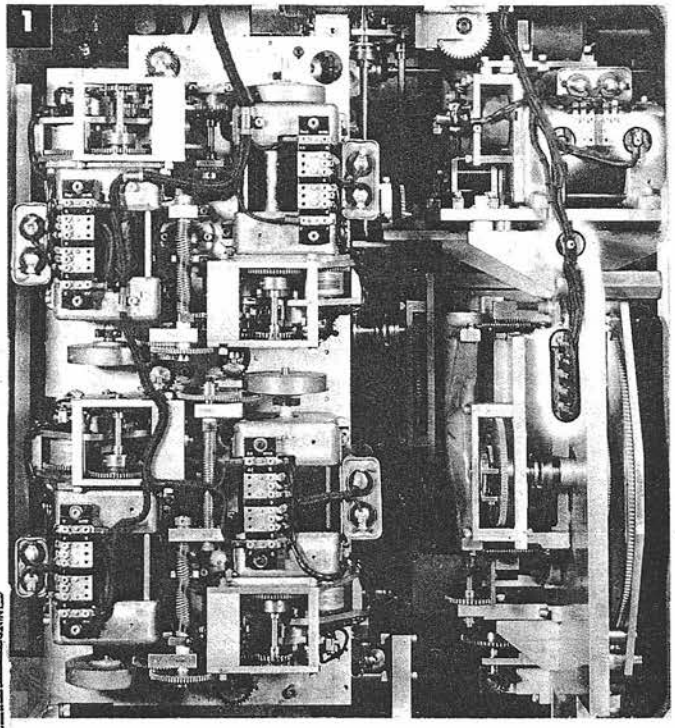
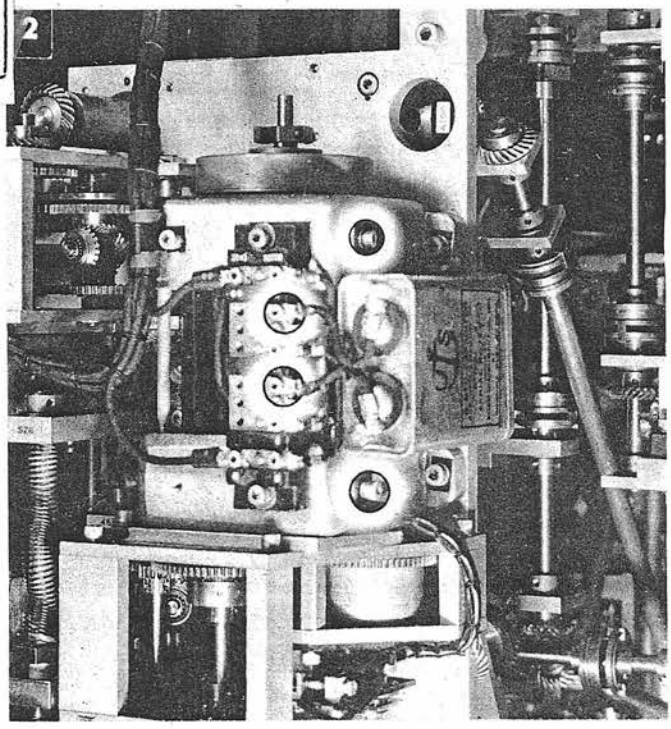
Co RECEIVER AND MOUNTING PLATE





1 Remove the two screws connecting cable leads U and UU to the servo terminal block of the *Co* receiver. Remove the five screws connecting the *Co* leads to the terminal block below the receiver. Loosen the screw securing the cable clamp above the terminal block. Free the cable.



2 Remove the two screws connecting the capacitor leads to the servo terminal block of the *Dtwj* follow-up. Remove the two screws securing the capacitor and remove it.

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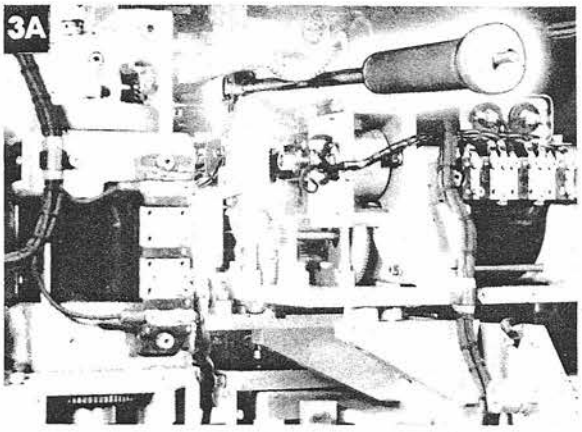
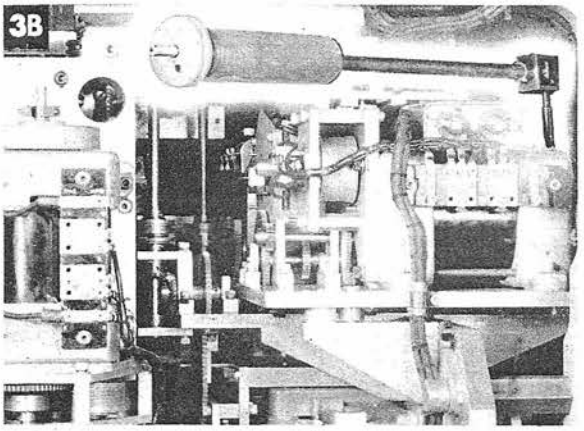
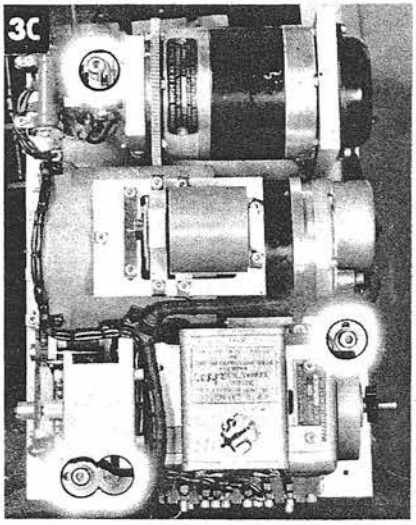
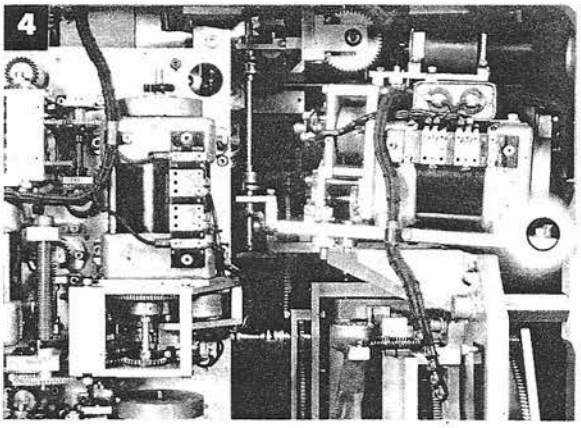
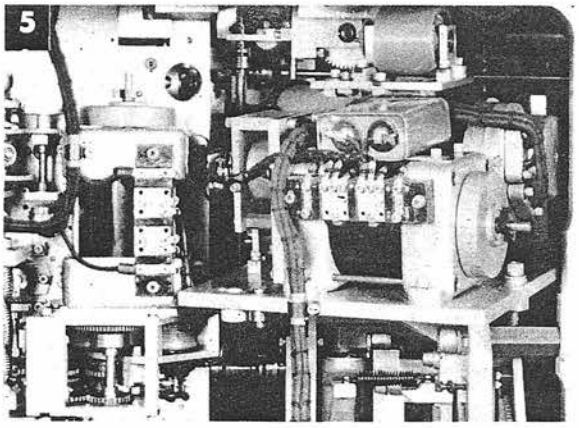






3 Using an angle screw driver, loosen the three screws securing the *Co* receiver to its mounting plate. Do not remove the screws from the *Co* mounting plate for they are difficult to reach and may drop into the mechanism.





4 Lift the receiver to disengage the dowels and move it out slightly to reach a cable clamp at the right rear corner. Remove the screw and the cable clamp.

5 Pull the receiver out a little more to reach the screw securing the cable clamp behind the fine synchro. Remove the screw and the clamp carefully.

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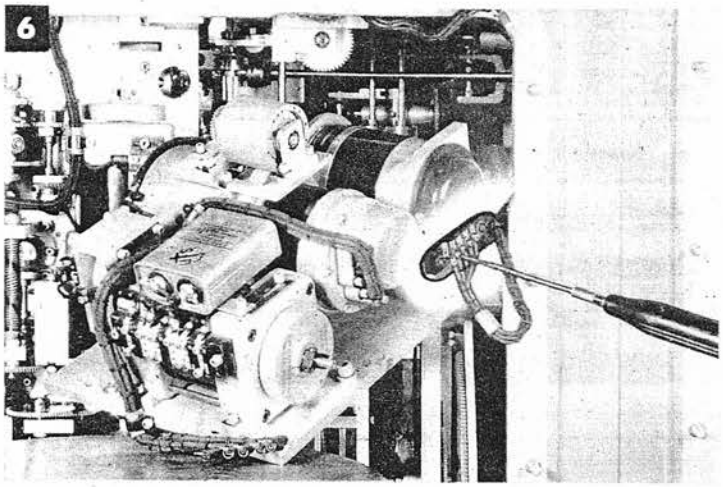
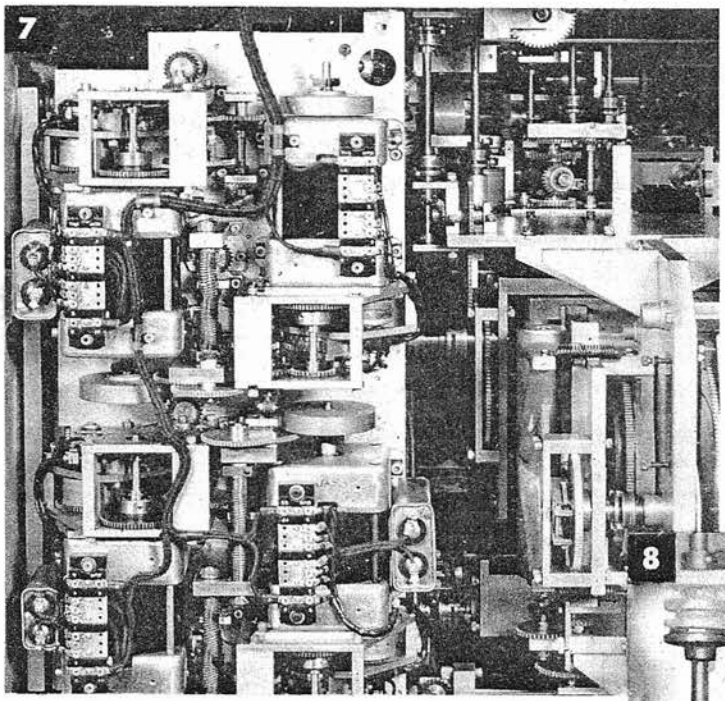


6 Ease the receiver out still farther to reach the five screws connecting the cable leads to the synchro terminal block. Remove the five screws.

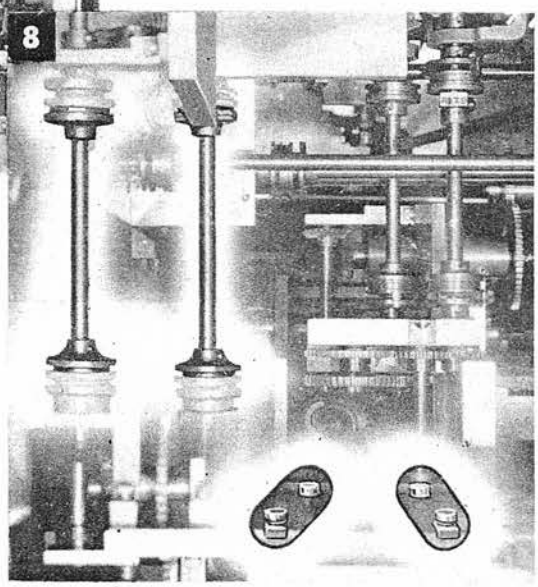


7 Remove the receiver.

To reinstall the *Co* receiver, reverse the removal procedure.

Readjust clamp A-179.

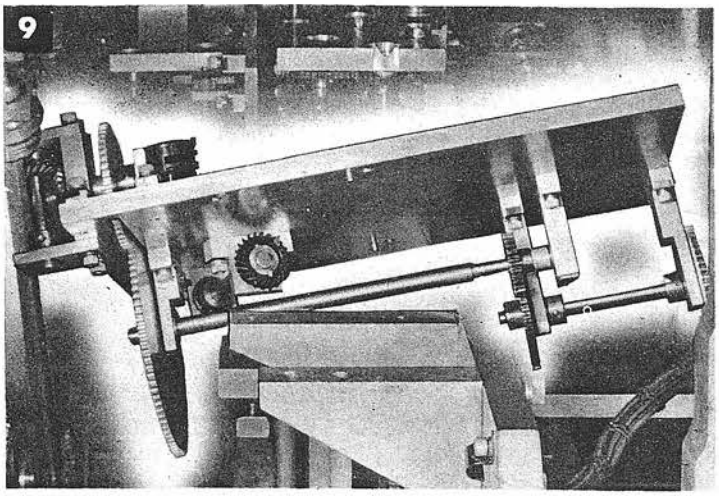
Run transmission tests.



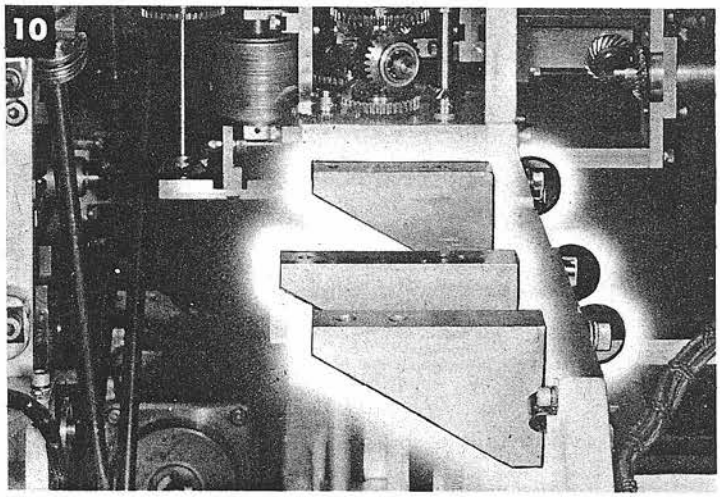
When the *Co* receiver is removed to gain access to other mechanisms, it is sometimes desirable to remove the mounting plate below the receiver.

8 Remove the locking spring from the coupling shaft in the time line. Remove the shaft.
Remove the locking spring from the coupling shaft in the *cR* line. Remove the shaft.
Remove the four screws securing the plate.

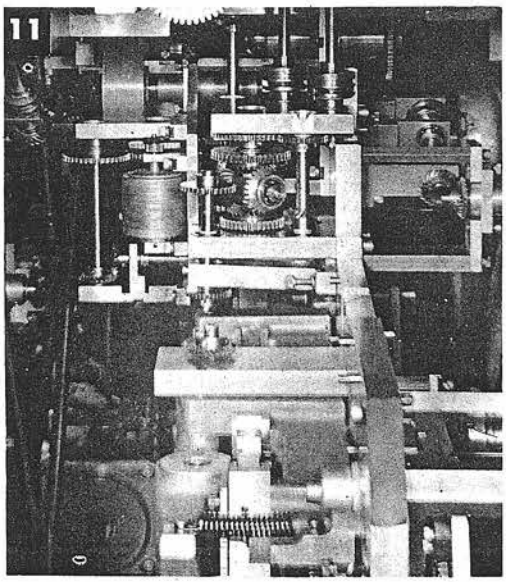
9 Tilt the plate and remove it.



10 To increase the working space, remove the two screws securing each supporting bracket.



11 Remove the brackets.



To reinstall the brackets and the plate, reverse the removal procedure. When reinstalling the *cR* coupling shaft, position it to establish the proper relationship between the *cR* dials and the *cR* intermittent drive.

Reinstall the *Co* receiver.

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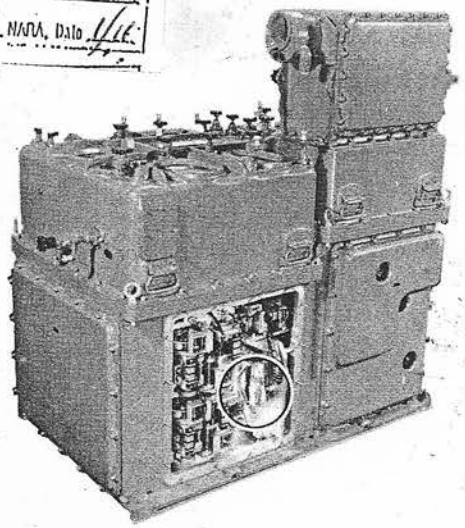
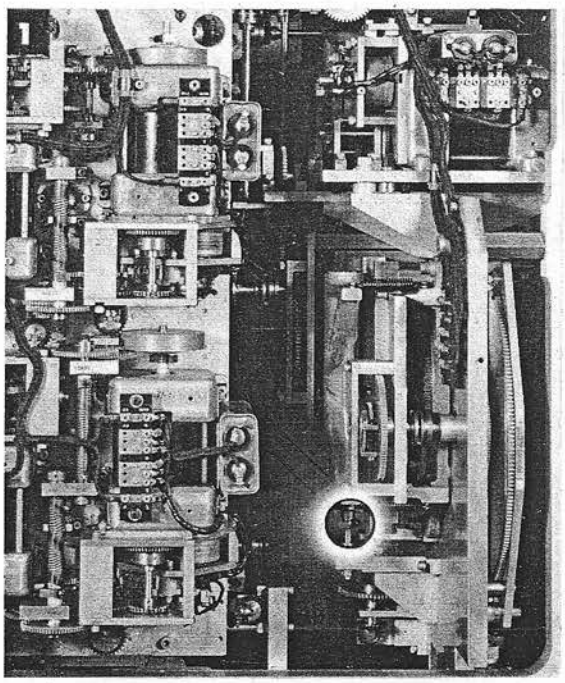
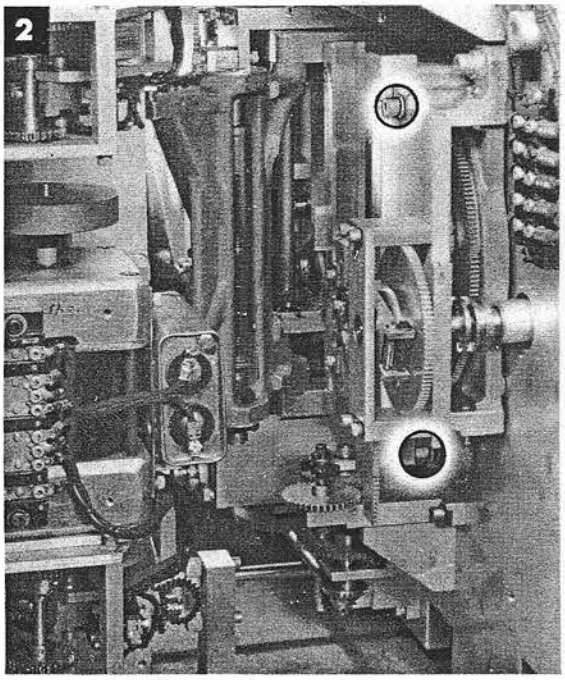
1/cR VERNIER ASSEMBLY

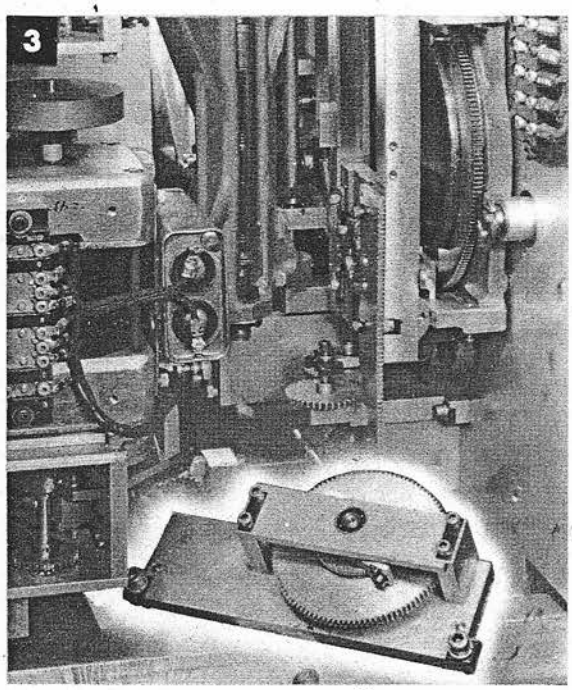




1 Loosen clamp A-142. Slide the coupling along the shaft so that the 1/*cR* integrator can be opened.



2 Remove the two springs. Remove the two balls carefully.
Remove the two screws securing the vernier assembly to the integrator



3 Remove the vernier assembly.

To reinstall the 1/*cR* vernier assembly, reverse the removal procedure.

Readjust clamps A-149 and A-150.

Run tests.

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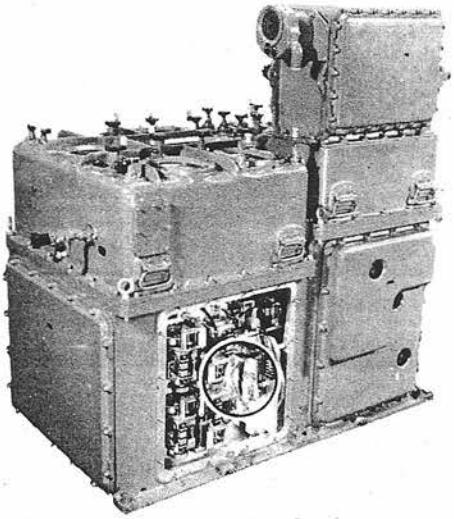
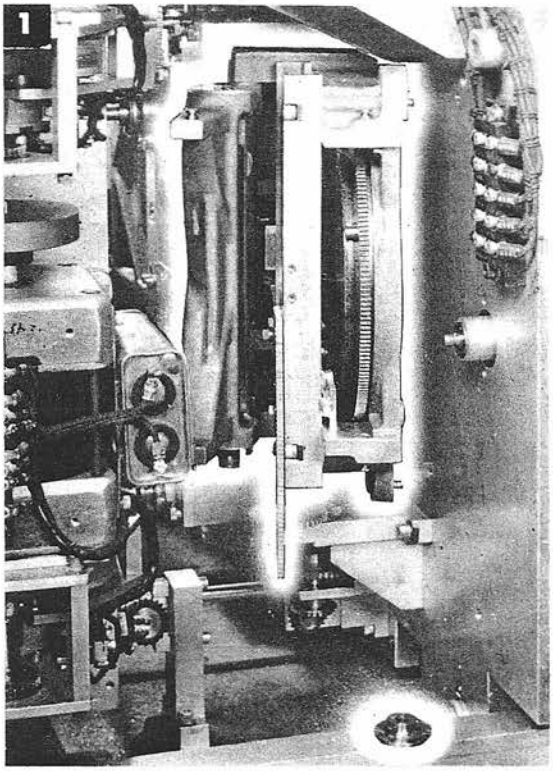
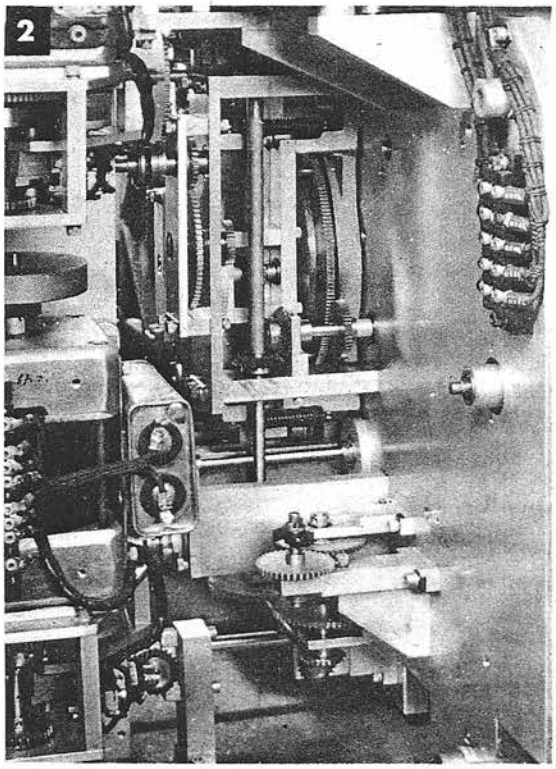


1/cR INTEGRATOR

1/*cR* Vernier Assembly, page 670



1 Remove the three large screws securing the integrator. Use a socket head screw wrench to remove the screw at the upper rear corner of the integrator casting.



2 Work the dowels loose from the mounting plate. Unpin the coupling of the 1/*cR* vernier assembly. Remove the coupling.

NOTE: Usually the integrator can be removed without removing the coupling of the 1/*cR* vernier assembly.

Remove the mechanism.

To reinstall the 1/*cR* integrator, reverse the removal procedure.

Reinstall the 1/*cR* vernier assembly.

Readjust clamps A-149 and A-150.

Run tests.

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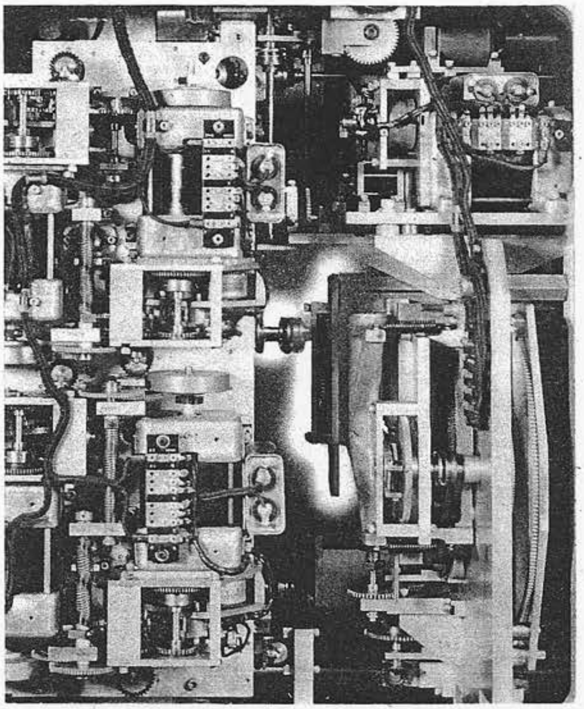
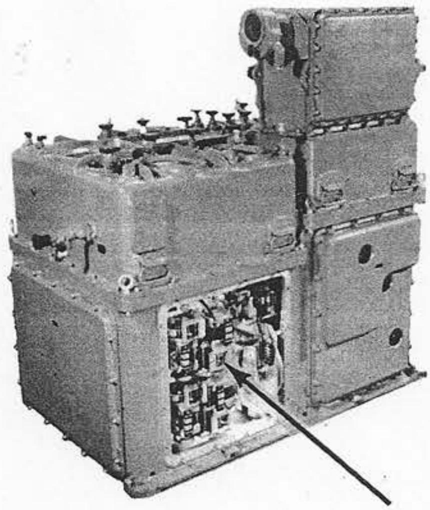
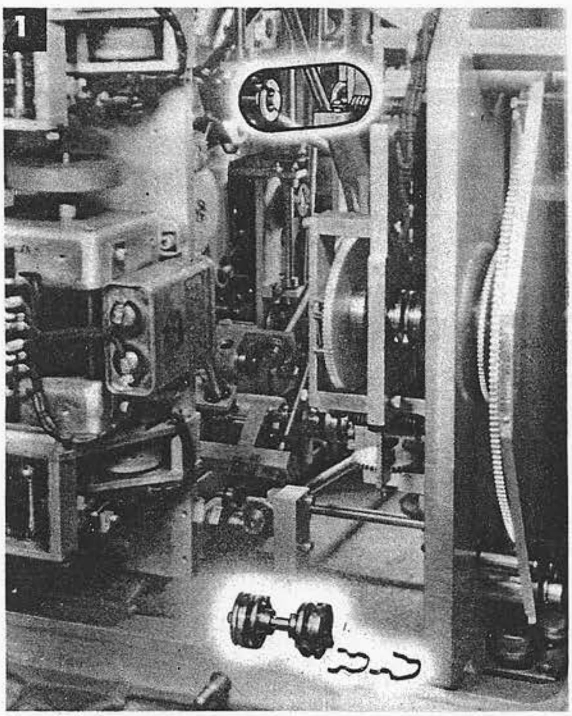
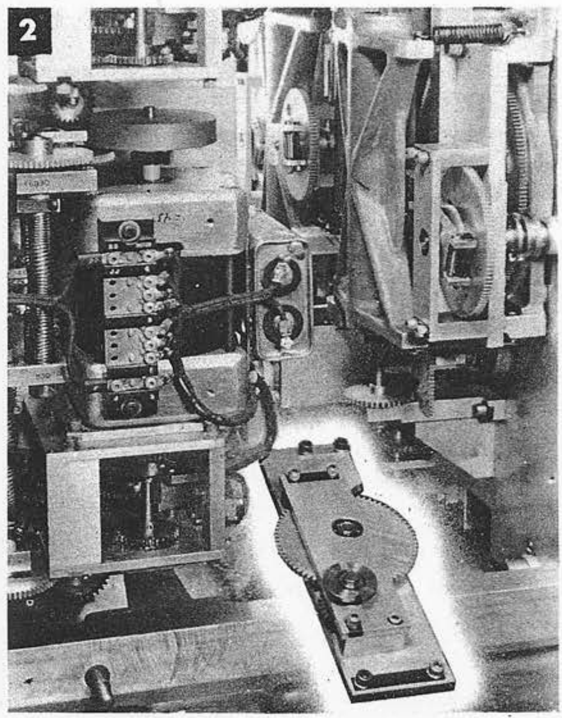
RdBs VERNIER ASSEMBLY



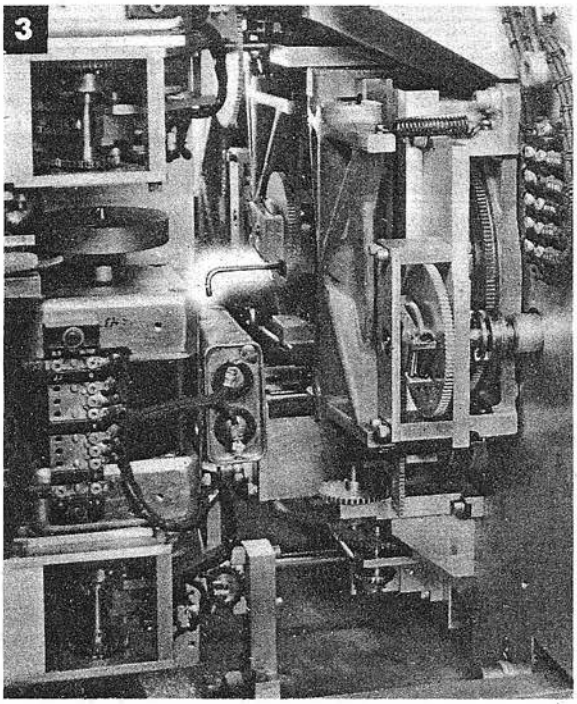




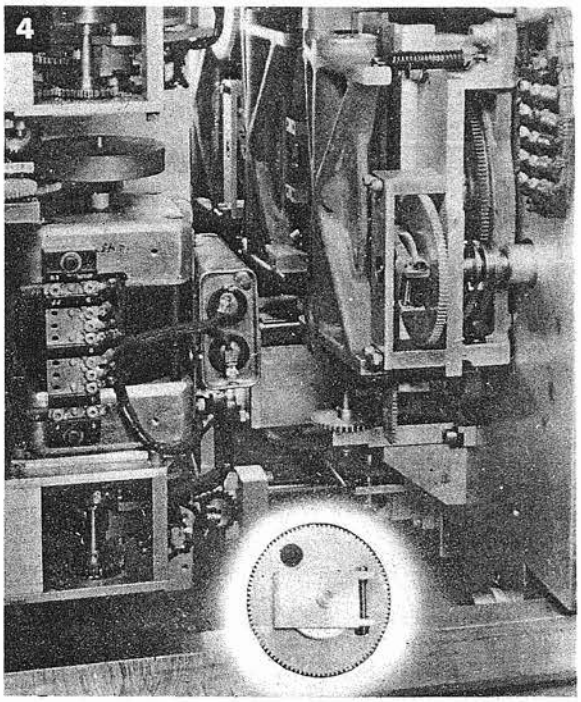


1 Remove the locking springs from the short coupling shaft in the *RdBs* line next to the vernier assembly. Remove the shaft.

2 Remove the four screws securing the plate and associated gearing at the rear of the coupling just removed. Remove the plate.



3 Remove the four screws securing the plate behind the vernier. These screws can be reached through the access hole in the vernier gear.



4 Remove the *RdBs* vernier assembly.

To reinstall the *RdBs* vernier assembly, reverse the removal procedure.

Readjust clamps A-139 and A-140.

Run tests.

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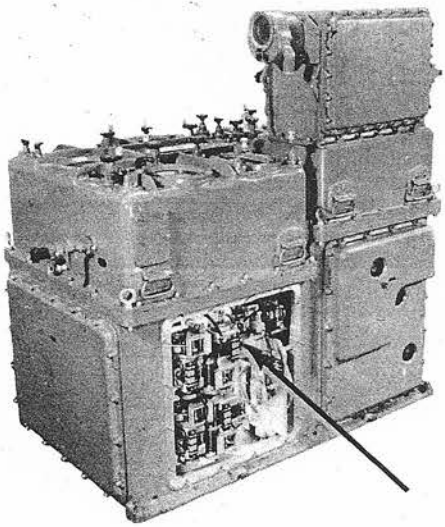
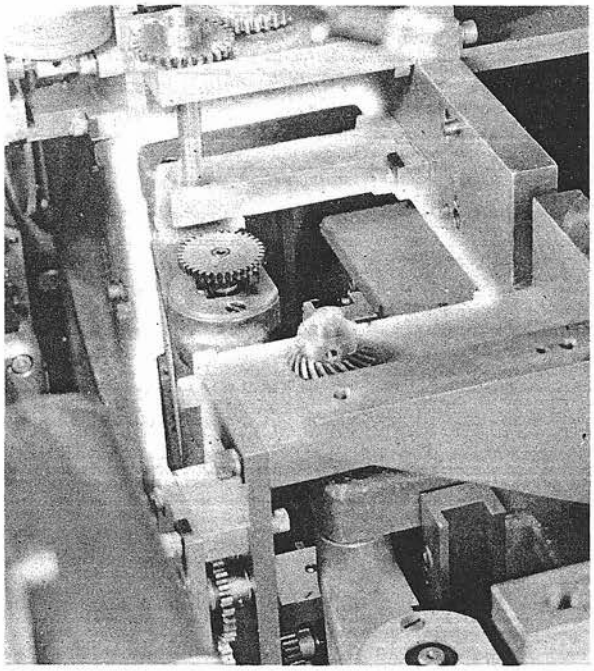
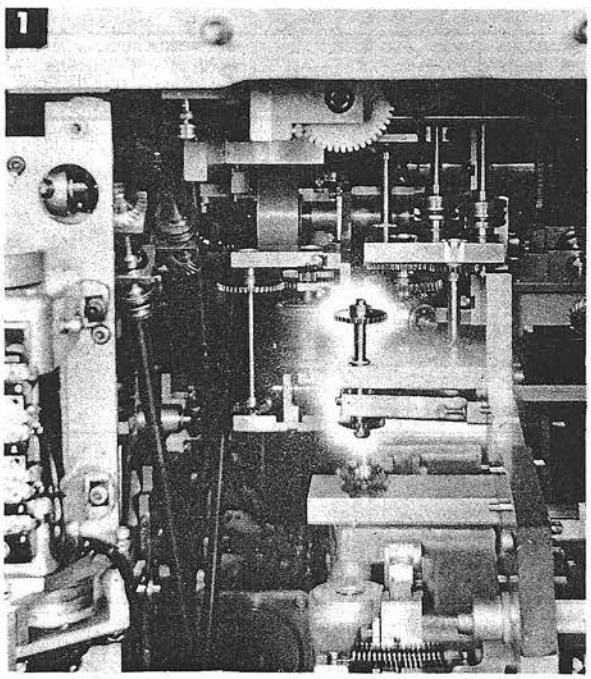
RdBs INTEGRATOR

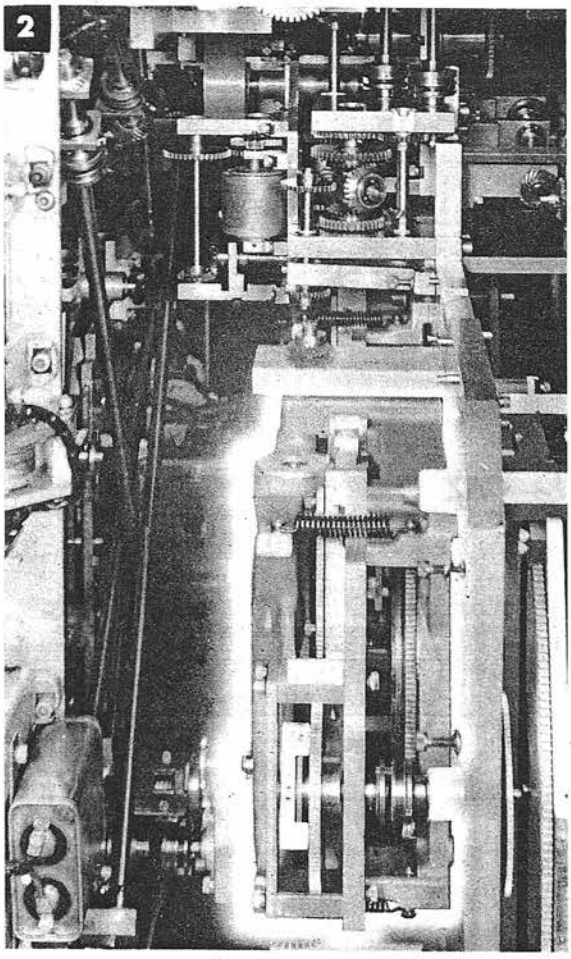


Co Receiver and Mounting Plate, page 666
1/*cR* Vernier Assembly, page 670
1/*cR* Integrator, page 671
RdBs Vernier Assembly, page 672

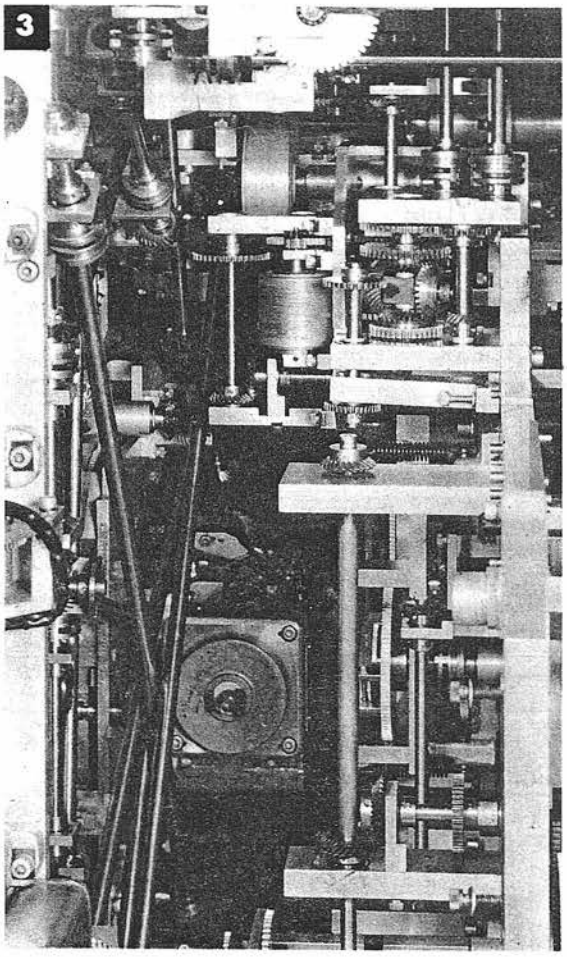




1 Remove the two screws securing the lower hanger of the vertical shaft assembly connecting with the *RdBs* integrator output gear. Raise the shaft as far as it will go.



2 Remove the three screws securing the integrator.
Work the dowels loose.



3 Remove the integrator through the space cleared by the removal of the *Co* receiver and plate.

To reinstall the integrator, reverse the removal procedure. Reinstall all the other mechanisms removed.

Readjust the *cR* intermittent drive through the coupling shaft.

Readjust clamps A-139, A-140, A-149, A-150, and A-179.

Run tests.

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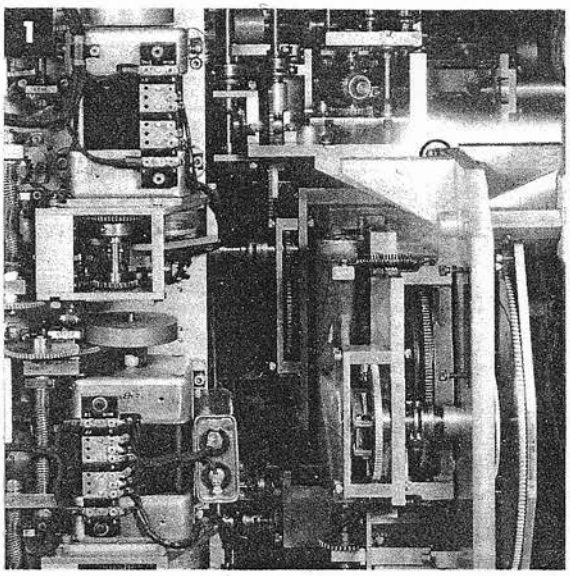
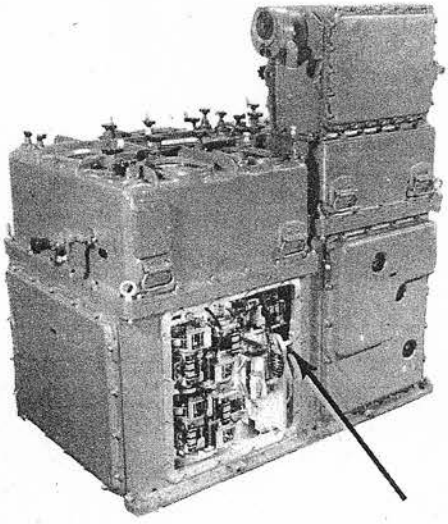
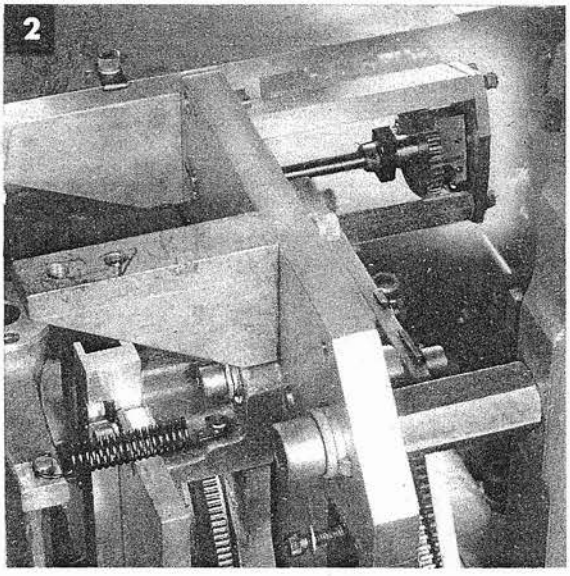
cR VERNIER ASSEMBLY

Co Receiver and Mounting Plate, page 666

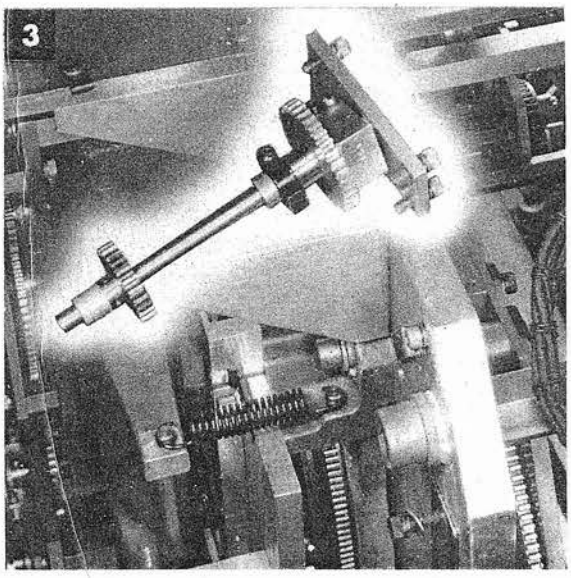




1 Remove the two screws securing the rear supporting bracket for the *Co* receiver. Remove the bracket.



2 Remove the three screws securing the small plate for the *cR* vernier assembly.



3 Remove the assembly with the plate. There is a spacer on the end of the shaft.

To reinstall the *cR* vernier assembly, reverse the removal procedure.

Readjust clamps A-151 and A-152.

Run tests.

Reinstall the *Co* receiver. Readjust clamp A-179.

Run transmission tests.

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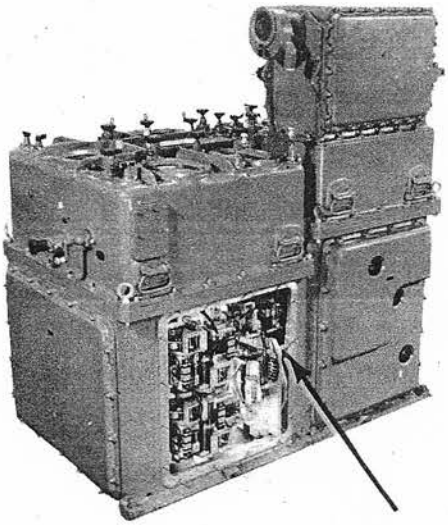
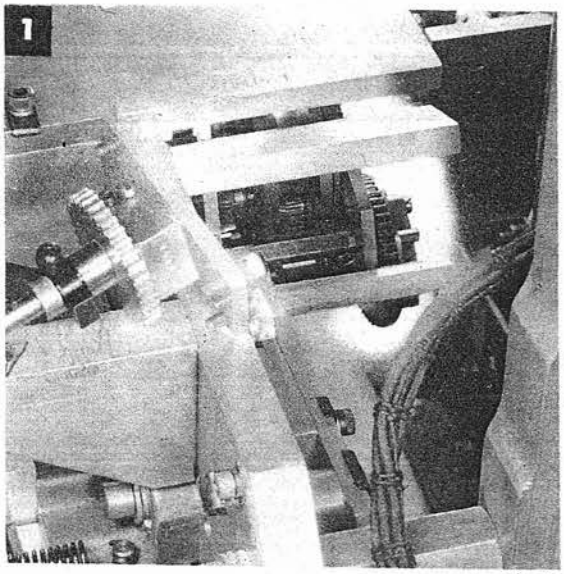
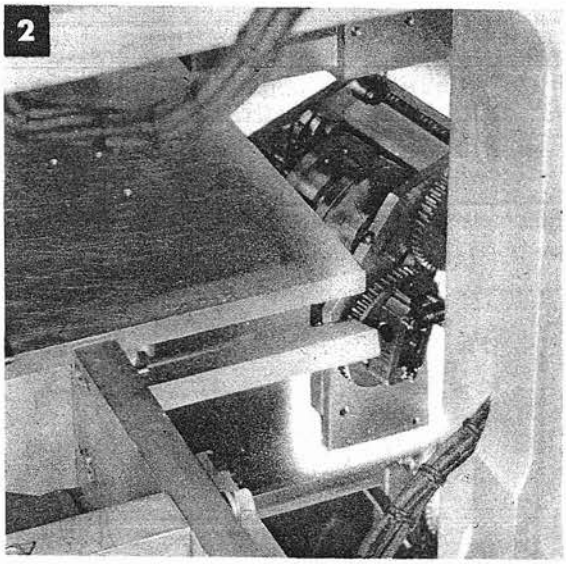


cR INTERMITTENT DRIVE

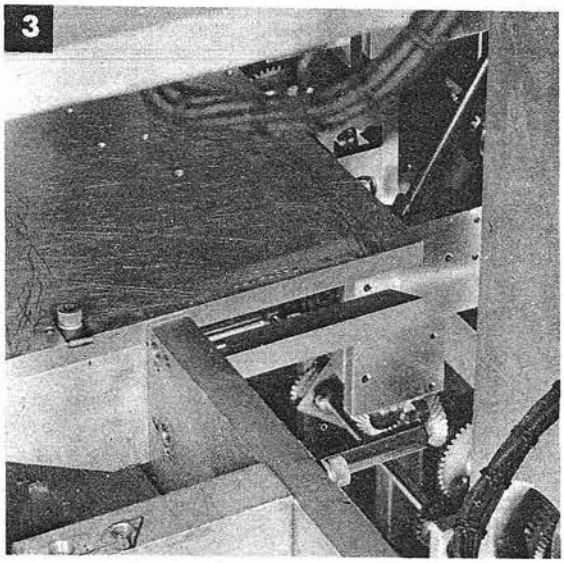
cR Vernier Assembly, page 676



1 Remove the three screws securing the intermittent drive. Hold the unit while removing the last screw.



2 Tilt the intermittent drive to clear the surrounding posts and plates.



3 Remove the *cR* intermittent drive.

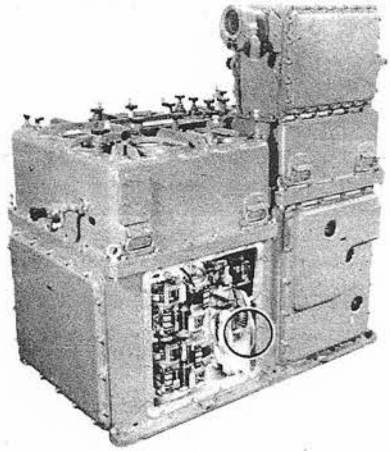
To reinstall the *cR* intermittent drive, reverse the removal procedure.

Reinstall the mechanisms removed.

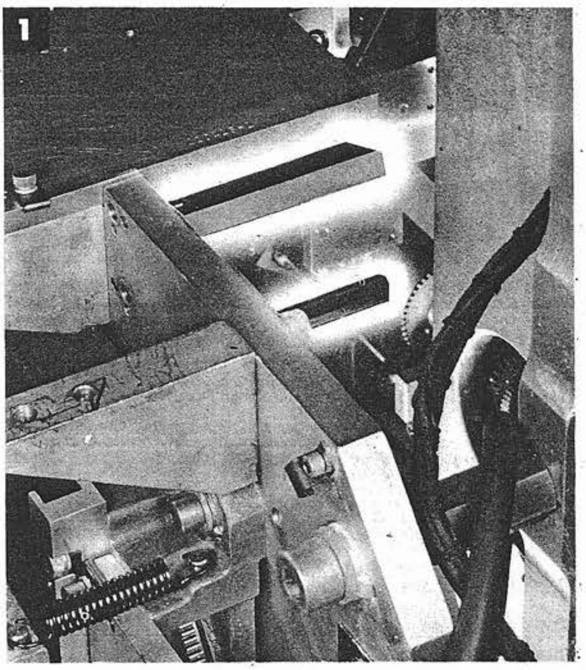
Readjust clamps A-233, A-151, A-152 and A-179.

Run tests.

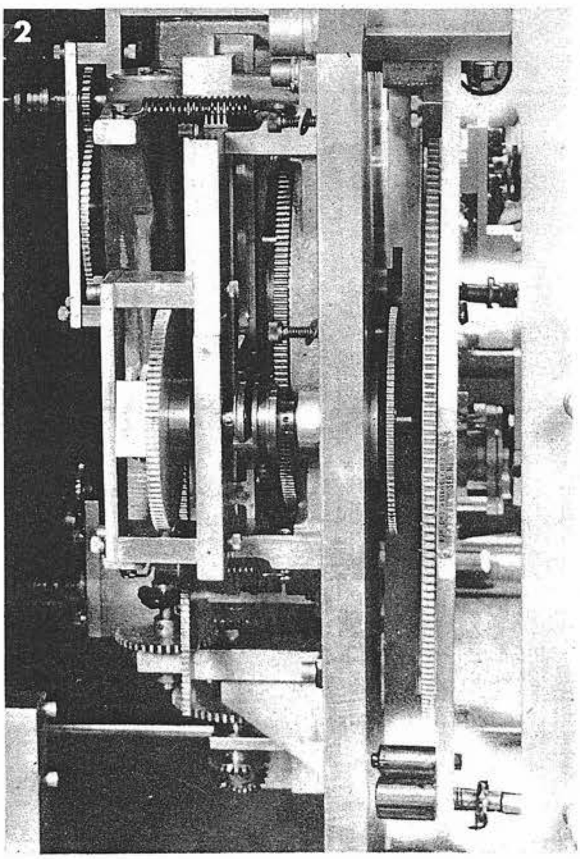
1/cR CAM



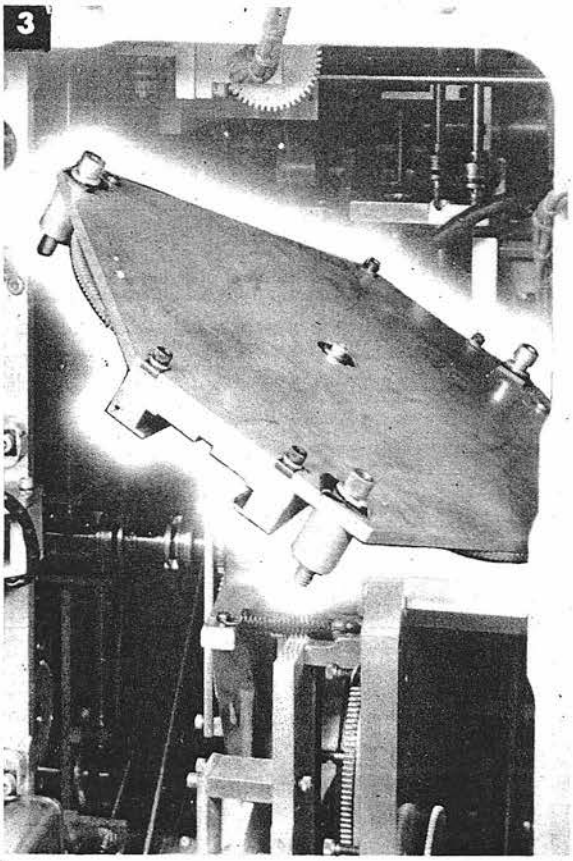
Co Receiver and Mounting Plate, page 666
cR Vernier Assembly, page 676
cR Intermittent Drive, page 677



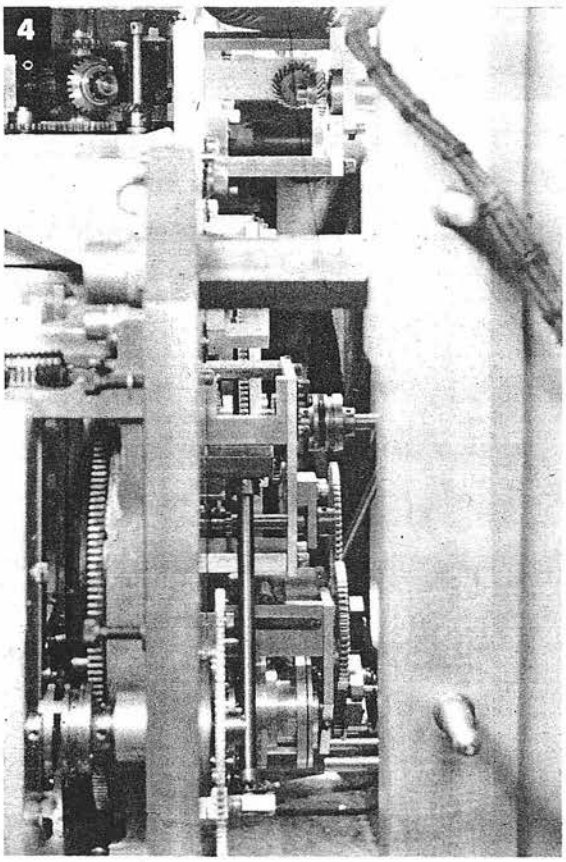
1 Remove the hexagonal post supporting the plate for the *cR* vernier assembly.
Remove the two screws securing the hanger-type post and remove it.



2 Partially back out the two screw dowels that position the 1/*cR* cam.
Remove the three screws securing the cam mounting plate.



3 Tilt the mechanism upward.



4 Remove the 1/c*R* cam.

To reinstall the 1/c*R* cam, reverse the removal procedure.

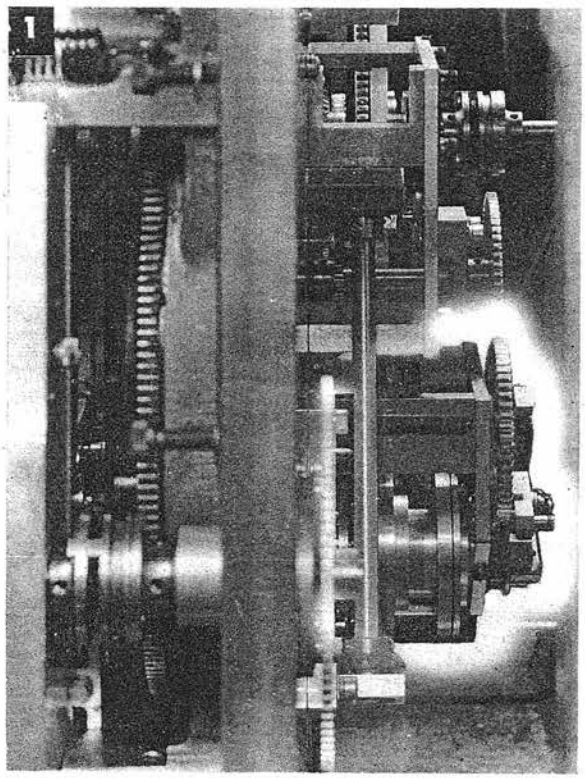
NOTE:
The 1/c*R* cam controls the travel of the 1/c*R* integrator. Position the 1/c*R* integrator carriage to make vernier clamp A-149 accessible before reinstalling the 1/c*R* cam. After reinstalling the cam, use clamp A-149 to adjust the integrator carriage roughly so that it does not limit the travel of the cam.

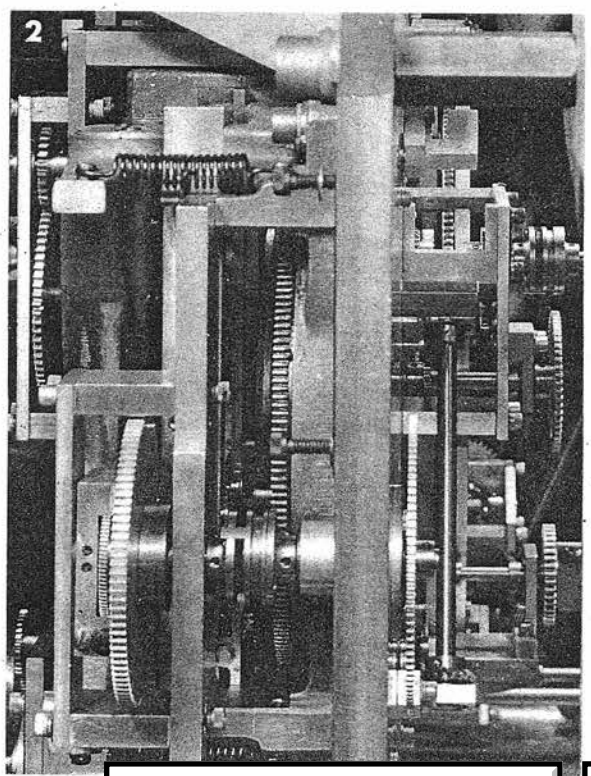
Reinstall the mechanisms removed.

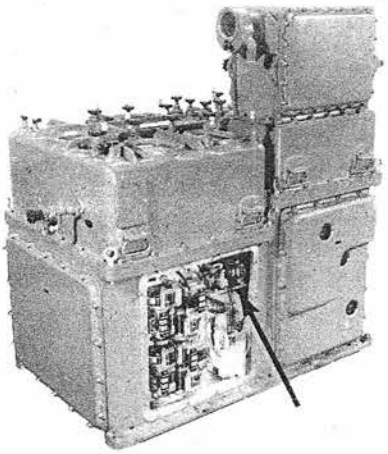
Readjust clamps A-233, A-151, A-152, A-149, and A-179.

Run tests.

E INTERMITTENT DRIVE







Co Receiver and Mounting Plate, page 666
cR Vernier Assembly, page 676
cR Intermittent Drive, page 677
1/*cR* Cam, page 678

1 Back out the two screw dowels. Remove the three screws securing the intermittent drive. Support the mechanism while removing the last screw.

2 Remove the intermittent drive.

To reinstall the intermittent drive, reverse the removal procedure.

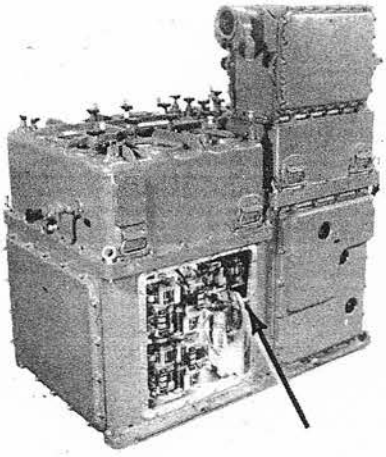
Tighten clamp A-251.

Reinstall the other mechanisms removed.

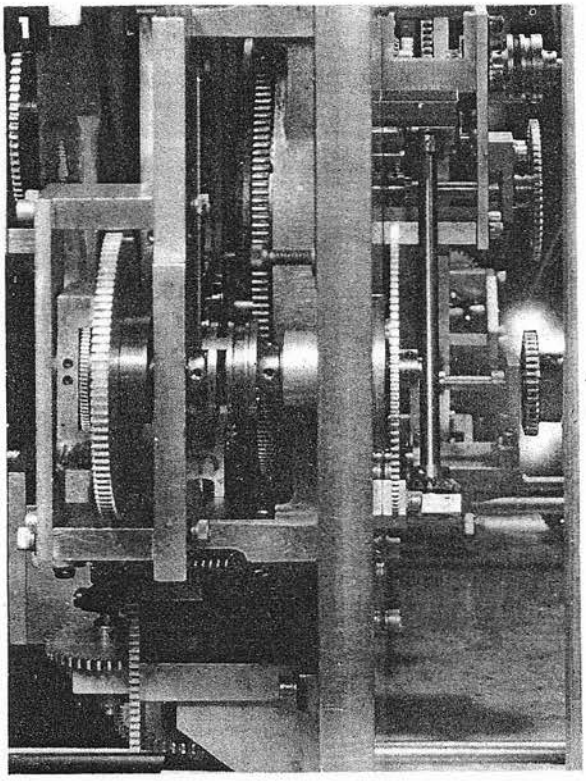
Readjust clamps A-250, A-233, A-151, A-152, A-149, A-150, A-145, A-146, and A-179.

Run tests.

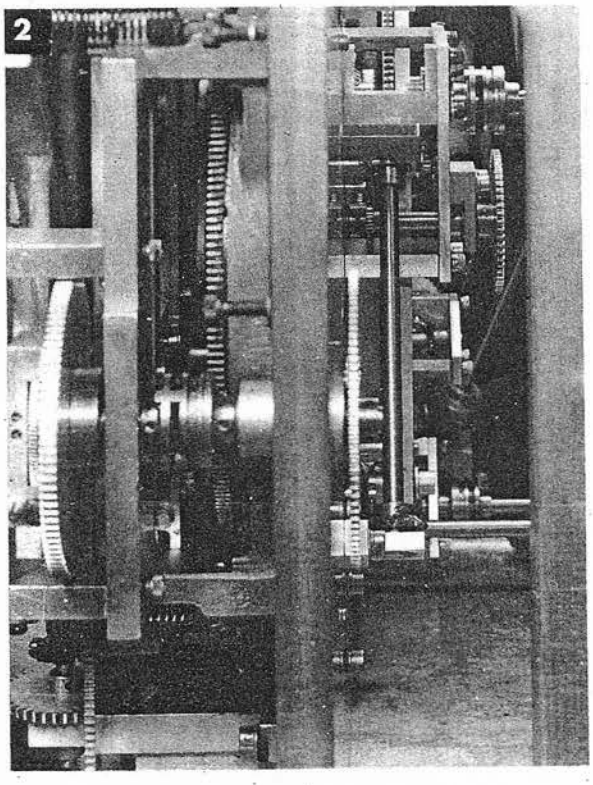
SECANT E VERNIER ASSEMBLY



Co Receiver and Mounting Plate, page 666
cR Intermittent Drive, page 677
1/*cR* Cam, page 678
E Intermittent Drive, page 680



1 Remove the two screws securing the cast hanger to the rear of the integrator mounting plate.



2 Lift out the vernier assembly.

To reinstall the assembly, reverse the removal procedure.

Reinstall the other mechanisms removed, and follow the readjustment procedure outline for the reinstallation of the *E* intermittent drive, page 680

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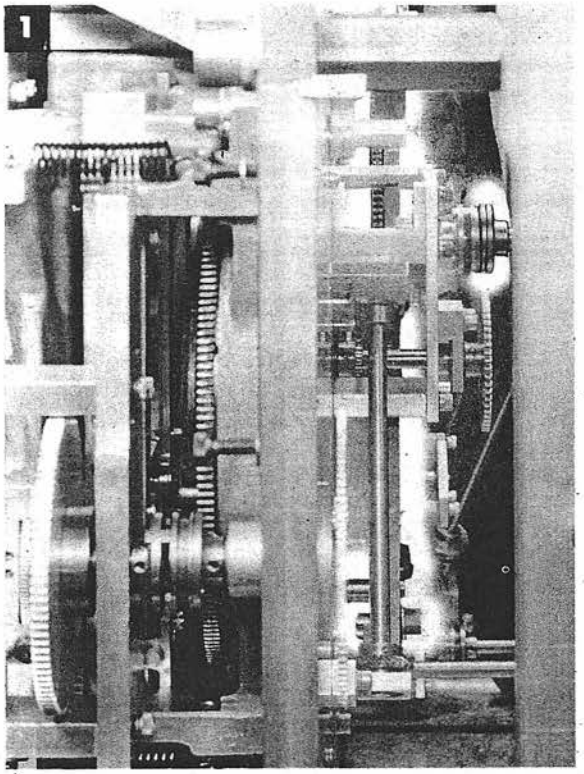
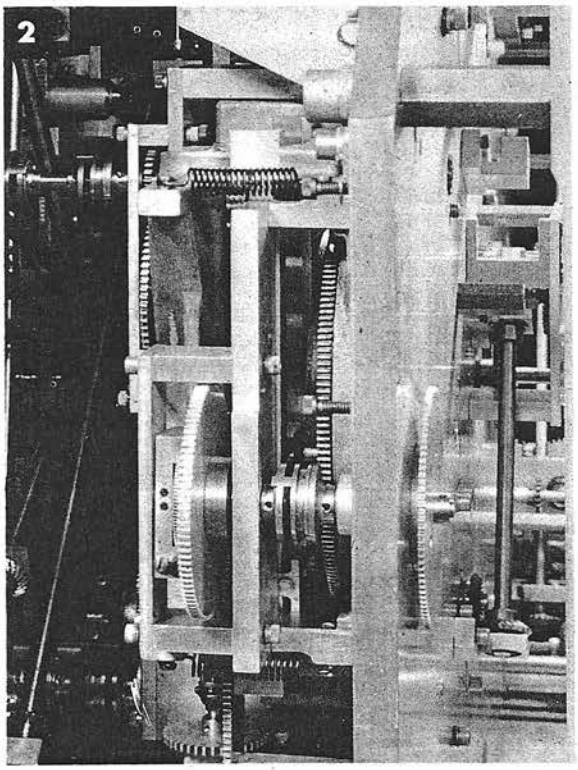
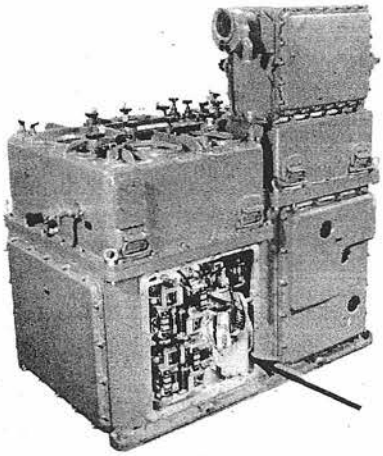
SECANT E CAM







Co Receiver and Mounting Plate, page 666
cR Vernier Assembly, page 676
cR Intermittent Drive, page 677
1/*cR* Cam, page 678
E Intermittent Drive, page 680
Secant *E* Vernier Assembly, page 681

1 Remove the coupling section from the *E* line between the front and back units of the computer.
Back out the two screw dowels and remove the three screws securing the secant *E* cam.

2 Remove the secant *E* cam.

To reinstall the secant *E* cam, reverse the removal procedure.

NOTE:
It is important to reinstall the cam so that its travel corresponds with the travel of the secant *E* integrator. The vernier of the integrator must be accessible.

Reinstall the other mechanisms removed.

Readjust clamps A-250, A-251, A-233, A-151, A-152, A-149, A-150, A-145, A-146, A-147, A-148, A-179 and A-260.

Run tests.

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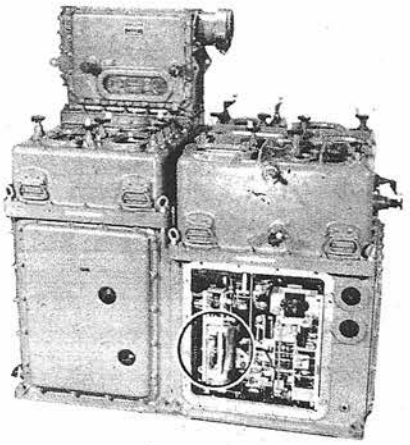
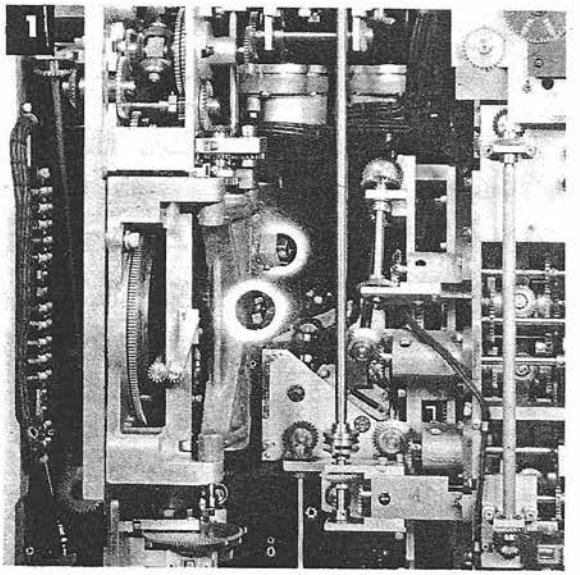
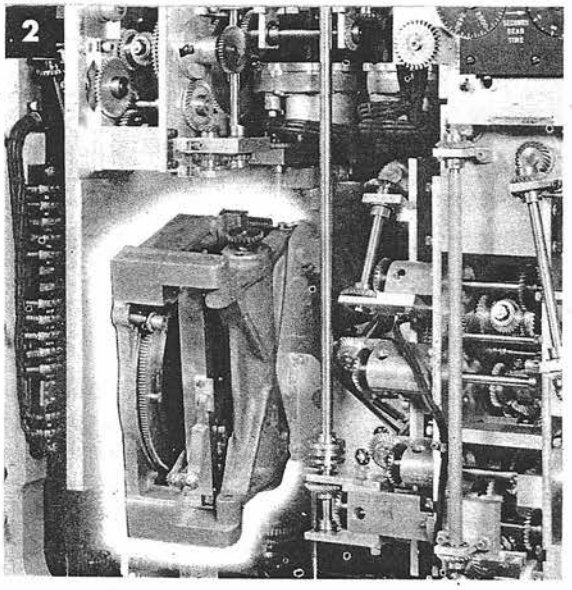
RdE INTEGRATOR

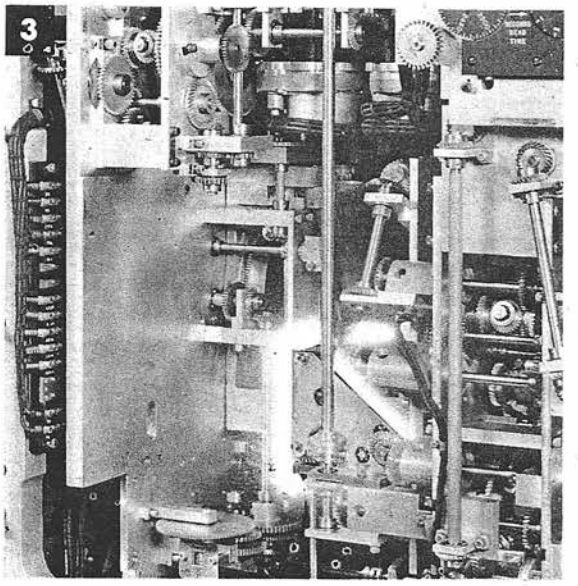




1 Loosen clamps A-211 and A-155. Slip the gear on which each clamp is mounted toward the end of its shaft as far as clearance will permit.



2 Remove the three screws securing the integrator to the mounting plate. Work the dowels free from the plate. Remove the integrator.



3 To provide clearance, it may be necessary to remove the $WrD + KRdBs$ follow-up, page 684.

To reinstall the integrator, reverse the removal procedure.

Tignten clamp A-211.

Readjust clamps A-155 and A-154.

Run tests.

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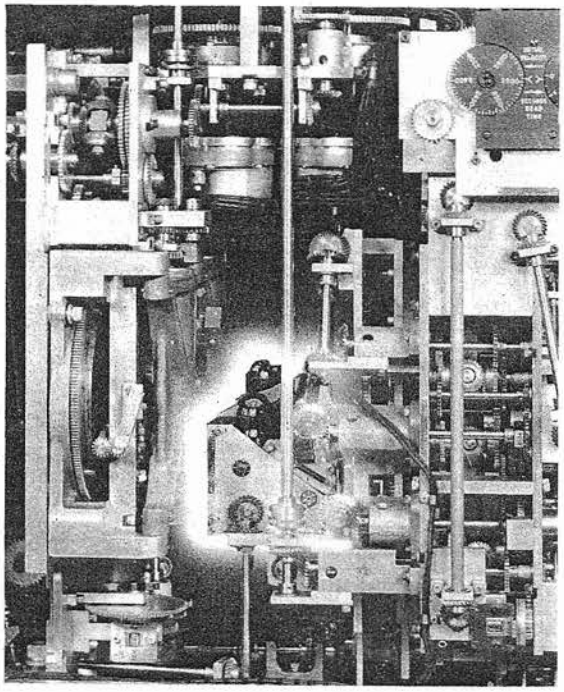
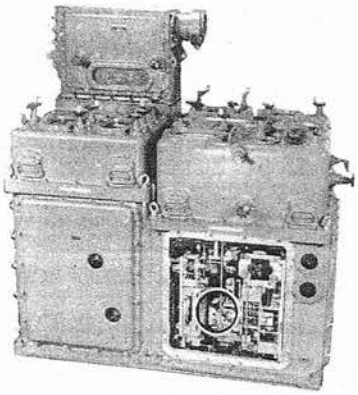
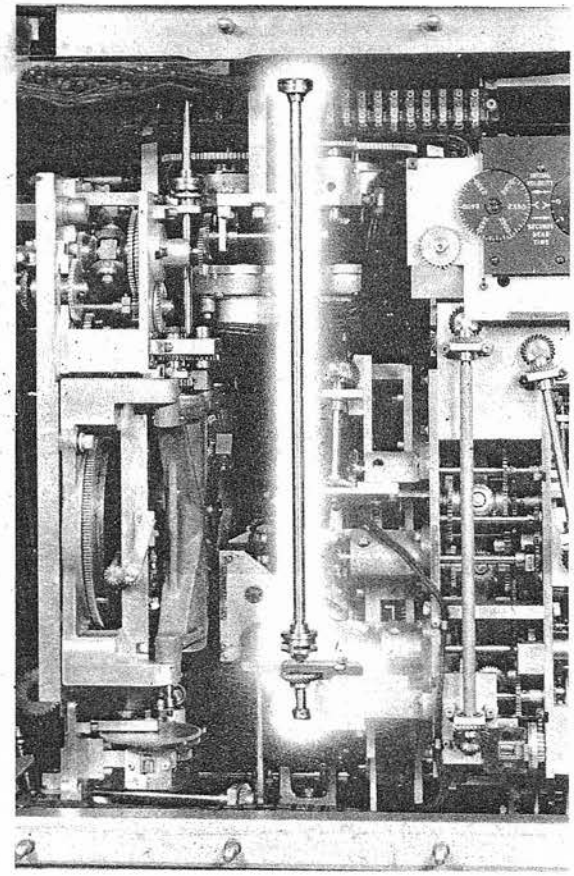
WrD + KRdBS FOLLOW-UP

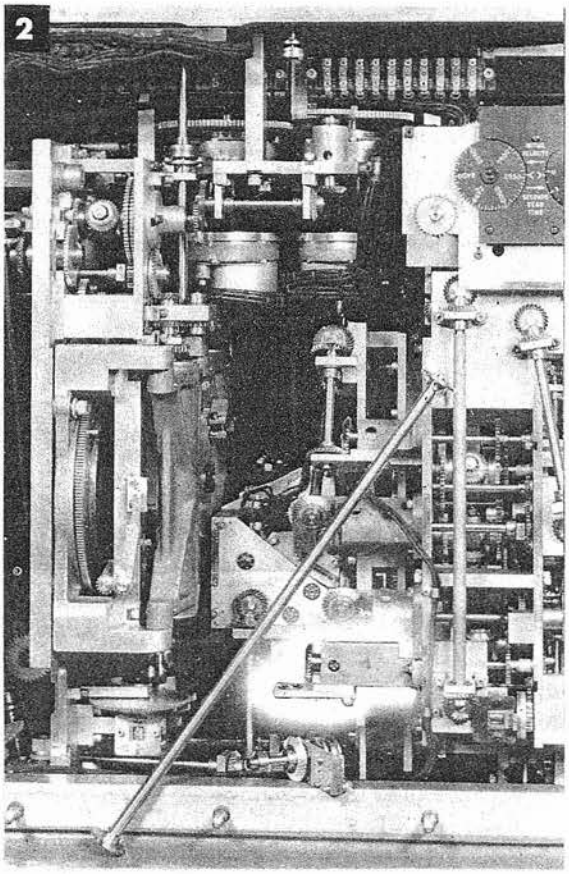




1 Remove the locking springs from the long coupling shaft in the *Xo* line near the follow-up. Remove the shaft.
Remove the two screws securing the mating shaft assembly below the coupling. Remove the shaft assembly.

2 Unpin the collar of the bevel gear that meshes with the gear on the shaft just removed. Remove the gear.





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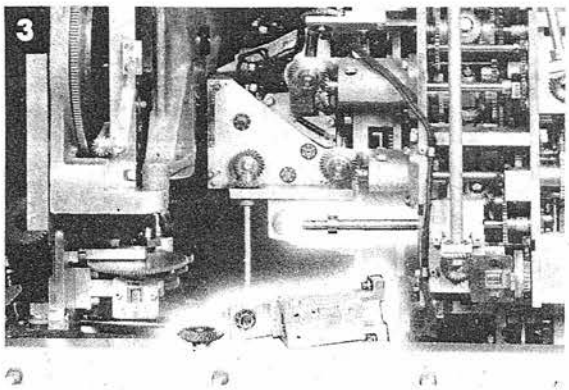
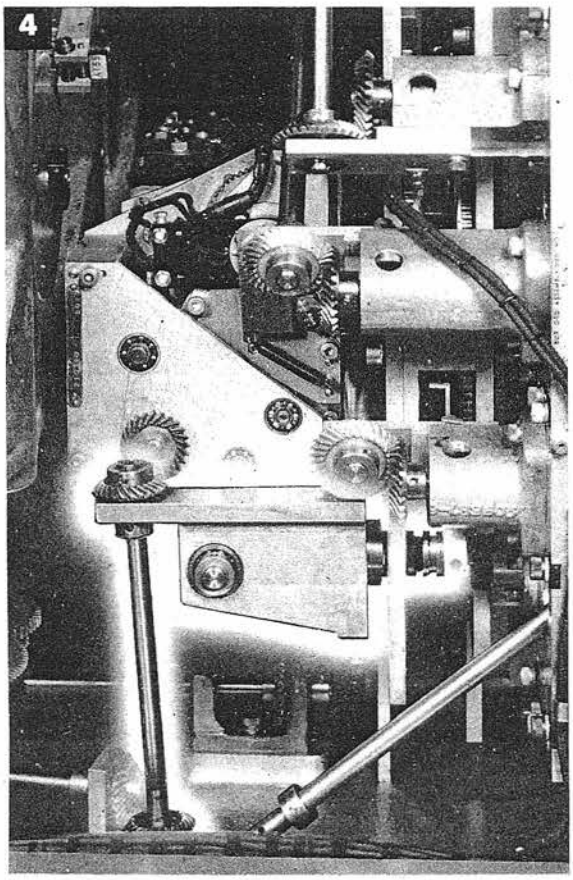
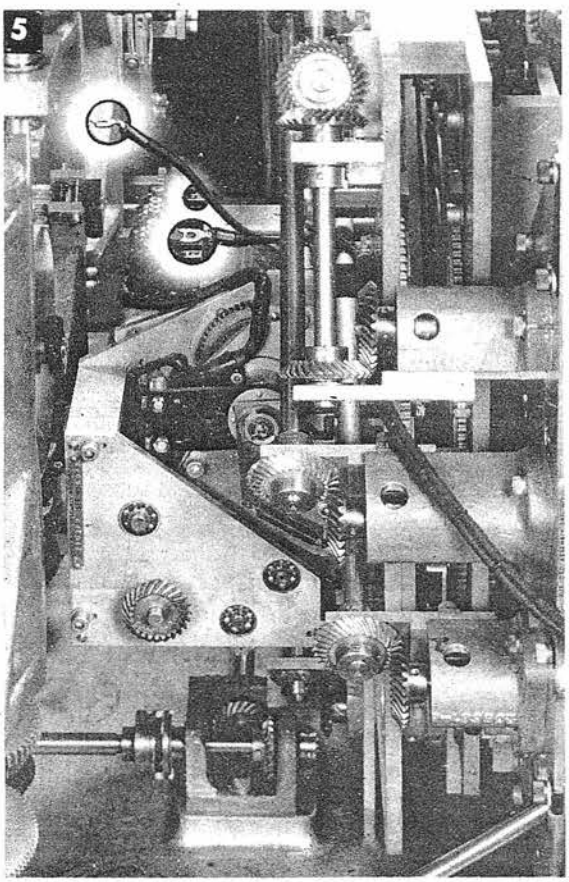


3 Remove the two screws securing the casting for the shaft assembly. Remove the casting so that the shaft hangs free.

4 Remove the screws securing the hangers and casting for the input and output gearing of the follow-up. Remove the assembly. For clearance it may be necessary to loosen the screws in the terminal block on the floor of the computer.

5 Remove the two screws connecting cable leads 1G and GG to the servo terminal block of the $WrD + KRdBs$ follow-up.





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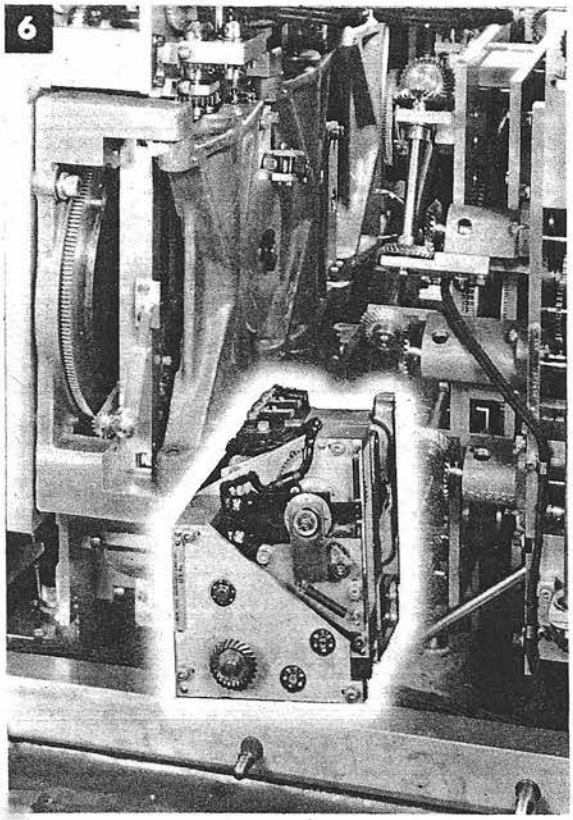
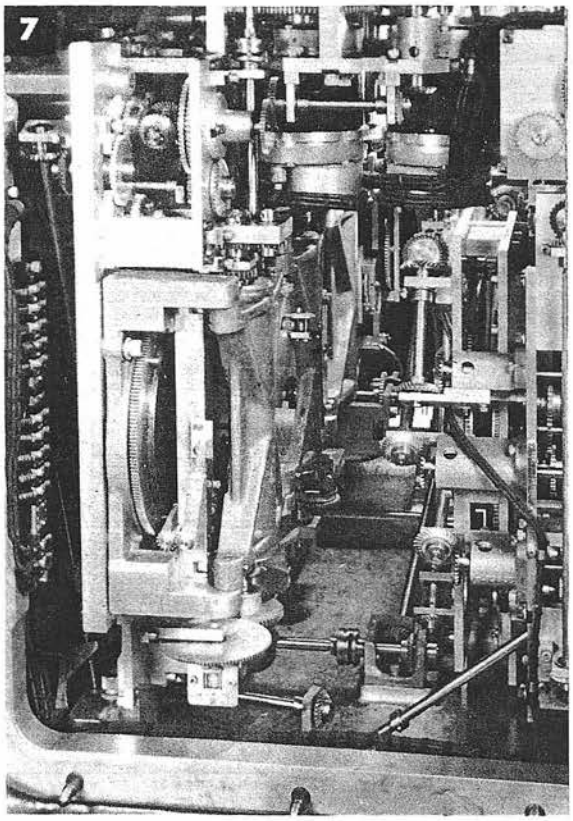


6 Remove the four screws securing the servo motor. Support the follow-up while removing the last screw.



7 **Remove the** follow-up.

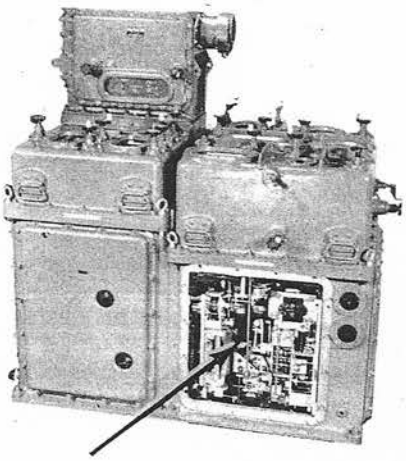
To reinstall the *WrD* + *KRdBs* follow-up, reverse the removal procedure.

NOTE:
Tighten one screw to hold the follow-up at the proper mesh before inserting the other three screws.

Reinstall the *Xo* coupling shaft.

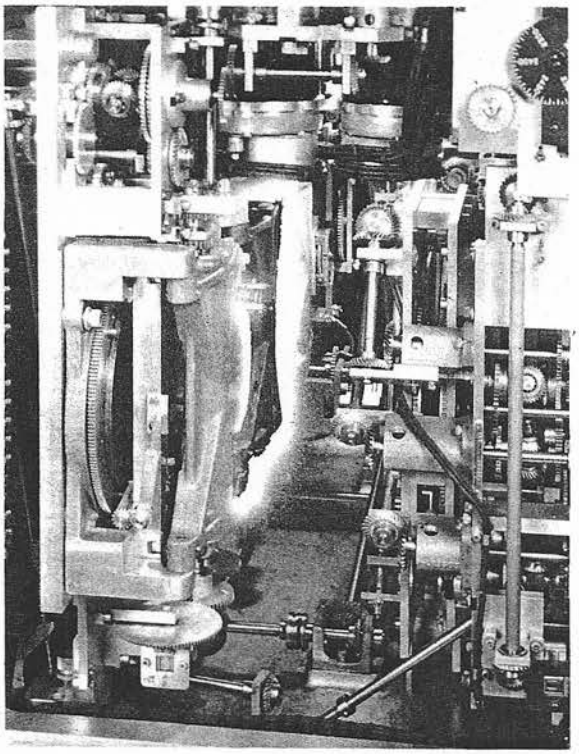
Readjust clamps A-131, A-229, and A-230.

Run computer and star shell tests.



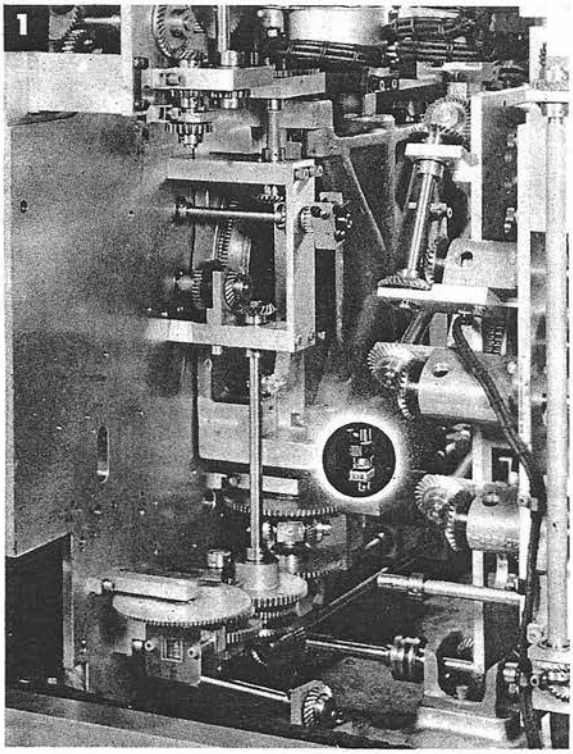
RdE Integrator, page 683
WrD + *KRdBs* Follow-up, page 684

SECANT E INTEGRATOR



1 Loosen clamps A-176 and A-143. Slide the coupling down out of the way. Be careful not to lose the upper spacer.

Remove the three screws securing the integrator.



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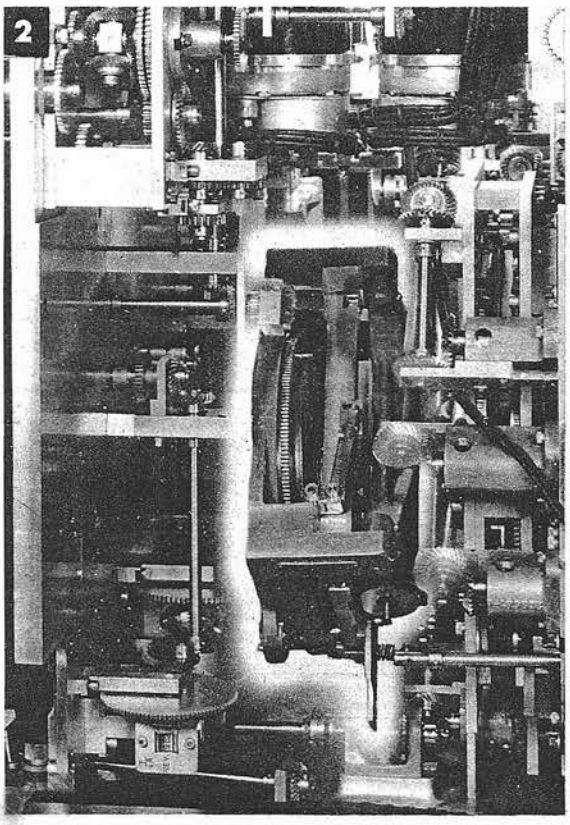
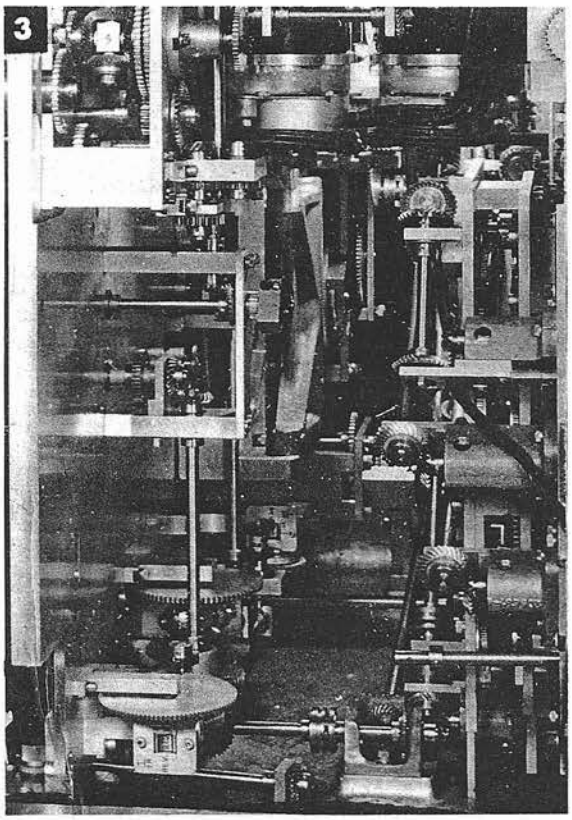


2 Work the dowels free from the mounting plate. Tilt the integrator to clear.



3 Remove the integrator.

To reinstall the secant *E* integrator, reverse the removal procedure. The travel of the integrator must agree with the travel of the secant *E* cam. The vernier adjustment must be accessible.

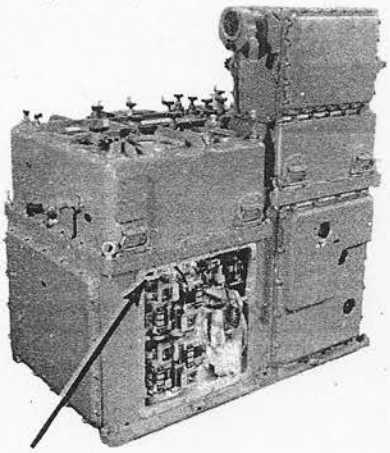
Reinstall the other mechanisms removed.

Tighten clamps A-176, A-143, and A-211.

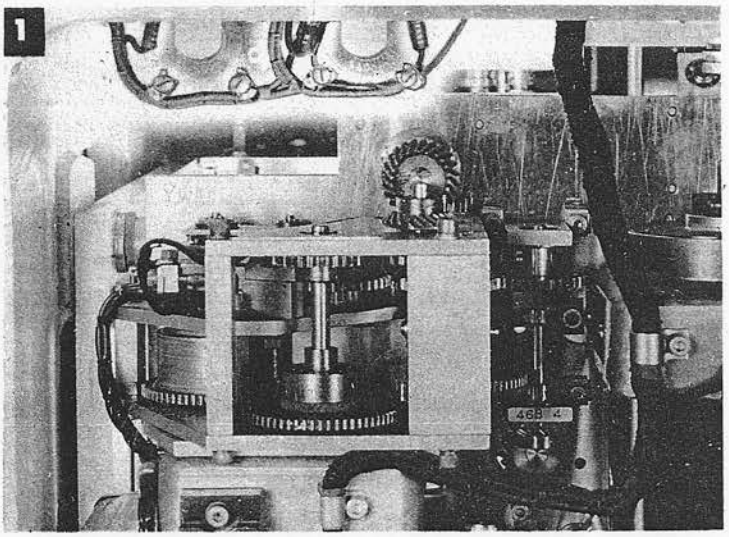
Readjust clamps A-147, A-148, A-154, A-155, A-131, A-229, and A-230.

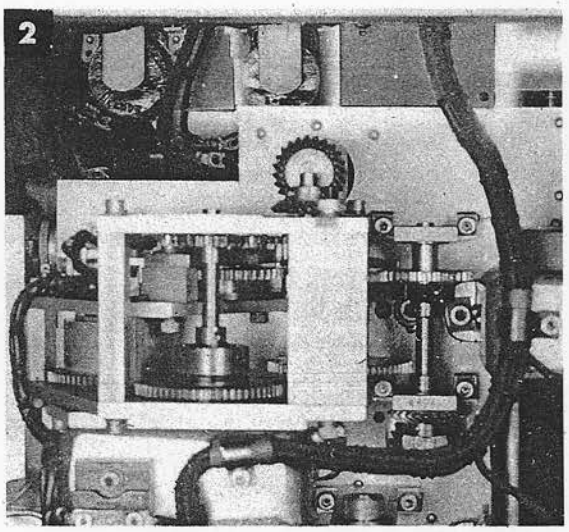
Run tests.

TARGET COURSE INCREASING AND DECREASING RELAYS

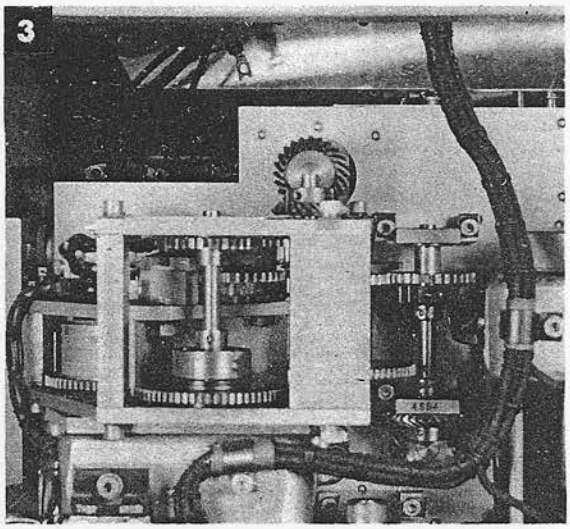


1 Remove the screws from all cable connections on the relays. Do not drop the terminal screws. They cannot be picked up with a magnet.





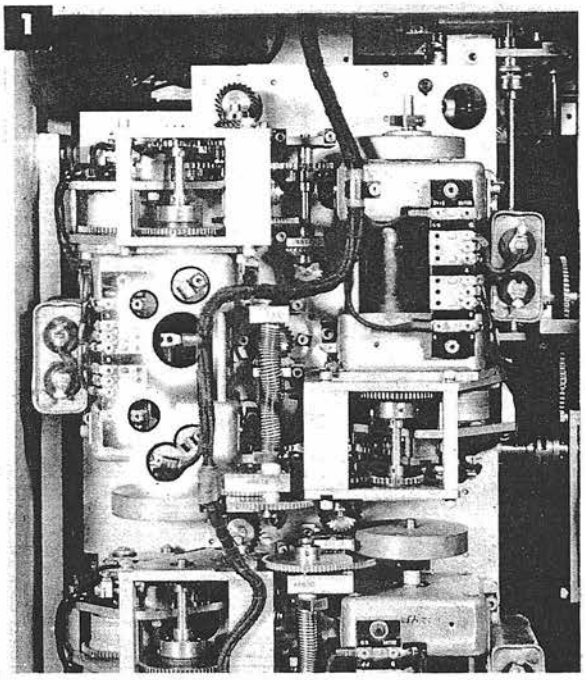
2 Remove the two screws securing the relay mounting plate.

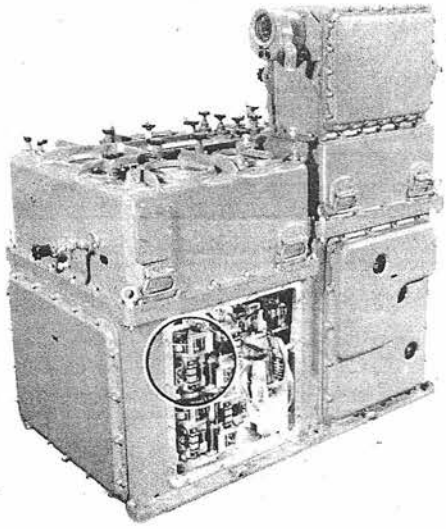


3 Remove the relays.

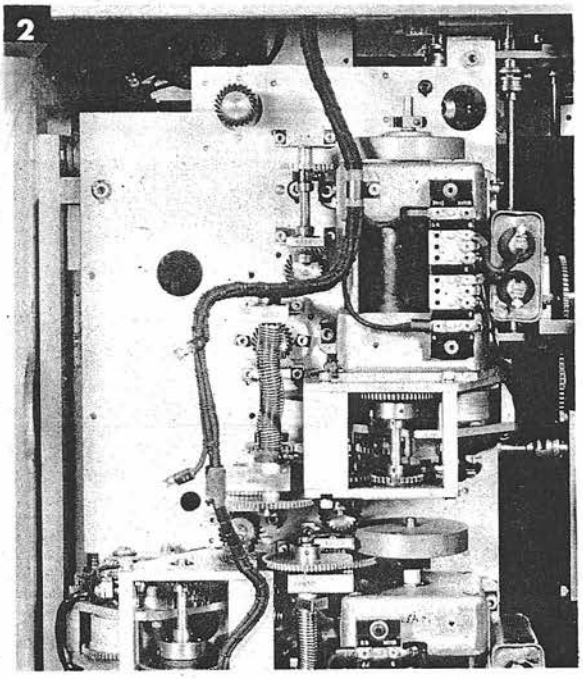
To reinstall the relays, reverse the removal procedure.

Ywgr FOLLOW-UP





1 Remove the two screws connecting cable leads F and FF to the servo terminal block.
Loosen the two screws securing the cable clamps to the servo motor.
Free the cable.



2 Remove the four screws securing the servo motor to the mounting plate.
Support the follow-up while removing the last screw.
Remove the follow-up.

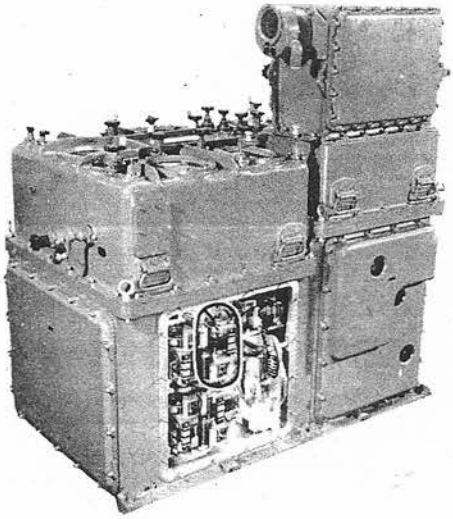
To reinstall the *Ywgr* follow-up, reverse the removal procedure.

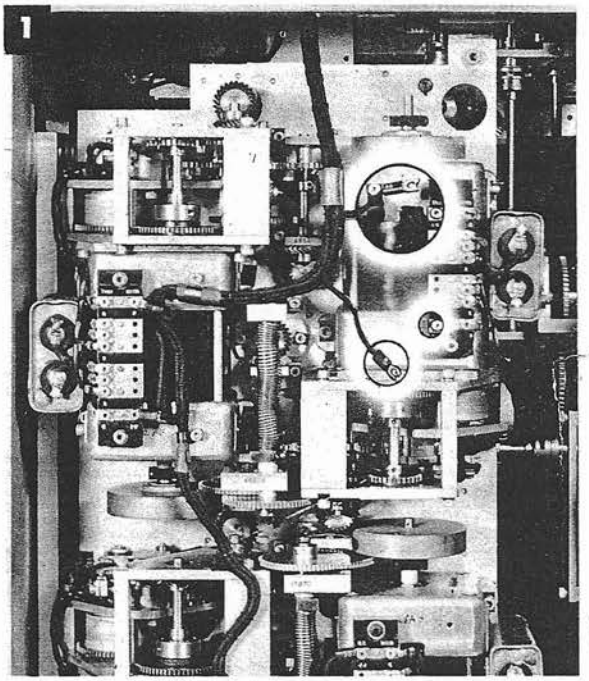
Readjust clamp A-101.

Check clamp A-100.

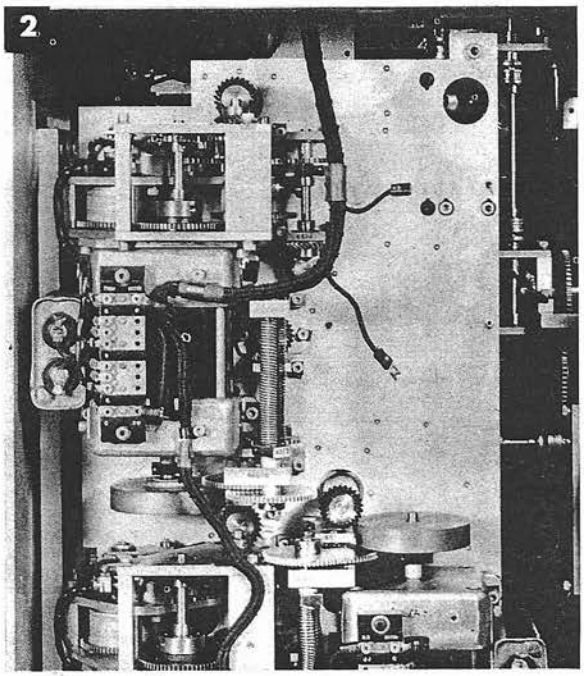
Run tests.

Dtwj FOLLOW-UP





1 Remove the two screws connecting cable leads G and GG to the servo terminal block.
Loosen the screw securing the cable clamp to the servo motor. Free the cable.



2 Remove the four screws securing the servo motor to the mounting plate. Remove the follow-up.

To reinstall the *Dtwj* follow-up, reverse the removal procedure.

Readjust clamps A-217 and A-102.

Run tests.

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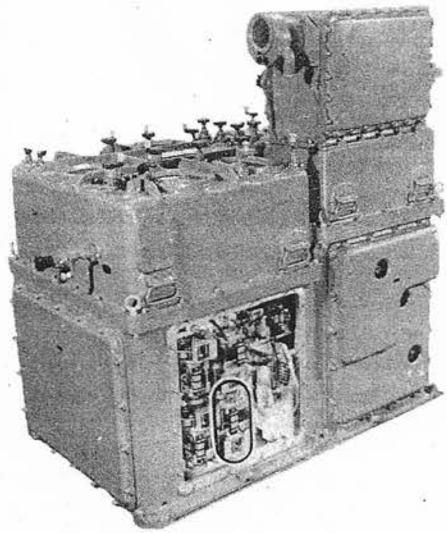
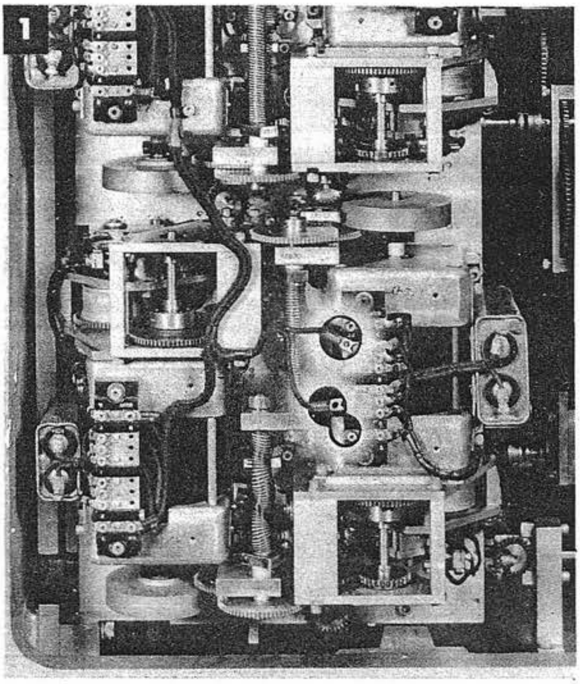
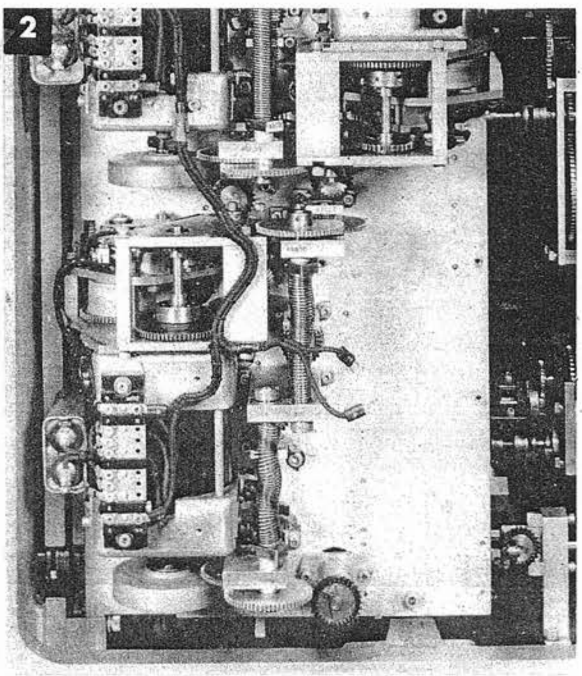
R2 FOLLOW-UP





1 Remove the two screws connecting cable leads J and JJ to the servo terminal block.



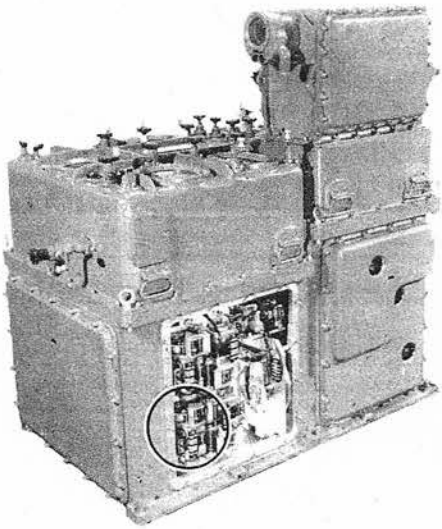
2 Remove the four screws securing the servo motor to the mounting plate. Support the follow-up while removing the last screw.
Remove the follow-up.

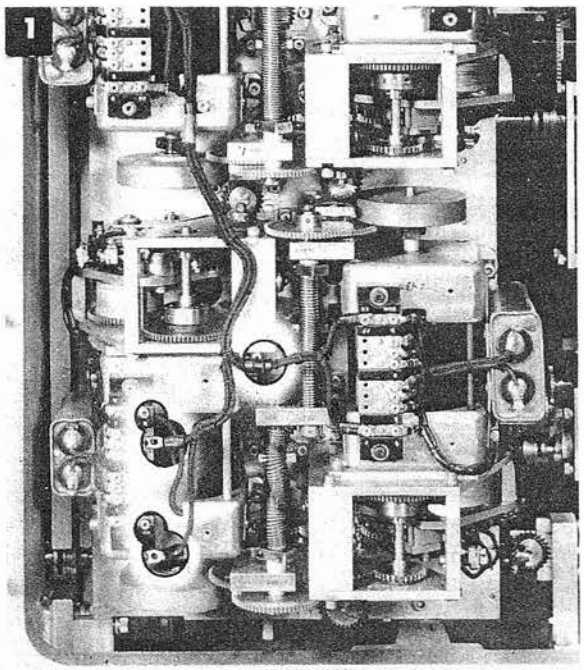
To reinstall the *R2* follow-up, reverse the removal procedure.

Readjust clamps A-220 and A-104.

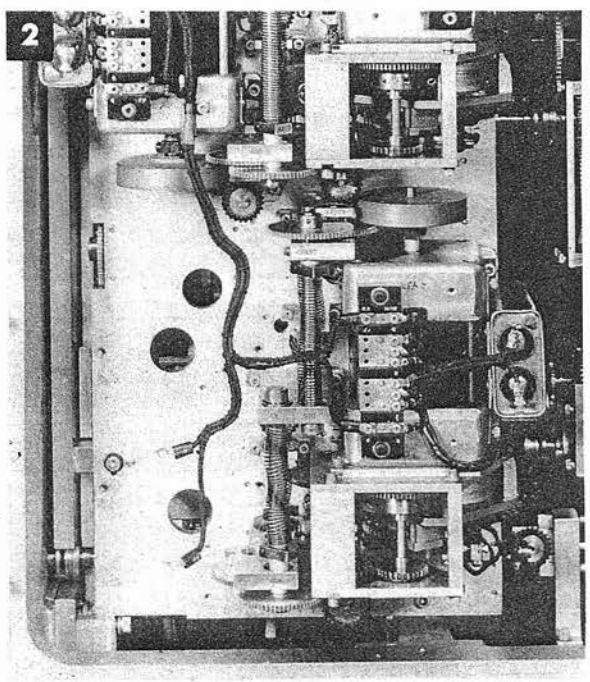
Run tests.

V FOLLOW-UP





1 Remove the two screws connecting cable leads H and HH to the servo terminal block.
Loosen the screw securing the cable clamp to the lower end of the follow-up gearing. Free the cable.



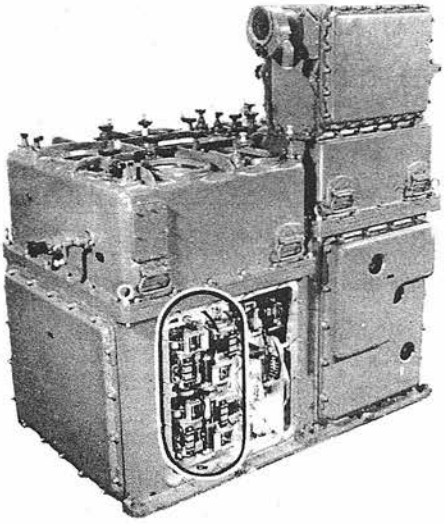
2 Remove the four screws securing the servo motor to the mounting plate. Support the follow-up while removing the last screw.
Remove the follow-up.

To reinstall the *V* follow-up, reverse the removal procedure.

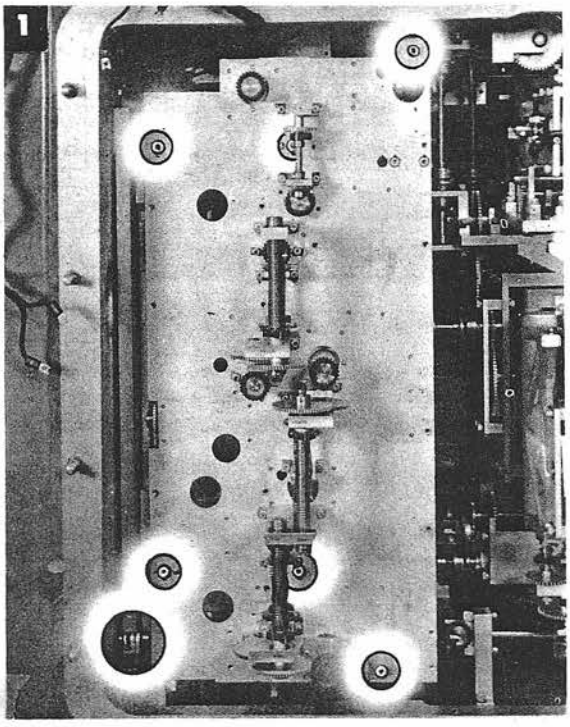
Readjust clamps A-221 and A-103.

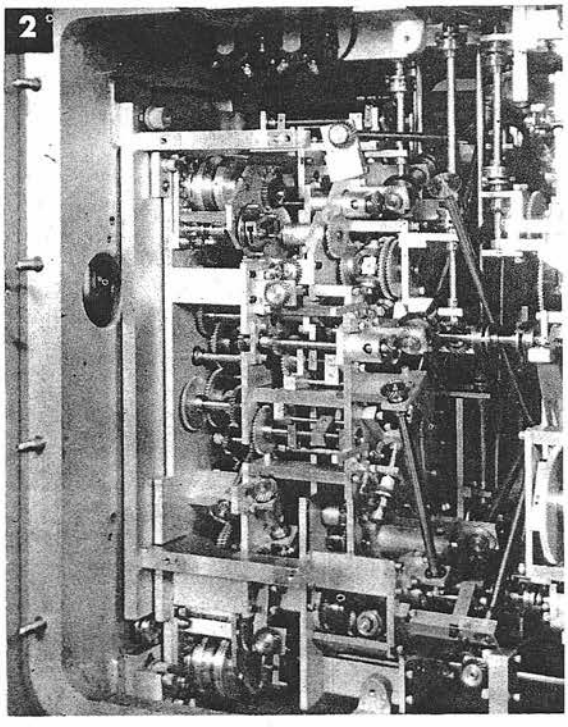
Run tests.

PREDICTION FOLLOW-UP MOUNTING PLATE



Ywgr Follow-up, page 690
Dtwj Follow-up, page 691
R2 Follow-up, page 692
V Follow-up, page 693





1 Lay the cable to one side.
Remove the two screws securing the hanger on the *Dtwj* output gearing to the hanger behind the upper right corner of the plate.
Remove the six large screws securing the plate.
Tilt the right edge of the plate to disengage a coupling at the lower left corner.

2 Remove the plate.

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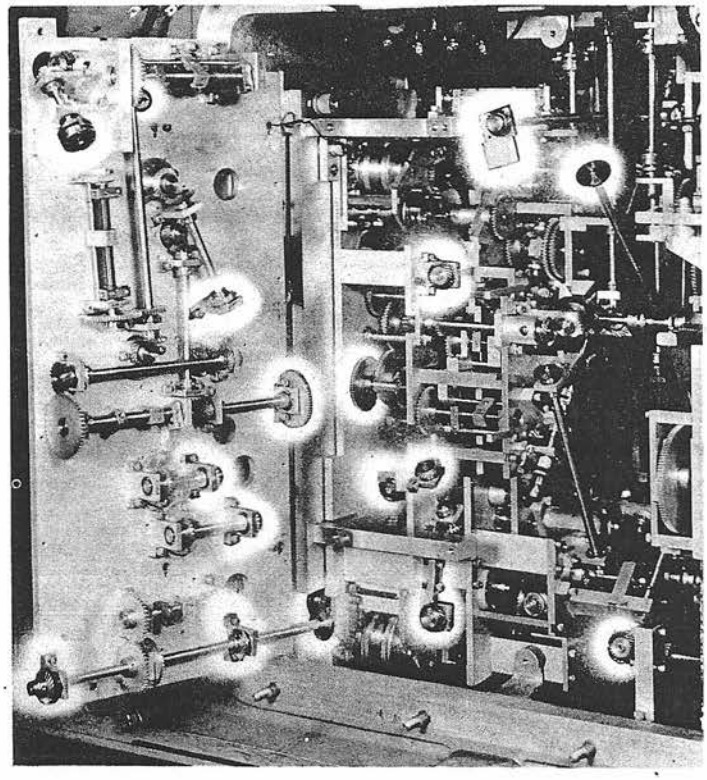
To reinstall the plate, reverse the removal procedure. When positioning the plate, each connection indicated must be properly engaged before the screws are tightened.

Connect the power leads to the terminal blocks of the follow-ups in the order indicated in the following steps.

Loosen clamps A-100 and A-156 before attempting any readjustment.

Readjust clamps A-184, A-180, A-198, and A-74.



Connect power leads F and FF to the terminal block of the *Ywgr* servo motor. Readjust clamps A-101 and A-100.

Connect power leads J and JJ to the terminal block of the *R2* servo motor. Readjust clamps A-220, A-104 and A-156.

Connect power leads H and HH to the terminal block of the *V* servo motor. Readjust clamps A-221 and A-103.

Connect power leads G and GG to the terminal block of the *Dtwj* servo motor. Readjust clamps A-217 and A-102.

Recheck the adjustment of clamps A-100 and A-106.

Check clamps A-110, A-107, A-105, and A-157.

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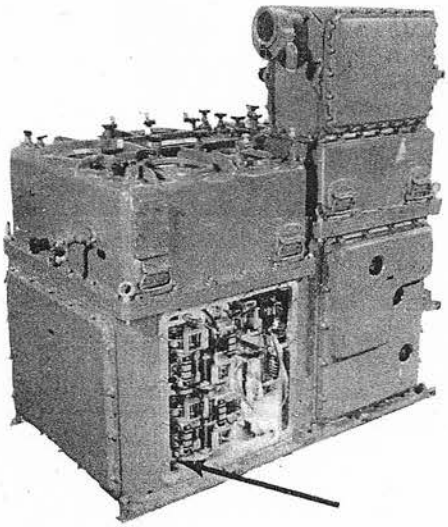
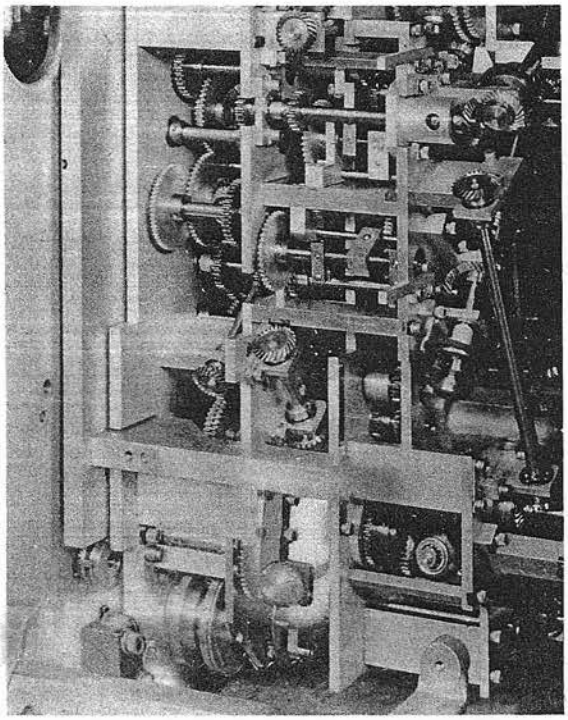
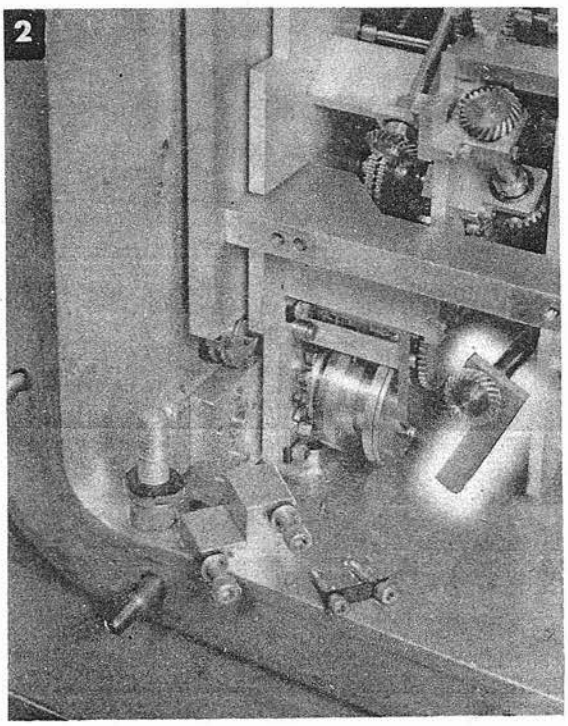
E2 INTERMITTENT DRIVE



Ywgr Follow-up, page 690
Dtwj Follow-up, page 691
R2 Follow-up, page 692
V Follow-up, page 693
Prediction Follow-up Mounting Plate, page 694



1 Remove the two screws securing the block at the lower front corner of the computer.
Remove the block.
Remove the large screw securing the large mounting plate to the computer.
Remove the two screws securing the hanger just behind the intermittent drive.



2 Let the hanger swing free.

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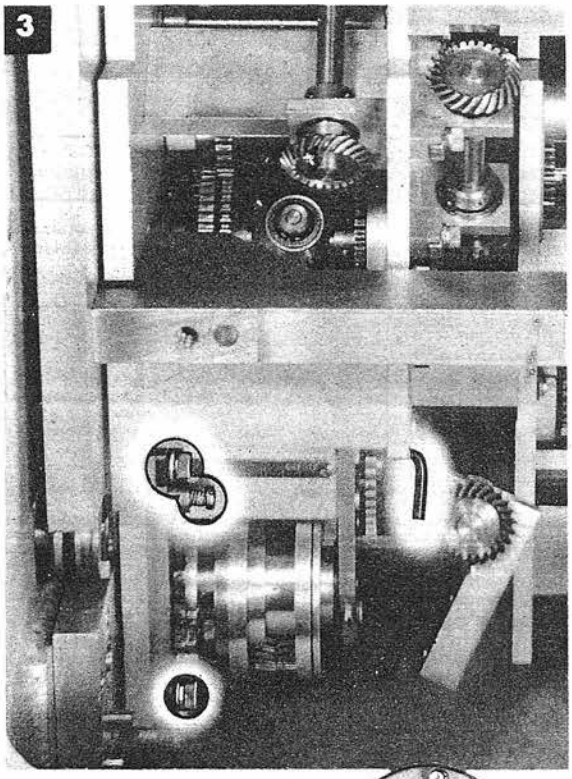
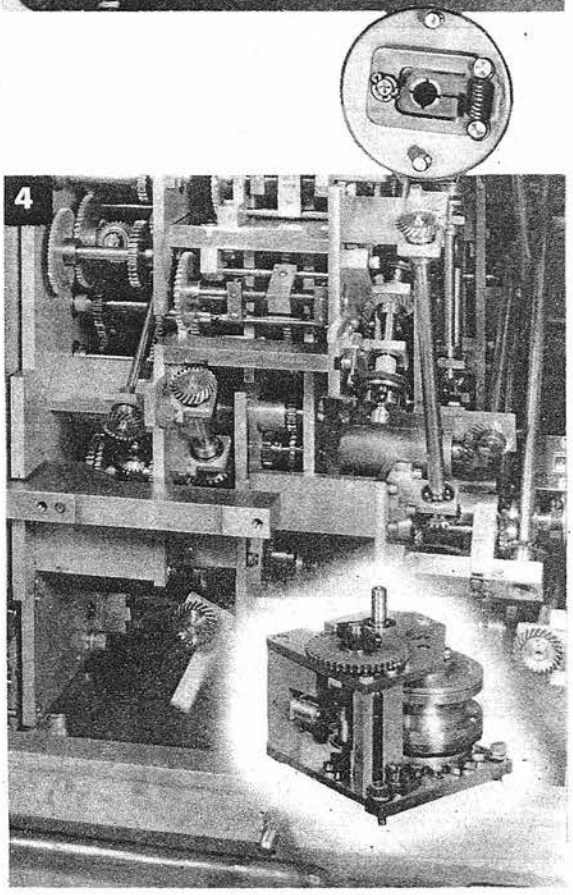


3 Loosen the shock absorber clamp. Remove the shock absorber. Using a socket head screw wrench, remove the rear screw of the intermittent drive.
Back out the two screw dowels and remove the other two screws.



4 Remove the intermittent drive.

To reinstall the intermittent drive, reverse the removal procedure.

Tighten clamps A-114 and A-182. (CAUTION: These clamps cannot be reached after the follow-up plate is installed.)

Reinstall the follow-up mounting plate and the *Ywgr, Dtwj, R2,* and *V* follow-ups.

Readjust clamp A-72 and make the adjustments listed in the reinstallation of the follow-up mounting plate, page 695

Run tests.

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