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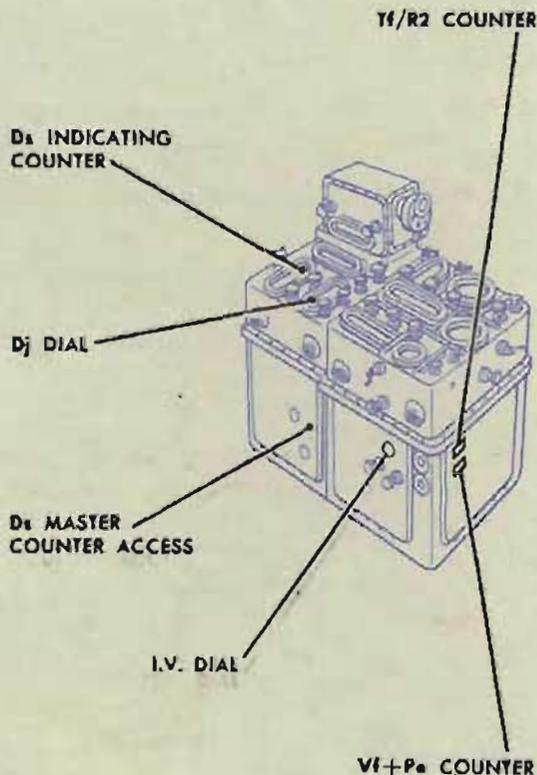
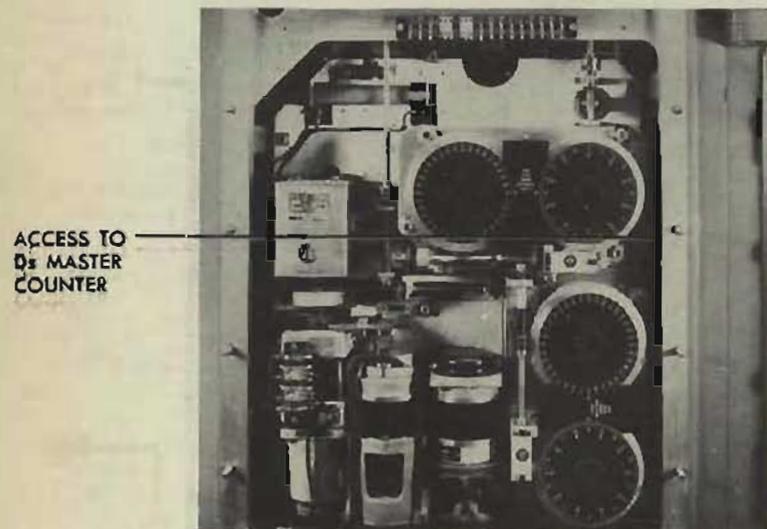
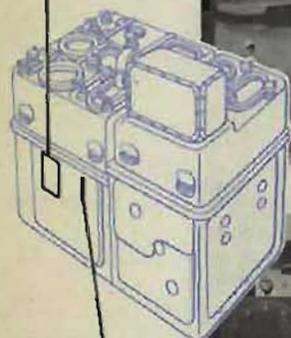
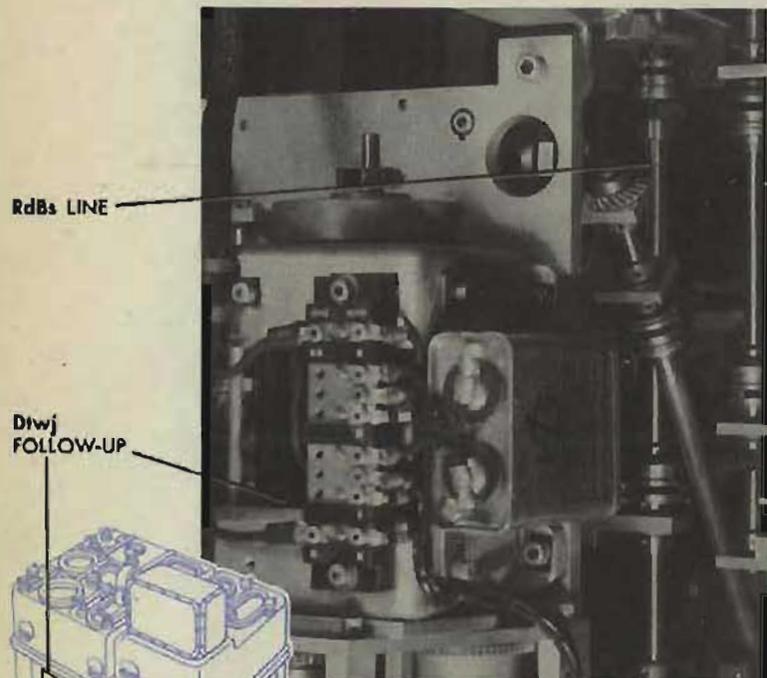
ERRORS IN Ds

$$D_s = D_{twj} - D_{ts}$$

Check the *D_{twj}* follow-up.

Check the *D_s* counters.

If the *D_s* indicating counter reading does not agree with the *D_s* master counter reading, check A-89 and A-94.



Checking the network inputs

Check the $I.V.$ input by checking A-536.

Check the $Vf + Pe$ input by comparing the reading on the $Vf + Pe$ counter with the value given in the intermediate quantities. If the readings do not agree, check the $Vf + Pe$ network; see page 131.

Check the $Tf/R2$ input by comparing the reading on the $Tf/R2$ counter with the value given in the intermediate quantities. If the readings do not agree, check the $Tf/R2$ network; see page 130. Check the Dj input by checking A-500.

Check the $RdBs$ input; see page 137.

Check the WrD input; see page 138.

Checking the network

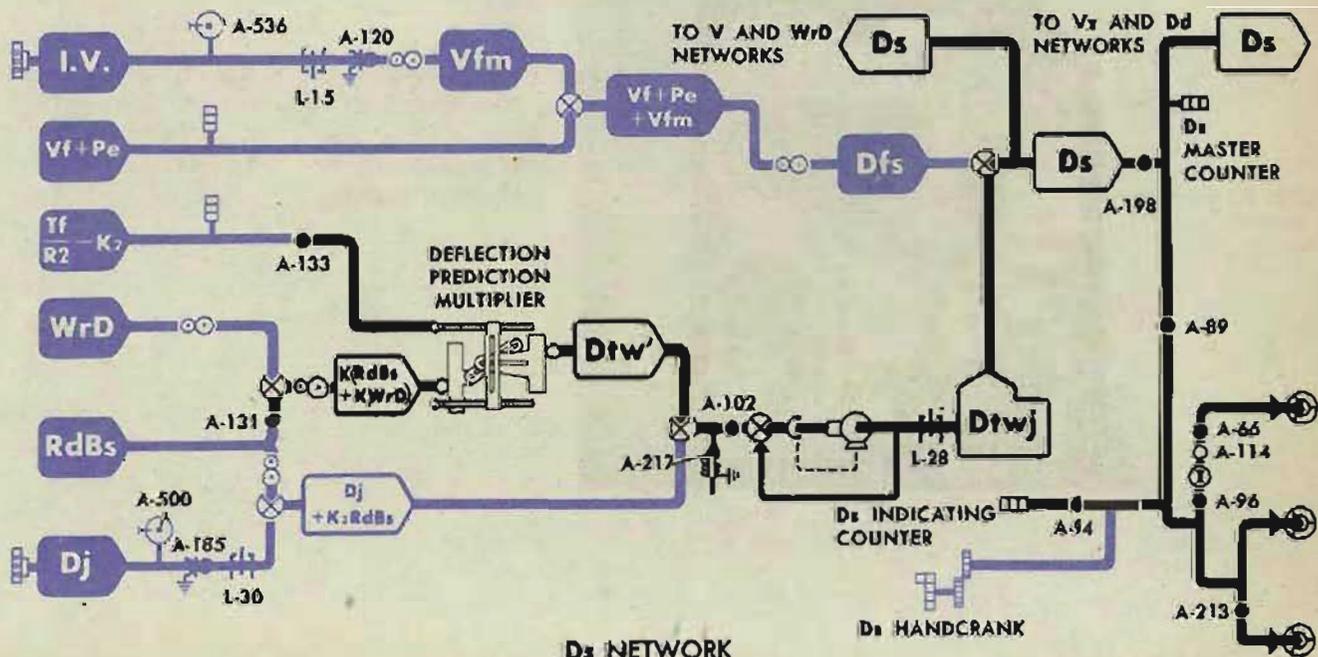
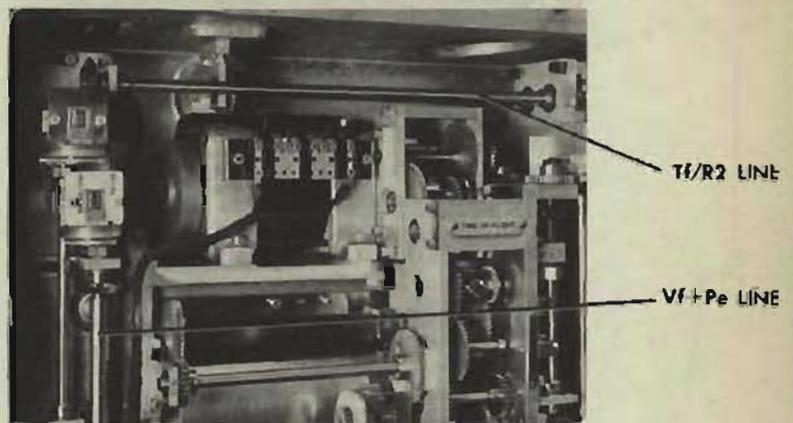
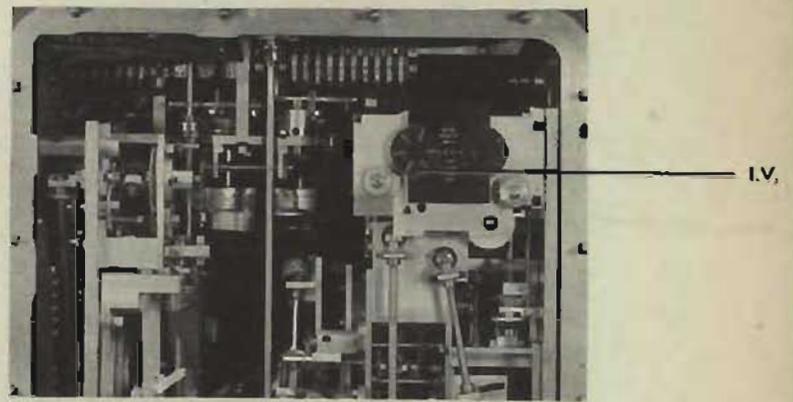
When the network inputs are correct, but Ds is in error:

Make the unit check test of the deflection prediction multiplier.

The check test may indicate an error in one of the inputs of the multiplier.

- 1 If the lead screw is incorrectly positioned, check A-133.
- 2 If the rack is incorrectly positioned, check A-131.

When all the inputs are correct, check A-198 and A-102.



ERRORS IN P_h AND P_v

Checking the network inputs

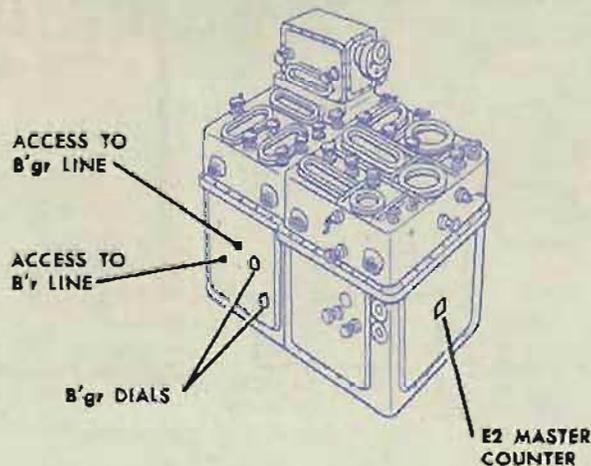
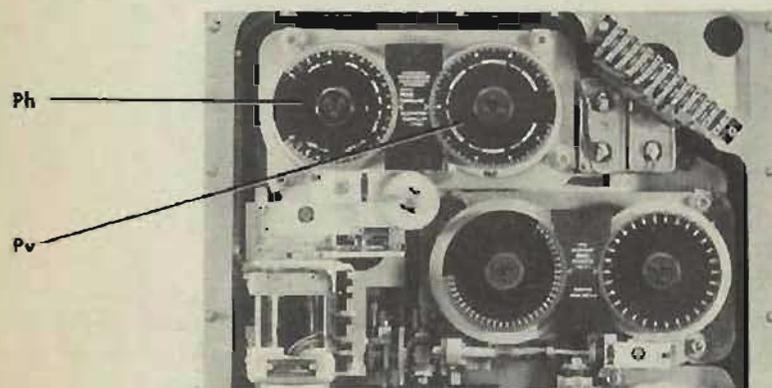
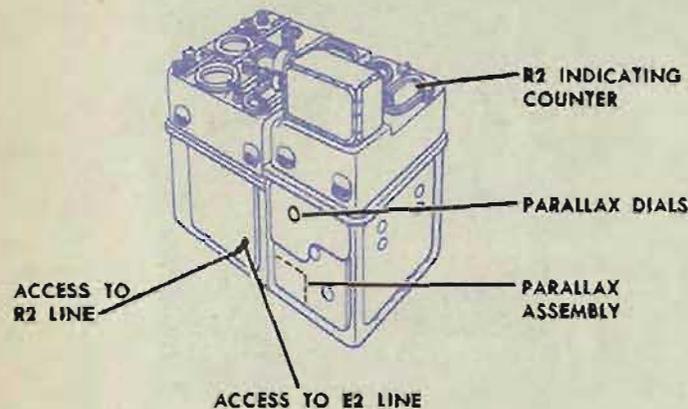
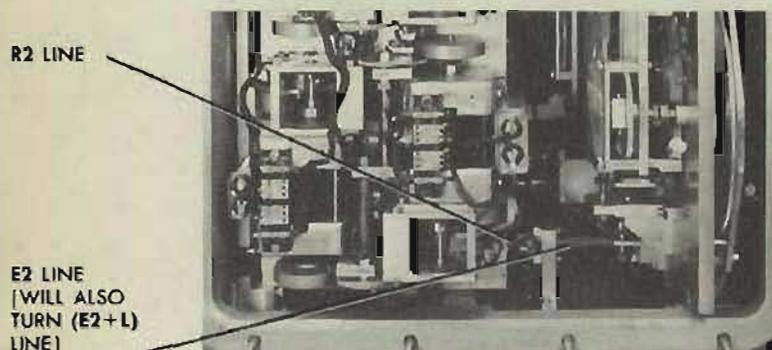
Check the R_2 input by comparing the reading on the R_2 indicating counter with the value given on the problem results form. If the R_2 reading does not agree with the R_2 value given, check the R_2 network; see page 122.

Check the E_2 input by comparing the reading on the E_2 master counter with the value given in the intermediate quantities. If the E_2 reading does not agree with the E_2 value given, check the E_2 network; see page 124.

If $B'gr$ is the input to the parallax component solver, check the value by comparing the reading on the $B'gr$ dials with the value given on the problem results form. If $B'gr$ is in error, check the $B'gr$ network; see page 106.

If $B'r$ is the input to the parallax component solver, check the problem set-up value on the stable element dials.

Check the L input by checking A-58, A-28, and A-505.



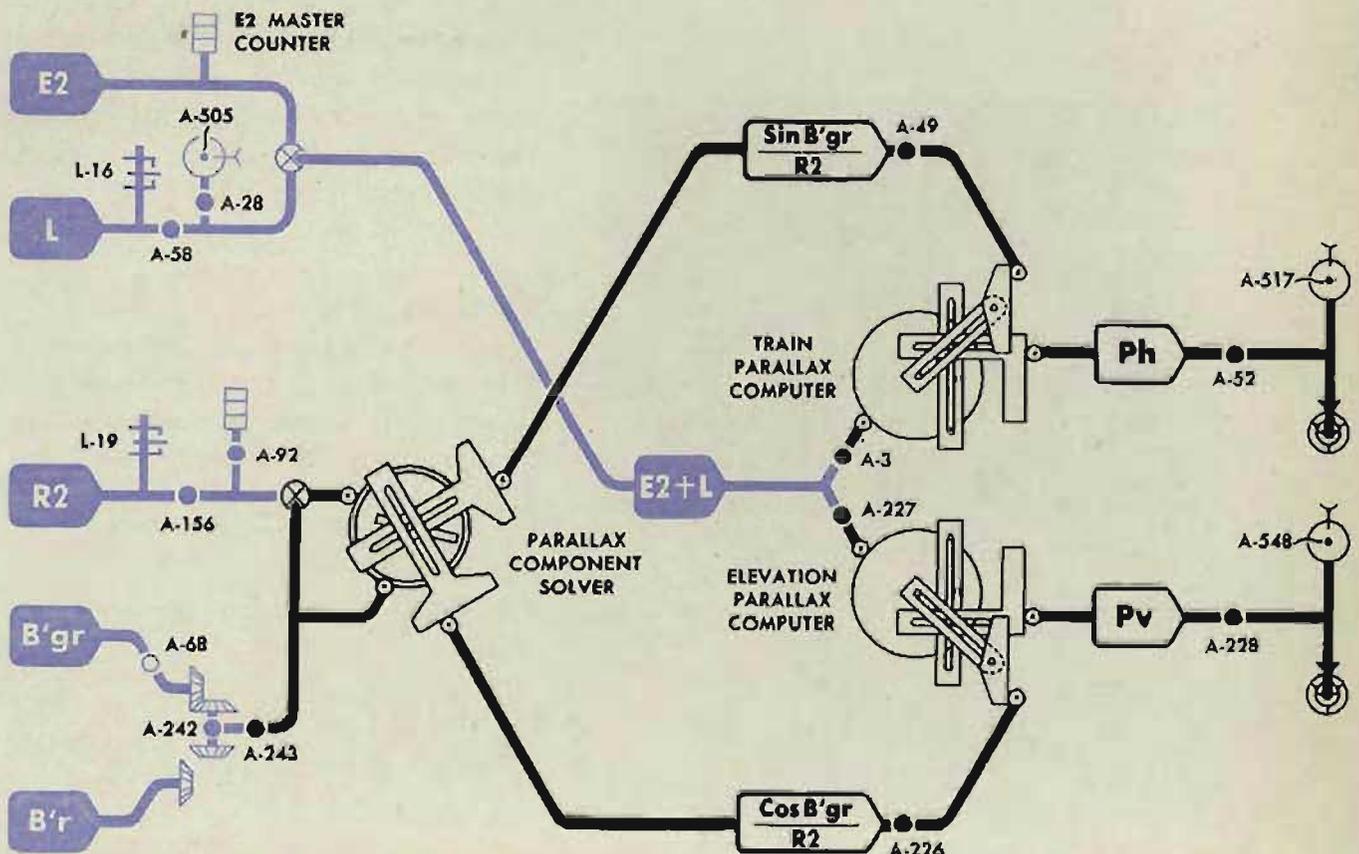
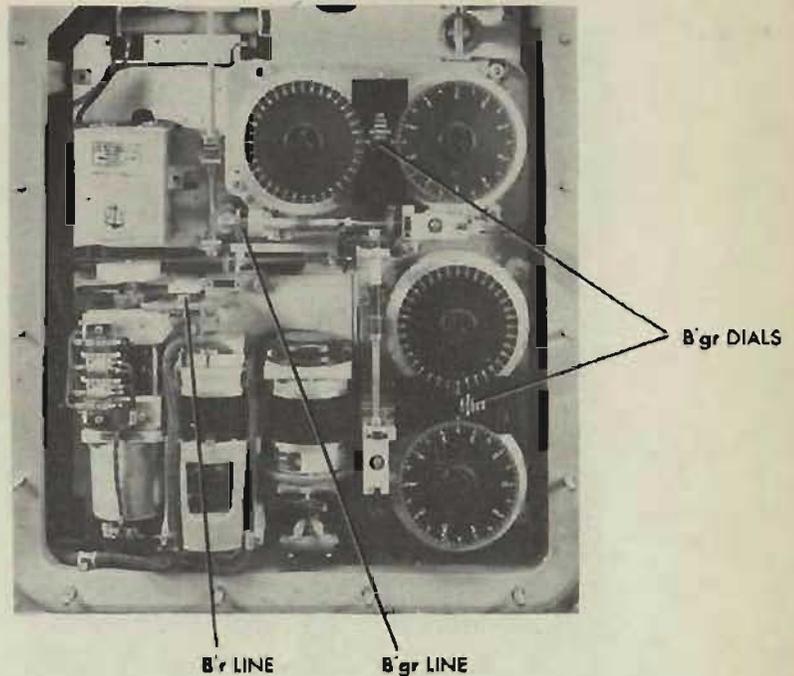
Checking the network

When the network inputs are correct but Ph is in error, run the unit check test of the parallax section. The unit check test will indicate errors in the inputs to the parallax component solver or the train parallax computer. If there are errors in the parallax component solver, check A-156, A-242, and A-243.

If there are errors in the train parallax computer, check A-49 and A-3. If the unit inputs are correct, check A-52 and A-517.

When the network inputs are correct but Pv is in error, run the unit check test of the parallax section. The unit check test will indicate errors in the inputs to the parallax component solver or the elevation parallax computer. If there are errors in the parallax component solver, check A-156 and A-243. If there are errors in the elevation parallax computer, check A-226 and A-227.

If the unit inputs are correct, check A-228 and A-548.



ERRORS IN FUZE

Serial Nos. 780 and lower

$$F = f(E2, R3) \text{ where } R3 = R2 + RTg, \\ \text{and } RTg = dR \cdot Tg$$

Check the fuze follow-up.

Check A-77.

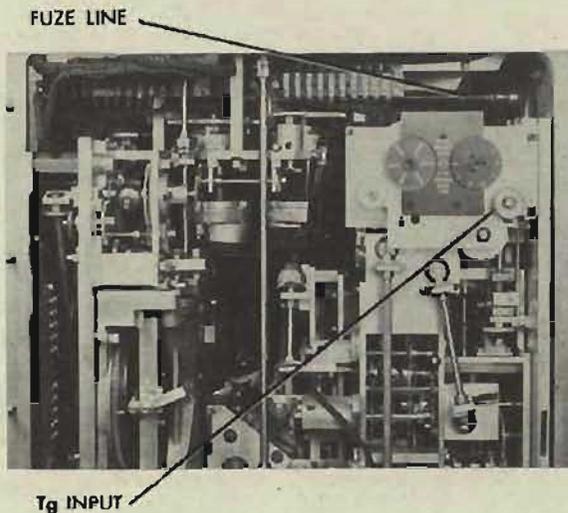
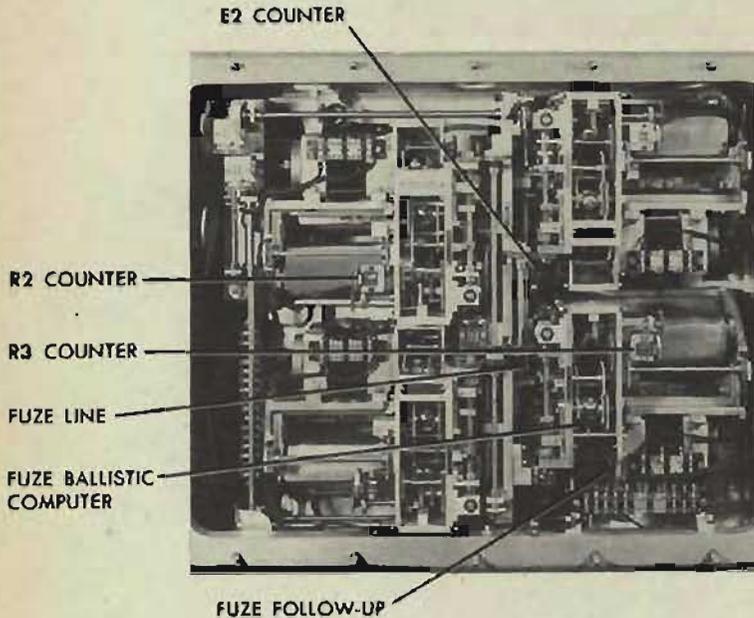
Checking the network inputs

Check the *E2* input by comparing the *E2* master counter reading with the *E2* intermediate quantity. If the counter reading is incorrect, check the *E2* network; see page 124.

Check the *R2* input by comparing the *R2* counter reading with the value given on the problem results form. If the counter reading is incorrect, check the *R2* network; see page 122.

Check the *dR* input by comparing the *dR* dial reading with the *dR* intermediate quantity. If the dial reading is incorrect, or cannot be read accurately, check the *dR* network; see page 134.

Check the *Tg* input by checking A-535.



Checking the network

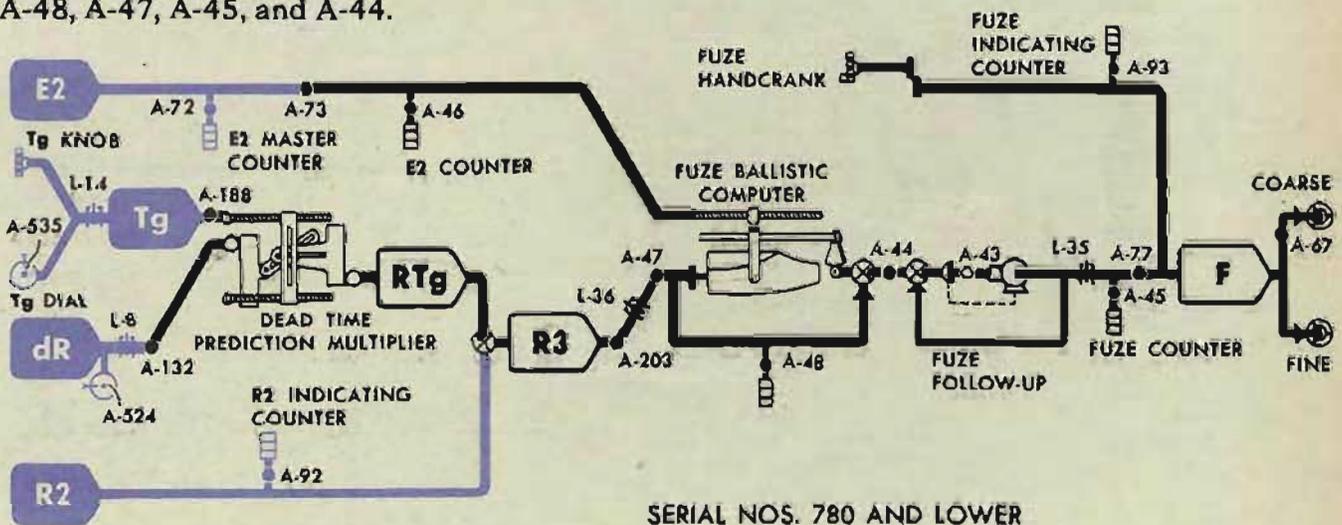
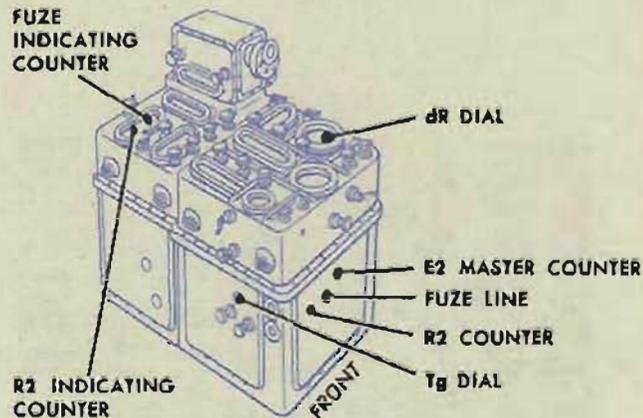
When the network inputs are correct but fuze is in error:

Check the *E2* counter in the fuze ballistic computer against the *E2* master counter. If the readings differ, check A-73.

Check the reading on the *R3* counter against the *R3* intermediate quantity.

If the *R3* reading does not agree with the value given, make the dead time prediction multiplier check test; see page 206. If multiplier errors are indicated, check A-188 and A-132. Check A-203.

If the *R3* and *E2* counter readings are correct and the fuze ballistic counter reading is in error, run the unit check test of the fuze ballistic computer. If the unit check test indicates error in the ballistic computer, check A-46, A-48, A-47, A-45, and A-44.



Serial Nos. 781 and higher

$$F = f(E2, R3) \text{ where } R3 = R2 + RTg,$$

$$\text{and } RTg = (dRs - dRm) (Tg + F - Tf)$$

Check the fuze follow-up.

Check A-77.

Checking the network inputs

Check the *E2* input by comparing the *E2* master counter reading with the value given in the intermediate quantities. If the counter reading is incorrect, check the *E2* network; see page 124.

Check the *R2* input by comparing the *R2* counter reading with the value given on the problem results form. If the counter reading is incorrect, check the *R2* network; see page 122.

Check the *Tg* input by checking A-535.

Check the *I.V.* input by checking A-536.

Check the *Tf* input by comparing the *Tf* master counter reading with the value given in the intermediate quantities. If the counter reading is incorrect, check the *Tf* network; see page 129.

Check the *dRs* input by first checking *dR*. Compare the *dR* dial reading with the value given in the intermediate quantities. If the dial reading is incorrect, or cannot be determined accurately, check the *dR* network; see page 134. If *dR* is correct, check A-181.

Checking the network

When the network inputs are correct but fuze is in error:

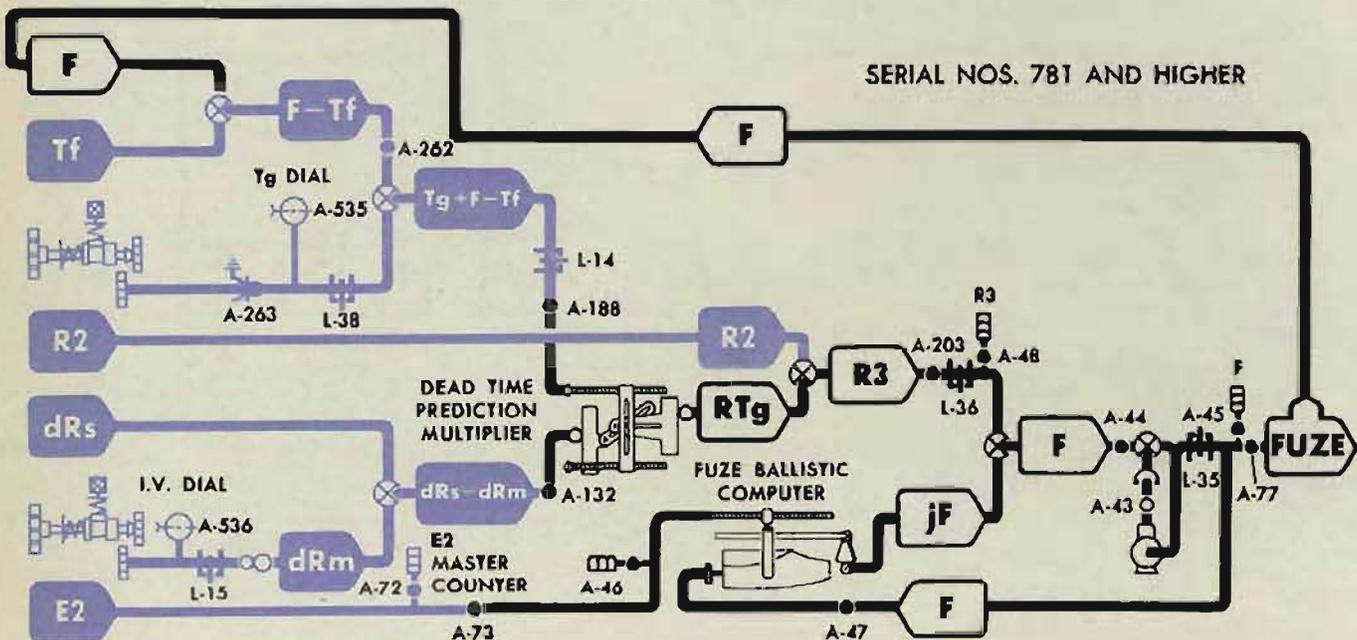
Check the *E2* counter in the fuze ballistic computer against the *E2* master counter. If the readings differ, check A-73.

Check A-262.

Make the dead time prediction multiplier check test; see page 206. If multiplier errors are indicated, check A-188 and A-132.

Check A-203.

Make the unit check test of the fuze ballistic computer. If this test indicates errors in the ballistic computer, check A-46, A-48, A-45, A-47, and A-44.



CHECKING THE Dd NETWORK

$$Dd = jDd + Dz$$

Check the Dd follow-up.

Checking the network inputs

Check the $E2$ input by comparing the reading on the $E2$ master counter with the value given on the problem results form. If the $E2$ counter reading does not agree with the value given, check the $E2$ network; see page 124.

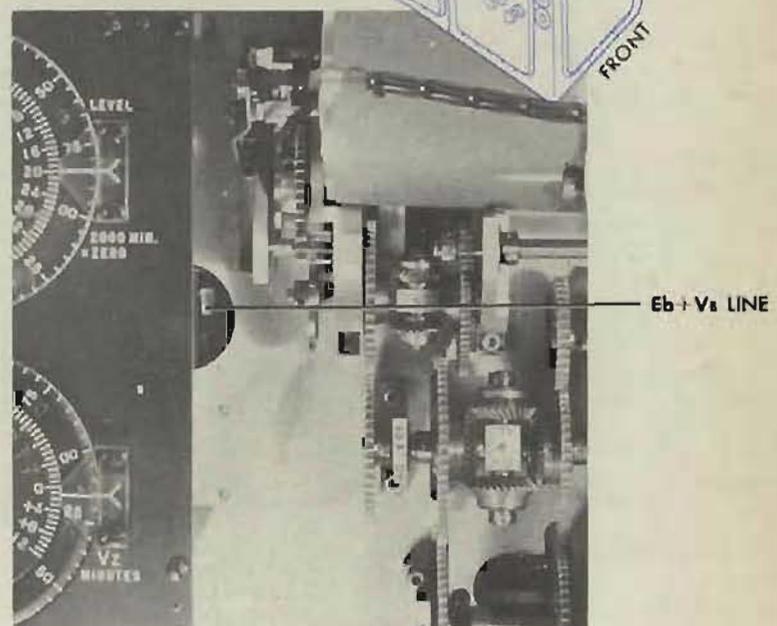
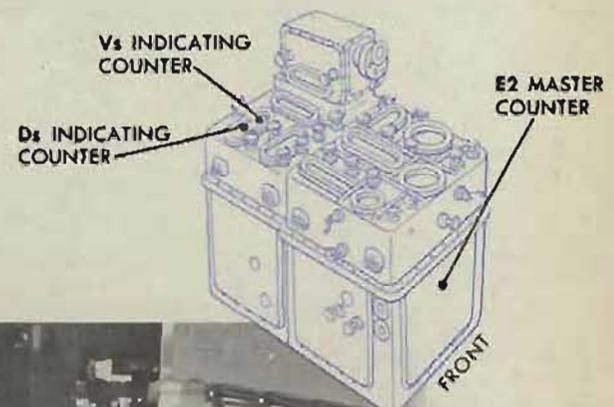
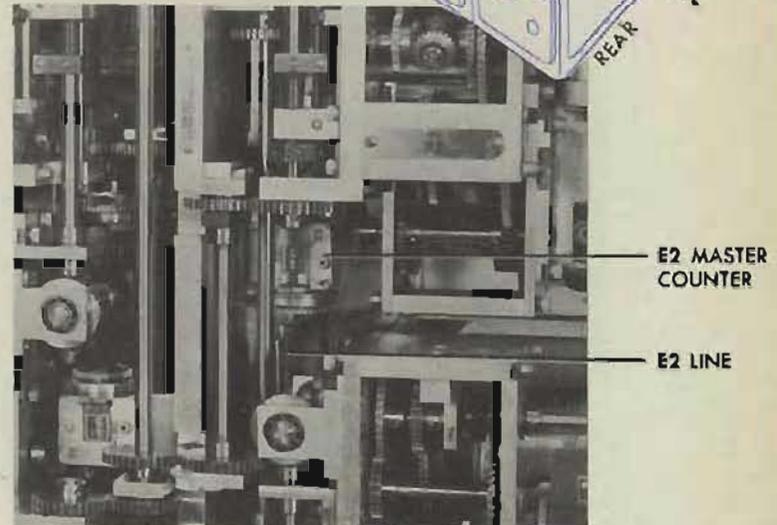
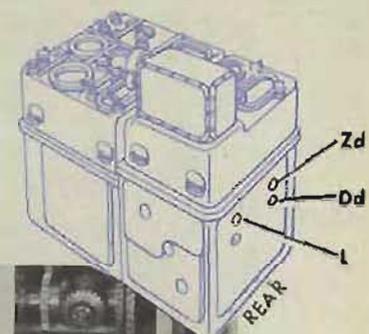
Check the Ds input by comparing the reading on the Ds indicating counter with the value given on the problem results form. If the Ds counter reading does not agree with the value given, check the Ds network; see page 110.

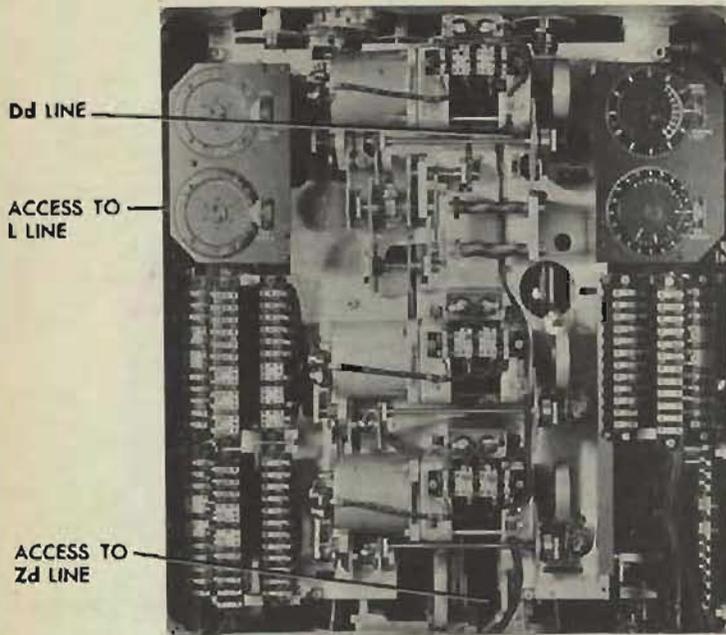
Check the Vs input by comparing the reading on the Vs indicating counter with the value given on the problem results form. If the Vs counter reading does not agree with the value given, check the Vs network; see page 108.

Check the L input by checking A-58, A-28 and A-505.

Check the Eb input by checking the synchronize elevation network; see page 132.

Check the Zd input by checking A-30, A-507, and A-112.





If the network inputs are correct, make the check test of the trunnion tilt section.

The check test will indicate errors in the inputs to the trunnion tilt units. One of the following may be incorrectly positioned:

The Zd vector of the Dz computer. Check A-35.

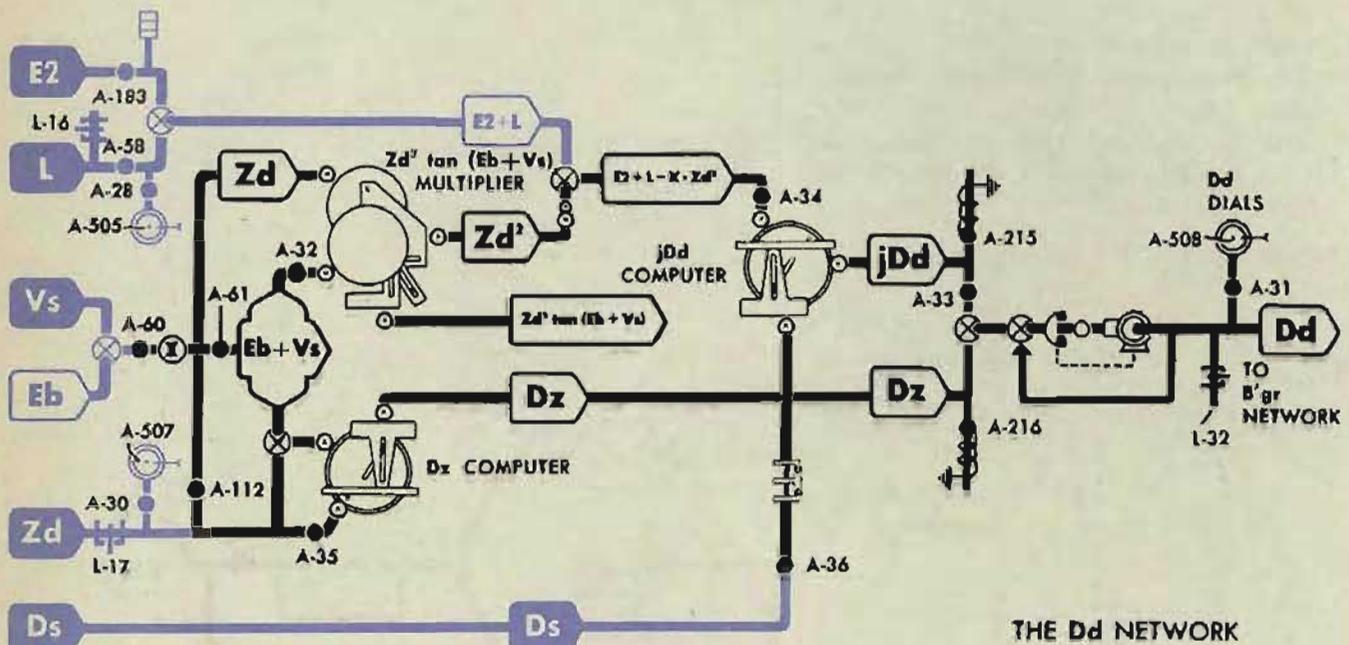
The $Eb + Vs$ cam of the Dz computer. Check A-60 and A-61.

The Ds rack of the jDd computer. Check A-36.

The $E2 + L - KZd^2$ cam of the jDd computer. Check A-34.

If the unit inputs are correct, check A-33, A-31, and A-508.

If any adjustments are altered, check the take-up springs A-215 and A-216.



CHECKING THE Vz NETWORK

$$V_z = [Zd' \tan (Eb + Vs)] + (Zd \cdot Ds)$$

Check the Vz follow-up.

Check the Ds input by comparing the Ds indicating counter reading with the Ds value given on the problem results form. If the Ds counter reading does not agree with the value given, see page 110.

Check the Vs input by comparing the Vs indicating counter reading with the Vs value given on the problem results form. If the counter reading does not agree with the value given, see page 108.

Check the Zd input by checking A-30 and A-507.

Check the Eb input by checking the synchronize elevation network; see page 132.

When all the inputs are correct but Vz is in error, run the unit check test of the trunnion tilt section.

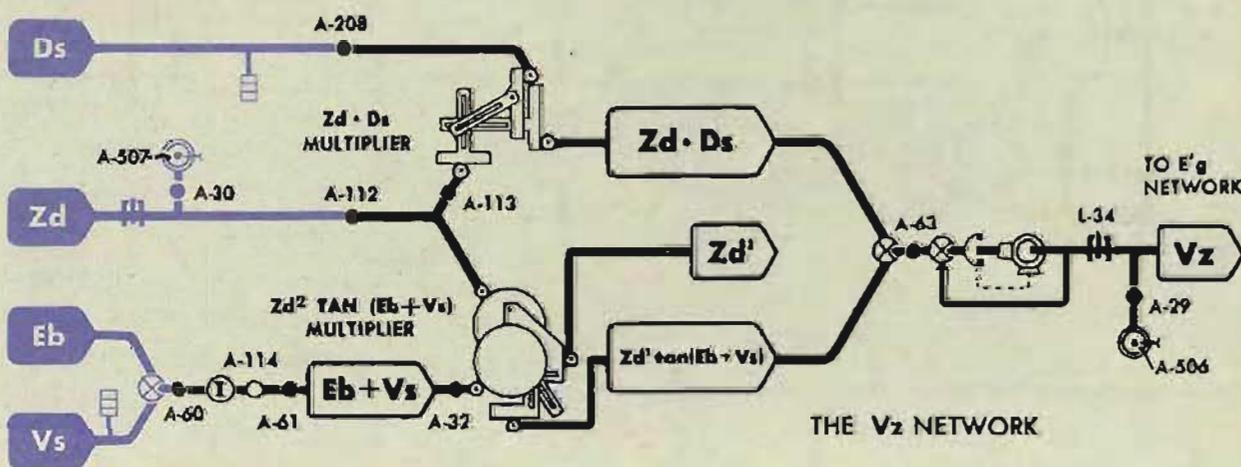
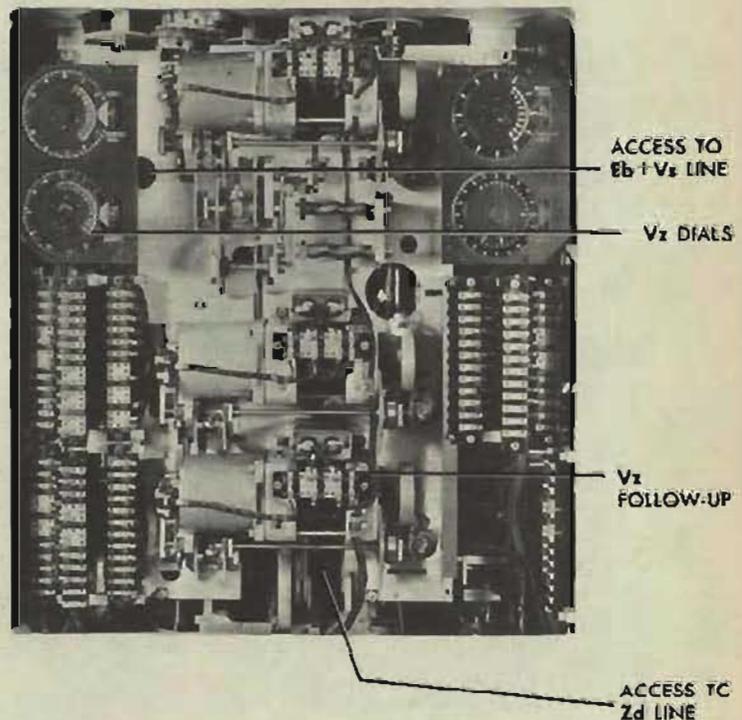
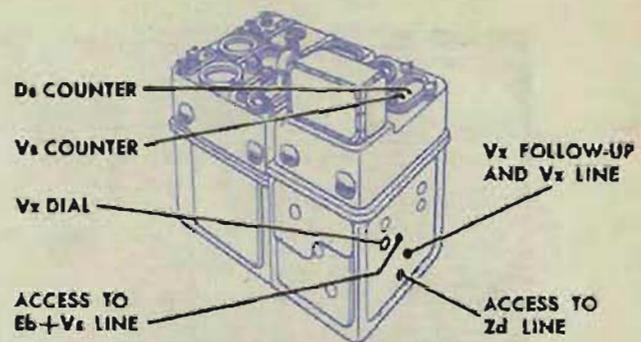
The unit check test will indicate errors in the inputs to the multipliers. Any of the following may be incorrectly positioned:

The Zd rack of the Zd · Ds multiplier or the Zd input to the square cam of the Zd' tan (Eb + Vs) multiplier. Check A-112 and A-113.

The Ds rack of the Zd · Ds multiplier. Check A-208.

The Eb + Vs cam of the Zd' tan (Eb + Vs) multiplier. Check A-60, A-61 and A-32.

If Vz is still in error, check A-63, A-29, and A-506.



THE Vz NETWORK

CHECKING THE B_r NETWORK

$$B_r = B'r + jB'r$$

Check the $jB'r$ follow-up.

Check the $B'r$ input by checking the problem setup value on the stable element dials, and check A-602.

Check the L input by checking A-58 and A-28.

Check the Z_d input by checking A-30 and A-112.

When these inputs are correct, run the unit check test of the deck tilt section, see page 220.

The unit check test will indicate errors in the inputs to the component solver or multipliers. One of the following may be incorrectly positioned:

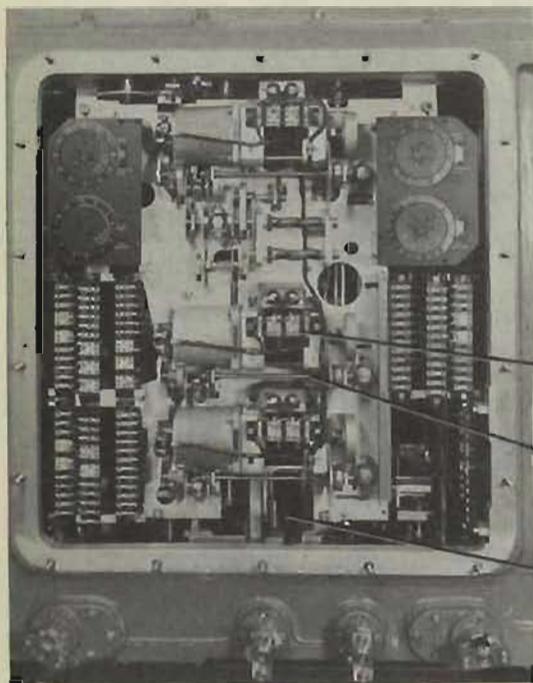
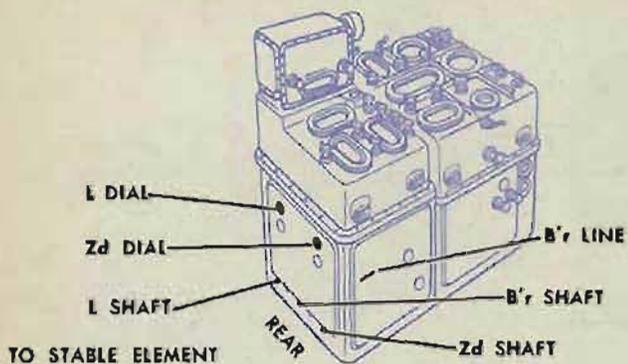
The vector gear of the deck tilt component solver. Check A-99.

The lead screw of the $L \cdot L \sin 2B'r$ multiplier. Check A-65.

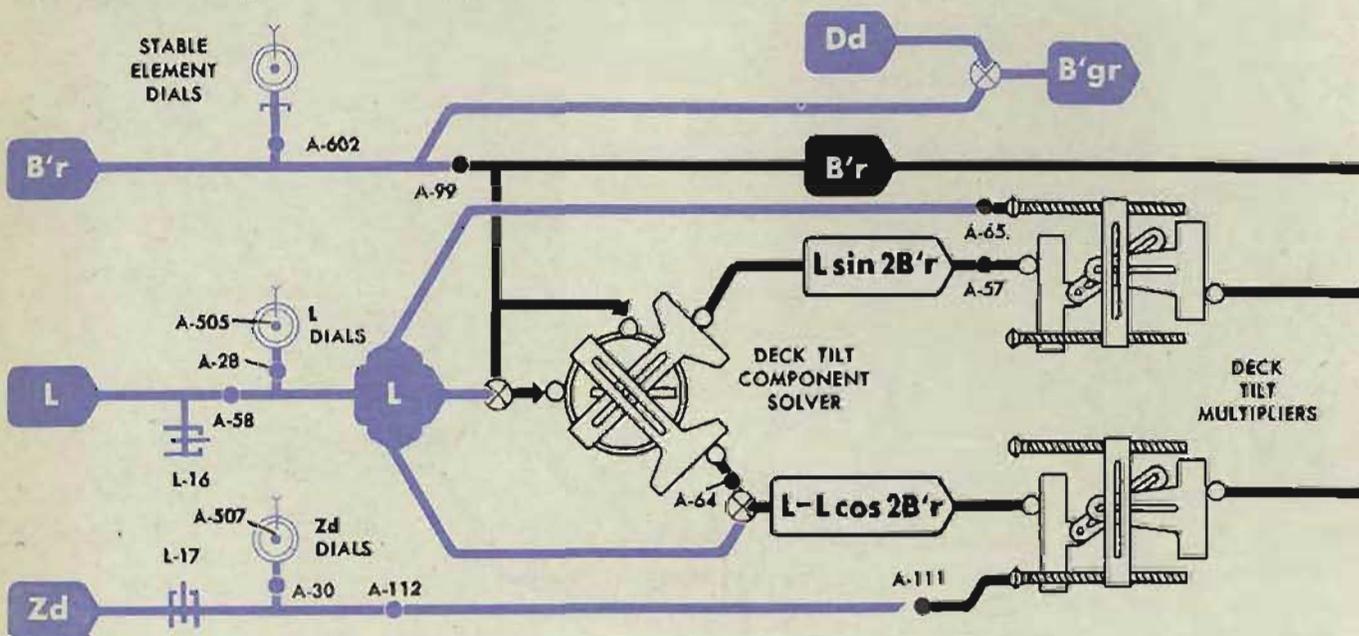
The input rack of the $L \cdot L \sin 2B'r$ multiplier. Check A-57.

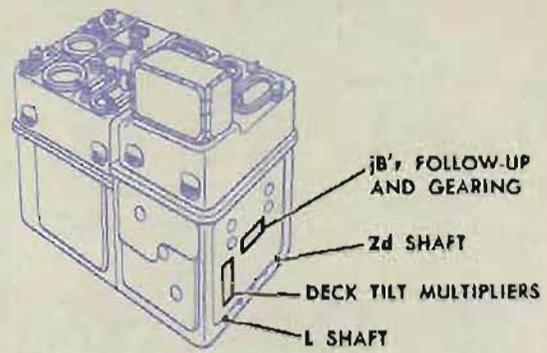
The lead screw of the $Z_d (L - L \cos 2B'r)$ multiplier. Check A-111.

The input rack of the $Z_d (L - L \cos 2B'r)$ multiplier. Check A-64.



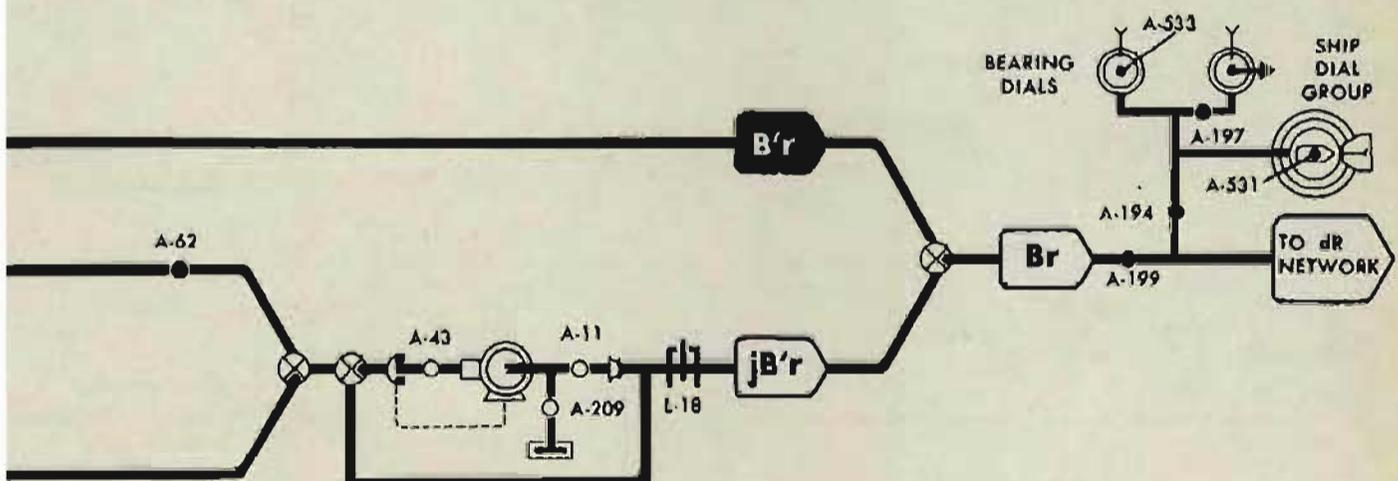
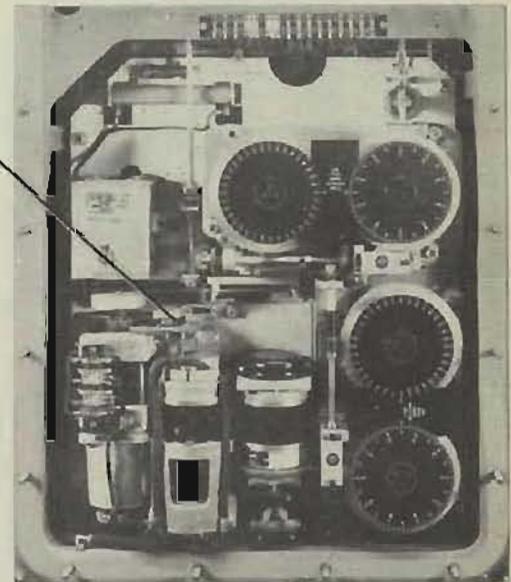
L B_r Z_d





If *Br* is still in error, check A-62, A-199, A-194, A-197, and A-531.

OUTPUT GEAR B'r RECEIVER



CHECKING THE R2 NETWORK

$$R2 = cR + R_{twm} + R_j$$

Check the $R2$ follow-up.

Checking the network inputs

Check the Tf input.

Set the $R2$ counter in the Tf ballistic computer at the correct intermediate value using the generated range crank in the OUT position.

Set the $E2$ counter in the Tf ballistic computer at the correct intermediate value with the sync E handcrank in the CENTER position, and check the reading of the Tf counter against the intermediate quantity. If the value of Tf is still incorrect, check the Tf network; see page 129.

Check the R_j input by checking A-234 and A-235.

Check the $I.V.$ input by checking A-536.

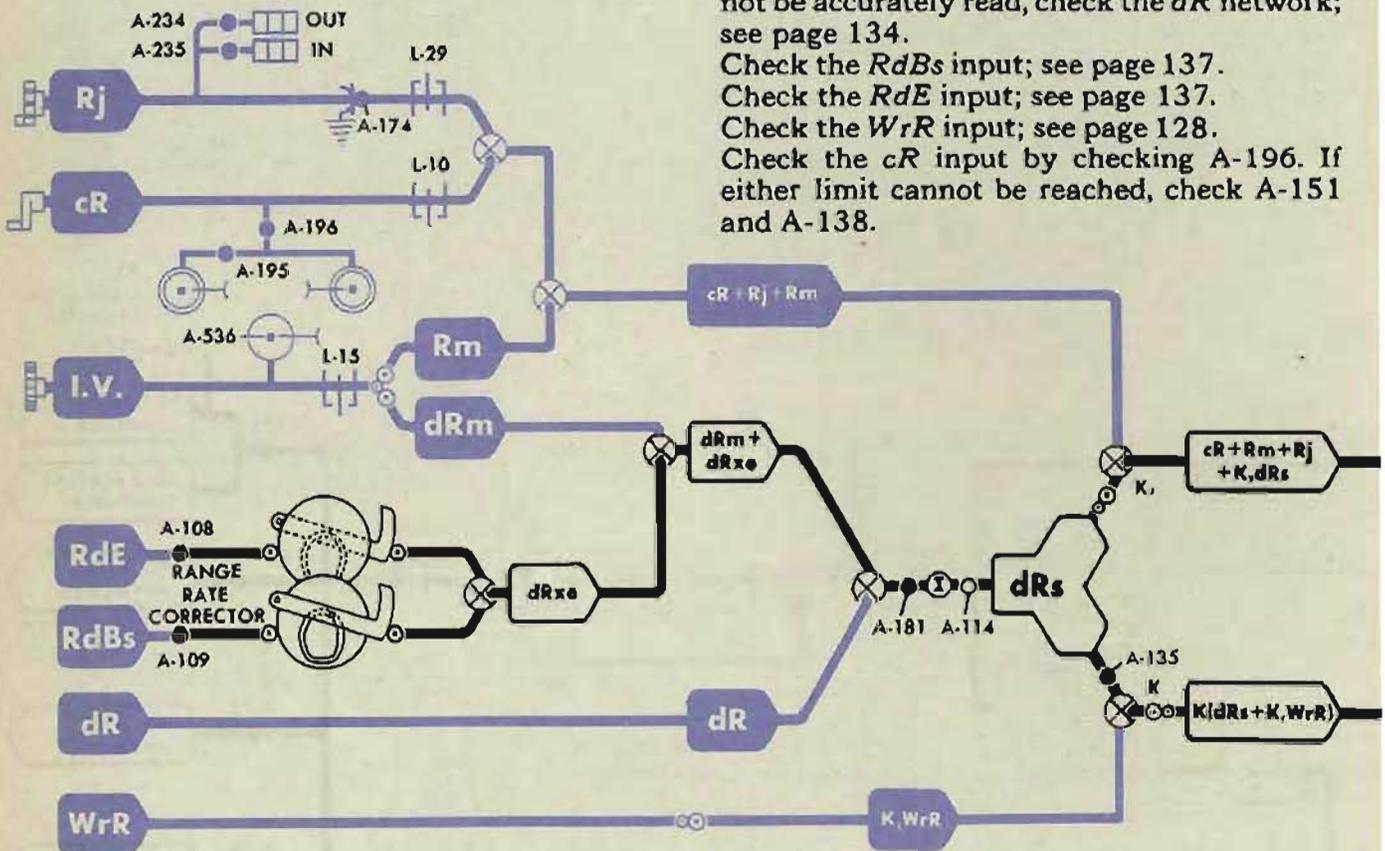
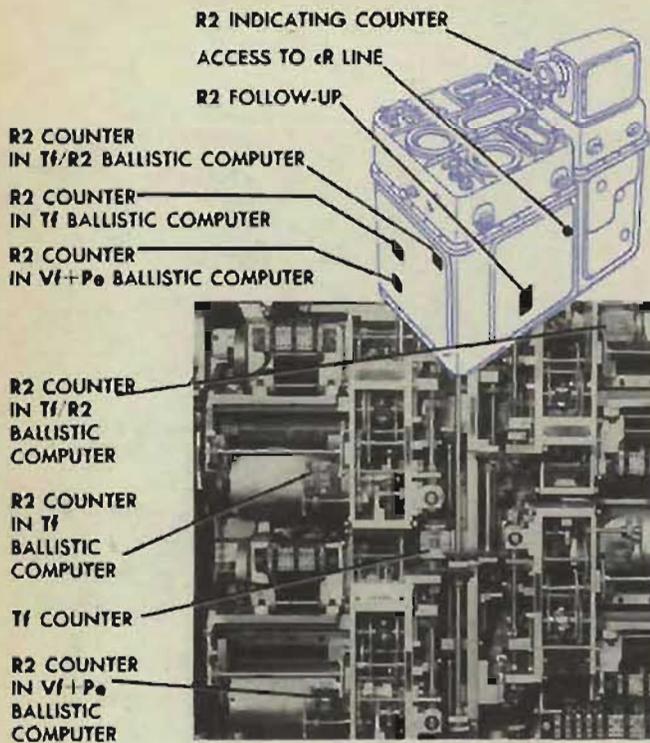
Check the dR input, by comparing the reading of the dR dial with the intermediate quantity. If the dial reading is not correct, or cannot be accurately read, check the dR network; see page 134.

Check the $RdBs$ input; see page 137.

Check the RdE input; see page 137.

Check the WrR input; see page 128.

Check the cR input by checking A-196. If either limit cannot be reached, check A-151 and A-138.



Checking the mechanism inputs

When the network inputs are correct, but *R2* is still in error, check the adjustment of A-108, A-109, and A-181.

Make the range prediction multiplier check test; see page 200.

If the lead screw is incorrectly positioned, check A-81.

If the rack is incorrectly positioned, check A-135.

Check A-104.

Turn the *R2* line with the generated range crank in the *OUT* position until the upper limit of L-19 is reached.

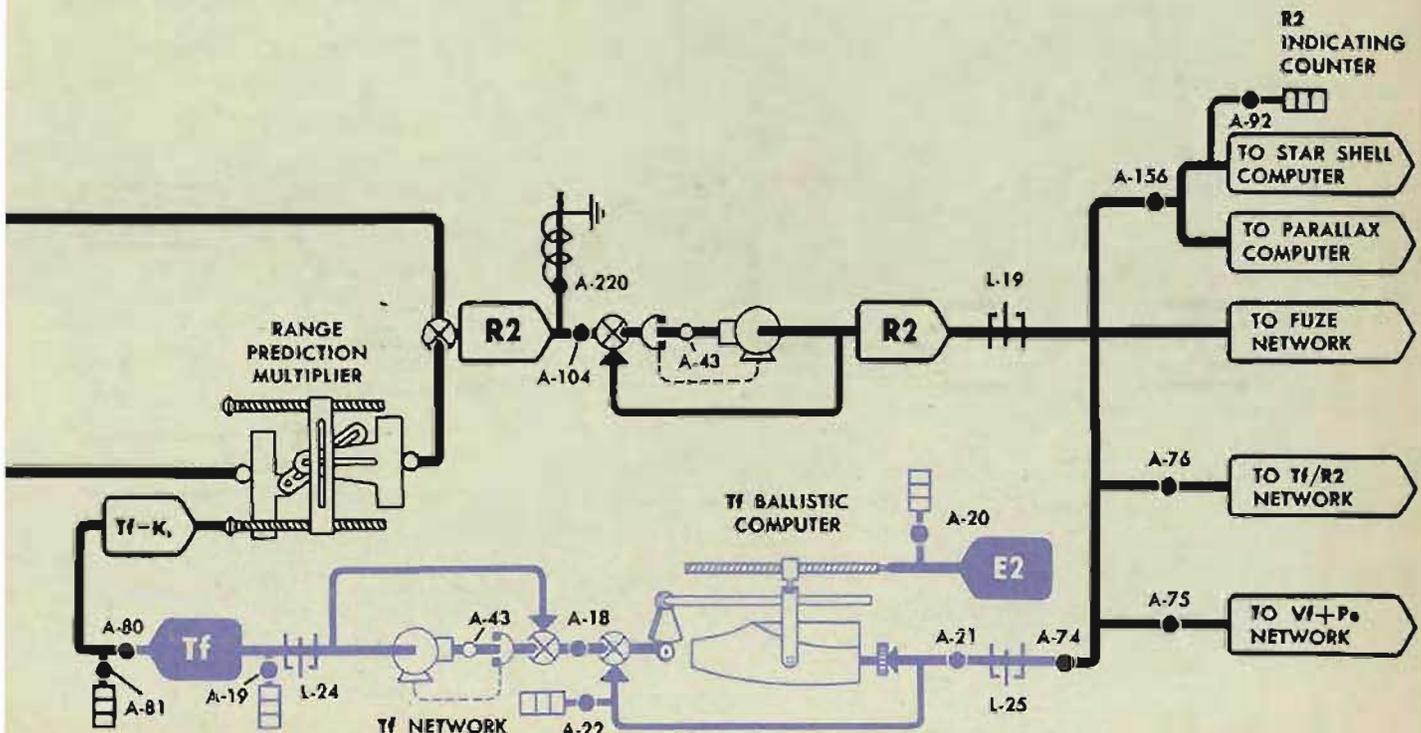
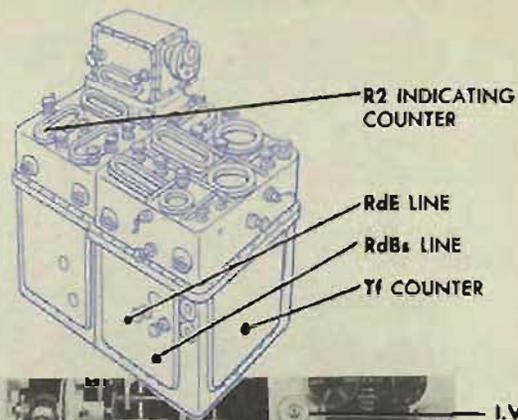
The *R2* counter in the *Tf* ballistic computer should read 18,000 yards. If this *R2* counter reading is not correct, turn the power OFF and check A-74.

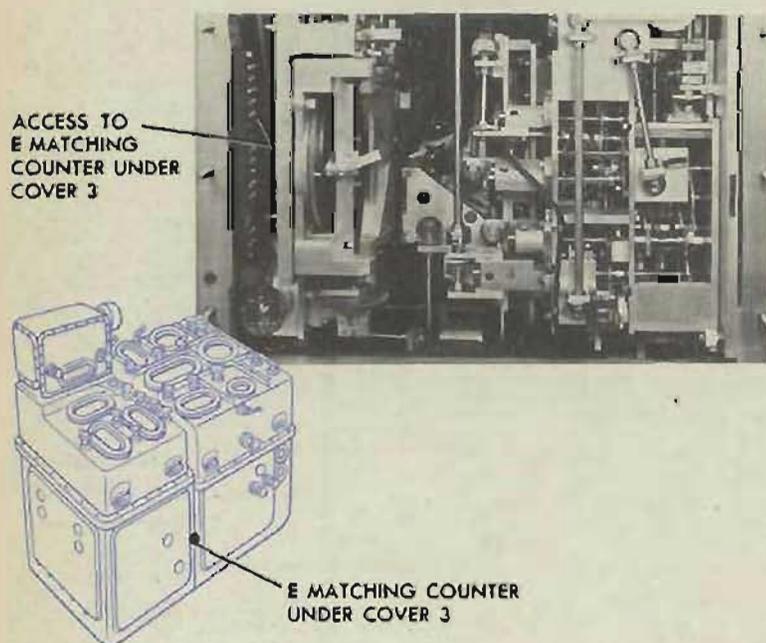
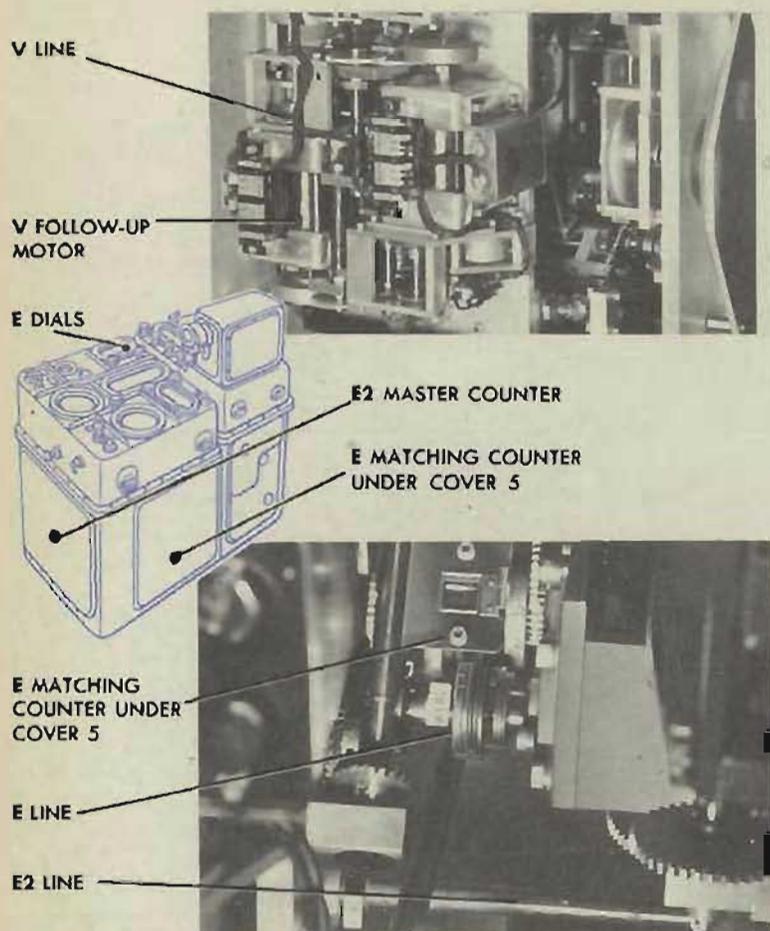
If the *R2* counter in the *Tf* ballistic computer is correct, read the *R2* counter in the *Tf/R2* ballistic computer. If it is incorrect, check A-76.

Read the *R2* counter in the *Vf + Pe* ballistic computer. If it is incorrect, check A-75.

If the *R2* counters in the ballistic computers are correct and the *R2* indicating counter does not read 18,000 yards, check A-156 and A-92.

Check A-203.





CHECKING THE E2 NETWORK

$$E2 = E + V$$

Check the *V* follow-up.

Checking the network inputs

Check the *E* input. Increase *E* to the upper limit of L-12. The *E* dials, the *E* matching counter under cover 3, and the *E* matching counter under cover 5, should all read 85°. If all the counters read 85°, check the *V* network.

If the *E* dials do not read 85°, check A-116 and A-189.

If the *E* matching counter under cover 3 does not read 85°, check A-259.

If the *E* matching counter under cover 5 does not read 85°, check A-260. If A-260 is readjusted, check A-250.

NOTE: The *E* matching counters and A-260 are not provided on instruments with Serial Nos. 434 and lower.

Check the *V* input; see page 126.

Checking the network

When the inputs are correct, check A-103 and A-180.

Check the *E2* intermittent drive. The *E2* intermittent drive should be at its cut-out position when the *E2* master counter reads 0° and 90°. Check that A-182 and A-114 are tight; then check A-72.

When the *E2* master counter reading is correct, check the *E2* counters by comparing the readings on all the *E2* counters with the reading on the *E2* master counter. One of the following counter readings may not agree with the master counter reading:

The reading on the *E2* matching counter. Check A-183.

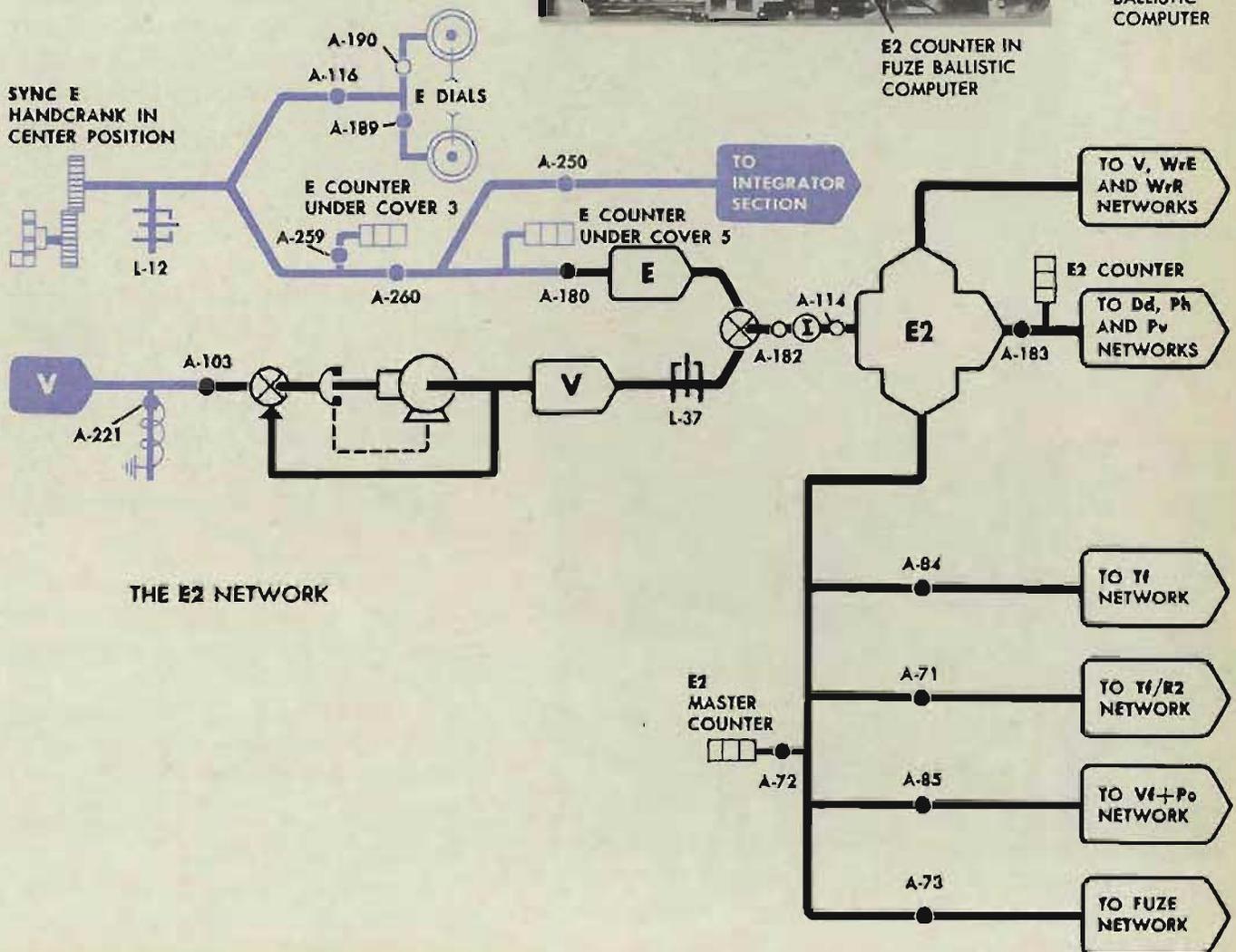
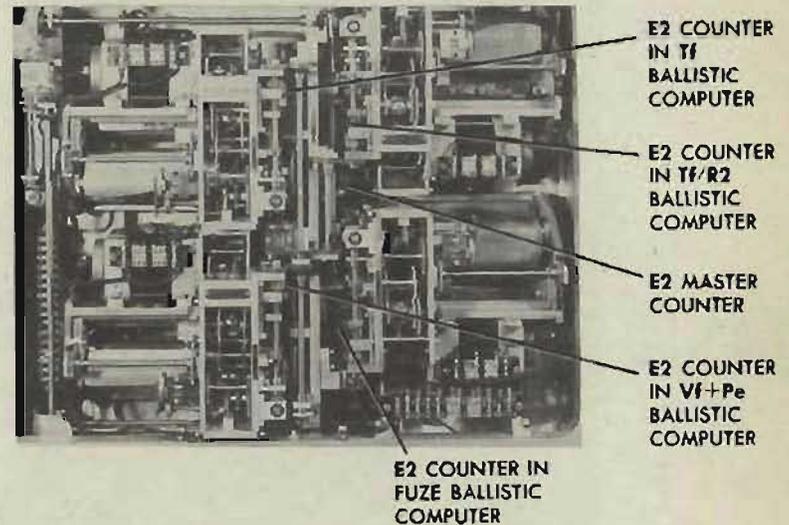
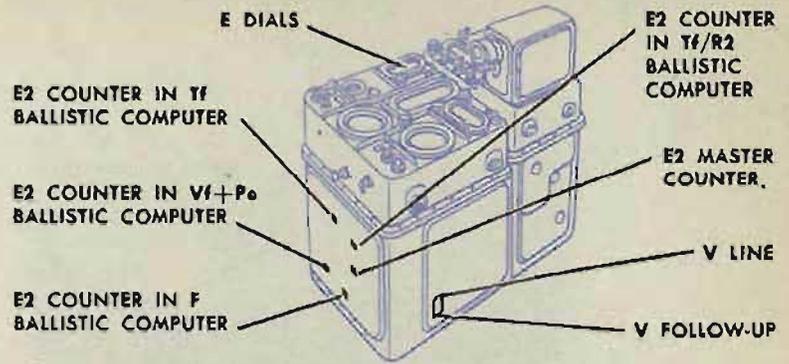
The reading on the *E2* counter in the fuze ballistic computer. Check A-73 and A-46.

The reading on the *E2* counter in the *Tf* ballistic computer. Check A-84 and A-20.

The reading on the *E2* counter in the *Tf/R2* ballistic computer. Check A-71 and A-40.

The reading on the *E2* counter in the *Vf + Pe* ballistic computer. Check A-85 and A-15.

If an *E2* adjustment to any of the ballistic computers is altered, check the limits of the *E2* intermittent drive. If either limit cannot be reached, check whether the ballistic cam follower is butting against the limit of travel.



THE *E2* NETWORK

CHECKING THE V NETWORK

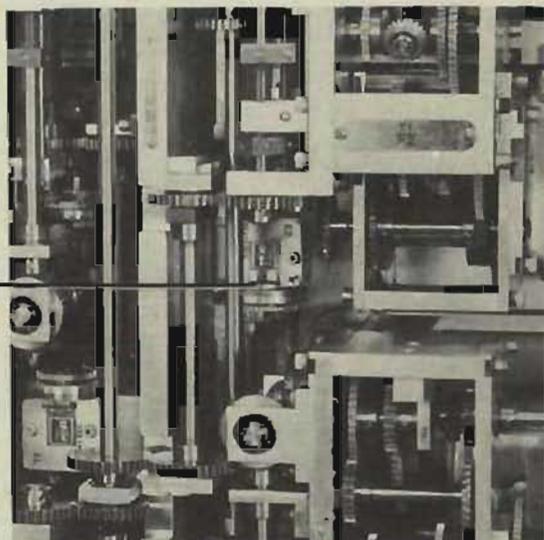
$$V = Vtw' - Vx + (KVj + K_2RdE)$$

Check the V follow-up.

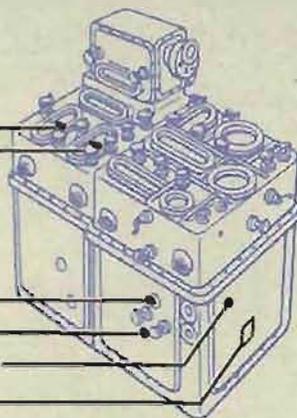
Checking the network inputs

Check the $E2$ input by comparing the reading on the $E2$ master counter with the value given in the intermediate quantities. If the counter reading does not agree with the value given, check the $E2$ network; see page 124.

$E2$ MASTER
COUNTER



D_s INDICATING COUNTER
 V_j DIAL

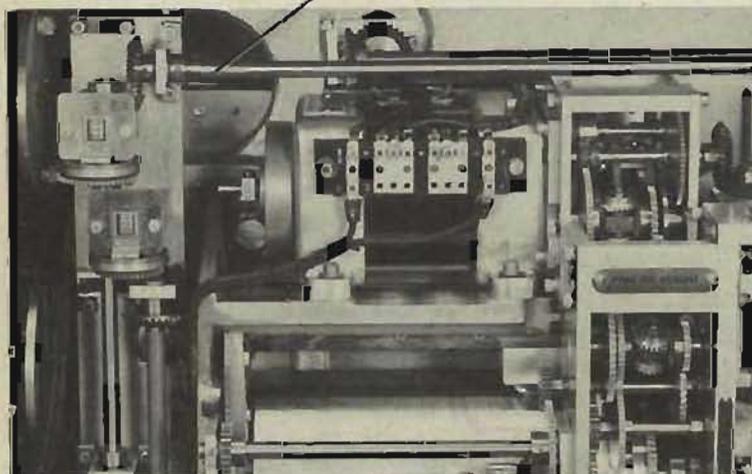


ACCESS TO THE RdE LINE
ACCESS TO THE W/E LINE
ACCESS TO THE $Tf/R2$ LINE
 $E2$ MASTER COUNTER

Check the D_s input by comparing the reading on the D_s indicating counter with the value given on the problem results form. If the counter reading does not agree with the value given, check the D_s network; see page 110.

Check the $Tf/R2$ input by comparing the reading on the $Tf/R2$ counter with the value given in the intermediate quantities. If the counter reading does not agree with the value given, check the $Tf/R2$ network; see page 130.

$Tf/R2$ LINE



Check the V_j input by checking A-501.

Check the *RdE* input; see page 137.
 Check the *WrE* input; see page 128.

Checking the network

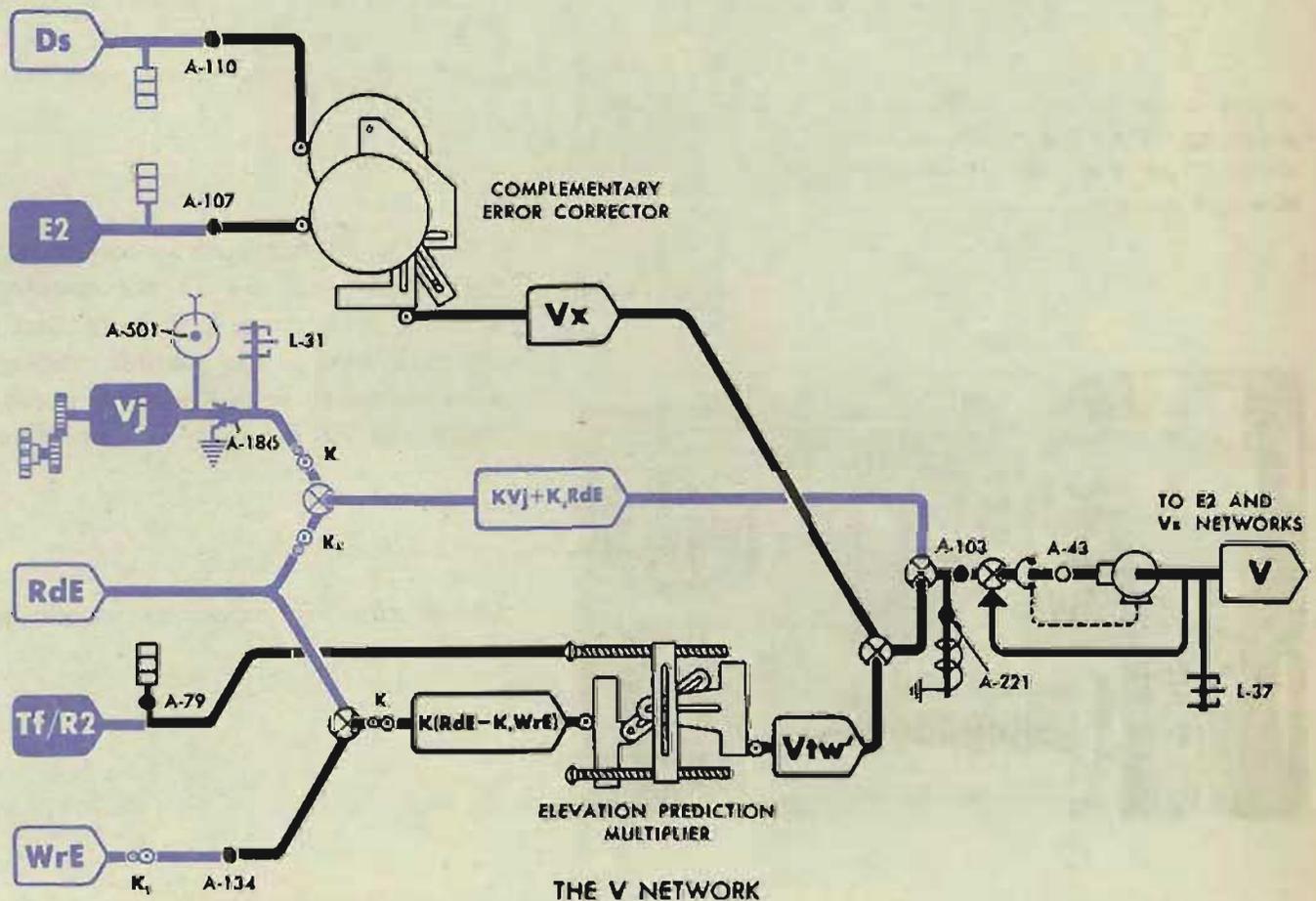
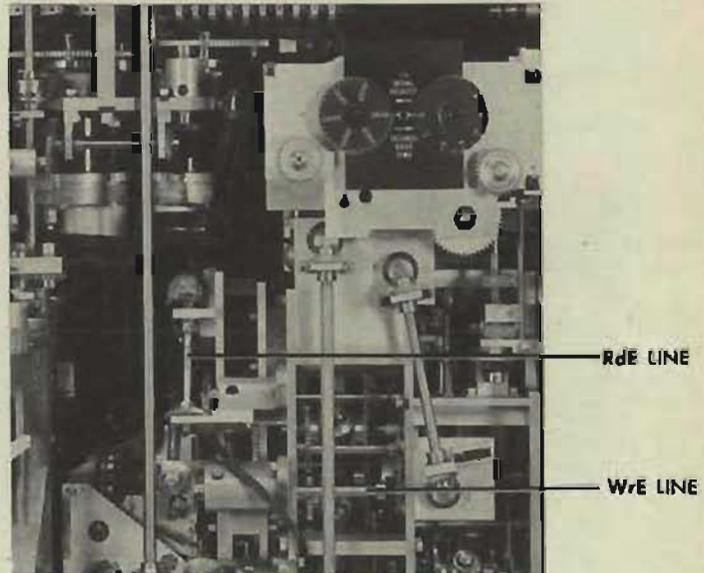
When the inputs are correct, check A-107 and A-110.

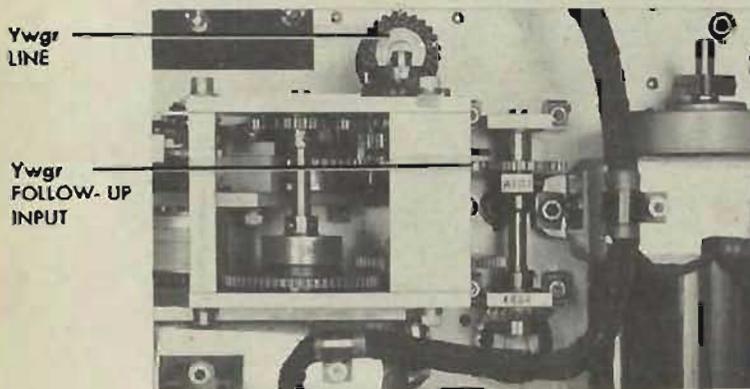
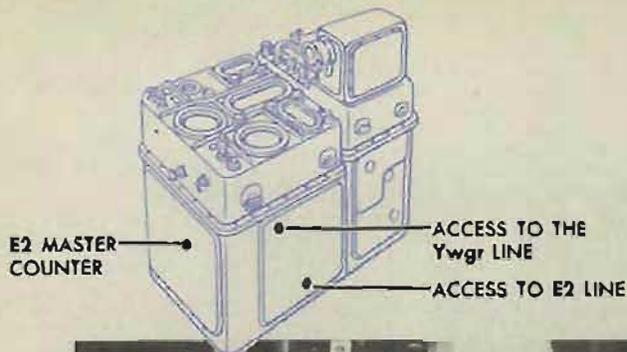
Make the elevation prediction multiplier check test; see page 202.

If the lead screw is incorrectly positioned, check A-79.

If the rack is incorrectly positioned, check A-134.

If *V* is still in error, check A-221 and A-103.





CHECKING THE W_rR AND W_rE NETWORKS

$$W_rR = Ywgr \cos (KE2)$$

$$W_rE = Ywgr \sin (KE2)$$

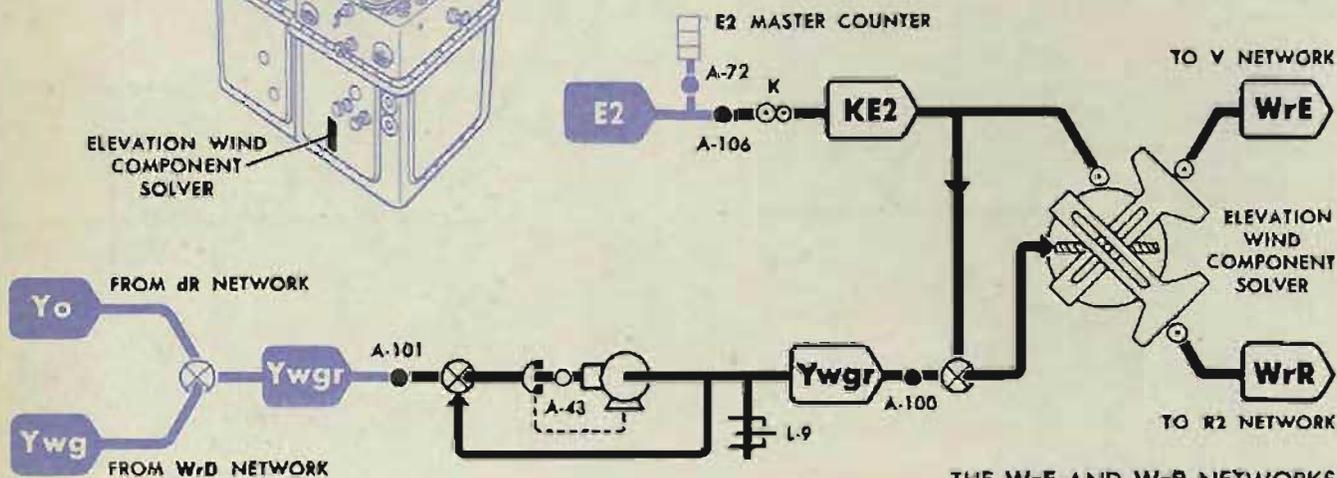
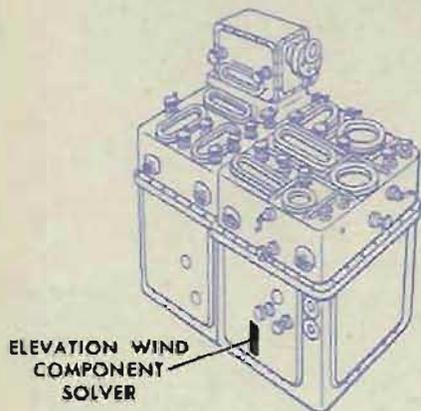
Check the $Ywgr$ follow-up.

Check the $E2$ input by comparing the reading on the $E2$ master counter with the $E2$ intermediate quantity. If the counter reading agrees with the value given, $E2$ is correct. If the counter reading does not agree with the value given, check the $E2$ network; see page 124.

Check the $Ywgr$ input by checking the W_rD network; see page 138. If W_rD is correct, $Ywgr$ and Y_o are also correct.

When the network inputs are correct, run the unit check test of the elevation wind component solver; see page 196.

If the speed pin is incorrectly positioned, check A-101 and A-100. If the vector gear is incorrectly positioned, check A-106.



THE W_rE AND W_rR NETWORKS

CHECKING THE Tf NETWORK

Check the *Tf* follow-up.

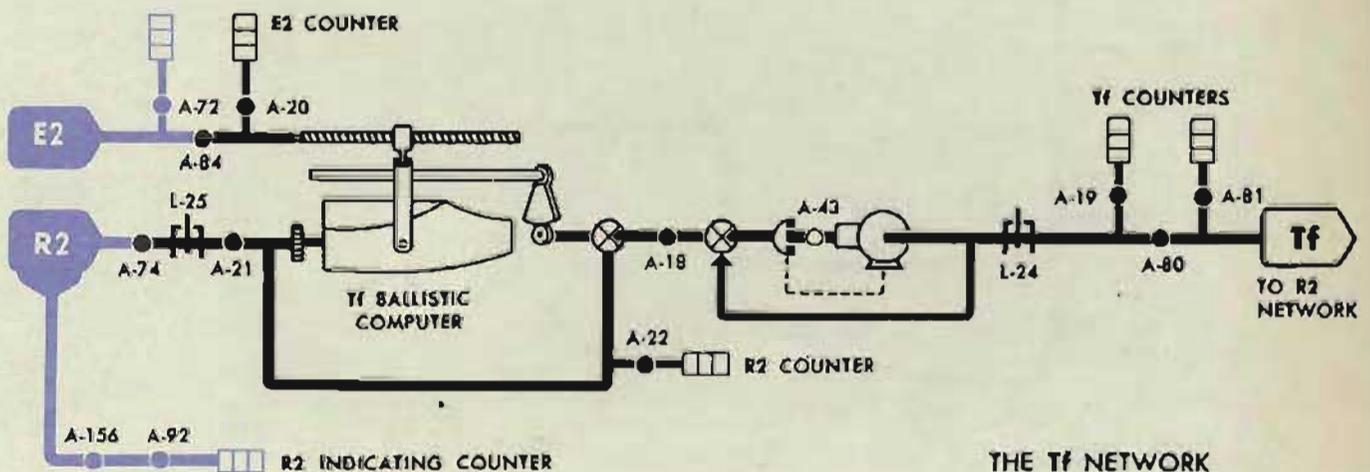
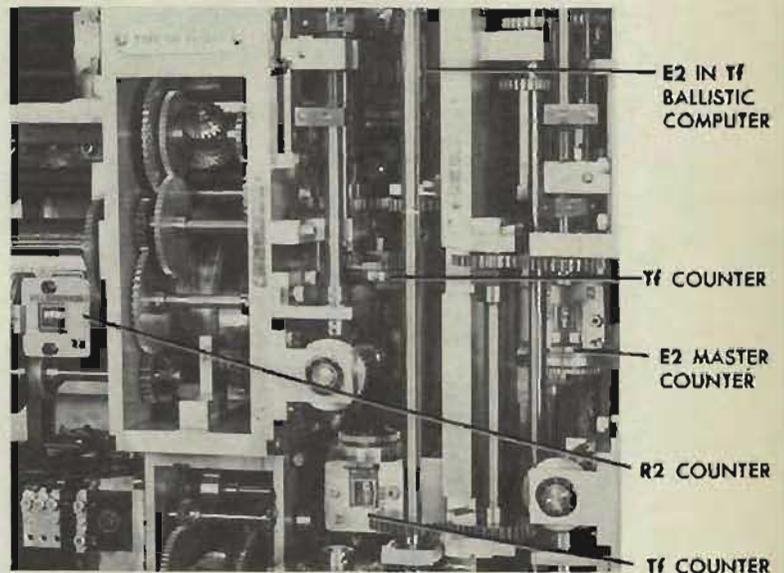
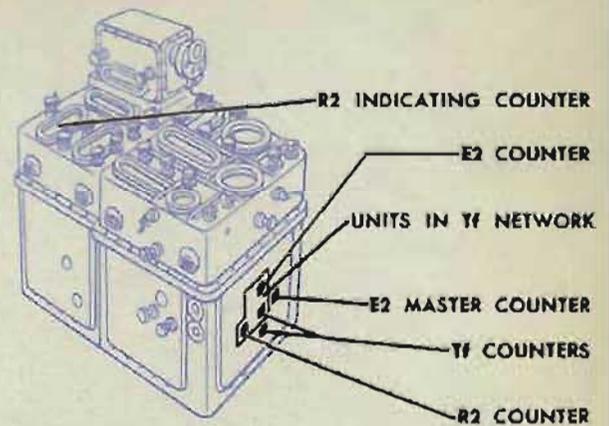
Check the *E2* input by comparing the reading on the *E2* master counter with the *E2* intermediate quantity. If the reading does not agree with the value given, check the *E2* network; see page 124.

Check the *R2* input by comparing the reading on the *R2* counter in the *Tf* ballistic computer with the *R2* intermediate quantity. If the reading does not agree with the value given, check the *R2* network; see page 122.

When the network inputs are correct, compare the reading on the *E2* ballistic counter with the reading on the *E2* master counter. If the ballistic counter reading is in error, check A-84.

When the *E2* and *R2* ballistic counter readings are correct but *Tf* is in error, make the *Tf* ballistic computer unit check test, see page 208.

If any adjustments are made, recheck A-84; then check A-74 and A-80.



CHECKING THE Tf/R2 NETWORK

Check the *Tf/R2* follow-up.

Check the *E2* input by comparing the reading on the *E2* master counter with the *E2* intermediate quantity. If the reading does not agree with the value given, check the *E2* network. See page 124.

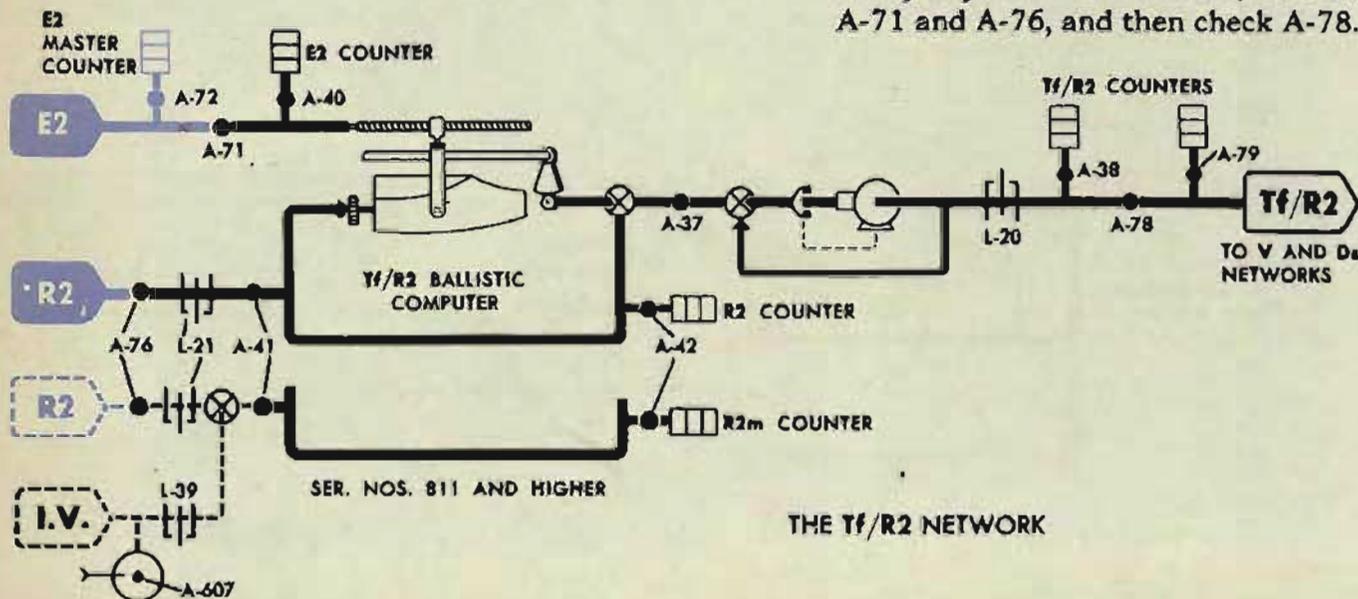
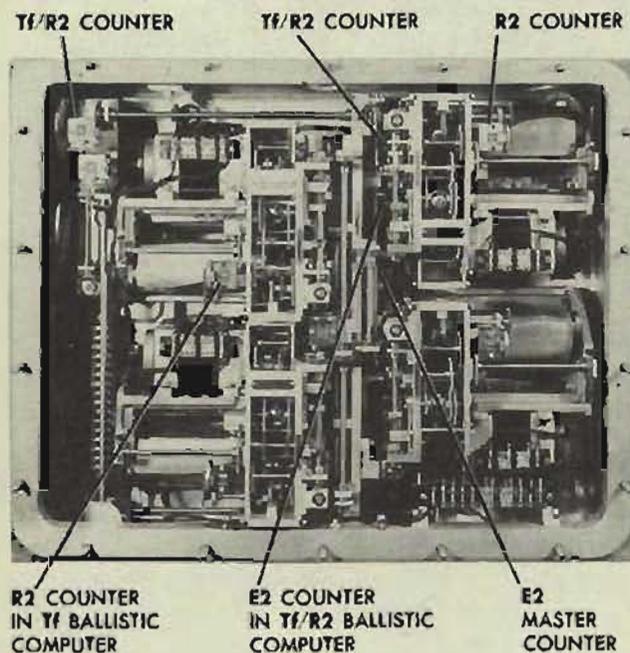
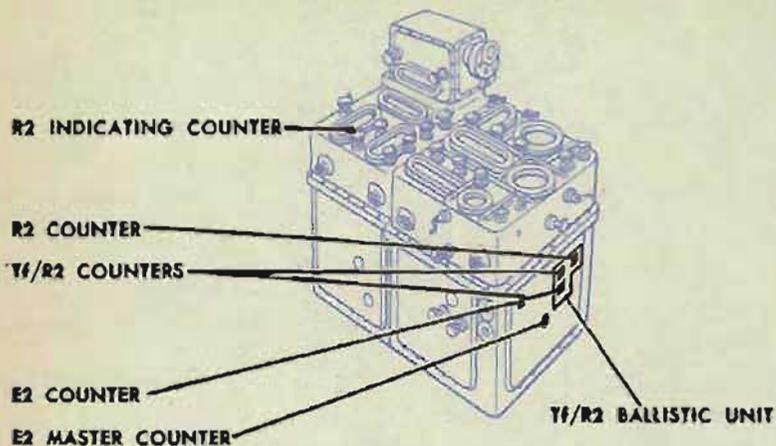
Check the *R2* input by comparing the reading on the *R2* counter in the *Tf* ballistic computer with the *R2* intermediate quantity. If the reading does not agree with the value given, check the *R2* network. See page 122.

When the network inputs are correct, compare the reading on the *E2* ballistic counter with the reading on the *E2* master counter. If the ballistic counter reading is in error, check A-71.

Compare the reading on the *R2* (or *R2m*) ballistic counter with the reading on the *R2* counter in the *Tf* ballistic computer (on Serial Nos. 811 and higher, set front *I.V.* dial at 2550 f.s.). If the readings do not agree, check A-76 (also A-607 on Serial Nos. 811 and higher).

When the *E2* and *R2* ballistic counter readings are correct but *Tf/R2* is in error, make the *Tf/R2* ballistic computer unit check test; see page 208.

If any adjustments are made, recheck A-71 and A-76, and then check A-78.



CHECKING THE $V_f + P_e$ NETWORK

Check the $V_f + P_e$ follow-up.

Check the E_2 input by comparing the reading on the E_2 master counter with the E_2 intermediate quantity. If the reading does not agree with the value given, check the E_2 network. See page 124.

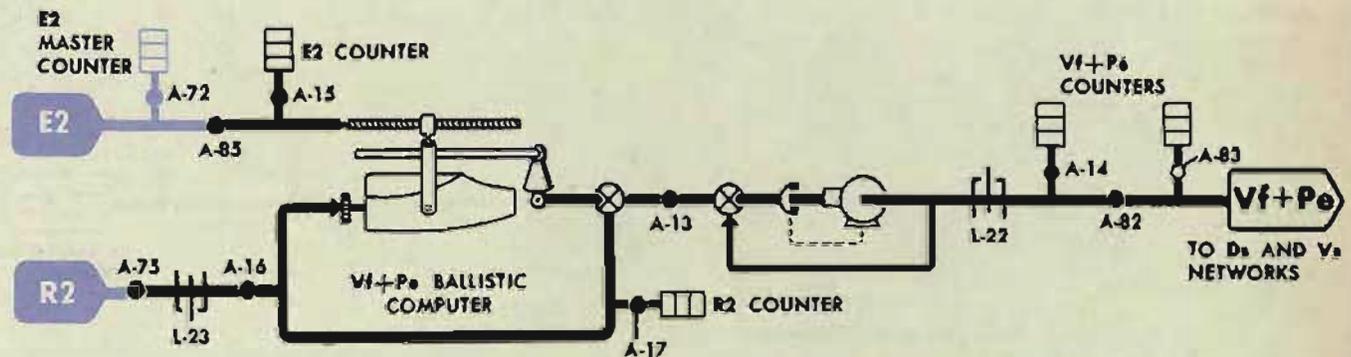
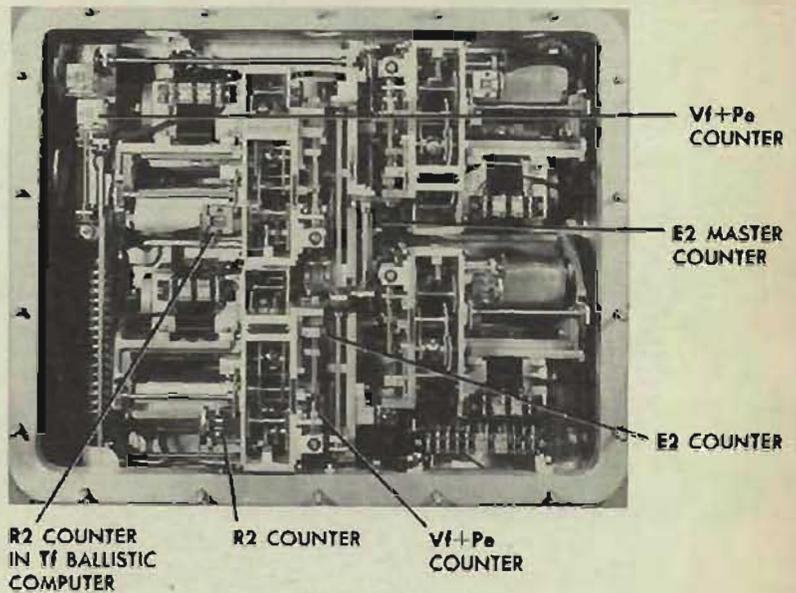
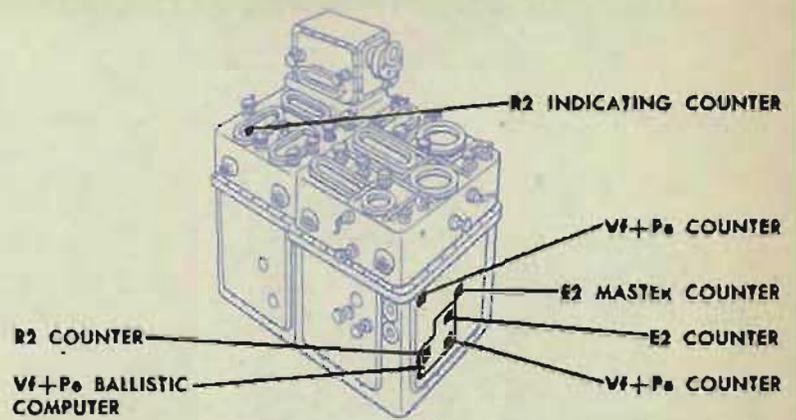
Check the R_2 input by comparing the reading on the R_2 counter in the T_f ballistic computer with the R_2 intermediate quantity. If the reading does not agree with the value given, check the R_2 network; see page 122.

When the network inputs are correct, compare the reading on the E_2 ballistic counter with the reading on the E_2 master counter. If the readings do not agree, check A-85.

Compare the reading on the R_2 ballistic counter with the reading on the R_2 counter in the T_f ballistic computer. If the readings do not agree, check A-75.

When the E_2 and R_2 ballistic counter readings are correct but $V_f + P_e$ is in error, make the $V_f + P_e$ ballistic computer unit check test; see page 208.

If any adjustments are made, recheck A-85 and A-75. Then check A-82.

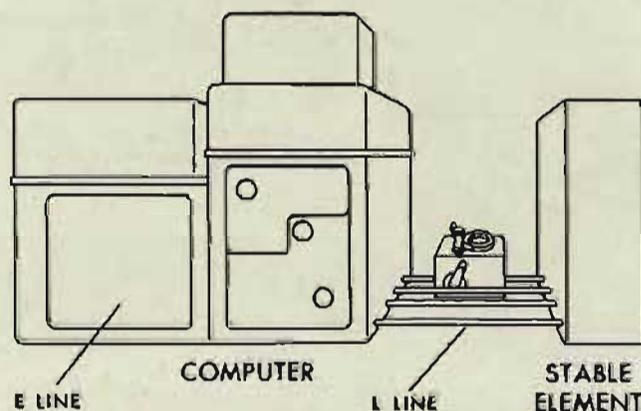
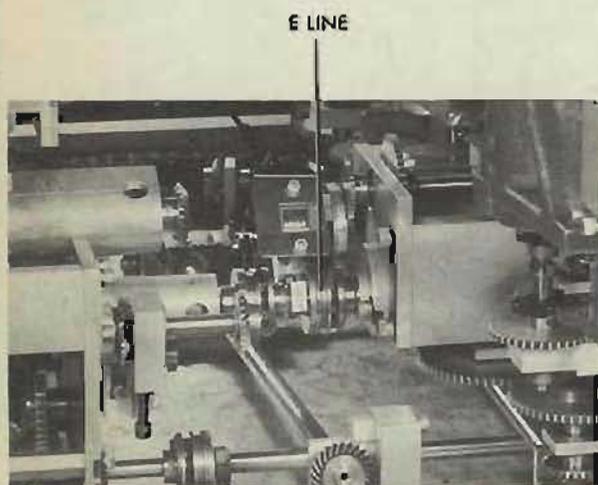
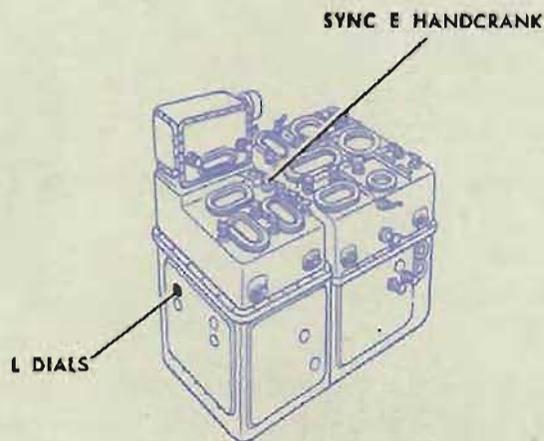
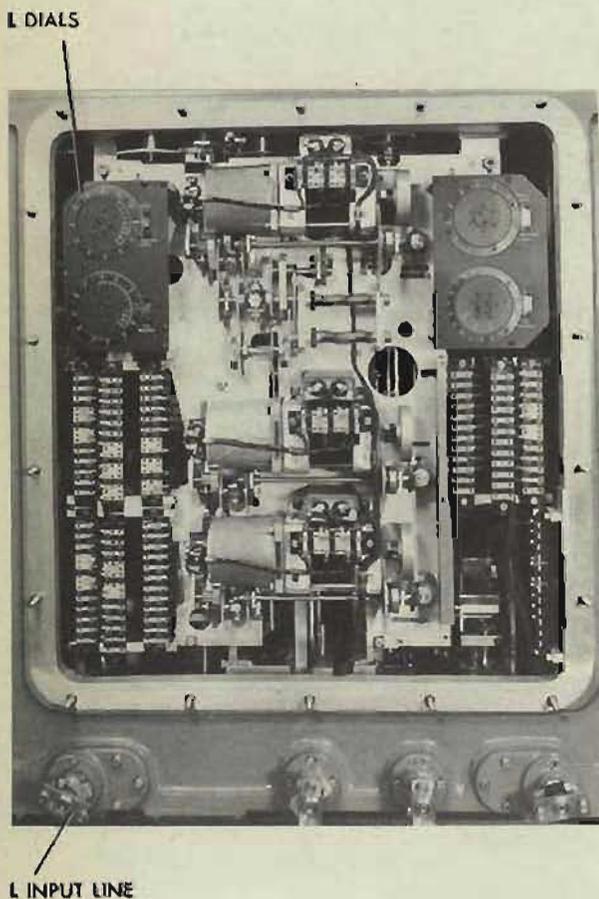


THE $V_f + P_e$ NETWORK

CHECKING THE SYNCHRONIZE ELEVATION NETWORK

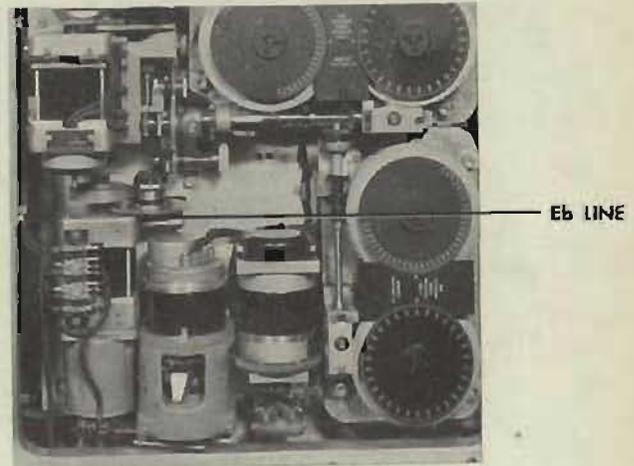
During A tests, $E_b = E + L$.

Check the *L* input by comparing the reading on the computer *L* dials with the reading on the stable element *L* dials. Run the *L* line to both limits. The stable element limit stop should stop the line at 3500' and 500'. If the readings do not agree, or the limits cannot be reached, check A-58, A-601, A-28, and A-505.

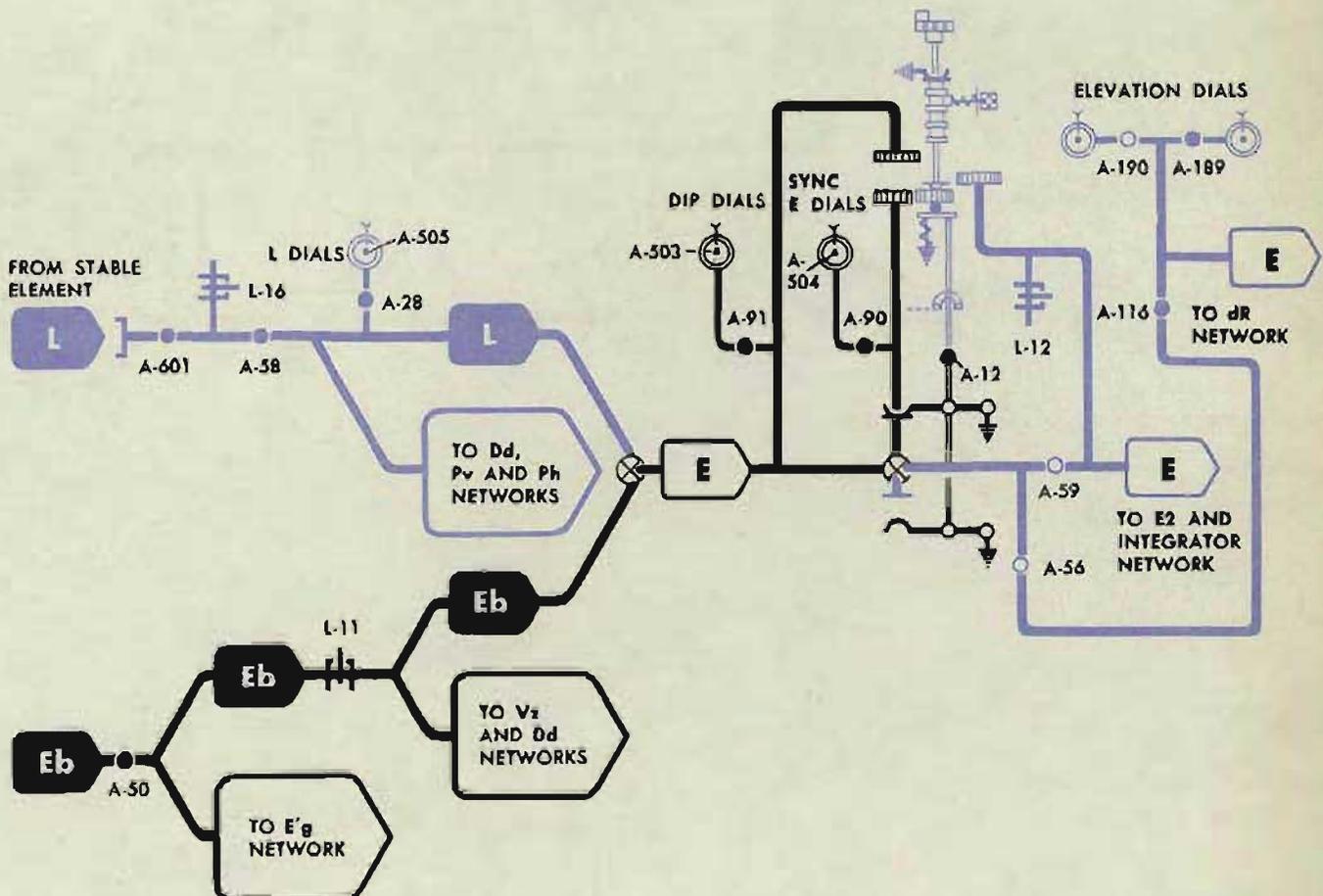


Check the *E* input by turning the *E* line to both limits with the synchronize elevation handcrank in the CENTER position. At the limits of L-12, the *E* dials should read -25° (or -5° for Serial Nos. 389 and lower) and $+85^\circ$. If the *E* dials do not read -25° and $+85^\circ$, check A-116 and A-189.

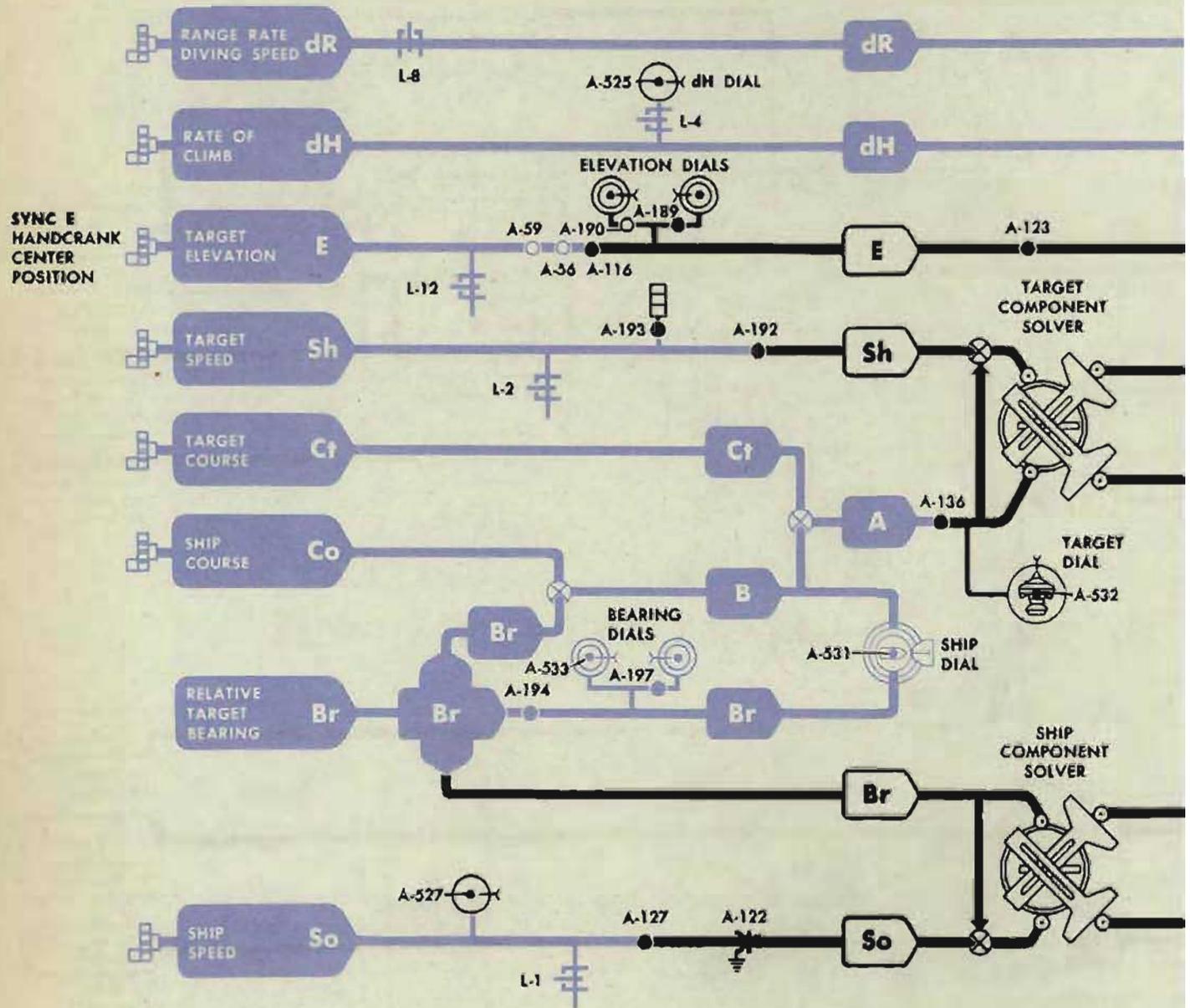
When the network inputs (*E* and *L*) are correct, check A-12, A-90, A-504, A-91, and A-503.

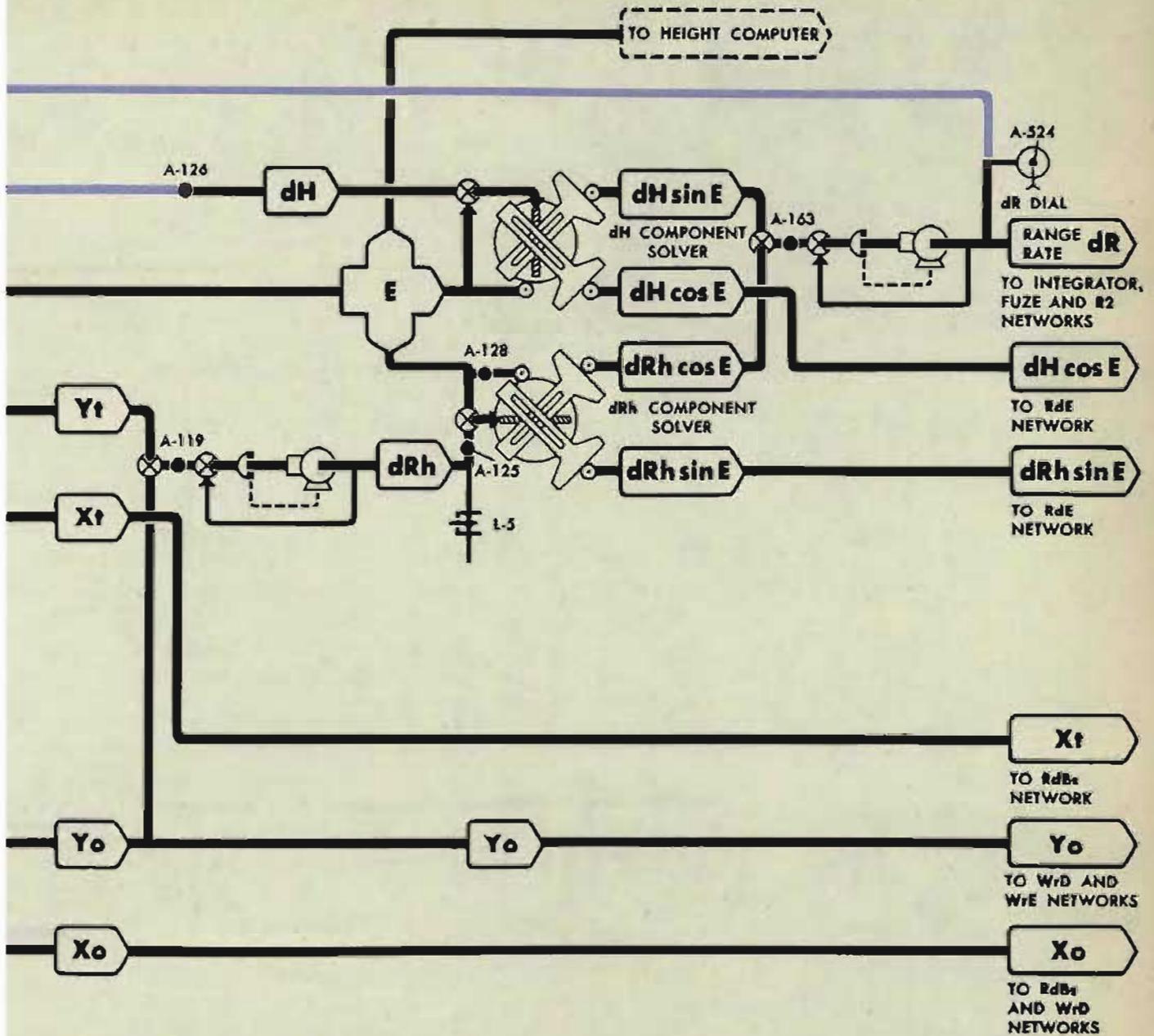


SYNCHRONIZE ELEVATION NETWORK



CHECKING THE dR NETWORK

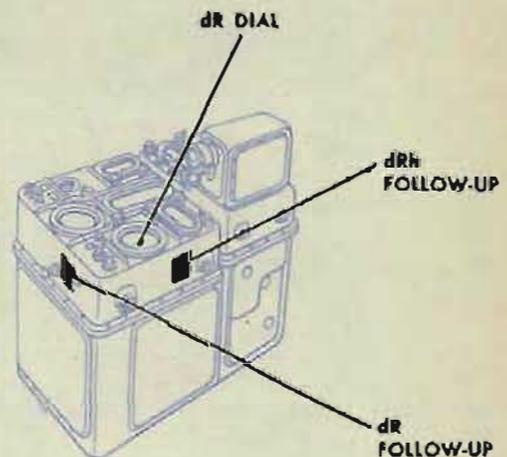


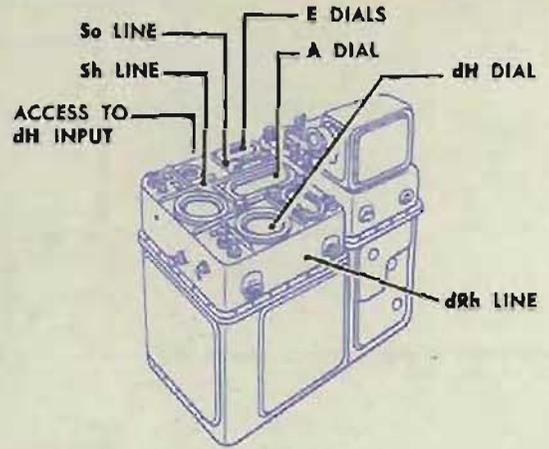
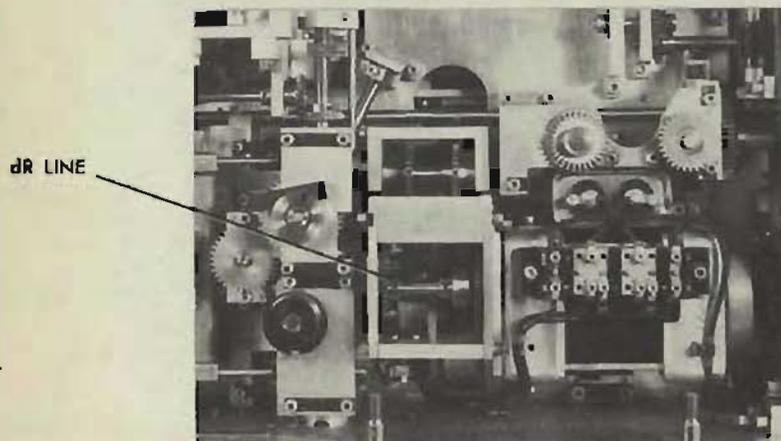
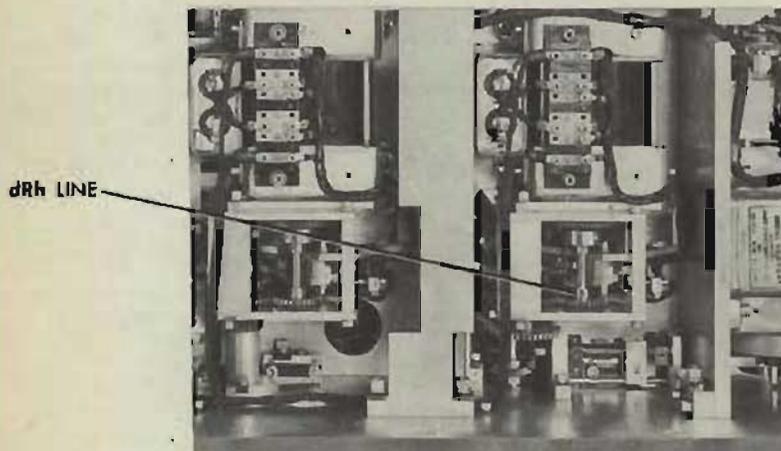
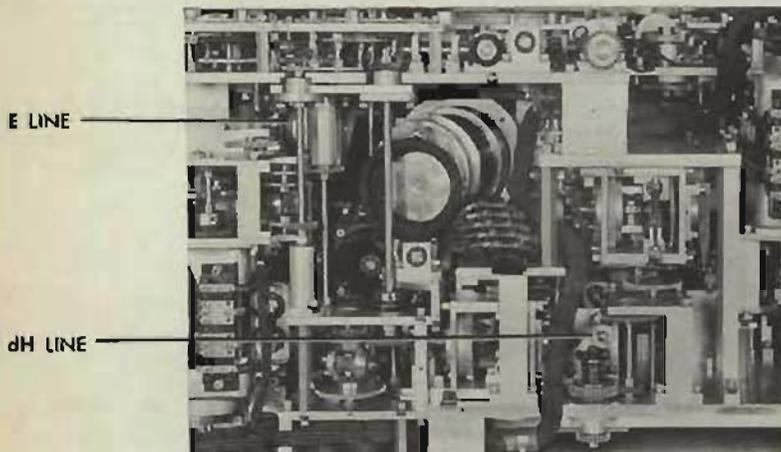
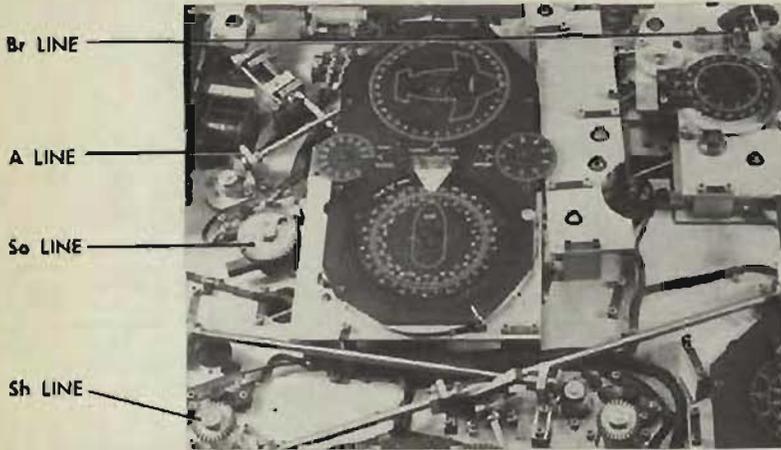


Checking the follow-ups

$$dR = dH \sin E + dRh \cos E$$

Check the dR dial against the values given in the intermediate quantities. Positive values of dR cannot be read because the dial is graduated only on the negative side. Since the dial is graduated at ten-knot intervals, small errors cannot be seen. To obtain the most accurate check, a test problem should be set up in which dR has a value very close to a graduation on the dial. Such problems are 5, 9, and 13. If the dR dial reading does not agree with the specified value, check the dRh follow-up, the dR dial and follow-up, A-119, A-524, and A-163.





Checking the component solvers

Run the unit check test of the relative motion group; see page 190. The unit check test may indicate an error in one of the component solvers. Remove cover 1. Any of the following may be incorrectly positioned:

- 1 The speed pin of the ship component solver; check the *So* input line by checking A-527 and A-127.
- 2 The speed pin of the target component solver; check the *Sh* input line by checking A-193 and A-192.
- 3 The vector gear of the ship component solver; check A-194.
- 4 The vector gear of the target component solver; check the *A* line by checking A-532.
- 5 The speed pin of the *dH* component solver; check the *dH* input line by checking A-525 and A-126.
- 6 The speed pin of the *dRh* component solver; check the *dRh* line by checking A-119 and A-125.
- 7 The vector gear of the *dH* component solver; check the *E* line by checking A-116, A-189 and A-123.
- 8 The vector gear of the *dRh* component solver; check the *E* line by checking A-128. (A-123 should always be checked and adjusted before A-128.)

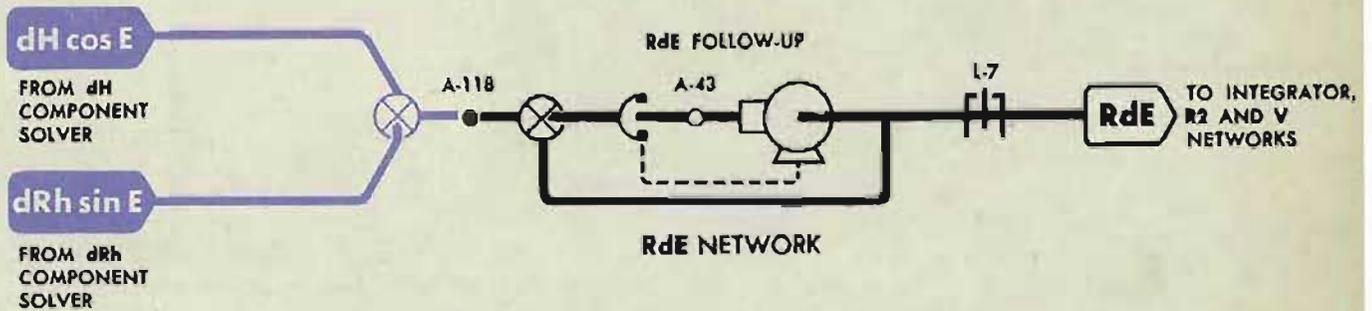
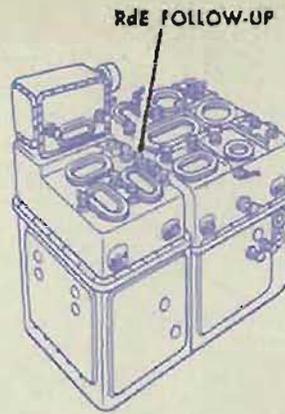
CHECKING THE RdE NETWORK

$$RdE = dH \cos E - dRh \sin E$$

Check the dR network; see page 134.
If dR is correct, $dH \cos E$ and $dRh \sin E$ may be assumed to be correct.

Check the RdE follow-up.

Check A-118.



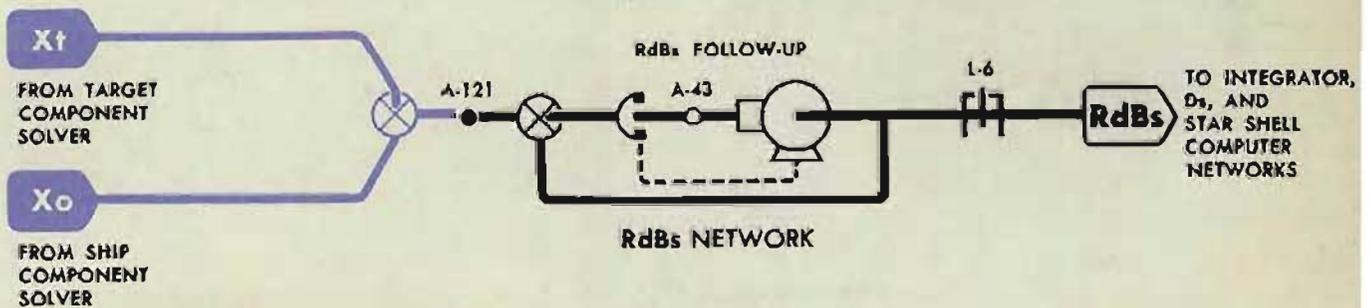
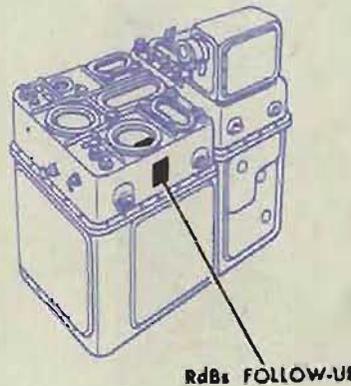
CHECKING THE $RdBs$ NETWORK

$$RdBs = Xo + Xt$$

Check the dR network; see page 134.
If dR is correct, Xo and Xt may be assumed to be correct.

Check the $RdBs$ follow-up.

Check A-121.



CHECKING THE W_rD NETWORK

$$W_rD = X_o + X_w g$$

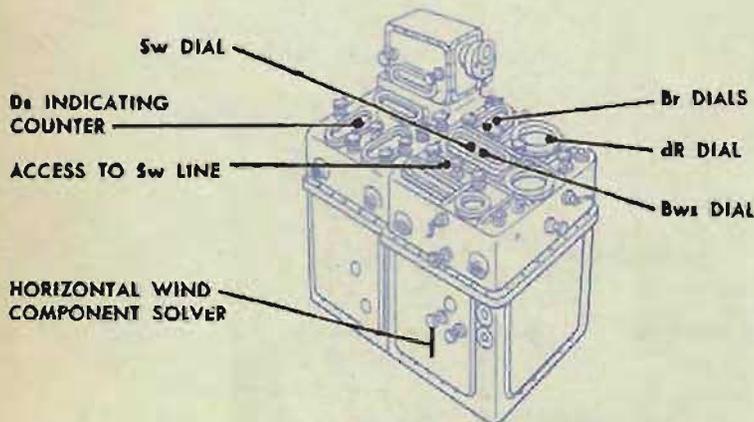
Checking the network inputs

Check the X_o input by checking the dR network. See page 134.

Check the D_s input by comparing the reading on the D_s indicating counter with the value given on the problem results form. If the counter reading agrees with the value given, the D_s input is correct.

If the D_s counter reading does not agree with the value given, check the D_s network; see page 110.

Check the S_w input by checking A-528.



Sw LINE

Check the Br input by comparing the reading on the Br dial with the Br quantity. If the dial reading agrees with the value given, the Br input is correct.

If the Br dial reading does not agree with the value given, check the Br network; see page 120.

Co and Bw are input settings and therefore can be assumed to be correct.

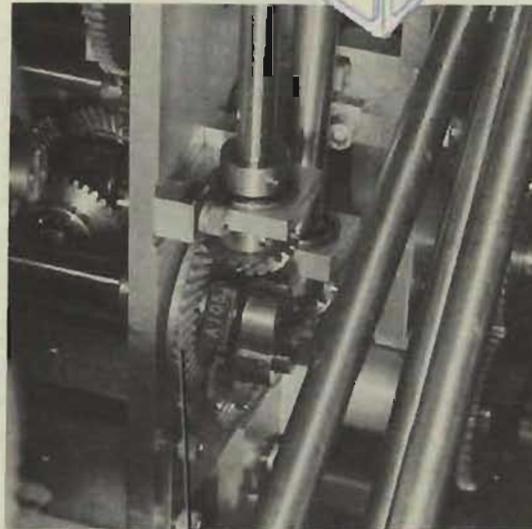
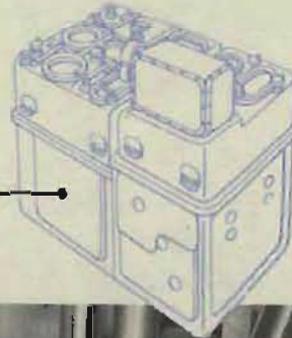
Checking the network

When the network inputs are correct, run the unit check test of the horizontal wind component solver; see page 194.

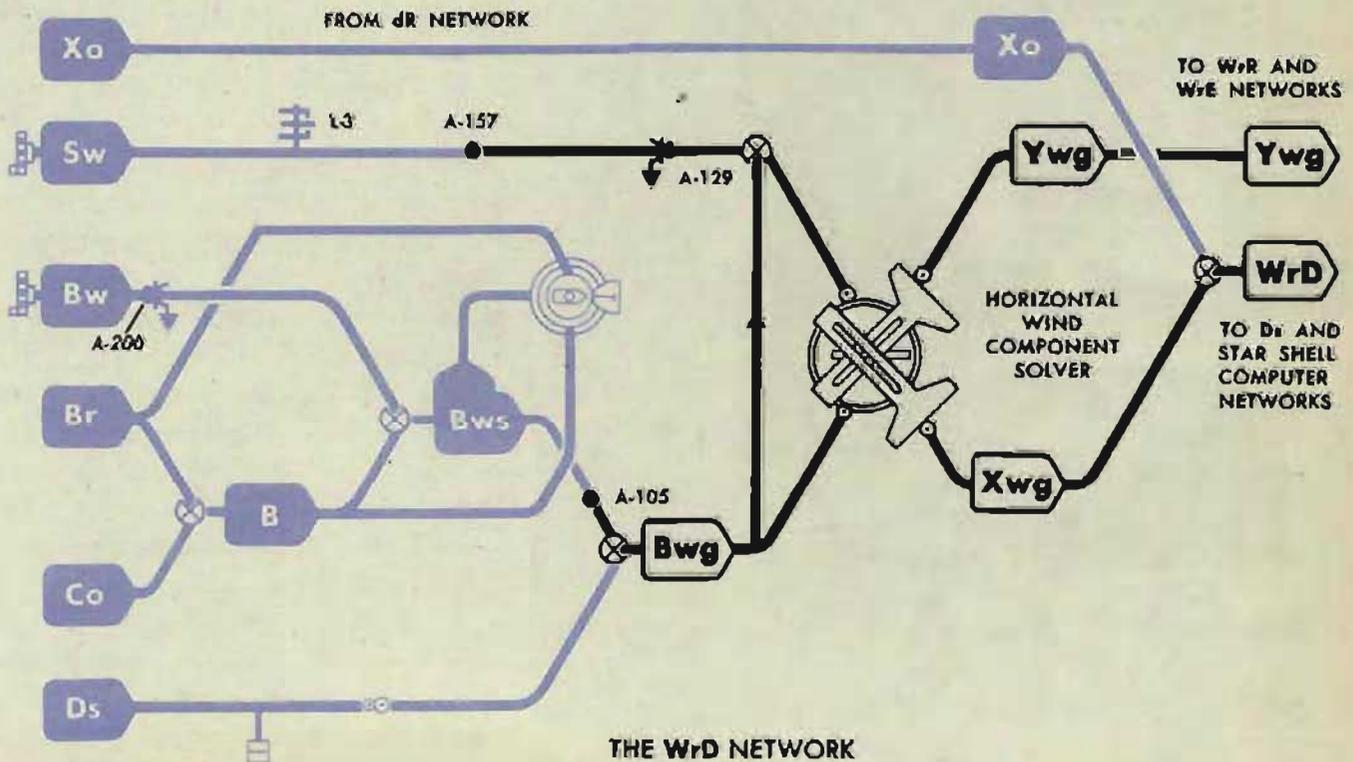
If the speed pin is incorrectly positioned, check A-157.

If the vector gear is incorrectly positioned, check A-105.

ACCESS TO Bws LINE



Bws LINE



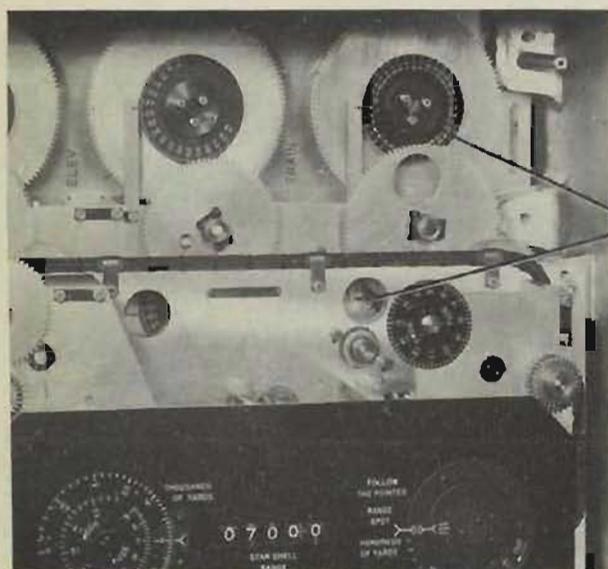
THE WrD NETWORK

ERRORS IN B'grn

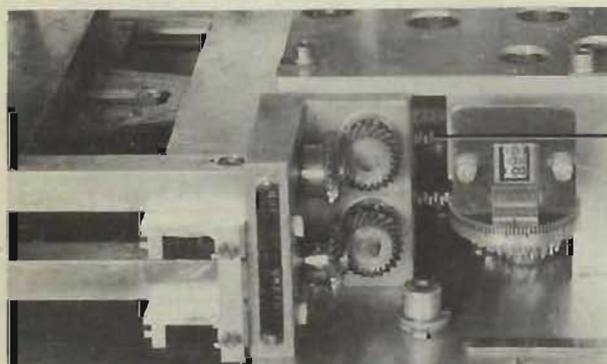
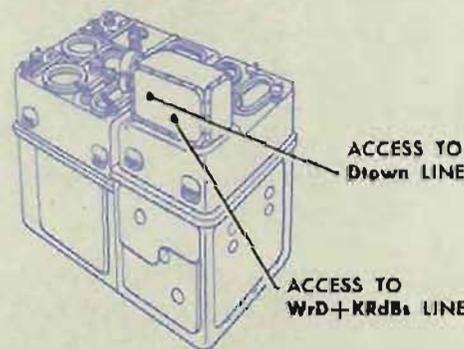
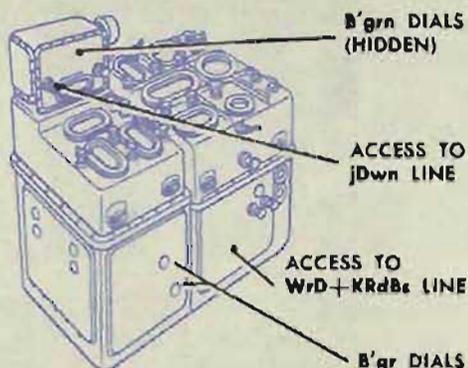
Checking the network inputs

Check the $R2$ input by comparing the reading on the computer $R2$ counter with the value given in the intermediate quantities. If the counter reading does not agree with the value given, check the $R2$ network; see page 122.

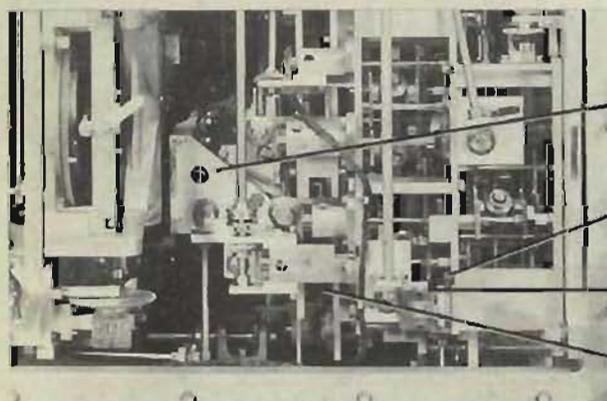
Check the $B'gr$ input by comparing the $B'gr$ dial reading with the value given in the intermediate quantities. If the dial reading does not agree with the value given, check the $B'gr$ network; see page 106.



B'grn DIALS



WrD+KRdBs LINE IN STAR SHELL COMPUTER



WrD+KRdBs FOLLOW-UP IN COMPUTER MK 1

A-229

WrD+KRdBs COUNTER IN COMPUTER MK 1

ACCESS TO A-230

Check the $WrD + KRdBs$ input. If $B'gr$ is correct, the $WrD + KRdBs$ line up to the $WrD + KRdBs$ counter in the Computer Mark 1 will also be correct. Check the $WrD + KRdBs$ counter in the star shell computer. If the counter reading does not agree with the value in the intermediate quantities, check the counter in the star shell computer against the counter in the Computer Mark 1. If the counter readings do not agree, check A-230* and the $WrD + KRdBs$ follow-up. If the two counter readings agree, but are not at the value given in the intermediate quantities, check A-229* and A-6.

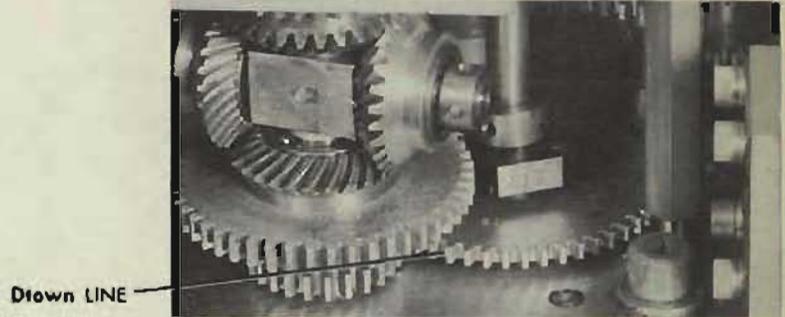
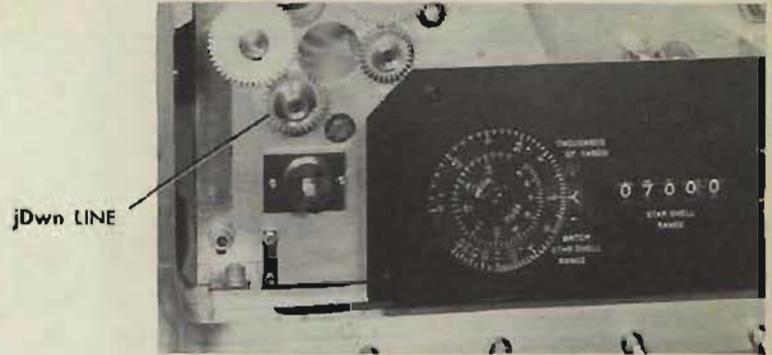
*These adjustments are in the Computer Mark 1. All others are in the star shell computer.

Check the *jDwn* input by checking A-5.

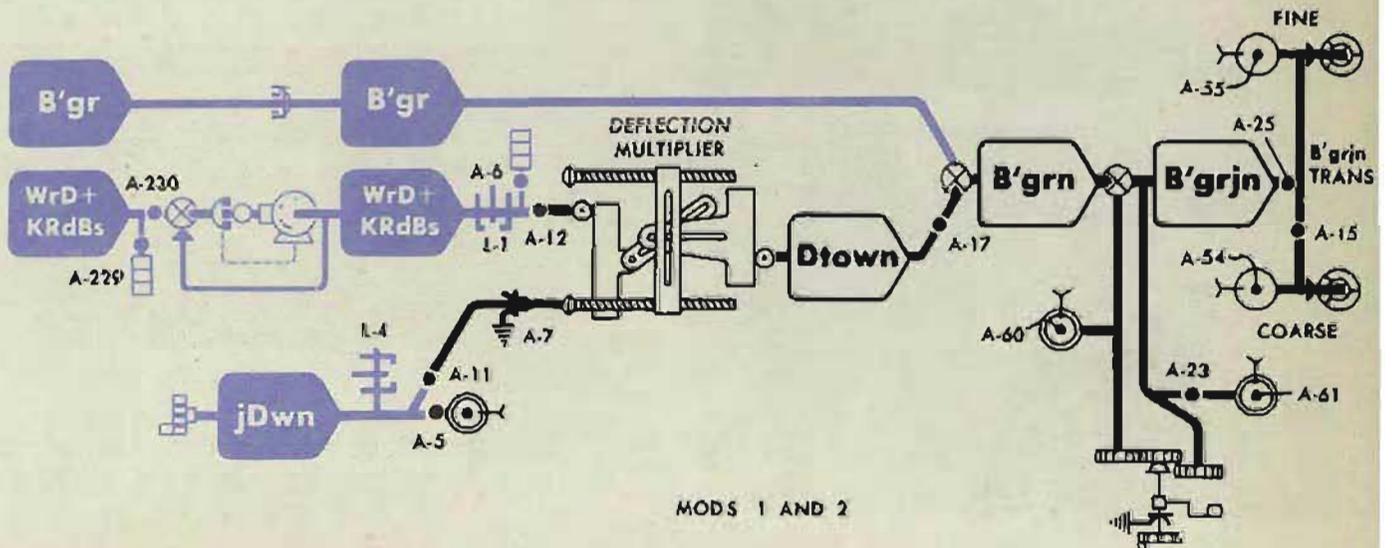
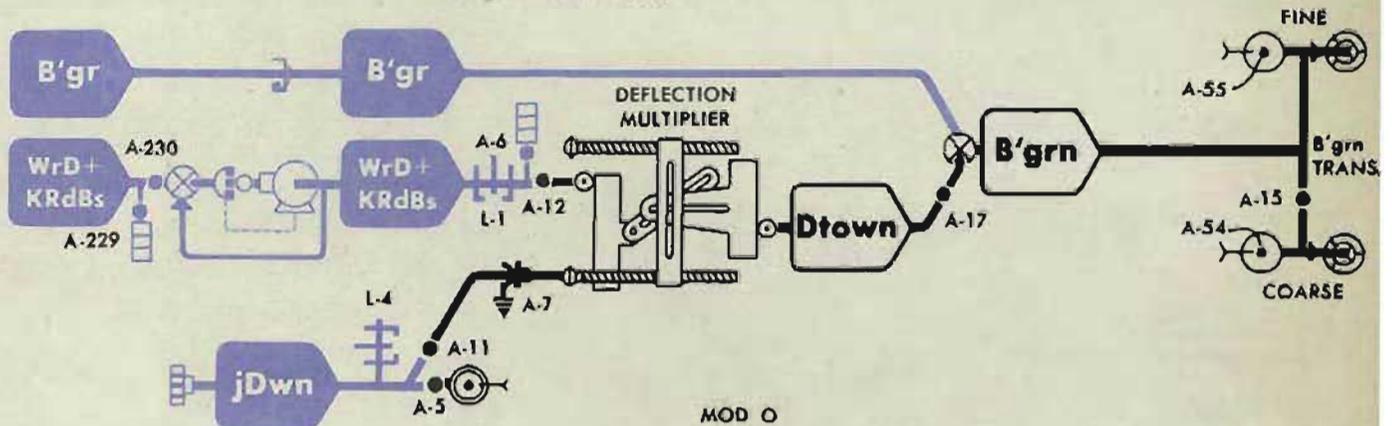
Checking the network

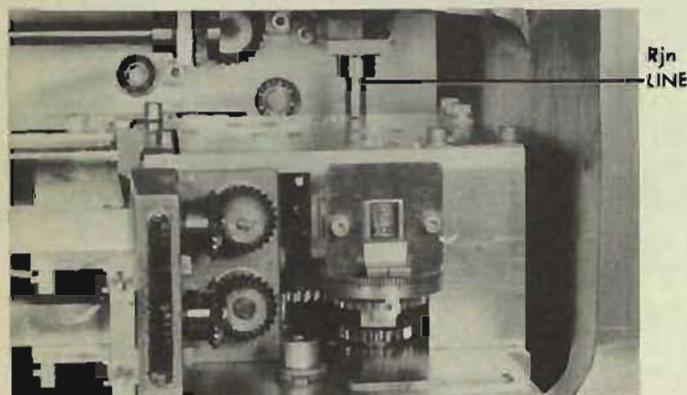
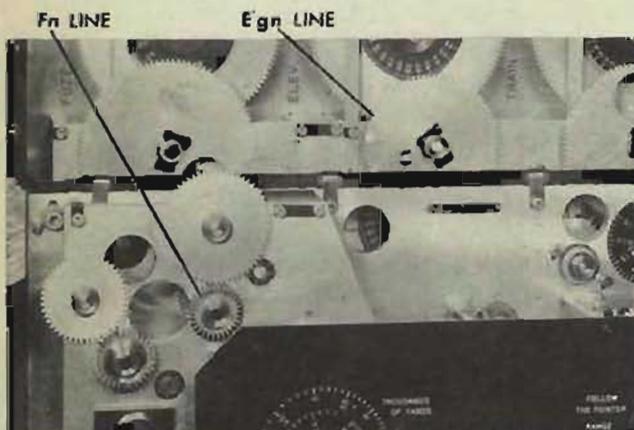
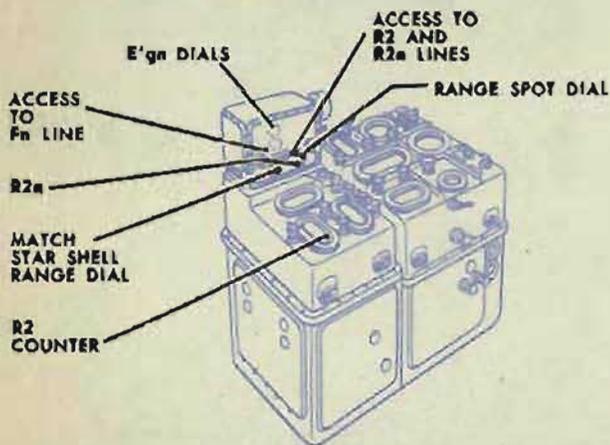
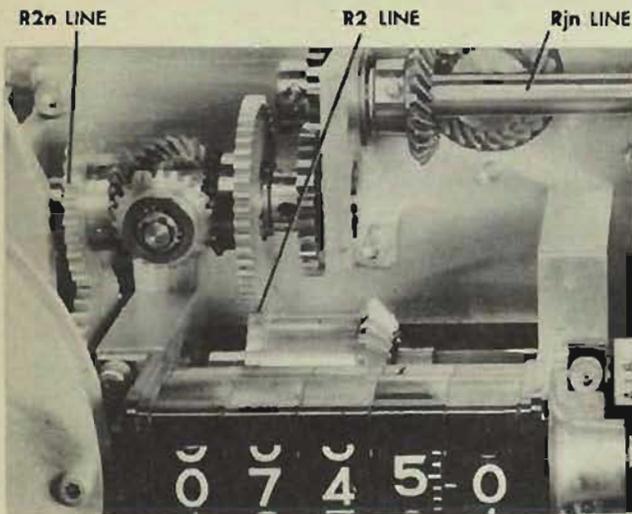
When the network inputs are correct, check A-12, A-11, A-17, A-15, A-54 and A-55.

For Mods 1 and 2, also check A-60, A-61, and A-23.



B'grn NETWORK





ERRORS IN $E'gn$

Check the $R2$ input by comparing the reading on the computer $R2$ counter with the value given under intermediate quantities. If the counter reading does not agree with the value given, check the $R2$ network; see page 122.

Check the $E'g$ input by comparing the reading on the computer $E'g$ dials with the $E'g$ value given in the intermediate quantities. If the dial reading does not agree with the value given, check the $E'g$ network; see page 107. When the dial reading is correct, check A-231.*

When the $R2$ and $E'g$ inputs are correct, but $E'gn$ is in error, check the Rjn input by comparing the reading on the star shell range counter with the value given in the intermediate quantities. If the counter reading does not agree with the value given, check A-2 and A-18. Check that A-1 is tight.

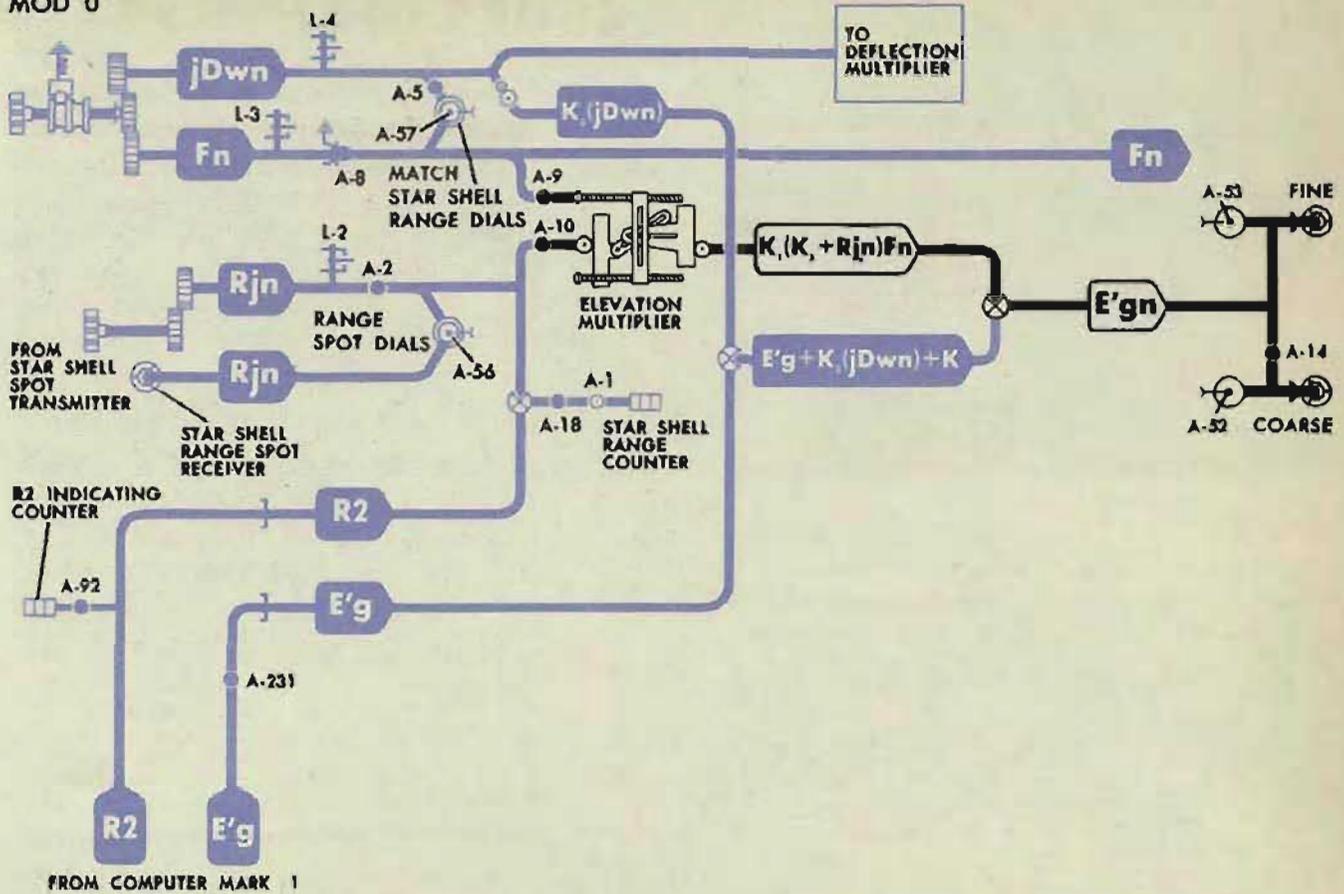
Check the $jDwn$ input by checking A-5.

Check the Fn input by checking A-57.

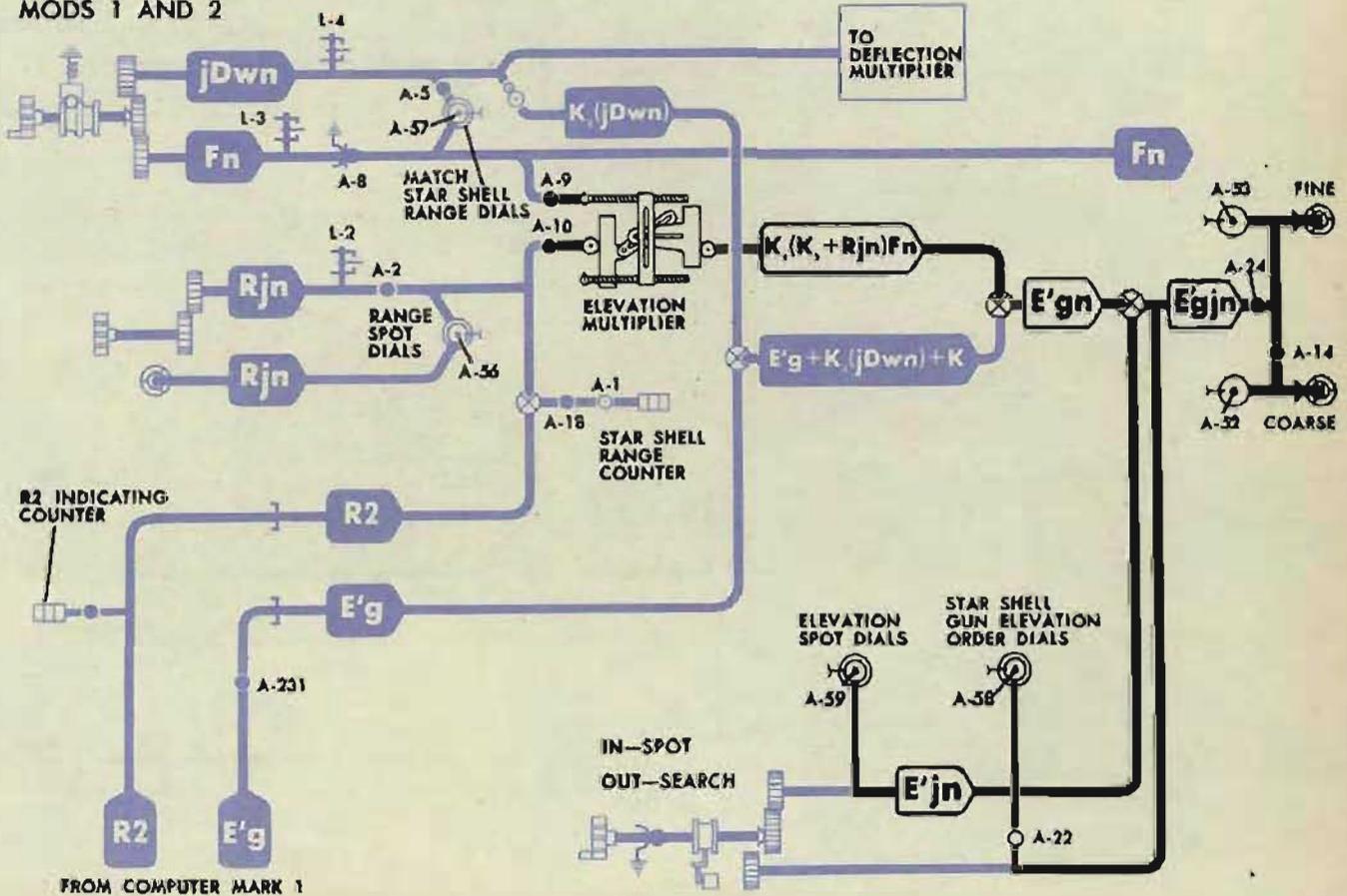
When all the inputs are correct, check A-9, A-10, A-14, A-52 and A-53. For Mods 1 and 2, also check A-58, A-59 and A-22.

*This adjustment is in the Computer Mark 1. All others are in the star shell computer.

STAR SHELL GUN ELEVATION NETWORK
MOD 0



MODS 1 AND 2

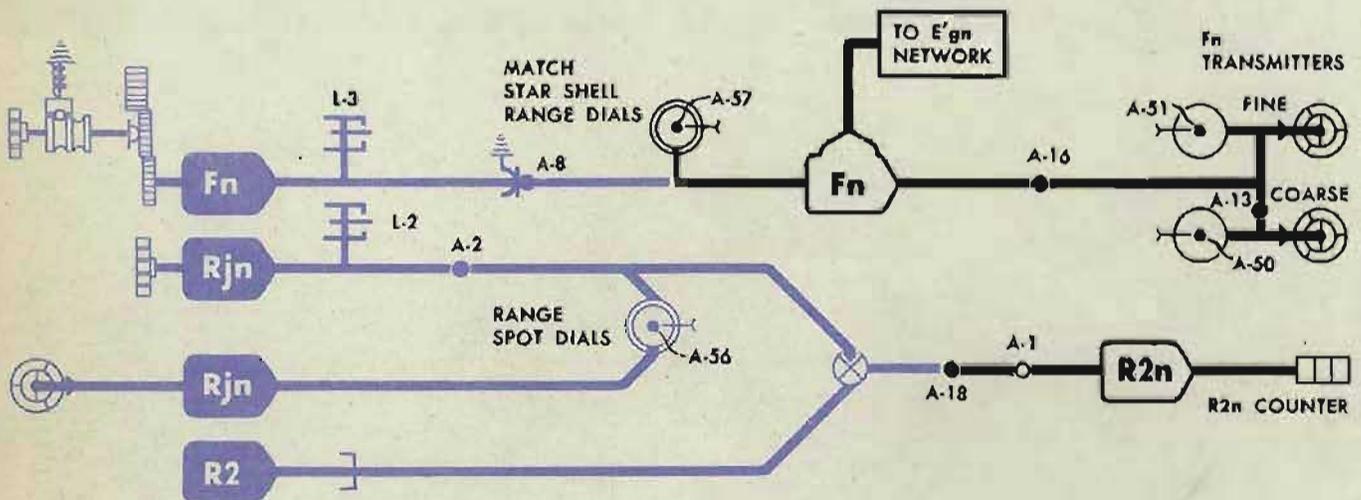


ERRORS IN F_n

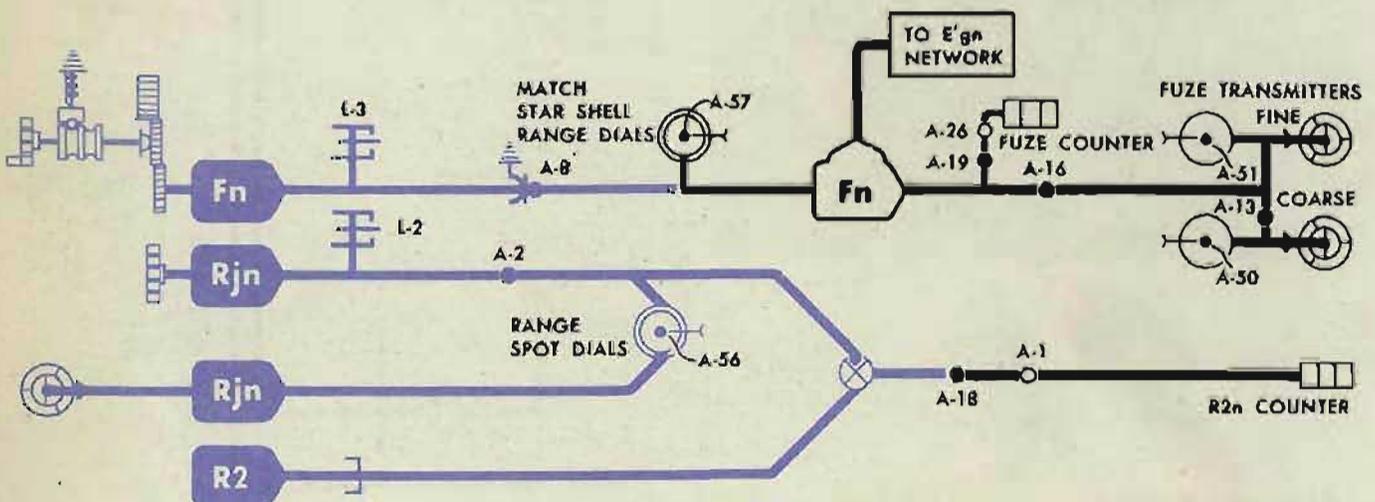
The R_2 input to the F_n network should be checked and corrected before any adjustments are made within the network.

Check the R_2 input by comparing the reading on the R_2 indicating counter with the R_2 intermediate quantity. If the reading on the R_2 indicating counter does not agree with the R_2 value given, check the R_2 network; see page 122.

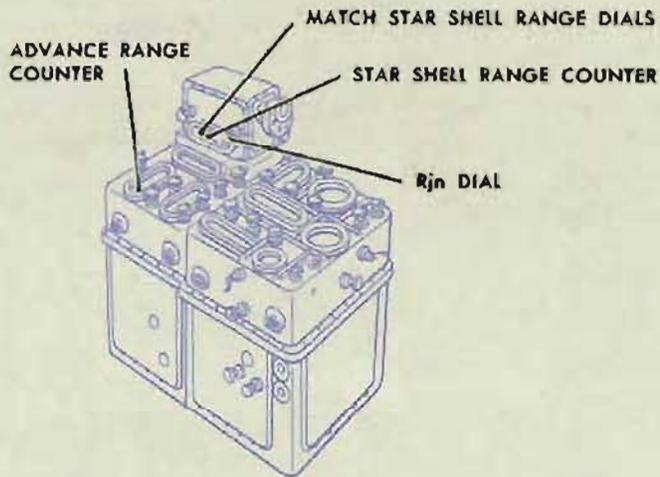
STAR SHELL FUZE NETWORK IN MOD 0



STAR SHELL FUZE NETWORK IN MODS 1 AND 2

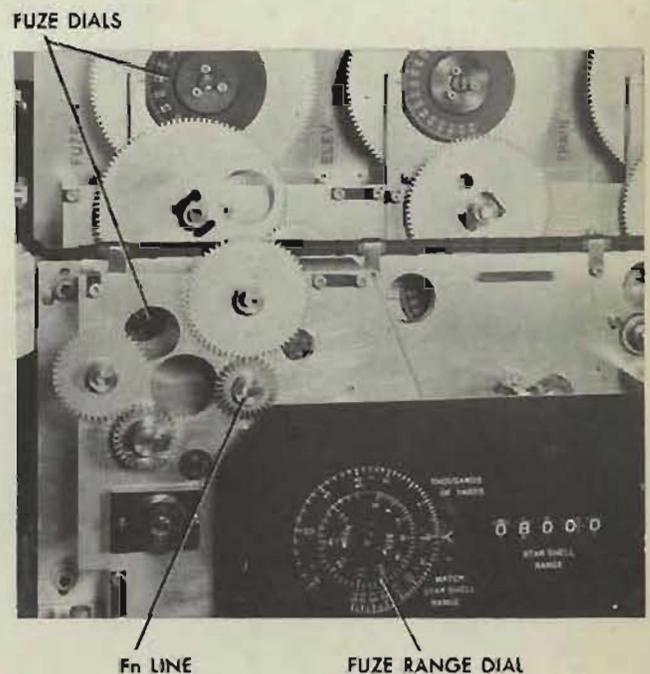


Check the $R2n$ input by comparing the reading on the $R2n$ counter with the $R2n$ intermediate quantity.



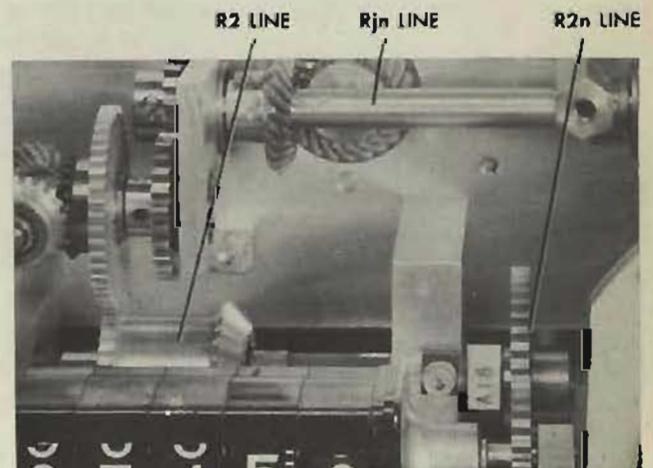
Check the Rjn input by checking A-2.

If $R2n$ is in error, check A-18, and check that A-1 is tight.



If both $R2$ and $R2n$ are correct, check A-16, A-57, A-13, A-50 and A-51.

For Mods 1 and 2, also check A-19 and A-26.



B TEST ANALYSIS

In the following analysis, the word "error" refers to *rate error* derived from the B test results.

B test analysis provides a method of finding and correcting B test errors. Before they can be analyzed and corrected, a complete set of B tests should be run. To find the cause of error, the type of error should first be determined.

TYPES OF ERRORS

Large errors

Large errors may be considered as those errors that exceed the allowable maximum. Their existence usually indicates that an adjustment has changed, or that mechanical trouble exists. The cause should be found and corrected.

Small errors

Small errors may be considered as those errors that exceed the allowable average, but are within the allowable maximum. They may become sizable in the course of normal operation and usually can be reduced by refining the vernier adjustments. If these errors increase slowly over a period of time, they are probably caused by wear in the computer. To reduce those caused by wear, it is usually necessary to reduce the lost motion in the units and the shaft lines.

Unstable errors

Unstable errors may be of two types. In one type, the error varies for several setups of the same problem. This is usually caused either by inaccurate problem setups, or by excessive lost motion or binding in the gearing or integrator units. In the other type, the error varies for consecutive time intervals of the same problem setup. This variation is usually caused by mechanical defects in a unit or by a generated quantity backing out through some other line.

SIGN OF ERRORS

Refer to page 30 for computing error.

Problems 1, 12, and 23 are *zero rate* problems; problems 2 to 6, 13 to 17, and 24 to 28 are decreasing problems; and problems 7 to 11, 18 to 22, and 29 to 33 are increasing problems. Examination of the input values will show the nature of each problem.

If the generated output is too much, the problem is said to be too fast; if the output is too little, the problem is too slow.

To determine whether a problem is too fast or too slow, check the direction of rotation of the fine generated dial. During increasing problems, range and elevation turn clockwise, while bearing turns counterclockwise. During decreasing problems, the fine generated dials turn in the opposite direction.

In elevation and bearing problems, if the selected index of the inner dial has turned beyond the calculated value on the fine ring dial, the problem is running too fast. If the index has not reached the calculated value, the problem is running too slowly.

Converting plus or minus to fast or slow may seem confusing, since the graduated ring dial is stationary during the elevation and bearing B tests. A study of the sketches, however, will show that: Plus errors in decreasing elevation and bearing problems and minus errors in increasing problems indicate that the problems are running too fast. Minus errors in decreasing problems and plus errors in increasing problems indicate that the problems are running too slowly.

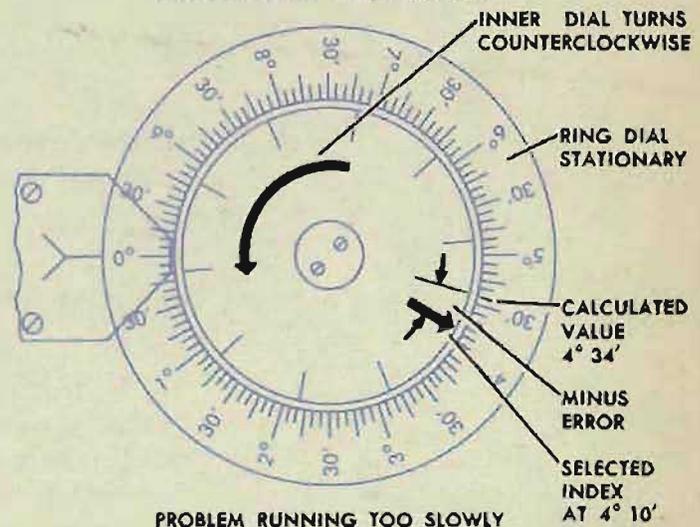
Since the generated range dials are graduated, and both range dials turn during B tests, it can easily be determined whether range problems are fast or slow.

CAUSES OF ERRORS

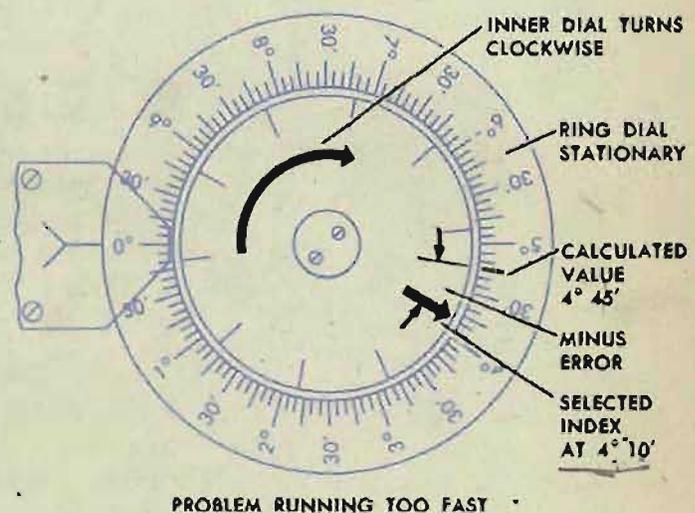
Very large errors may be caused by a defective follow-up or an incorrect relative motion rate. The follow-ups and relative motion rates can be checked by running A test problems and making the relative motion component solver unit check test. Other errors are usually caused by incorrect adjustments or mechanical defects in the integrator group.

ELEVATION DIALS

PROBLEM 15—DECREASING



PROBLEM 18—INCREASING



CORRECTING THE ERRORS

When the cause of the error is found, the necessary repairs and readjustments should be made. If no repairs are necessary, the vernier adjustments should be refined to give the proper integrator outputs. The vernier adjustments are usually made by the trial and error method and may require several refinements to obtain satisfactory results.

If most of the adjustments of the bearing and elevation integrator group are upset, or any units have been removed for repairs and reinstalled, either of the two following procedures may be used:

- 1 Follow the complete adjustment of the integrator group as given at the end of this chapter, page 160.
- 2 First, check and readjust if necessary: A-233, A-152, A-155, A-250, A-146, and A-140.
Second, run the T/cR and (T/cR) sec E integrator unit check tests, page 212.
Third, run the special bearing and elevation integrator problems given in this chapter on page 159.

READING THE DIALS

The analysis of test error is based on the assumption that the errors have been calculated from proper dial readings. Reading the dials correctly in elevation and bearing B tests requires an understanding of the relation between the inner and outer dials during the tests.

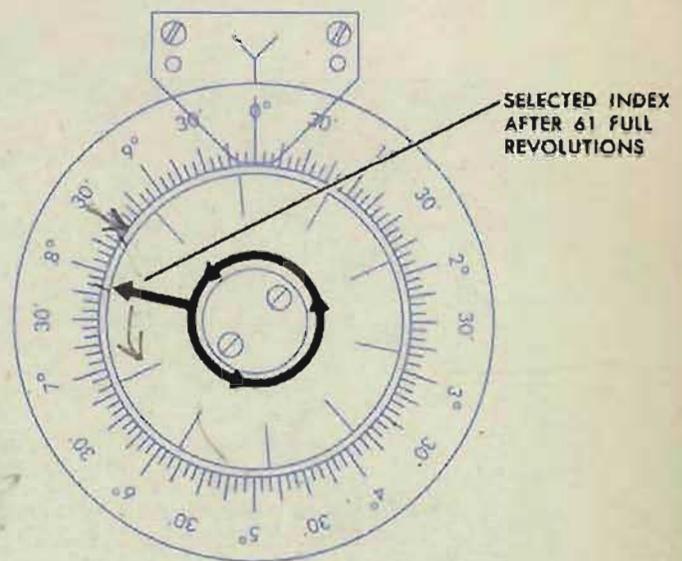
Only the *inner fine* generated elevation and bearing dials turn during B tests. The observed elevation and bearing dials do not turn. The calculated values listed on the record form for problem results are actually $360^\circ - cE$ and $360^\circ - cBr$. Values are specified in this way because it is convenient to read rotation of the inner dial directly against the graduated ring dial for all problems.

To obtain the full reading of $360^\circ - cE$ or $360^\circ - cBr$, it is necessary to count the revolutions of the fine dial for some time interval, then compare with the rate, dE or dB , for the same time interval. This is found from the deg./min. value for the problem, given on the problem setup sheet. Each revolution of the fine cE or cBr dial counts 10° . If the number of revolutions checks, the generated rate is correct within 10° . Then the full instrument reading will be the actual reading of the fine inner dial against the outer dial, preceded by the tens and hundreds of degrees of the calculated value for $360^\circ - cE$ or $360^\circ - cBr$.

FOR EXAMPLE

Consider problem 33, in which the calculated value is $108^{\circ}24'$ at the end of the first one-minute interval. The value of dB is given as $+611.6$ deg./min., so the fine inner dial should turn slightly over 61 revolutions in the one-minute period. Assume that the selected index mark on the cBr dial has stopped at the reading $7^{\circ}50'$, as shown in the sketch, after making 61 full revolutions. Then the generated rate is correct within 10° , and the instrument reading is $7^{\circ}50'$ preceded by the tens and hundreds of degrees of the calculated reading, or $107^{\circ}50'$. The error will be $+34'$. In this case the problem is too fast.

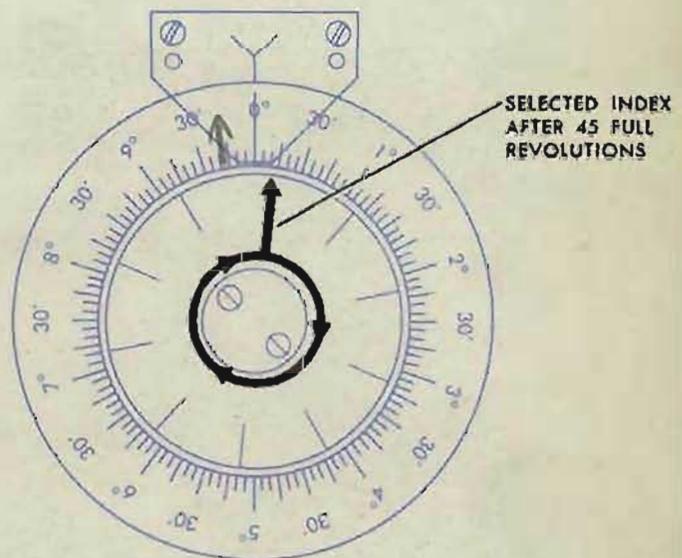
FINE BEARING DIALS



PROBLEM 33

As another example, consider problem 25, in which the calculated value is $89^{\circ}42'$ at the end of the first one-minute interval. The value of dB is given as -449.7 deg./min. Assume that the inner dial has made slightly over 45 revolutions and stopped at $0^{\circ}10'$, as shown in the sketch. Although the number of revolutions does not check, watching rotation of the dial will show that completion of the 45th revolution is less than 1° error in generation over the 44.97 revolutions called for by the rate, dB . Therefore the generated rate is still correct within 10° . But the quantity $360^{\circ} - cBr$ has passed through 90° . Therefore the total instrument reading to be recorded is $90^{\circ}10'$. The error will be $+28'$. This problem is also too fast.

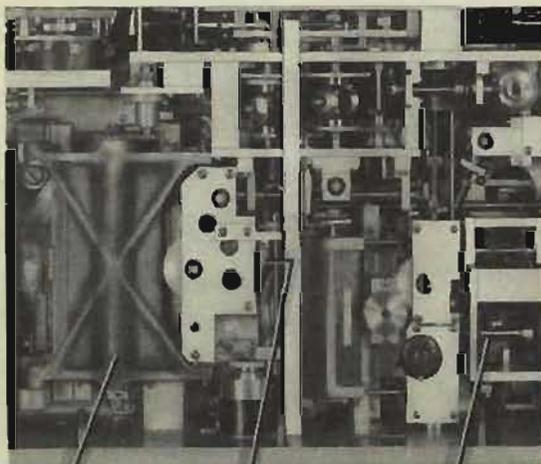
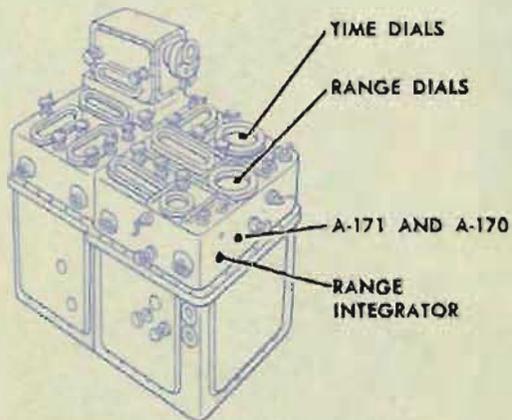
FINE BEARING DIALS



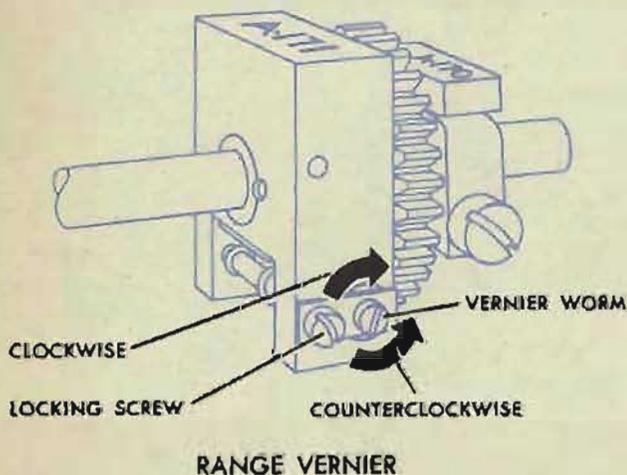
PROBLEM 25

The full readings of $360^{\circ} - cE$ are obtained in a similar manner.

CORRECTING ERRORS IN RANGE B TESTS



RANGE INTEGRATOR ACCESS TO A-170 AND A-171 dR FOLLOW-UP



Large errors

Large errors are usually caused by mechanical defects or an incorrect value of dR . Check the dR follow-up. Refer to page 559 and also to OP 1140A.

Check A-163.

Check the dR input to the range integrator. See *Checking the dR Network*, page 134.

Errors of like sign in all problems

If the dR input has been checked and found correct, and still all errors have like signs, the carriage of the range integrator is incorrectly positioned. Check that A-170 is tight and does not slip.

Readjust A-171 as follows:

Loosen the locking screw on A-171.

If all the errors are *plus*, turn the vernier worm in a *counterclockwise* direction.

If all the errors are *minus*, turn the vernier worm in a *clockwise* direction.

Tighten the locking screw on A-171 and recheck. Continue the adjustment until the *plus* errors balance the *minus* errors.

Errors of one sign in decreasing problems and errors of the opposite sign in increasing problems

Problems 2 through 6 are decreasing problems, and 7 through 11 are increasing problems.

If the errors for problems 2 through 6 are *minus* and 7 through 11 are *plus*, all problems are running *too fast*.

If the errors for problems 2 through 6 are *plus* and 7 through 11 are *minus*, all problems are running *too slowly*.

If all problems are too fast or all problems are too slow, the speed pin of one or more of the relative motion component solvers may be incorrectly positioned. Make the relative motion component solvers check test, page 190. Check the A test results.

Excessive error at high elevation

In problems 4, 5, 7, and 8, a high value of elevation is used. If the rate errors in these problems are especially large, the speed pin of the dH component solver may be incorrectly positioned. If only problem 7 has a large error, the vector gear of the dRh component solver may be incorrectly positioned. Make the relative motion component solvers check test, page 190. Check the A test results.

Excessive error at low elevation

In problems 2, 3, and 6, a low value of elevation is used. If the rate errors in these problems are especially large, the dRh component solver speed pin may be in error. Make the relative motion component solvers check test, page 190. Check the A test results.

Unstable errors

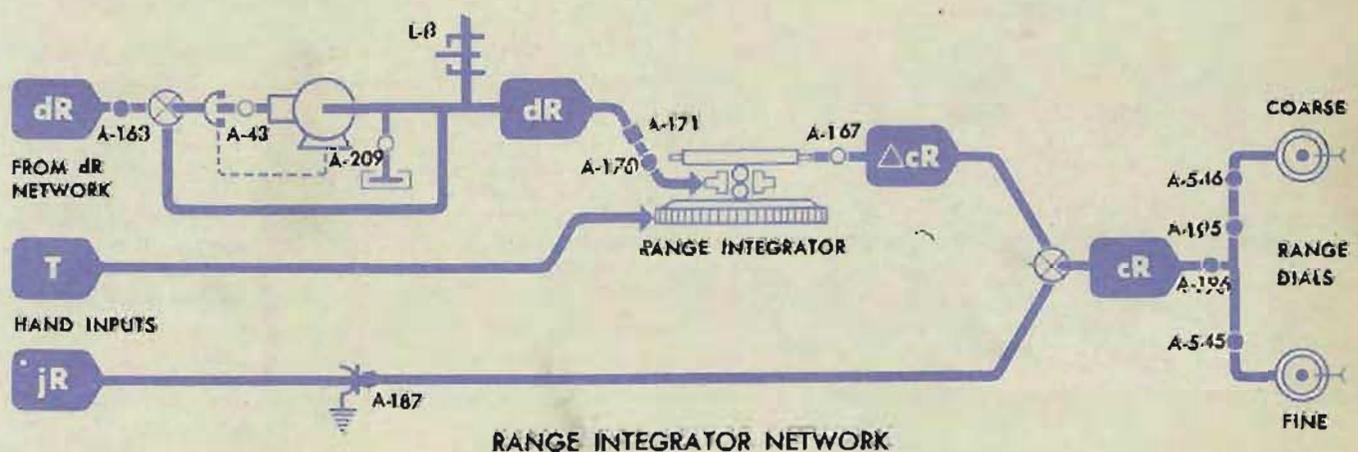
Unstable errors are usually caused by one of the following mechanical defects:

A faulty range integrator

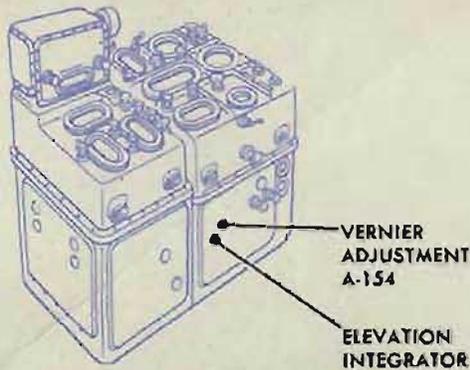
Check the range integrator for mechanical defects. Refer to page 557, and also to OP 1140A.

Sticking or binding in the dR line

Check the dR follow-up, shaft line, and gearing under cover 1. Refer to page 559, and also to OP 1140A.



CORRECTING ERRORS IN ELEVATION B TESTS



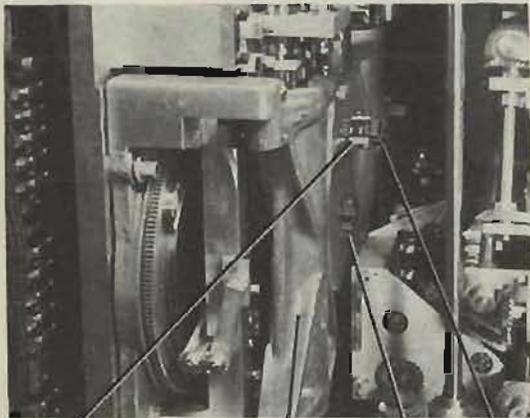
Large errors

Large errors are usually caused by mechanical defects.

Check the *RdE* and integrator networks for mechanical casualties.

Make the *T/cR* integrator check test. See page 212.

Check the *RdE* follow-up. Refer to page 559, and also to OP 1140A.



Errors of like sign in all problems

If the *RdE* input has been checked and found correct, and still all errors are of like sign, the carriage of the elevation integrator is incorrectly positioned. Check that A-155 and A-211 are tight.

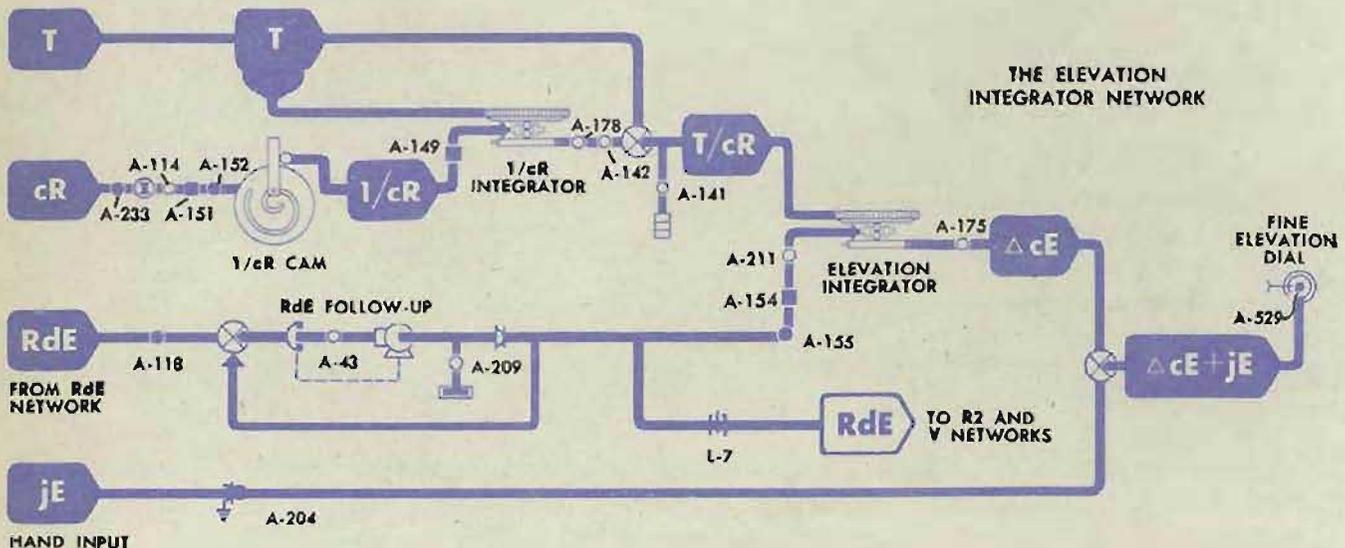
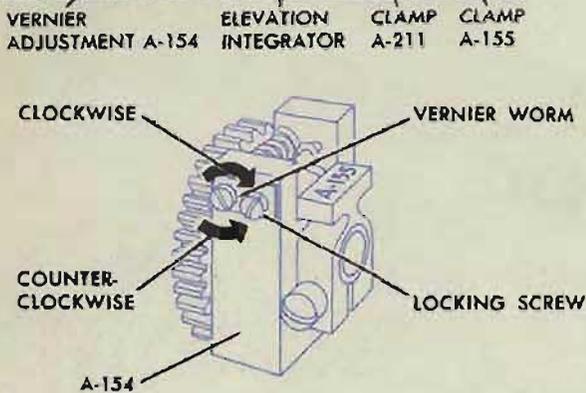
Readjust A-154 as follows:

Loosen the locking screw on A-154.

If all the errors are *plus*, turn the vernier worm in a *clockwise* direction.

If all the errors are *minus*, turn the vernier worm in a *counterclockwise* direction.

Tighten the locking screw on A-154 and re-check.



Errors of one sign in decreasing problems and errors of the opposite sign in increasing problems

Such errors show that all problems are too fast or too slow. These errors may be caused by:

Error in RdE

The cause of error may be in the relative motion group. If there is error in any of the relative motion component solvers, the range B tests and A tests will also show the error. See *Checking the RdE Network*, page 137. Check the A test results.

Error in T/cR

Make the T/cR integrator check test, page 212.

The T/cR counter readings may be correct in the T/cR integrator check test and yet be incorrect for a satisfactory set of B tests. If a record of T/cR counter readings for a satisfactory set of B tests has been kept, readjust A-149 to these readings.

If no record has been kept, readjust A-149 as follows:

Loosen the locking screw of A-149.

If all problems run *too slowly*, turn the vernier screw *counterclockwise* to correct a minus error in problems 13 through 17 and a plus error in problems 18 through 22.

If all problems run *too fast*, turn the vernier screw *clockwise* to correct a plus error in problems 13 through 17, and a minus error in problems 18 through 22.

Tighten the locking screw of A-149 and recheck.

NOTE:

Any adjustment of T/cR will have a greater effect on the bearing B test results than on the elevation B test results.

Excessive errors at short range

In problems 13, 14, 21, and 22, short-range values are used.

If the rate errors in these problems are especially large, and the rate errors at long or medium range are smaller, or very small:

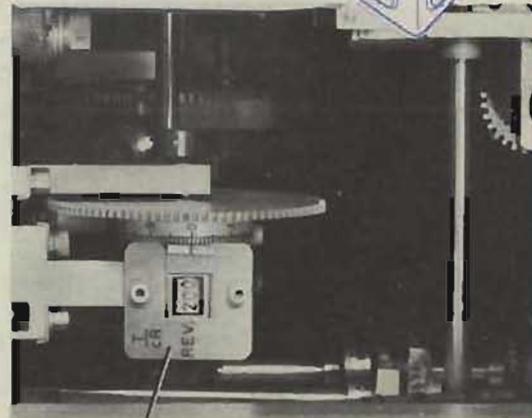
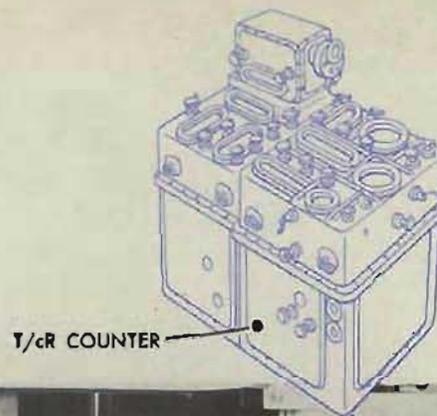
Check the cR intermittent drive, A-233.

Check that A-114 and A-152 are tight.

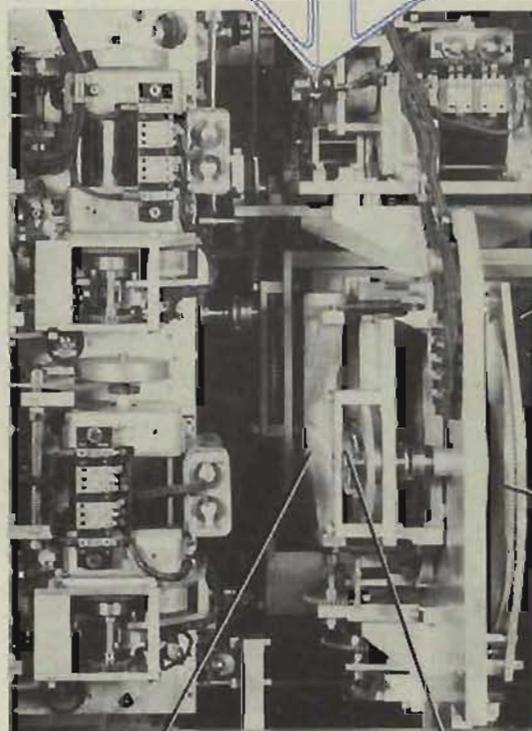
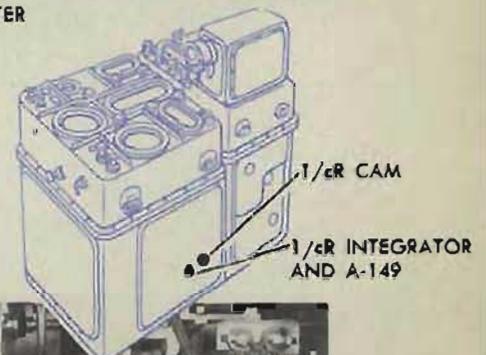
Readjust A-151.

NOTE:

Any adjustment of A-151 will have a greater effect on the bearing B test results than on the elevation B test results.



T/cR COUNTER



T/cR INTEGRATOR

A-149

Excessive error at low elevation

In problems 12, 16, and 19, low values of elevation are used. If the rate errors in these problems are especially large, the dH component solver may be in error. Make the relative motion component solvers check test, page 190. Check the A test results.

Excessive error at high elevation

In all problems except 12, 16, and 19, high values of elevation are used. If the rate errors in these problems are especially large, the speed pin of the dRh component solver may be incorrectly positioned. Make the relative motion component solvers check test, page 190. Check the A test results.

NOTE:

An error in the dH or dRh component solver will also show in range B tests.

Unstable errors

Unstable errors are usually caused by one of the following mechanical defects:

A faulty elevation integrator

Check the elevation integrator for mechanical defects. Refer to page 557, and also to OP 1140A.

A faulty $1/cR$ integrator

Check the $1/cR$ integrator for mechanical defects. Refer to page 557 and also to OP 1140A.

Sticking or binding in the RdE line

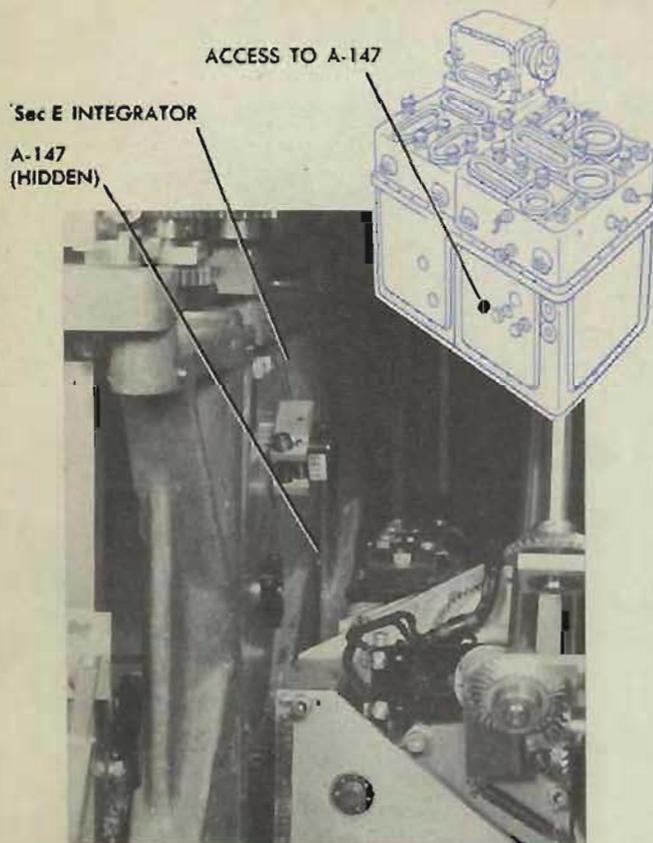
Slight sticking in the input gearing of the RdE follow-up may cause relatively large errors in all elevation B test problems. Check the RdE follow-up, shaft line, and gearing. Refer to page 559, and also to OP 1140A.

Sticking or binding in the cR or $1/cR$ line

Check the cR shaft line and gearing, the cR intermittent drive and shock absorber, the $1/cR$ cam and gearing, and the vernier assemblies for mechanical defects. Refer to page 552, and also to OP 1140A.

NOTE:

Any mechanical defect in cR or $1/cR$ will cause a larger error in bearing B tests.



Errors of one sign in decreasing problems and errors of the opposite sign in increasing problems

Such errors show that all problems are too fast or too slow. This may be caused by an error in *RdBs* or an error in (T/cR) sec *E*.

Error in *RdBs*

The speed pin of the ship component solver or the target component solver may be incorrectly positioned. This will cause all problems to run either too fast or too slow. If all problems are too slow, the vector gear of either the ship component solver or the target component solver may be incorrectly positioned. Refer to *Checking the RdBs Network*, page 137. Check the A test results.

Error in (T/cR) sec *E*

First, run the (T/cR) sec *E* integrator check test. Refer to page 215. If all readings in this test are either too slow or too fast, readjust A-147 as follows:

Loosen the locking screw of A-147. If all readings are too slow, turn the vernier screw *counterclockwise*. If all readings are too fast, turn the vernier screw *clockwise*. Tighten the locking screw of A-147 and recheck. Continue the adjustment until the check test errors are at a minimum.

Rerun the bearing B tests. If the same type of error still exists, there may be an error in T/cR .

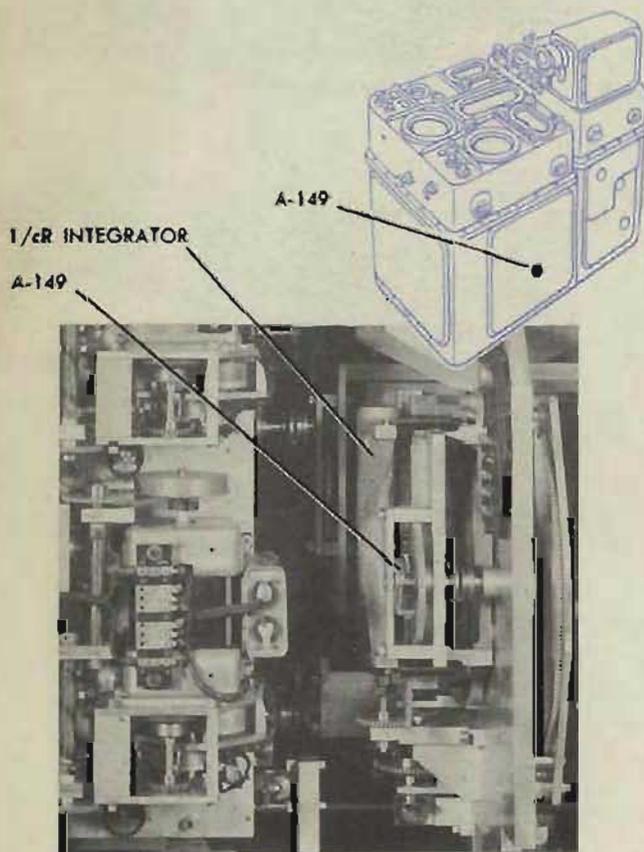
Run the T/cR integrator check test. Refer to page 212. If all readings in this test are either too slow or too fast, readjust A-149 as follows:

Loosen the locking screw of A-149. If all readings are too slow, turn the vernier screw *counterclockwise*. If all readings are too fast, turn the vernier screw *clockwise*.

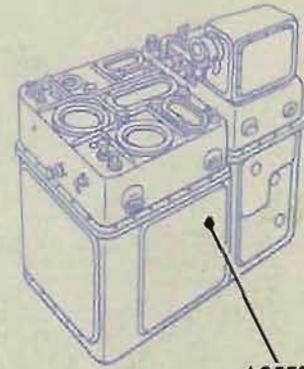
Tighten the locking screw of A-149 and recheck. Continue the adjustment until the check test errors are at a minimum.

NOTE:

Any adjustment of A-149 will also affect the elevation B test results.



Rerun the bearing B tests. The results may not be entirely satisfactory even though the T/cR and (T/cR) sec E check test errors have been brought to a minimum. If a record has been kept of the proper counter readings for a satisfactory set of B tests, readjust A-147 and A-149 to these readings. If no record has been kept, readjust A-147 slightly, noting the effect on the B test results. Slight readjustment of A-149 may also be necessary to correct this type of error.



ACCESS TO A-151

Large error at short range

In problems 24, 25, and 32, short range values are used. If the rate errors in these problems are especially large, and the rate errors in other problems with medium or long-range values are smaller, there may be an error in the $1/cR$ cam adjustment.

If a record of T/cR counter readings for satisfactory B tests has been kept, readjust A-151 to these counter readings.

If no record has been kept, readjust A-151 as follows:

Loosen the locking screw of A-151.

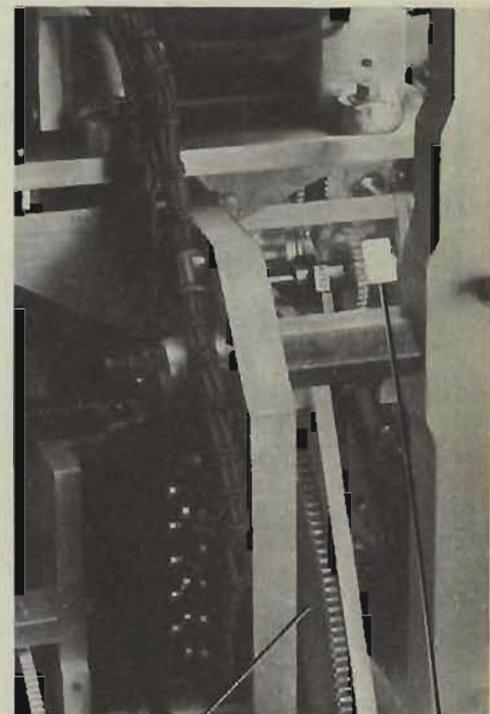
If the problems are slow, turn the vernier screw *counterclockwise* to correct a minus error in problems 24 and 25 and a plus error in problem 32.

If the problems are fast, turn the vernier screw *clockwise* to correct a plus error in problems 24 and 25 and a minus error in problem 32.

Tighten the locking screw of A-151 and recheck.

NOTE:

Adjustment of A-151 will also affect the elevation B test results.

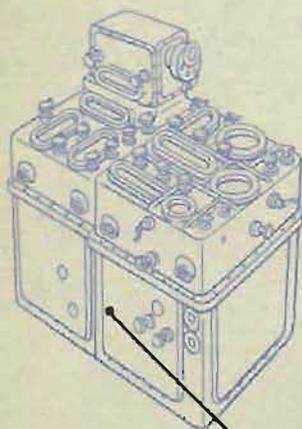


1/cR CAM

A-151

Large error at high elevation

Problems 24, 28, 32, and 33 have high elevation values. If the rate errors in these problems are especially large, and the rate errors in problems having low elevation values are smaller, there may be an error in the sec *E* cam adjustment.



ACCESS TO A-145

If a record of (T/cR) sec *E* counter readings for satisfactory *B* tests has been kept, readjust A-145 to these counter readings.

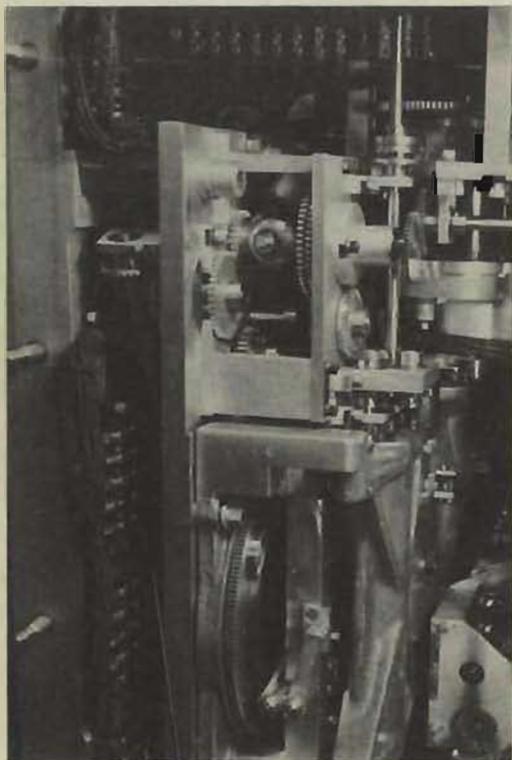
If no record has been kept, readjust A-145 as follows:

Loosen the locking screw of A-145.

If the problems are slow, turn the vernier screw *counterclockwise* to correct a minus error in problems 24 and 28 and a plus error in problems 32 and 33.

If the problems are fast, turn the vernier screw *clockwise* to correct a plus error in problems 24 and 28 and a minus error in problems 32 and 33.

Tighten the locking screw of A-145 and recheck.



ACCESS TO A-145

SPECIAL ELEVATION and BEARING INTEGRATOR TESTS

PROB. NO.	So KN.	Sh KN.	dH KN.	Br DEG.	A DEG.	E DEG.	cR YARDS	READ DIAL	TRUE RATE DEG./MIN.	ADJUST VERNIER NO.	QUANTITY
1A	0	0	+ 40	90	90	0	1700	cE	+ 45.54	A-154	RdE
1B	0	0	- 40	90	90	0	1700	cE	- 45.54	A-154	RdE
2A	0	40	0	0	90	70	1700	cBr	+133.15	A-139	RdBs
2B	0	40	0	0	270	70	1700	cBr	-133.15	A-139	RdBs
3	25	360	0	0	0	80	20000	cE	+ 36.69	A-149	1/cR
4	25	360	0	0	0	80	1700	cE	+431.67	A-151	cR
5	20	360	0	90	90	0	2800	cBr	+262.67	A-147	SEC E
6	20	360	0	90	90	70	2800	cBr	+767.99	A-145	E

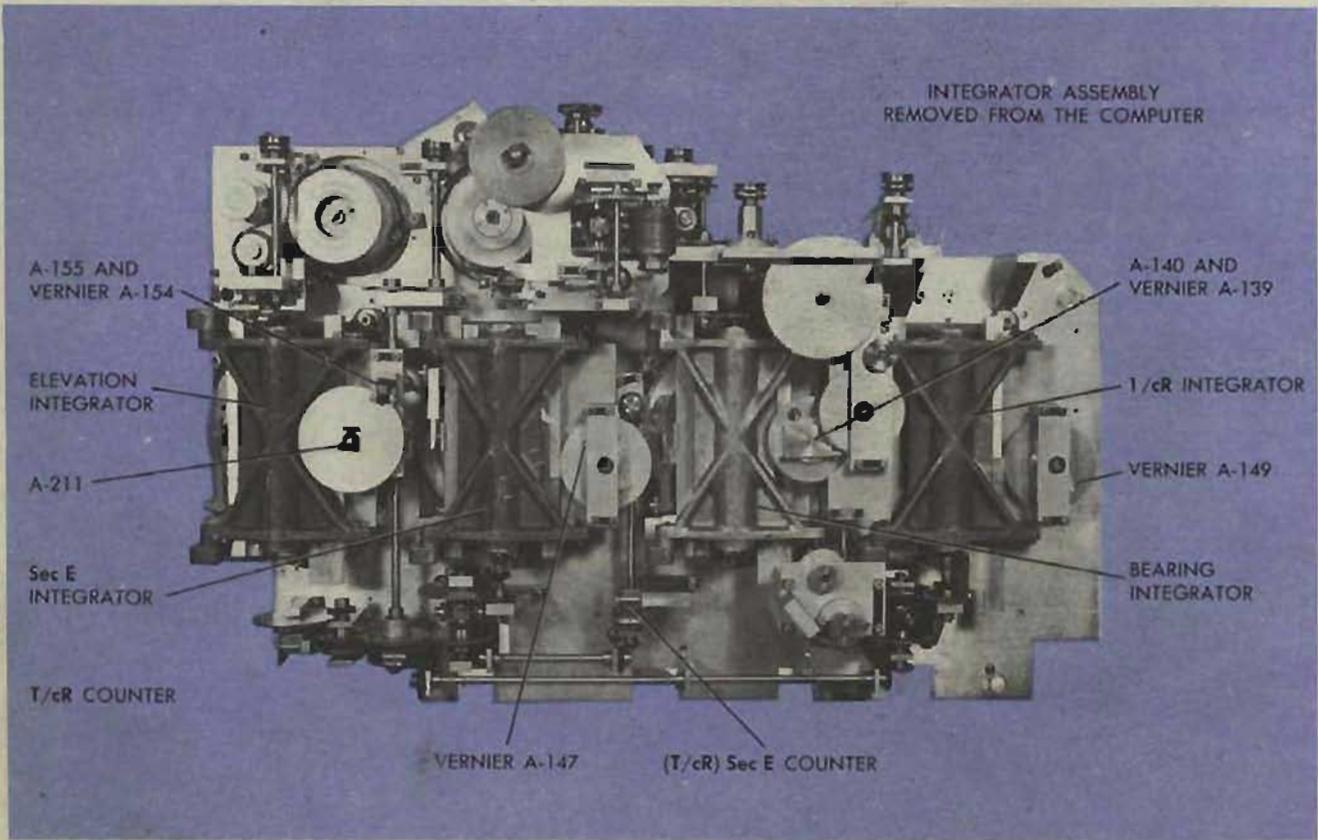
These tests indicate the effect of vernier adjustments on the integrators. These special problems will be useful during B test analysis to correct integrator errors. Problems 1A and 1B check the elevation integrator. Problems 2A and 2B check the bearing integrator. Problems 3 through 6 check the timing of the T/cR and (T/cR) sec E integrators. For each test, two time intervals are given. Use the short run for the preliminary adjustment, and the long run for the final check.

How to make the tests

- 1 Set up the computer for B tests.
- 2 Run problems 1A, 1B, and 2A, 2B. Adjust the indicated verniers to *balance* 1A with 1B, and 2A with 2B. Balanced errors will have equal magnitude and opposite sign. Disregard the size of the balanced errors.
- 3 Run problems 3 through 6. Make the indicated adjustment to bring the rate error for each to a minimum before proceeding to the next test.
- 4 After problem 6 is completed, run a full set of the standard elevation and bearing B tests.

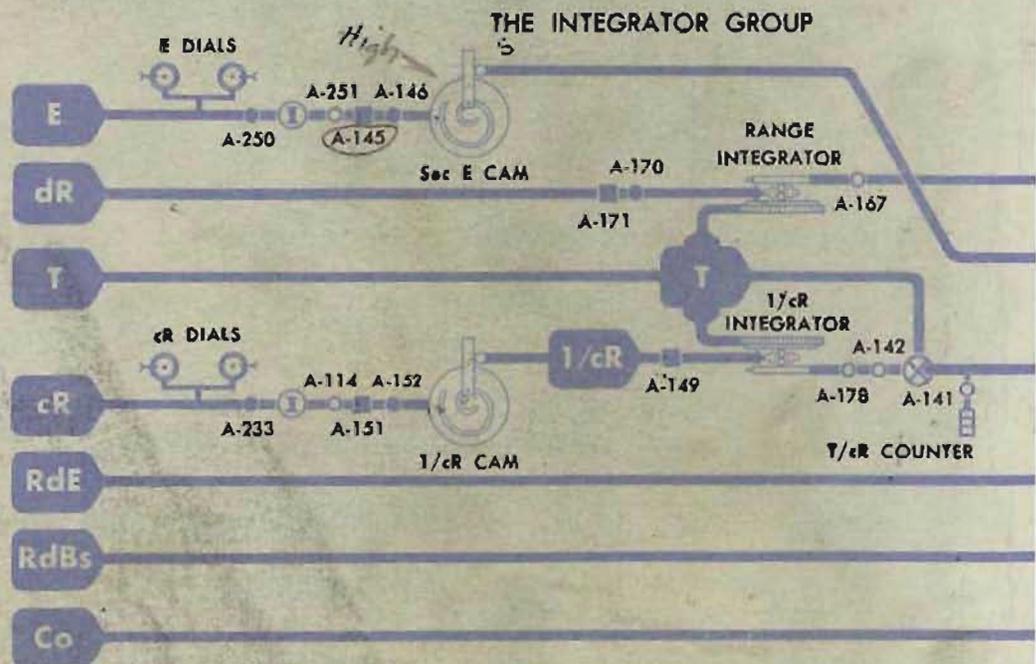
PROB. NO.	TIME SECS.	360°-CE DEG. & MIN.		ERROR MIN.	RATE ERROR MIN./MIN.	PROB. NO.	TIME SECS.	360°-CBT DEG. & MIN.		ERROR MIN.	RATE ERROR MIN./MIN.
		CALC.	READ					CALC.	READ		
1A	15	348° 37'				2A	15	326° 43'	27° 40'		
	60	314° 28'					60	226° 51'	slow		
1B	15	11° 23"				2B	15	33° 17'			
	60	45° 32'					60	133° 09'	132° 49'	20'	20'
3	15	350° 50"				5	15	294° 20'			
	60	323° 18'					60	97° 20'			
4	15	252° 05"				6	15	168° 00'			
	60	288° 20'					30	336° 00'			

COMPLETE ADJUSTMENT OF THE INTEGRATOR NETWORK



If all or most adjustments in the integrator group are upset, or if a unit in the integrator group has been removed and reinstalled, the whole integrator group must be readjusted to give a correct set of B tests.

Use the following adjustment procedure:



Preliminary adjustment

- 1 Disconnect the range integrator, or set up a zero range rate. (Refer to page 32.)
- 2 Adjust the following clamps:
 - A-233— cR intermittent drive to cR dials.
 - A-152— $1/cR$ cam to cR dials.
 - A-250— E intermittent drive to E dials.
 - A-146 (or A-210)— $sec E$ cam to E dials.
 - A-155— RdE input of elevation integrator to RdE line.
 - A-140— $RdBs$ input of bearing integrator to $RdBs$ line.

Refining the adjustment of T/cR

- 1 Set cR at 20,000 yards.
- 2 Adjust A-149.

Loosen the locking screw and adjust the vernier screw so that the T/cR counter makes 14.99 to 15.04 revolutions per minute. *29.97*

Turn the vernier screw counterclockwise to increase the integrator output.

Turn the vernier screw clockwise to decrease the integrator output.

Tighten the locking screw.
- 3 Set cR at ~~1500~~ yards. *1500 yds*
- 4 Adjust vernier A-151.

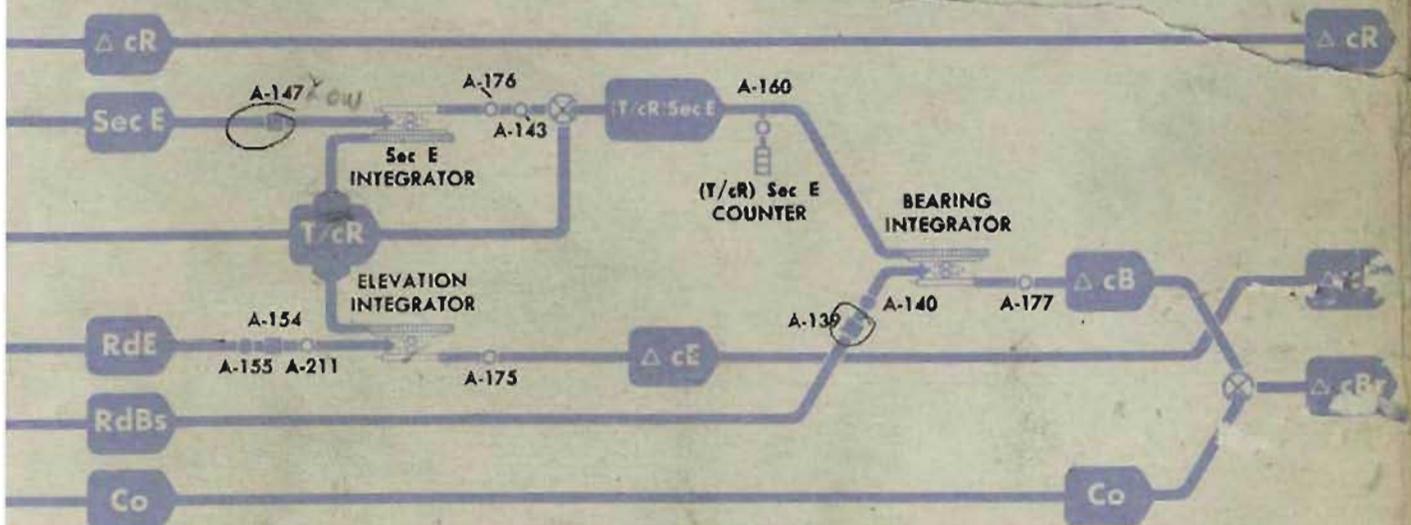
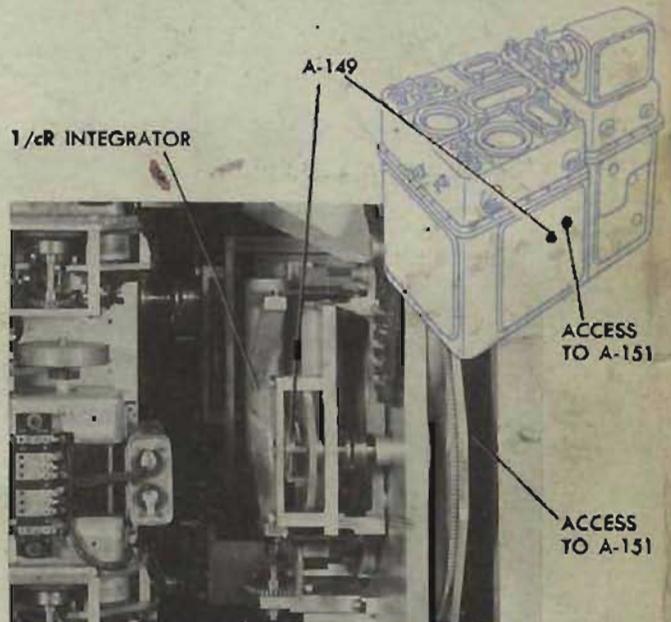
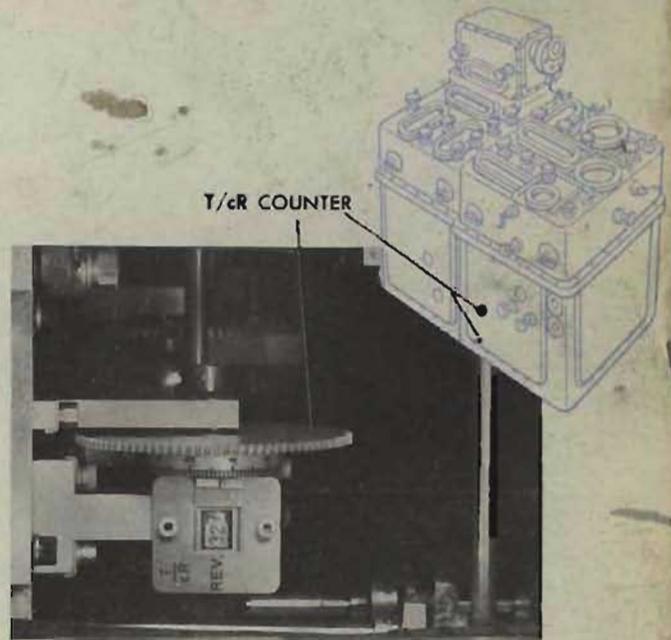
Loosen the locking screw and adjust the vernier screw so that the T/cR counter makes 187.32 to 187.37 revolutions per minute. *399.62*

Turn the vernier screw counterclockwise to increase the integrator output.

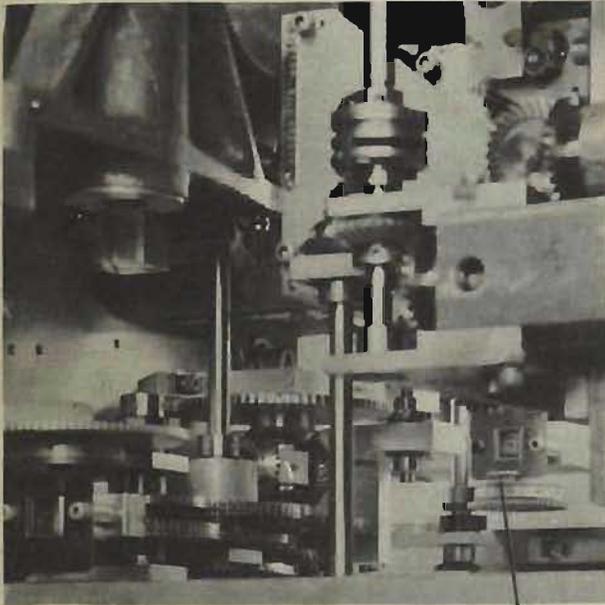
Turn the vernier screw clockwise to decrease the integrator output.

Tighten the locking screw.

Recheck A-149.



Refining the adjustment of (T/cR) sec E



(T/cR) Sec E COUNTER

- 1 Set *E* at 0°.
- 2 Set *cR* at a low value.
- 3 Adjust A-147.

Loosen the locking screw. Adjust the vernier screw so that the (T/cR) sec E counter makes from 62.84 to 62.89 revolutions per 100 revolutions of the T/cR counter.

Turn the vernier screw counterclockwise to increase the number of revolutions.

Turn the vernier screw clockwise to decrease the number of revolutions.

Tighten the locking screw.

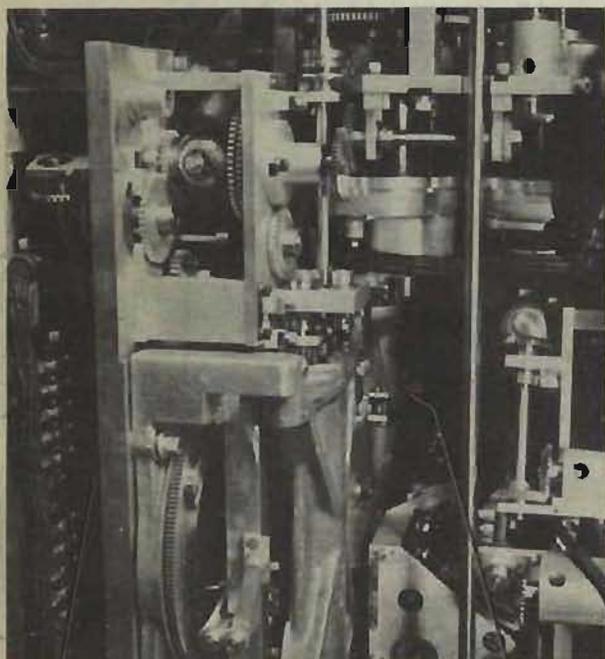
- 4 Set *E* at 70°.
- 5 Adjust vernier A-145.

Loosen the locking screw. Adjust the vernier screw so that the (T/cR) sec E counter makes from 183.73 to 183.78 revolutions per 100 revolutions of the T/cR counter.

Turn the vernier screw counterclockwise to increase the number of revolutions.

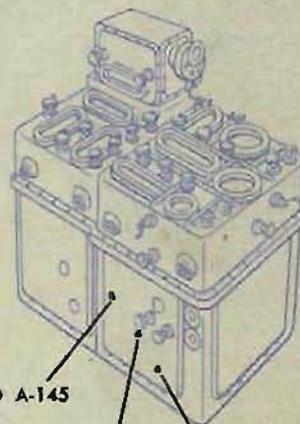
Turn the vernier screw clockwise to decrease the number of revolutions.

Tighten the locking screw.



ACCESS TO A-145

A-147 (HIDDEN)



ACCESS TO A-145

ACCESS TO A-147

ACCESS TO (T/cR) Sec E COUNTER

Refining the zero adjustment of RdE

- 1 Set A and Br at 90° .
- 2 Set So , Sh , and dH at 0 knots.
- 3 Set E at 45° .
- 4 Set cR at ~~1000~~⁵⁰⁰⁰ yards.
- 5 Adjust A-154. When A-154 is correctly adjusted, there should be no ΔcE output from the elevation integrator.

Refining the $1/cR$ cam

- 1 Run problem 18, elevation B tests. Record the value of $360^\circ - cE$ read at one minute.
- 2 Run problem 22, elevation B tests. Record the value of $360^\circ - cE$ read at one minute.
- 3 Compare the error in problem 22 to the error in problem 18.
- 4 Adjust A-151, until the error in problem 22 equals the error in problem 18 and has the same sign.

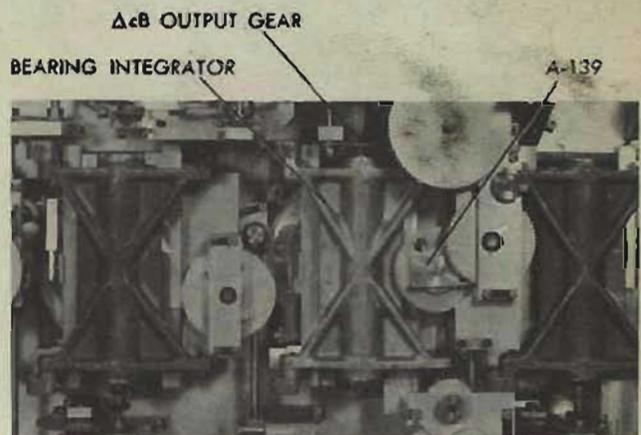
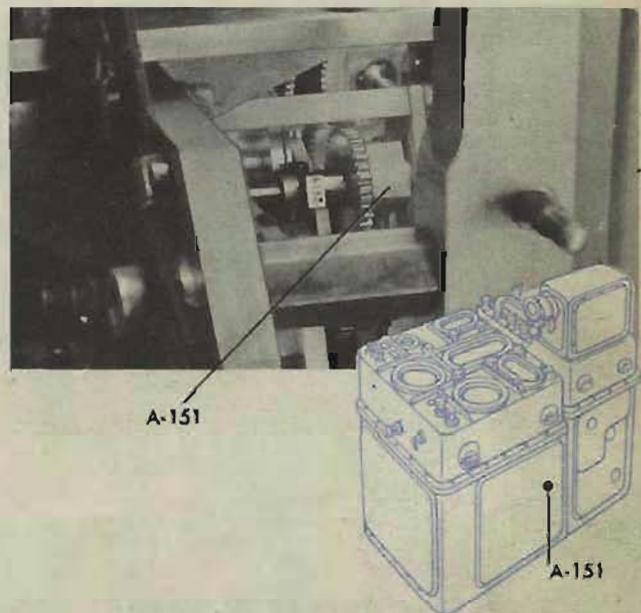
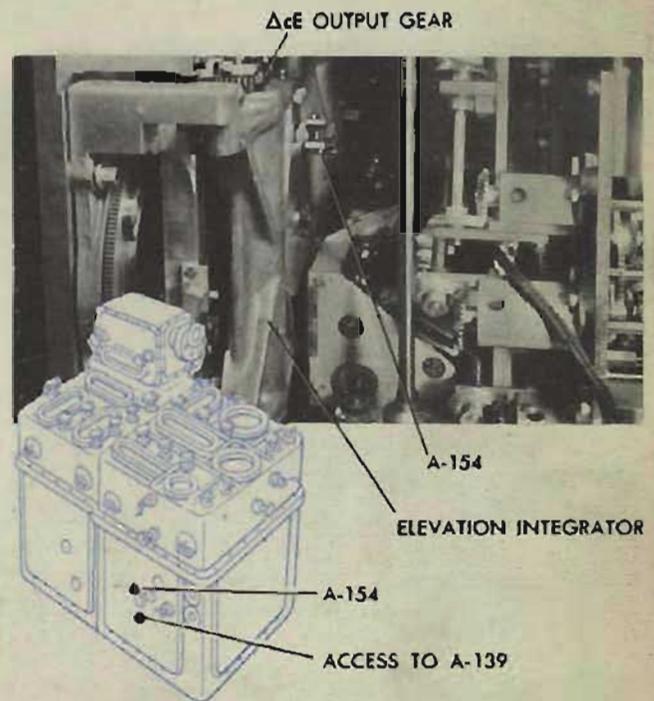
Turn the vernier screw counterclockwise to make problem 22 more minus, or clockwise to make it more plus. If a large adjustment is necessary, the result of problem 18 will also be affected.

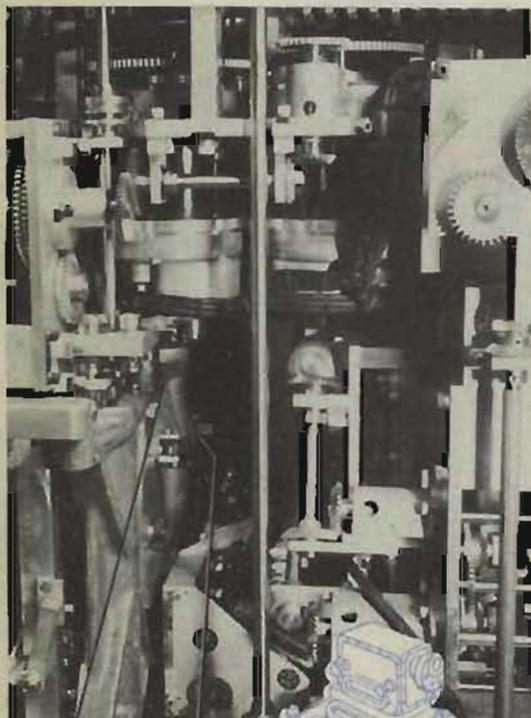
- 5 Rerun both problems.

Repeat until the errors in problems 18 and 22 are equal and of like sign.

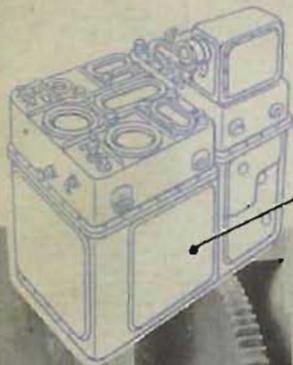
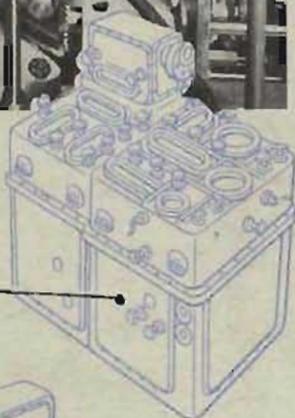
Refining the zero adjustment of RdBs

- 1 Set A and Br at 0° .
- 2 Set So and Sh at 0 knots.
- 3 Set E at 60° .
- 4 Set cR at 1600 yards.
- 5 Adjust A-139. When A-139 is correctly adjusted, there should be no ΔcB output from the bearing integrator.

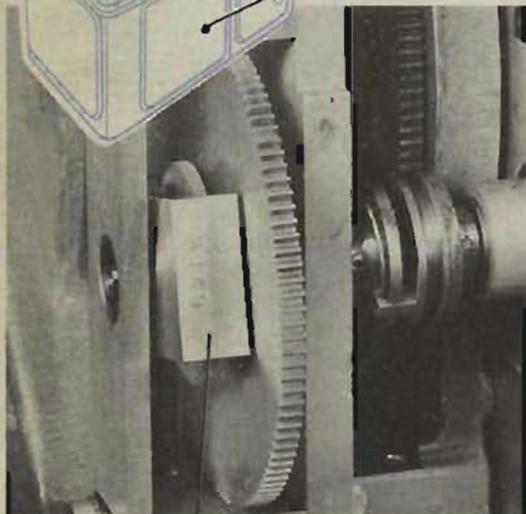


A-147
(HIDDEN)Sec E
INTEGRATOR

ACCESS TO A-147



A-149



A-149

Refining the sec E integrator

- 1 Run problem 25, bearing B tests, recording the value of $360^\circ - cBr$ read at one minute. Compute the error.
- 2 Run problem 27, bearing B tests, recording the value of $360^\circ - cBr$ read at one minute. Compute the error.
- 3 Compare the error in problem 25 to the error in problem 27.
- 4 Adjust A-147 until the error in problem 25 equals the error in problem 27 and has the same sign.
Turn the vernier screw counterclockwise to make problem 25 more plus, or clockwise to make it more minus.
Any adjusting will also change the results of problem 27.
- 5 Rerun both problems.
Repeat until the errors in problems 25 and 27 are equal and of like sign.

Refining the I/cR integrator

- 1 Adjust A-149 until the errors in problems 25 and 27 are between 0 and plus 10 minutes per minute.
Turn the vernier screw counterclockwise to make both errors more plus.
Turn the vernier screw clockwise to make both errors more minus.

Refining the sec E cam

- 1 Run problem 24, bearing B tests, recording the value of $360^\circ - cBr$ read at one minute. Compute the error.
- 2 Run problem 33, bearing B tests, recording the value of $360^\circ - cBr$ read at one minute. Compute the error.
- 3 Compare the error in problem 24 to the error in problem 33. Adjust A-145 until both errors are at a minimum. This adjustment will change the results of both problems almost equally, but with opposite effect on signs.

Turning the vernier screw counterclockwise will make problem 24 more plus, and problem 33 more minus.

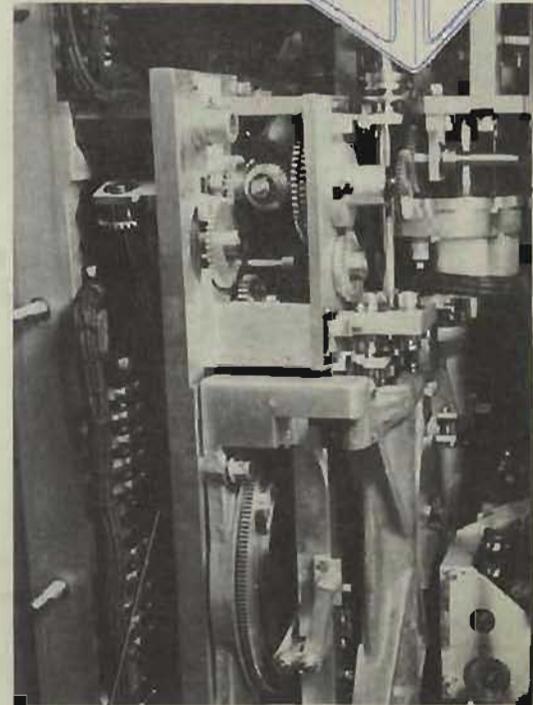
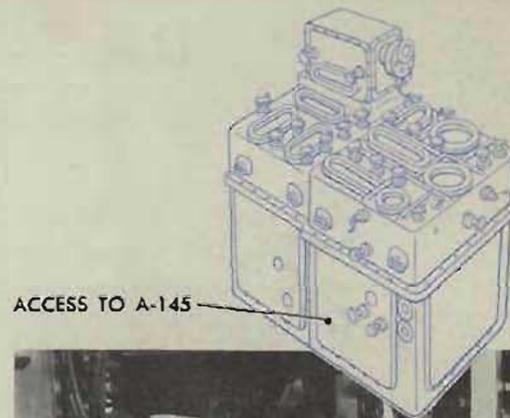
Turning the vernier screw clockwise will make problem 24 more minus, and problem 33 more plus.

For example: If the error in problem 24 is plus and the error in problem 33 is minus, a clockwise adjustment will bring the errors in both problems to a minimum.

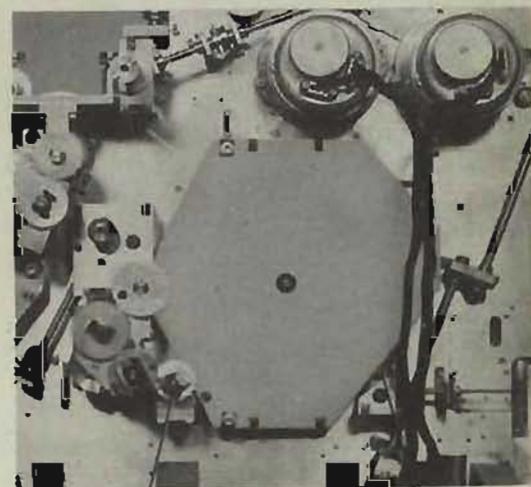
- 4 Rerun both problems after each adjustment until the results are satisfactory.

CHECKING THE REFINED ADJUSTMENTS

Run a complete set of elevation and bearing B tests. The errors should be within the allowable limits. If the errors exceed the allowable limits, readjust according to the types of error described earlier in this chapter. Check for mechanical defects.



ACCESS TO A-145



VERNIER A-145

Sec E CAM

C TEST ANALYSIS

C test analysis provides a means of locating and correcting C test errors. The analysis of C test errors is based on a complete set of C test and B test problem results. If A and B tests are satisfactory, C tests will usually be found satisfactory.

C tests check the adjustment and operation of both the relative motion group and the integrator group. B tests also give an accurate and thorough check of the integrator group. They differ from C tests since they are run with constant inputs, while C tests are run with constantly varying inputs.

CAUSES OF ERRORS IN C TESTS

At the point of manufacture, the C tests are run with a special setup to make the computer regenerative. Shipboard tests are usually run with the director to complete the regenerative system. The lost motion of the director receiver regulators, transmitters, and gearing all add to the lost motion of the computer receivers and mechanisms. For this reason, the allowable maximum errors that are listed on the C test record forms do not apply to C tests made on shipboard with the director.

Since the computer is made regenerative, the inputs of bearing, elevation, and range are controlled by their respective generated quantities. Thus an input quantity is directly affected by the accumulated error in the generated quantity. These errors in the input quantities will create errors in the rates, which in turn may cause a further increase in the errors in the generated quantities. The accumulation and regeneration of errors, therefore, is of great importance in C test analysis.

For example, in problem 10, if bearing is slow in the beginning, target angle and relative bearing will not decrease as rapidly as they should. This will create a negative error in dR which will cause range to decrease too rapidly. As the problem continues, range will accumulate an excessive negative error, which in turn may cause the $1/cR$ cam to overcorrect the previously slow generated bearing. This fast error in bearing accumulates and begins to decrease the error in range toward the end of the problem. Although the excessive error is in range, the step-by-step analysis of the problem shows that the original dR error was caused by a slow start in bearing. In order to correct this latter condition, the longer-range bearing B tests such as 27 would have to be made faster.

Transmission trouble

As long as the observed and generated dials remain matched, errors in the C tests are not being caused by transmission trouble. If the observed dial suddenly stops turning, or fails to remain matched to the generated dial, transmission checks should be made to locate the error.

Excessive lost motion

C tests may be in error even though the A and B test results were satisfactory. The A and B test errors may have been such that the addition of a little lost motion has caused excessive errors in C tests. It may be possible to make readjustments which will either reduce the B test errors or will change the sign of these errors, and thus reduce the C test errors.

Excessive lost output at the cross-over point

The cross-over point is the integrator position at which dR or RdE passes through zero and the output changes to the opposite direction. When the integrator is near the center position, the output torque is very low. If there is any overloading of the output line, the integrator will, in effect, have a wide zero output range instead of the theoretical "pin-point" zero position.

Problem 14 can be used to illustrate this condition. Elevation increases until bearing reaches 270° , and then decreases. If elevation increases at the correct rate until bearing reaches 270° , and then remains at the high value for several time intervals before decreasing, the elevation integrator may have failed to produce sufficient output at the cross-over point.

Loose frictions or faulty solenoid locks

The generated quantities may back out through a loose friction or a faulty solenoid lock.

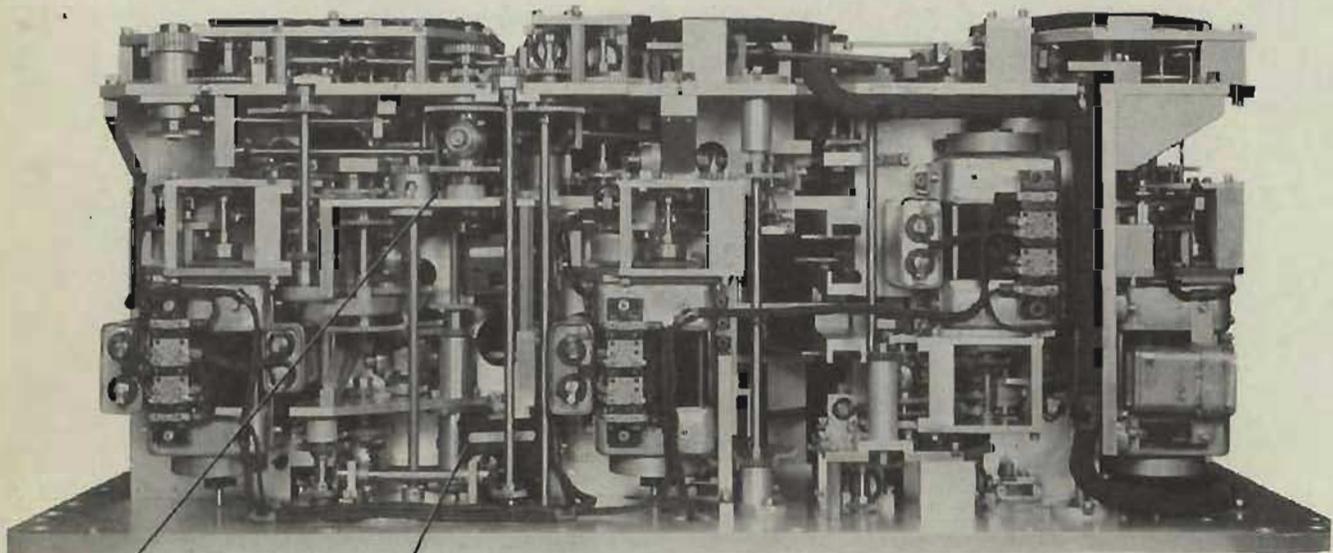
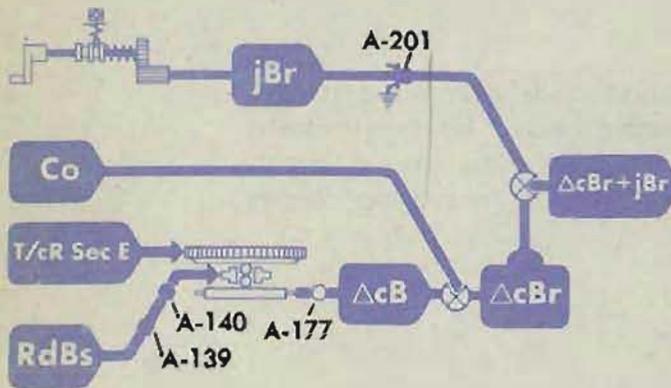
To check the generated bearing or generated elevation friction, observe the respective crank while rerunning one of the C test problems which was in error. Any movement of the crank indicates a loose friction. To check range, the crank should be removed and both input gears observed. A friction should be tight enough to prevent the generated quantity from backing out through an input gear.

CAUSES OF BEARING ERRORS IN C TESTS

Excessive bearing errors in C tests may be caused by:

Error in generated bearing

If bearing B tests are satisfactory, bearing errors in C tests are not likely to be excessive. However, if bearing is in error but range and elevation are satisfactory, further analysis is necessary. If bearing is slow, with minus errors in increasing problems and plus errors in decreasing problems, generated bearing is probably *backing out*. This condition may be caused by a loose friction or a faulty solenoid lock. Check A-201 and the solenoid lock on the jBr line.



ACCESS TO A-201

jBr LOCK

REAR OF CONTROL UNIT
COVER 1 REMOVED

It is possible for the errors in bearing B tests to be in such a direction that the addition of lost motion in the same direction causes excessive bearing errors in C tests.

Refer to the errors in the bearing B tests. It may be possible to reduce the C test bearing errors by making readjustments either to reduce or to change the sign of the errors in those B test problems with setup conditions similar to the C tests.

(Note: It is recommended in B test analysis that problems 25 and 27 be given slightly plus errors to aid C tests.)

Before changing B test errors, determine the effect of such a change on the other generated quantities throughout C tests.

Accumulated range or elevation errors

Analyze the errors in range and elevation in B and C test problems. If all the range tests have a negative trend, it may be possible to improve bearing by making range more plus. This can be done by adjusting the range integrator so that the zero range rate B test problem has a slight positive error. It might also help if the errors in elevation B test problems are reduced or changed in sign. Determine what the effect will be on the other generated quantities throughout C tests.

Error in target angle

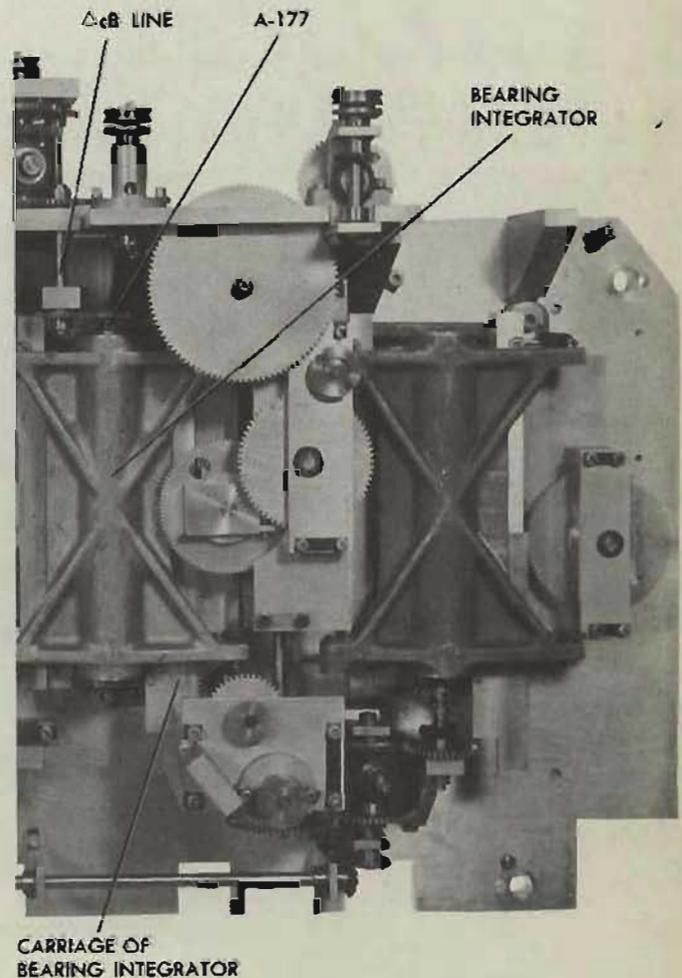
If A test and bearing B test results are satisfactory, it can be assumed that RdB_s is correct. To check this, run A test problem 6. Here an error of $\frac{1}{2}^\circ$ in target angle results in an error greater than 13' in $B'gr$. If the error in $B'gr$ is excessive, see *A Test Analysis*, page 106.

Bearing integrator

Check the bearing integrator for slipping or excessive lost output at the cross-over point. Inspect carefully for dirt or foreign material. Check the bearing integrator for overload. To do this, loosen A-177 and lift the gear out of mesh. Turn the ΔcB line and check that it is free and turns easily. Remesh the gear and tighten A-177.

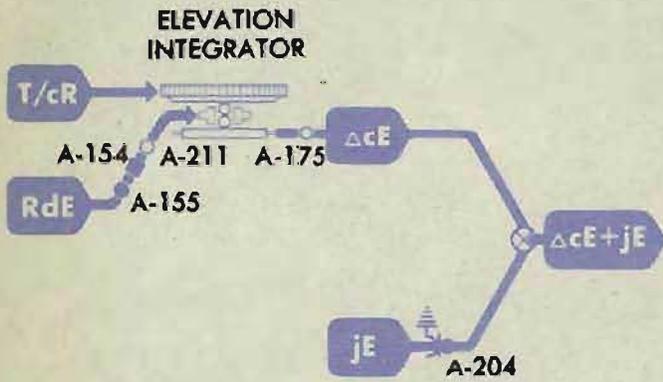
RdB_s shaft line

Check that the RdB_s line is free. Lift the carriage of the bearing integrator until the lost motion of the line is taken up. Check that the carriage drops back down of its own weight. If it does not drop back, see *Shaft Lines*, OP 1140A.



INTEGRATOR GROUP REMOVED FROM
COMPUTER

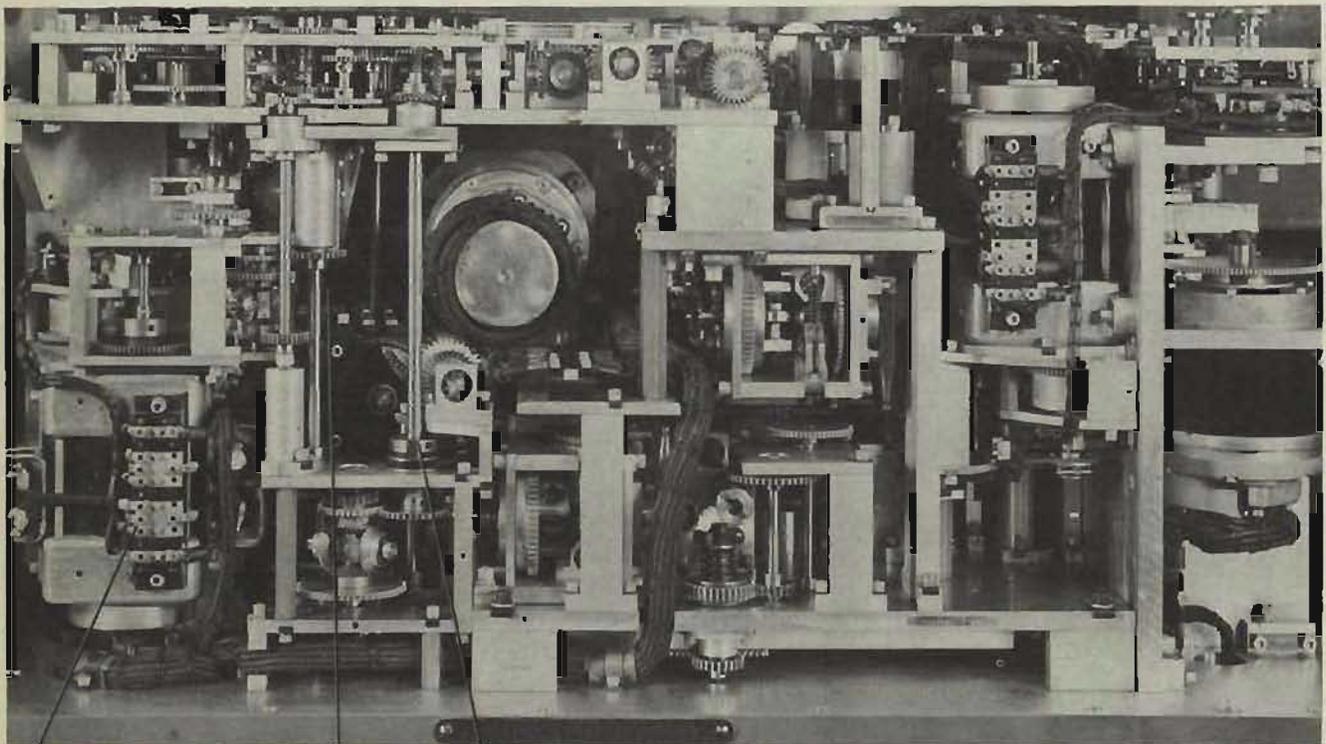
CAUSES OF ELEVATION ERRORS IN C TESTS



Excessive elevation errors in C tests may be caused by:

Errors in generated elevation

If elevation B tests are satisfactory, elevation errors in C tests are not likely to be excessive. However, if elevation in all problems is consistently slow, generated elevation may be backing out through a loose friction or a faulty solenoid lock on the jE line. Check A-204 and the solenoid lock on the jE line.



jE FOLLOW-UP

jE LOCK

A-204

LEFT SIDE OF COMPUTER COVER 1 REMOVED

It is possible for the errors in elevation B tests to be in such a direction that the addition of lost motion in the same direction causes excessive elevation errors in C tests.

Compare the elevation errors in C tests with the errors in elevation B tests. It may be possible to get more correct C test results by reducing the B test errors, or by changing their signs. However, before changing B test errors, determine whether the change will affect the other generated quantities throughout C tests.

Accumulated errors in bearing and range

Examine the errors in range and bearing in both B and C test problems. Determine whether the errors in range and bearing B tests can be reduced or changed in sign in order to reduce the C test elevation errors.

Error in RdE

If the errors in V_s in A tests are within the allowable limits, it can be assumed that RdE to the elevation integrator is correct. An error in RdE would also appear in B tests. If the errors in V_s are excessive, see *A Test Analysis*.

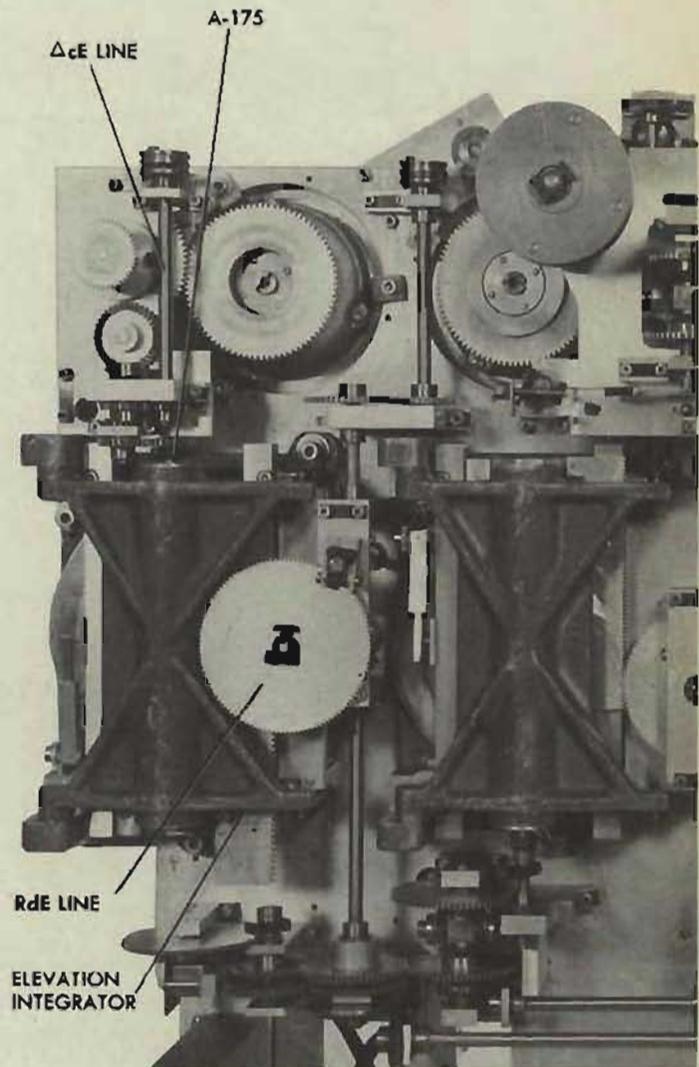
RdE shaft line

Check the RdE line for sticking or binding. Refer to *Shaft Lines*, OP 1140A.

Elevation integrator

Check the elevation integrator for excessive lost output at the cross-over point and for sticking or binding caused by dirt or foreign material.

Check the integrator output for overload. To do this, loosen A-175 and lift the gear out of mesh. Turn the ΔcE line and check that it is free from sticks or binds. Remesh the gear and tighten A-175.



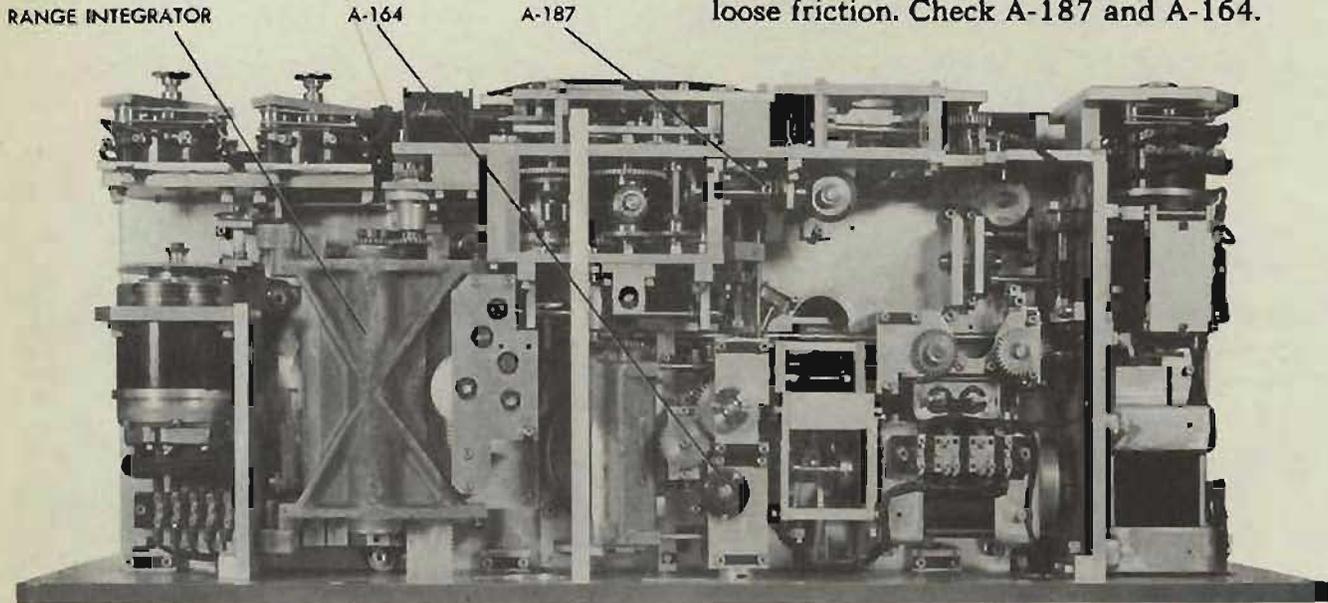
LEFT HALF OF INTEGRATOR GROUP

CAUSES OF RANGE ERRORS IN C TESTS

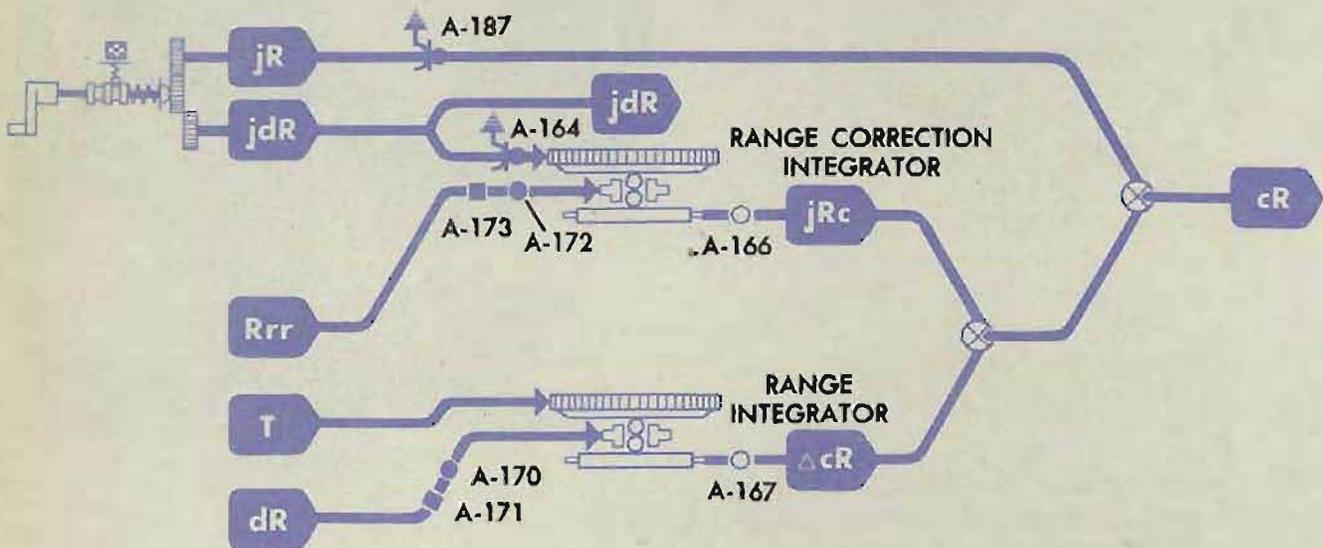
Excessive range errors in C tests may be caused by:

Error in generated range

If range is slow in all C test problems, generated range may be backing out through a loose friction. Check A-187 and A-164.



TOP FRONT OF COMPUTER



The errors in range B tests may be in such a direction that the addition of the over-all system lost motion may cause the C test range errors to become excessive. Analyze the errors in range B tests. It may be possible to improve the C test range readings by making corrections either to reduce or to change the signs of the errors in those B tests which have setup conditions similar to the C tests.

Error in dR

Check dR by running A test problems 1 and 9. If dR is in error, see *Checking the dR Network*, page 134.

Accumulated error in bearing and elevation

Any error in bearing means an equal error in target angle, which, at high target speeds, results in a large error in dR . A range rate error caused in this way must be corrected by correcting the bearing error. This usually means that adjustments should be changed in such a way as to make errors in bearing B test problems 25 and 27 more positive.

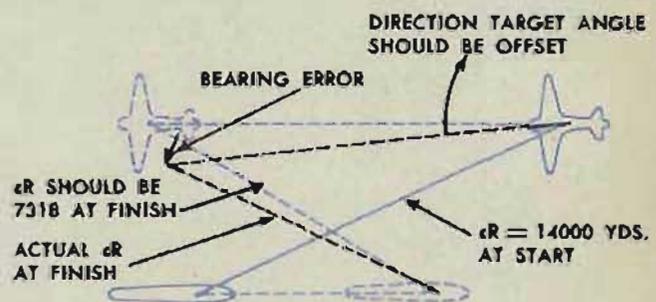
Analyze the elevation errors in B and C tests. Determine whether the B test errors can be altered or changed in sign in a way which will improve the C test range readings.

Error in target angle

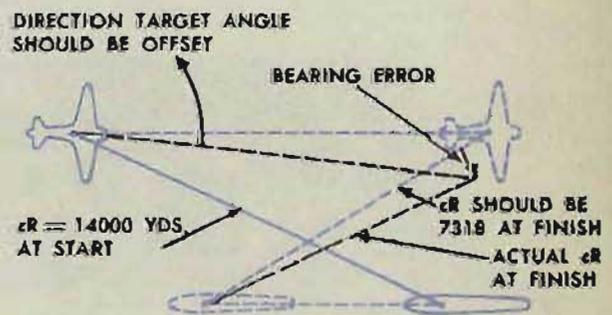
An error in target angle too slight to affect A test results may nevertheless cause excessive C test range errors. In order to determine and correct such an error in target angle, the following procedure is recommended:

- 1 Using the problem results, make an overlay of the diagrams for problems 8 and 9. Draw lines to indicate range and bearing at the end of each problem. Problems 8 and 9 are used because they have numerically equal rates. Therefore, when target angle is accurately adjusted, the two problems should have nearly equal range errors. When the range errors in the two problems differ greatly, a correction to target angle is indicated.
- 2 Repeat the problem with the larger range error, offsetting A very small amounts up to about half the width of a graduation mark. The offset should be in the direction which will improve the range readings in this problem.
- 3 When an offset is determined which satisfactorily improves range in the selected problem, rerun the other problem, using the same offset. The correct amount of offset will be indicated when the range errors in the two problems are about equal and of like sign.

TYPICAL PROBLEM OVERLAYS

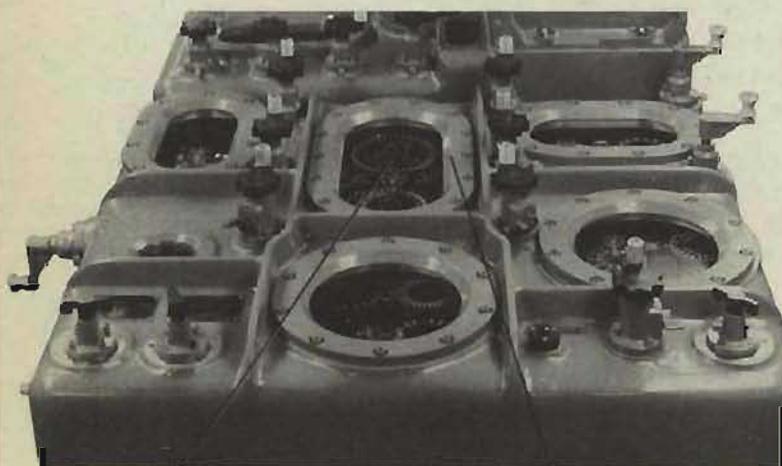


PROBLEM 8



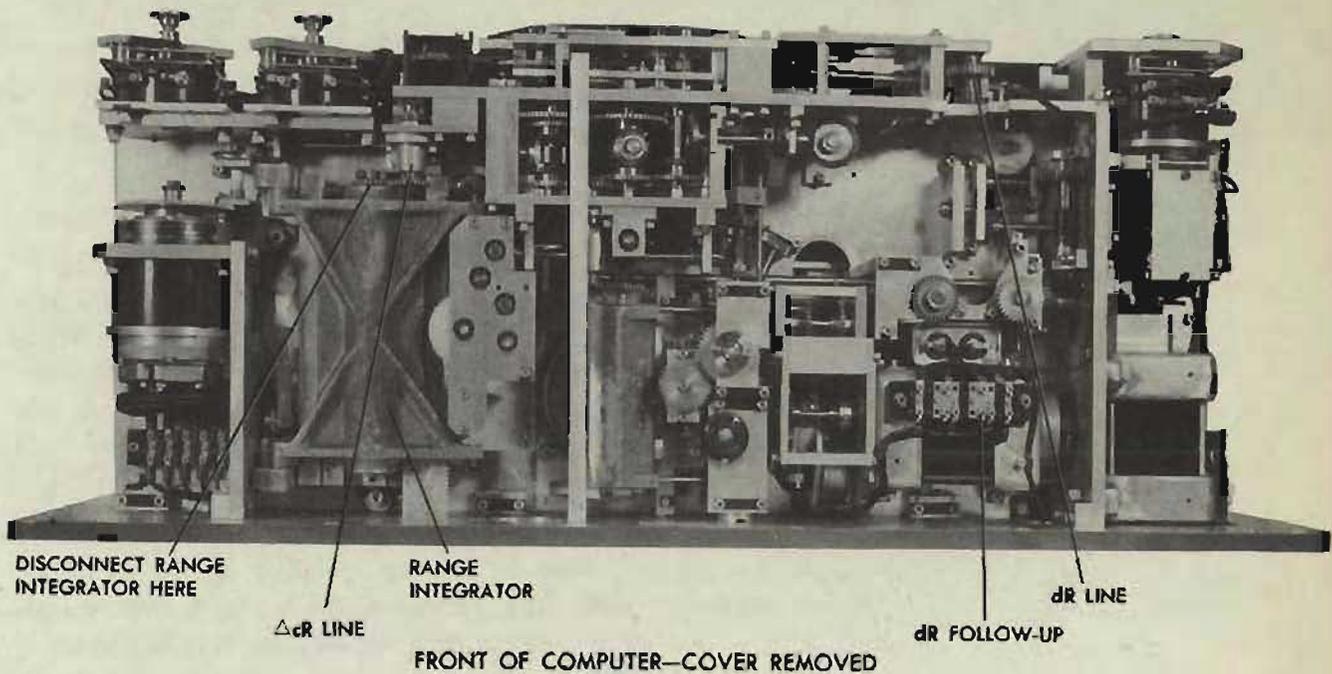
PROBLEM 9

- 4 Using the selected offset, rerun the remaining problems to make sure that none will be seriously affected.
- 5 Run A test problems 1 and 10, setting up target angle with the selected offset. Compare the results with previously run A tests, and check that there is no marked difference in the readings.
- 6 Remove the window over the target and ship dial group.
- 7 Set up C test problem 8 with the selected trial offset in target angle.
- 8 Loosen the dial screws (A-532) and slip the dial to read exactly 330° .
- 9 Tighten A-532.
- 10 Rerun problems 8 and 9.
- 11 RERUN ALL A, B, AND C TESTS.



A-532

REMOVE WINDOW



Sticking or binding

Sticking or binding in a shaft line or unit may be causing an error in dR during the C test. The following test may be used to determine whether the computing mechanism is being affected by this type of casualty. With power on, set target angle at zero. Carefully set target speed at exactly 200 knots, bringing it on slowly in the increasing direction. Mark a tooth on the friction drive gear which meshes with the dR motor pinion, and opposite this make an index mark on the plate. Now run Sh up to about 210 knots and slowly bring it back to exactly 200 knots. The spread or lag in dR can now be measured by counting the number of teeth between the index and the marked tooth. If the spread is considerably more than four teeth, the trouble must be eliminated. Check the shaft lines and units involved in the computation of dR , working back from the dR follow-up and its input gearing. See *Shaft Lines*, OP 1140A.

In order to include the Ct and A shaft lines in the above check, repeat the test with Sh fixed at 200 knots while setting A at 90° , first in the increasing direction and then in the decreasing. The spread in dR may be measured on the same gear.

Check the range integrator for overload. To do this, disconnect the integrator and check the ΔcR line. Reconnect the range integrator.

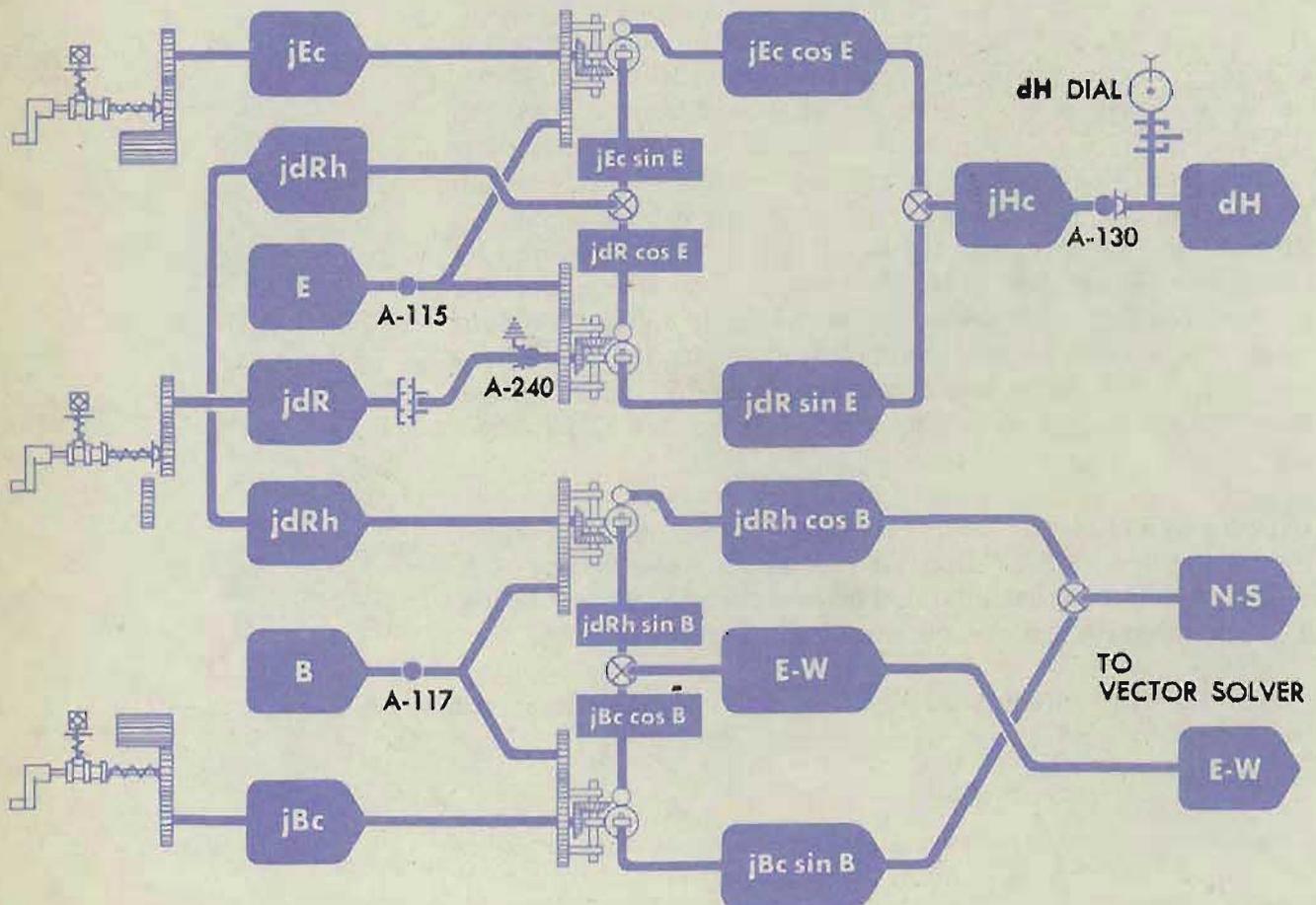
Check the integrator for excessive lost output at the cross-over point, and for sticking, binding, or jamming caused by dirt or foreign matter.

RATE CONTROL TEST ANALYSIS

This test analysis provides information for locating and correcting rate control test errors.

An error of ± 5 knots is the maximum allowable error for the acceptance test. However, if the computer has been operating satisfactorily with rate control errors slightly higher than the allowable, it is not advisable to attempt a readjustment as the errors affect only the solution time of the tracking problem and not the actual gun orders.

Before attempting to analyze and correct rate control errors, it must first be determined that the specified inputs were not introduced too rapidly. The *Sh* and *Ct* follow-ups are the limited type which drive more slowly than other types. Hence, if the rate corrections are introduced faster than the follow-ups can handle them, a portion will be lost in slippage at the vector solver input frictions. If the follow-up contacts and limit buffers are in correct adjustment (see page 561), they will not cause test errors when the inputs are introduced smoothly and at the proper speed.



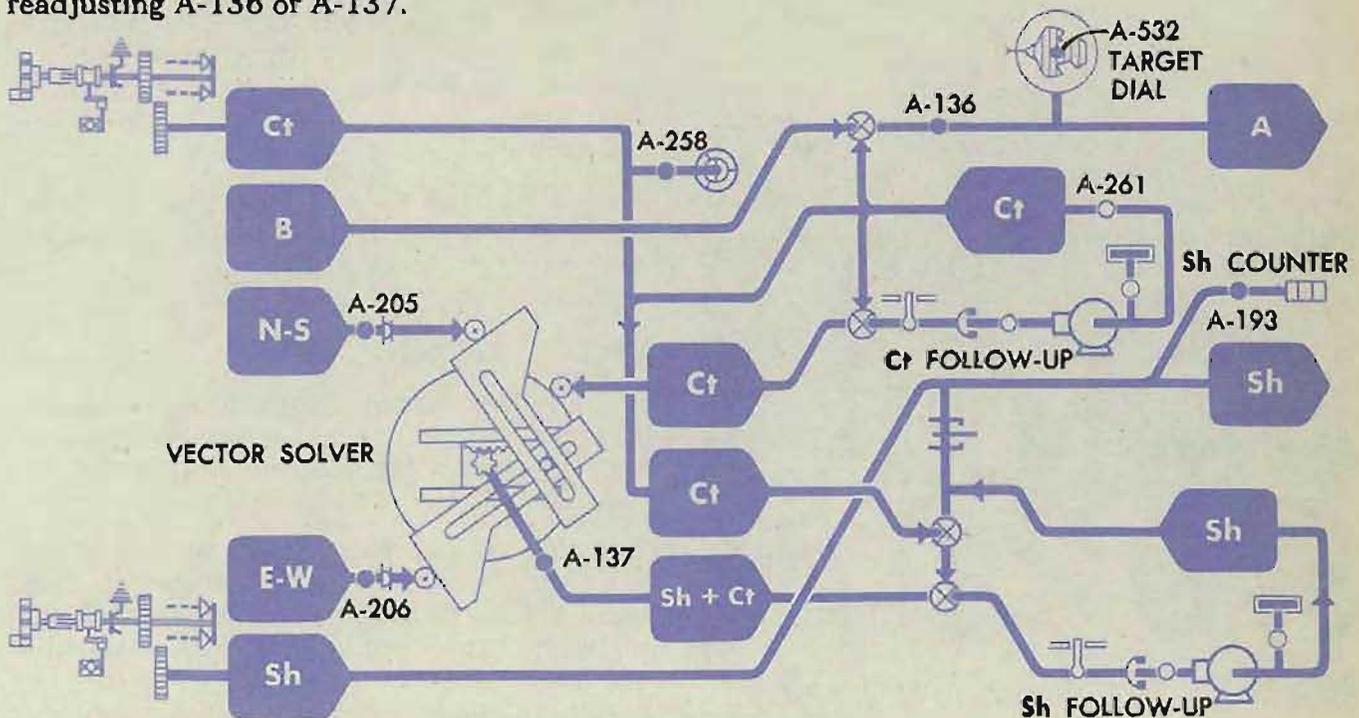
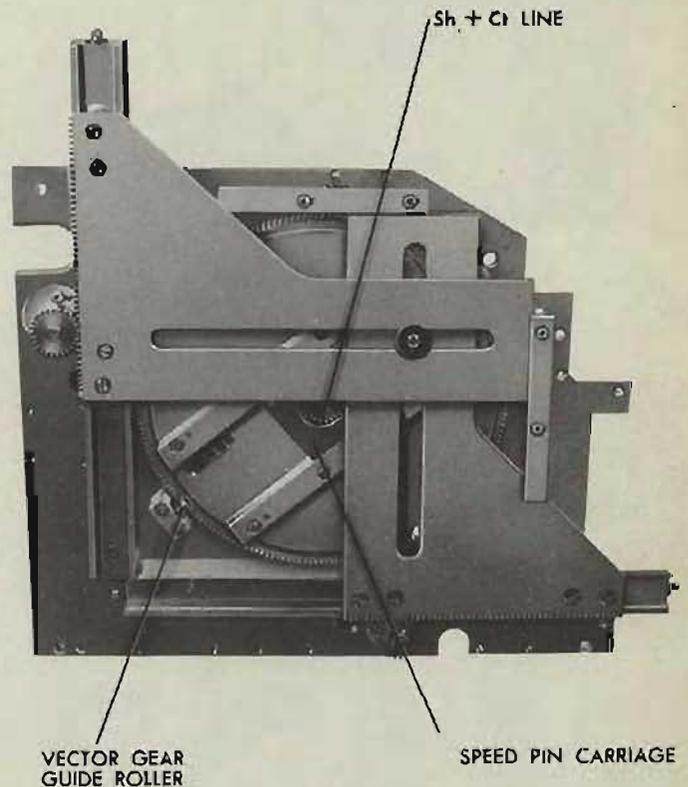
LOCATING AND CORRECTING ERRORS

Failure of Ct or Sh to rate control

If both *Ct* and *Sh* fail to respond, the power supply to the motors should first be checked. This check involves the two handcrank switches. If either one is open or defective, the power to both motors will be out.

Check the follow-up control contacts. See page 561.

If *Ct* and *Sh* fail to change, the vector solver may be jammed or damaged as a result of faulty readjustment technique. Such damage can be caused by hand-driving *Sh* into either limit while A-137 is upset or only approximately positioned. With A-137 out of adjustment, it is possible to drive the vector-solver pin carriage beyond the end of its guide rails. When this happens, the carriage may hit one of the rack rails or one of the four vector-gear rollers, thereby damaging the *Sh + Ct* line. If the carriage should extend into the spaces between two of these obstructions, it would lock the *Ct* line. When one of these restrictions is encountered, the inertia of the motor on the line being turned will usually cause damage before the restriction is felt. For this reason, extreme care must be taken when readjusting A-136 or A-137.



Errors in C_t or Sh

If the changes in Sh are too small, or if C_t does not change as much as specified in the special test for changes in C_t given on page 57, the errors may be due to faulty spacing of the follow-up contacts or of the limit buffers. When the contacts do not "make" sufficiently to maintain proper motor speed in each direction, the frictions on the N-S and E-W lines will slip, causing some loss of output. In this case the outer contacts may be too far apart, the center contact may be off center, causing a loss in one direction, or the neoprene buffers on the limit arm may be too thick, causing excessive restriction of contact motion. For readjustment of the follow-up contacts and limit buffers, see Locating Casualties, C_t and Sh follow-ups, page 561.

Check the vector solver frictions, A-205 and A-206.

Errors in the amount that C_t changes may also be due to faulty adjustment of the vector-solver speed pin. Check A-137.

If Sh changes when only C_t should change and the C_t change is too small, or if C_t changes when only Sh should change and the Sh change is too small, check A-117 and A-136. (When a change in A is called for, other quantities will begin to change after A has moved away from its initial position. At $80^\circ E$, it is normal for quantities other than the one being checked to change slightly.)

When the changes resulting from a smooth input are too small and appear to be rough or intermittent, check the component integrators for slippage due to dirt or wear. Also check the associated shaft lines. See OP 1140A.

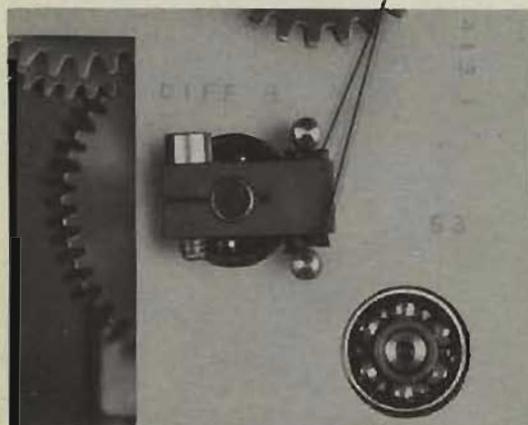
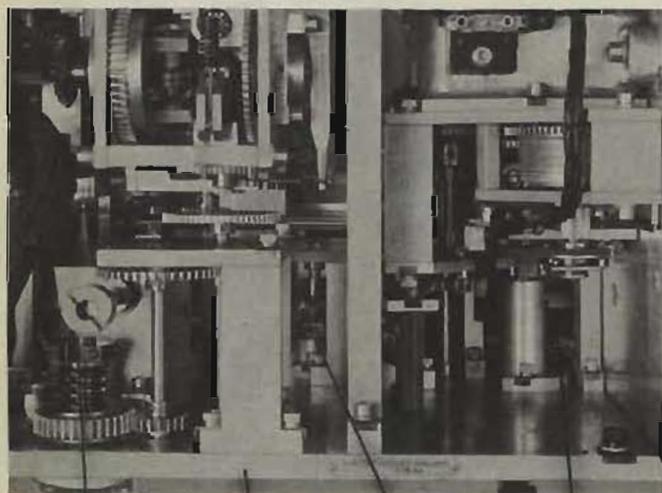
With E at 0° , if C_t and Sh change too little when cR is changed, and dH also changes by some amount, check A-115.

Errors in dH

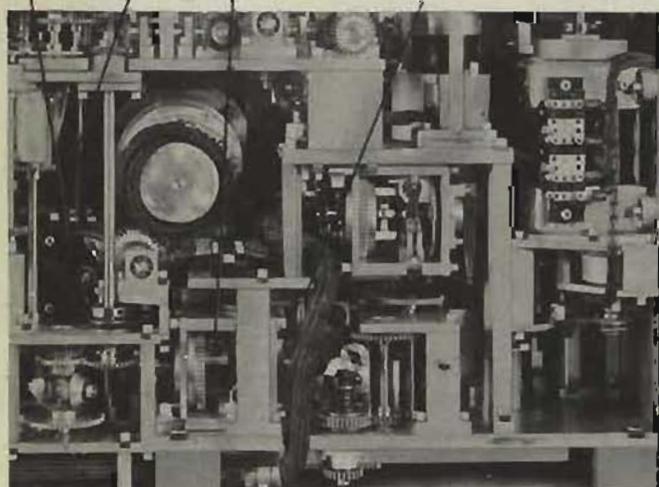
If dH fails to change, or changes erratically or intermittently, check the elevation component integrator for slippage due to dirt or wear. Refer to OP 1140A.

When C_t and Sh changes are correct, but dH is erratic or intermittent, check the jHc friction, A-130. If the friction is correctly adjusted and the trouble still exists, check the dH gearing and component solver for sticking and jamming. Refer to OP 1140A.

LIMIT BUFFERS

 C_t FOLLOW-UPN-S FRICTION
A-205

VECTOR SOLVER

 $Sh + C_t$ LINE
A-137E-W FRICTION
A-206 jE LOCK AND CLUTCH
(BEHIND jDR CLUTCH) jHc FRICTION
A-130BEARING
COMPONENT
INTEGRATOR jDR CLUTCHELEVATION COMPONENT
INTEGRATOR Sh MOTOR

At 0° elevation, an error in the adjustment of E to the elevation component integrator, A-115, may be indicated by either of two symptoms: (1) An elevation correction causes dH to change insufficiently and Sh and Ct to change when they should not; or, (2) a range correction causes a change in dH when only Sh or Ct should change.

Errors when range corrections are made

If the specified changes are incorrect throughout the test when cR is increased or decreased 450 yards:

Check the elevation component integrator for slippage due to dirt or wear.

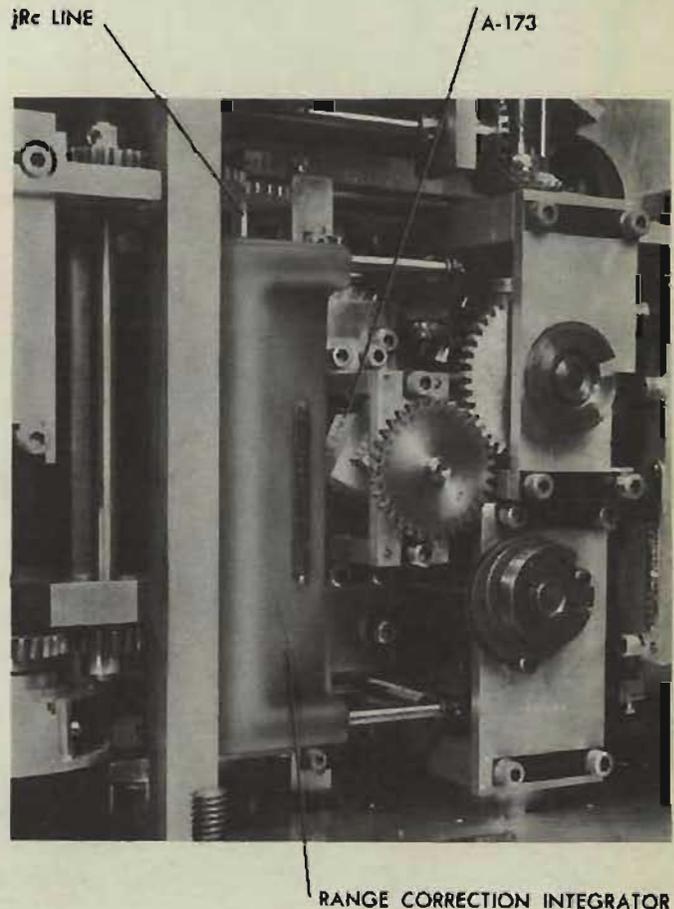
Check the carriage adjustment of the range correction integrator, A-173.

When increasing or decreasing cR causes no change in any of the quantities, check the jdR clutch. See OP 1140A.

Interchange or reversal of specified outputs

If, after readjustment to any of the rate control units, there is an interchange of test results, the vector solver or one of the component integrators is probably 90° out.

If the test results are reversed in direction, they indicate that one of the units is 180° out.



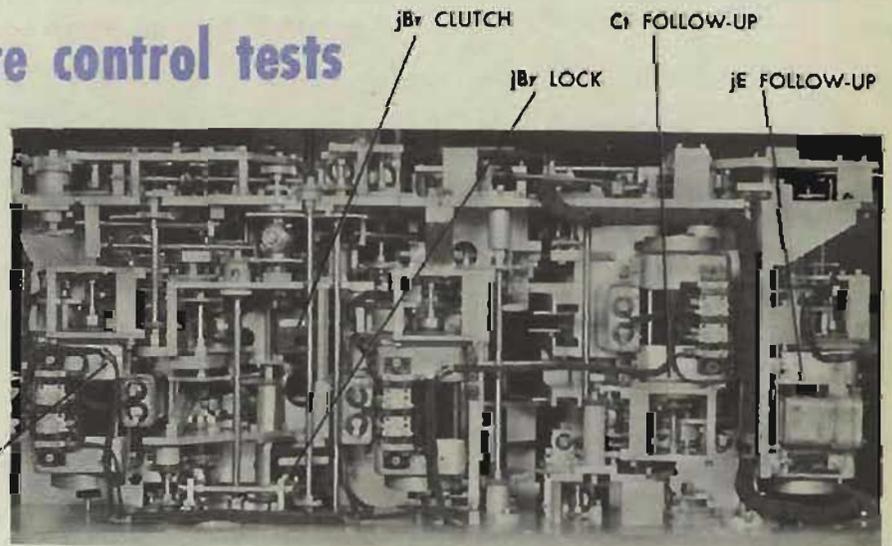
Errors in AUTO rate control tests

If the SEMI-AUTO rate control tests are satisfactory but errors exist during the AUTO rate control tests:

Check the operation of the solenoid locks and clutches. See page 553.

Check the operation of the jE and jBr follow-ups. See page 559.

jBr FOLLOW-UP



TRANSMISSION TEST ANALYSIS

LOCATING THE CAUSE OF ERRORS

The causes of errors in transmission tests may be divided into three groups:

- Receiver trouble
- Reversed wiring
- Open or shorted wiring

RECEIVER CHECK

Check the receivers as the first step in locating transmission test errors. Transmit a continuous signal and check the receiver output for one or more of the following symptoms:

No response

If the output does not turn or the synchro rotors do not follow the signal, make sure that the circuit is completely energized. Check all fuses. Check that the servo motor or capacitor is not dead. Check the synchro rotors for torque if they are accessible. Refer to *Synchro Receivers*, OP 1140A.

Erratic response

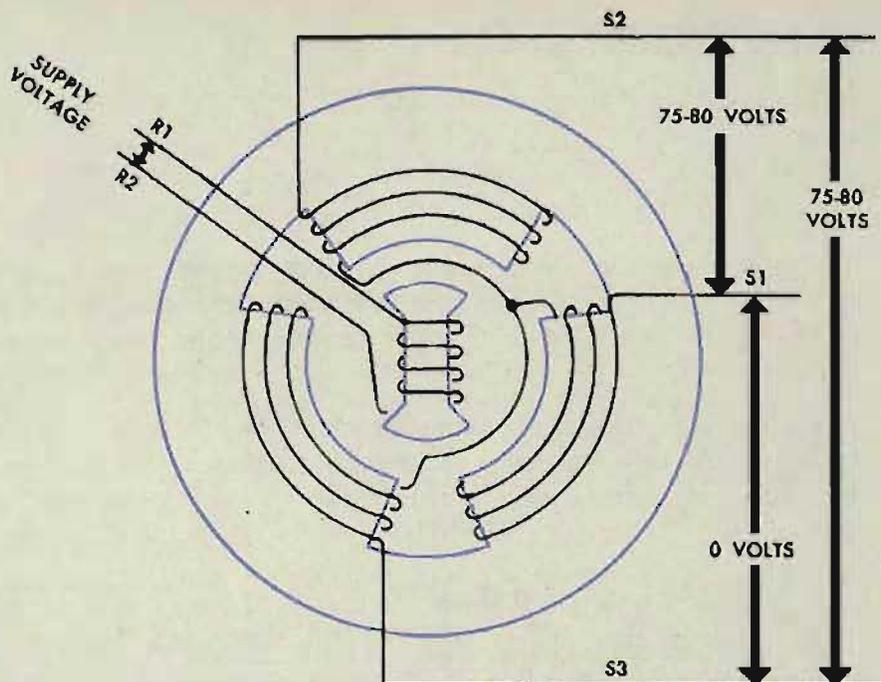
The receiver may jiggle, hunt, or follow in only one direction or its output may be rough or sluggish. See *Synchro Receivers*, OP 1140A.

Runaway response or drift

The servo runs constantly or drifts off from a synchronization point. This may be caused by open or shorted wiring, or mechanical defects. Refer to *Synchro Receivers*, OP 1140A.

Slow synchronization

If a receiver synchronizes too slowly, the cause may be a tight friction, an overloaded output line, or dirty contacts. Refer to *Shaft Lines*, and *Synchro Receivers*, OP 1140A.



VOLTAGE CHECK

A voltage check should be made to make sure that the stator windings are not being subjected to excessively high voltages. This check is especially important on new installations and on units where the wiring has been replaced. The voltage check is made at the computer terminal blocks. Refer to the wiring diagram for the unit being checked. To make the voltage check, transmit a zero signal and check the following voltages with all wires connected. (Note: A zero signal is one with the transmitter on electrical zero and not necessarily with the dial on zero. For example, electrical zero for range is 10,000 yards.)

R1-R2 should equal the power supply voltage, normally 115 volts.

S1 - S2 should be between 75 and 80 volts.

S2 - S3 should be between 75 and 80 volts.

S1 - S3 should be zero volts.

There should be no voltage between the rotor and the stator connections, except for an initial flicker. Note: Auto transformer type transmitters will show voltage between the rotor and the stator connections.

If the voltage across R1 and R2 is low, and a voltage equal to the power supply voltage exists between a rotor lead and a stator lead, they have been interchanged. De-energize the circuit and check the wiring to locate the interchanged leads. Refer to *Wiring*, OP 1140A.

If the voltage across R1 and R2 is equal to the power supply voltage and yet there is voltage between the rotor and the stator connections, it indicates a short in the wiring. De-energize the circuit and check the wiring to locate the short. Refer to *Wiring*, OP 1140A.

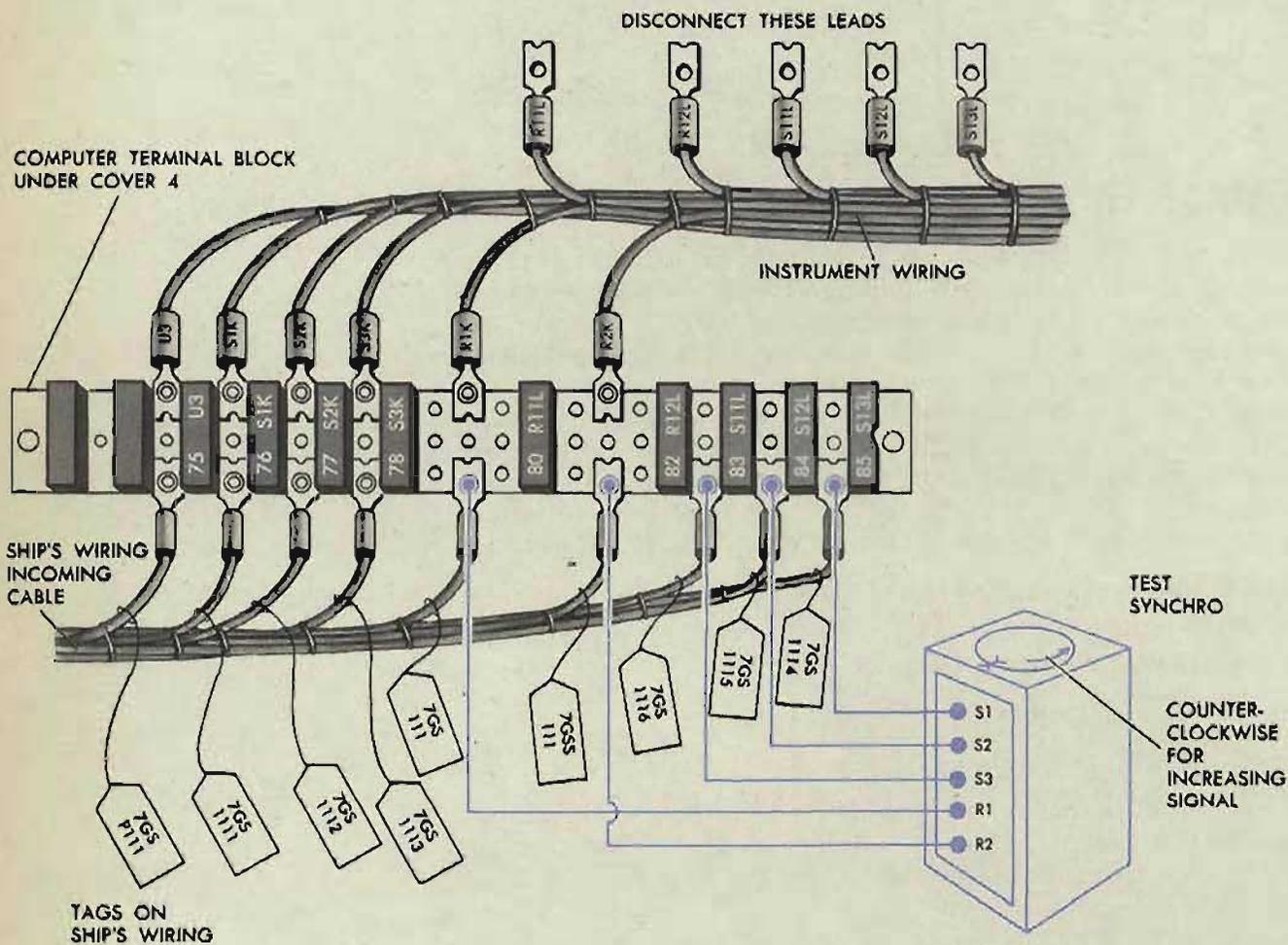
TEST SYNCHRO CHECK

A test synchro (standard motor) can be used to locate the error.

Using a test synchro to check a receiver

Disconnect the receiver leads at the computer terminal block to remove any possibility of feedback. Connect the test synchro to the ship's wiring at the proper terminals and energize the circuit.

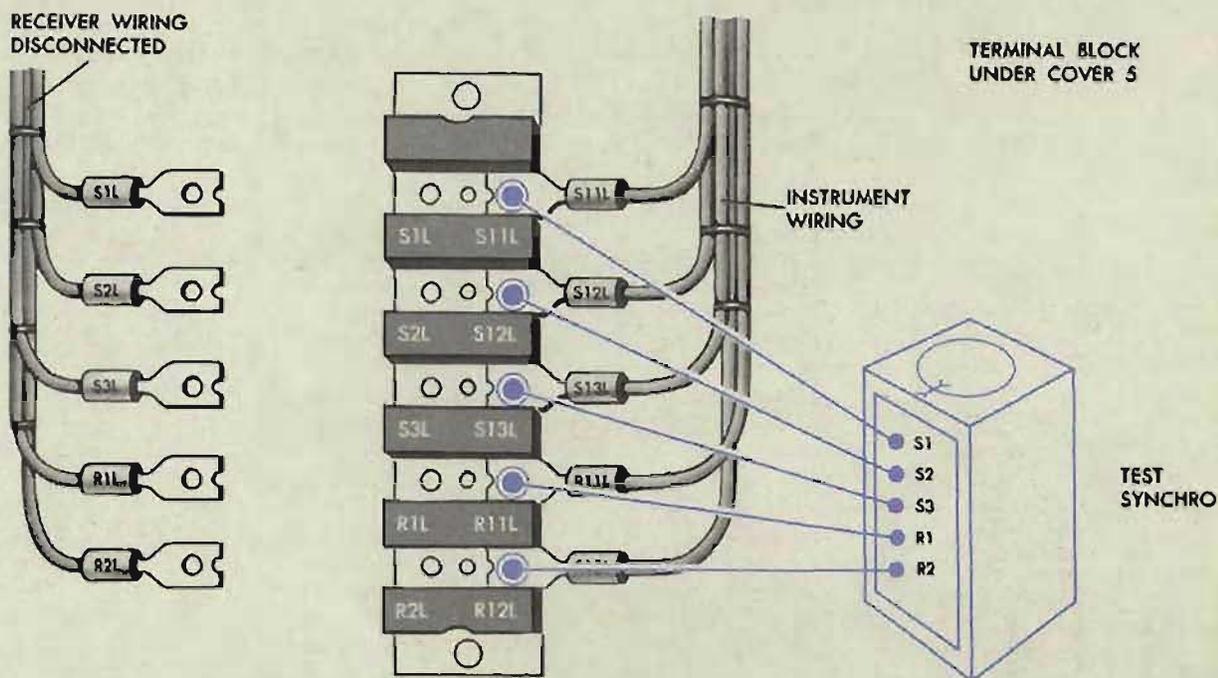
The illustration shows the fine synchro leads of the ship course receiver disconnected from the terminal block. The test synchro leads are connected to ship's wiring.



If the test synchro shows that the value being transmitted to the computer is in error, the trouble is not located in the computer. Refer to OP 1303.

If the test synchro shows that the value being transmitted to the computer is correct, but the receiver output is faulty, reconnect the receiver leads and move the test synchro to the receiver terminal block.

With the test synchro connected to the receiver terminal block of the fine synchro of the Co receiver, the lead connections would be as shown.



The test synchro now indicates whether the trouble is in the instrument wiring or the receiver. Refer to *Wiring, and Synchro Receivers*, OP 1140A.

Using a test synchro to check a transmitter

Disconnect the ship's wiring to the transmitter stator leads at the computer terminal block. Connect the standard test synchro to the instrument wiring at the proper terminals and energize the circuit.

If the test synchro shows that the value being transmitted from the computer is correct, the trouble is not in the computer. Refer to OP 1303.

If the test synchro shows that the value being transmitted from the computer is incorrect, reconnect ship's wiring to the transmitter stator leads and move the test synchro to the transmitter terminal block. The test synchro now indicates whether the trouble is in the instrument wiring or in the transmitter. Refer to *Wiring, and Synchro Transmitters*, OP 1140A.

TRANSMISSION TEST ANALYSIS TABLE

The following table will help to locate the cause of error. The transmitted value is electrical zero and the test synchro is the receiver.

Received Value	Direction of Rotation	Torque	Cause
300°	Reversed	Strong	S2 and S3 reversed, and R1 and R2 reversed
300°	Correct	Strong	R1 and R2 reversed, S3 to S1, S1 to S2 and S2 to S3
240°	Correct	Strong	S1 to S3, S2 to S1, S3 to S2
240°	Reversed	Strong	Reversed S1 and S2
180°	Correct	Strong	Reversed R1 and R2
180°	Reversed	Strong	S1 and S3 reversed, and R1 and R2 reversed
120°	Correct	Strong	S1 to S2, S2 to S3, S3 to S1
120°	Reversed	Strong	Reversed S2 and S3
90° or 270°	Correct	Strong	Shorted Rotor
60°	Correct	Strong	R1 and R2 reversed, S1 to S3, S2 to S1, S3 to S2
60°	Reversed	Strong	S1 and S2 reversed, and R1 and R2 reversed
0° or 180°	Correct	Weak	Open Rotor
0° or 180°	Correct at 0° Reversed at 180°	Weak	Open S2
0°	Reversed	Strong	Reversed S1 and S3
Dead Space 300° to 0°	Erratic	Weak	Open S1
Dead Space 0° to 60°	Erratic	Weak	Open S3
Locked on 120° or 300°			Shorted S1 and S2
Locked on 60° or 240°			Shorted S2 and S3
Locked on 0° or 180°			Shorted S1 and S3

The table is designed for a synchro calibrated at 360° per revolution and must be converted for a synchro with a different calibration. For example, on most destroyer installations, the value of the *So* receiver synchro is 40 knots per revolution. If the receiver synchronizes at 20 knots instead of 0 knots, refer to the table for "received value—180°." If there is a dead space between zero and 7 knots, refer to the table for "dead space—0° to 60°," etc. On a receiver such as the *Rj* receiver which has a value of 4000 yards per revolution, the limit stop which functions at OUT 1800 yards may prevent the unit from synchronizing "180—out." In some receivers it is possible to synchronize 360° out and still be in proper operation. The *So* receiver, which has a value of 40 knots per revolution, will synchronize at either 0 or 40 knots, and the *Rj* receiver will synchronize at 0, IN 4000, IN 8000, or IN 12,000 yards.

Dead space

The dead space, the area with zero torque, can be determined by gently moving the dial of the test synchro and checking the rotor torque. This dead space varies considerably, depending upon whether the lead is entirely open or is merely making poor contact. As the torque increases, the synchro hum also increases.

Direction of rotation

The direction of rotation depends upon whether the test synchro is connected to the instrument wiring or to external ship's wiring. When it is connected to ship's wiring, the correct direction of rotation is counterclockwise for an increasing signal. When it is connected to the instrument wiring, the correct direction of rotation must be obtained from the Navy lead designation charts pasted inside the cover. For example, the lead designation chart shows, for the fine *Co* receiver motor, a clockwise rotation for an increasing signal, so the test synchro should turn clockwise as *Co* is increased.

A locked rotor

If the rotor of the synchro is locked, or appears to be locked at certain positions as the input signal is changed, there may be mechanical jamming of the rotor or a short circuit between the *S* leads. See *Synchro Receivers*, OP 1140A, and OP 1303.

A short or ground

To locate a short or ground, disconnect the leads at both terminals and megger the leads with respect to each other and with respect to ground. Refer to *Wiring*, OP 1140A.

An open lead

To locate an open lead, touch one of the leads to ground and megger the other end to ground. Refer to *Wiring*, OP 1140A.

Part three

UNIT CHECK TESTS

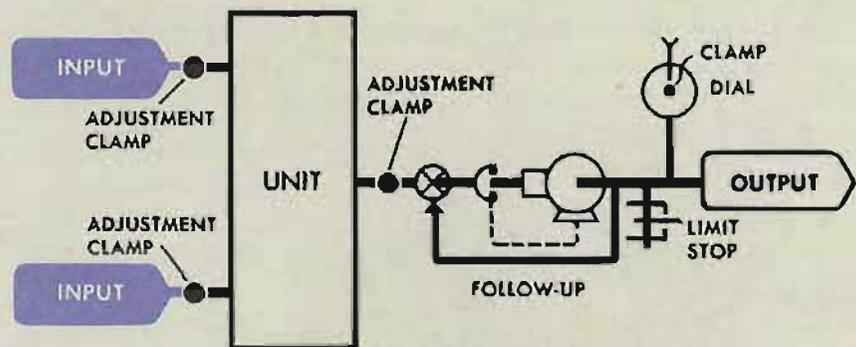
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UNIT CHECK TESTS

Unit check tests are quick tests of individual computing units or related groups of units. These tests will reveal mechanical defects and adjustment errors in a particular unit, or faulty adjustment of the unit to its input quantities. Unit check tests are used during analysis of A test errors whenever a specific unit or unit network must be checked for error.

These unit check tests are arranged in a definite order so that the procedure in many later tests depends upon obtaining satisfactory results from the earlier tests. Therefore, if several different unit or network checks are made, they should be performed in the order given.



A TYPICAL UNIT NETWORK

RUNNING THE UNIT CHECK TESTS

To run a check test, known input values are set up at the computer and the output values are read on the computer dials or counters. In many cases, the input quantities can be set, and the output quantities can be read, without removing any of the computer covers.

A summary of unit check tests is provided at the end of this chapter. For personnel familiar with the computer, these short tests will be found helpful in making quick unit checks to isolate faulty networks.

UNIT CHECK TEST ERRORS

For each unit check test, the correct output values are given. The actual output values of a unit are compared with the correct values to determine whether that unit is in error. An erroneous output will indicate that one of the elements of the unit being checked is incorrectly positioned.

Such an error may be caused by a faulty input, improper adjustment of the unit to its inputs, mechanical casualties in the unit, or follow-up trouble. Before any adjustments are changed, check the unit for broken parts, sticking, or excessive lost motion and check all follow-ups in the unit network.

If any mechanical casualties are found, refer to *Locating Casualties* and *Removal of Mechanisms* in this OP, and to OP 1140A for repair of the unit.

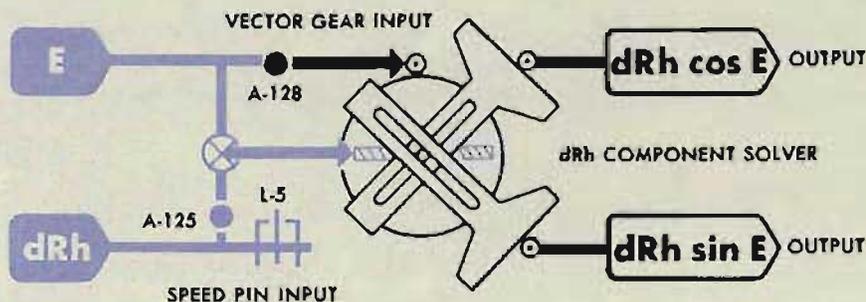
If there are no mechanical troubles but the unit check test indicates an error, check the inputs to the unit and the adjustment of the unit. See *A Test Analysis*, page 90.

CAUTION: Do not make any readjustments until the exact cause for error has been found.

If the error was caused by a slipped clamp, the reason for the slippage should be determined before the clamp is re-adjusted.

For example: Suppose that the results of tests indicate faulty operation of the dRh component solver. The relative motion component solver check test is made, and indicates that the vector gear of the dRh component solver is incorrectly positioned. The dRh network and component solver are checked for trouble, but no mechanical casualties are found. The A test analysis shows that A-128 is incorrectly adjusted.

It is possible that the clamp on A-128, though seemingly tight, will not hold the adjustment when subjected to excessive overload. Such an overload may occur when the E line is run into its limit stop at full speed.

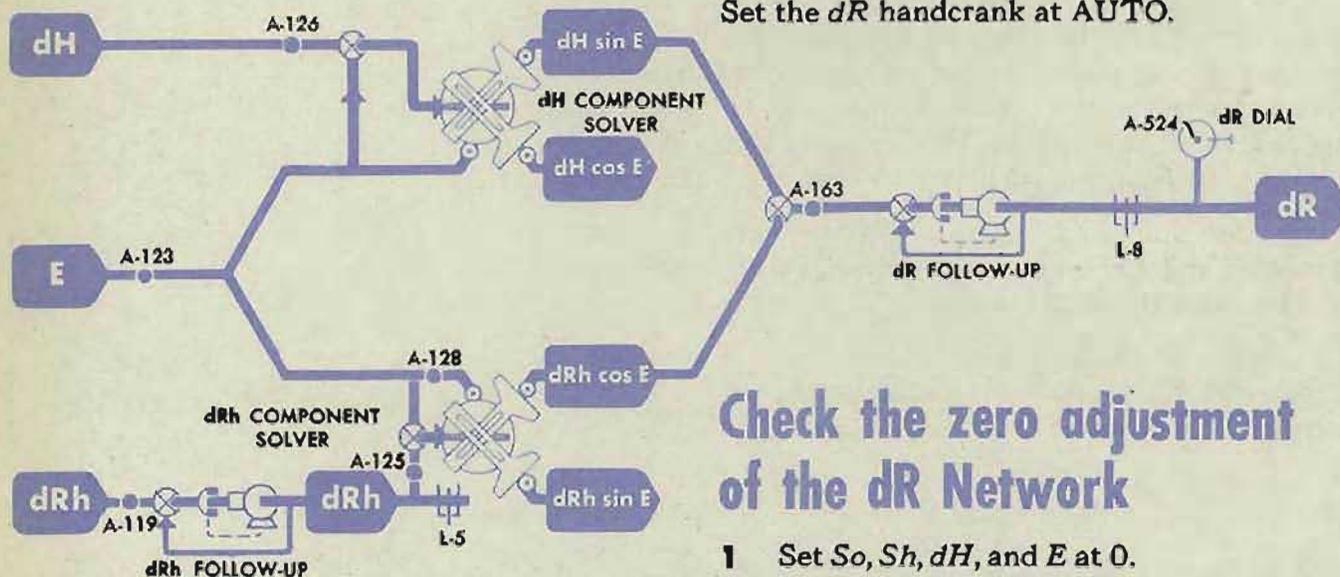


RELATIVE MOTION COMPONENT SOLVERS CHECK TESTS

Turn the power ON.

Turn the control switch to LOCAL.

Set the dR handcrank at AUTO.



Check the zero adjustment of the dR Network

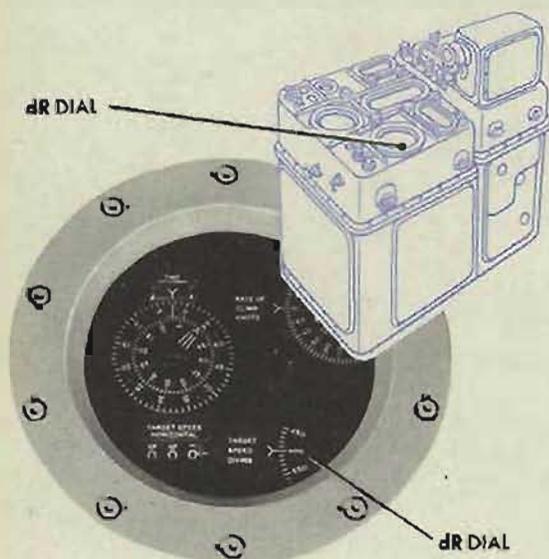
- 1 Set S_o , S_h , dH , and E at 0° .
- 2 Set B_r and A at 90° .
The dR dial should read 0 .

If the dR dial does not read 0° , either the dRh component solver lead screw is incorrectly positioned, or the dR follow-up and dial adjustment is incorrect.

- 3 Turn E from 0 to 85° .

If the dR dial moves toward 0 while E is increasing, the dRh component solver lead screw is incorrectly positioned. Continue the test to determine the cause of error.

If the dR dial does not move, but remains off 0 while E is rotated, check A-524, the dR follow-up, and the shaft line and gearing to the dR dial.



Check the speed pin of the Ship Component Solver

- 1 Set E at 0° .
- 2 Set S_o , S_h , and dH at 0 .
- 3 Set B_r and A at 90° .
 dR should read 0 , if the zero adjustment of the dR network is correct.

- 4 Turn the *Co* handcrank until *Br* reads 0° .
(*A* should remain at 90° .)

The *dR* dial should remain at 0 while *Br* is turned from 90° to 0° .

If the *dR* dial moves off 0, the *So* speed pin is incorrectly positioned.

Check the speed pin of the Target Component Solver

- 1 Set *E* at 0° .
- 2 Set *So*, *Sh*, and *dH* at 0.
- 3 Set *Br* and *A* at 90° .
- 4 Turn *A* from 90° to 0° .

The *dR* dial should remain at 0 while *A* is turned from 90° to 0° .

If the *dR* dial moves off 0, the *Sh* speed pin is incorrectly positioned.

Check the vector gear of the Ship Component Solver

- 1 Set *E* at 0° .
- 2 Set *Br* and *A* at 90° .
- 3 Set *Sh* at 0 knots.
- 4 Turn *So* from 0 to 45 knots.

The *dR* dial should not move while *So* is run from 0 to 45 knots.

If the *dR* dial does not remain at 0, the vector gear of the ship component solver is incorrectly positioned.

Check the vector gear of the Target Component Solver

- 1 Set *E* at 0° .
- 2 Set *A* and *Br* at 90° .
- 3 Set *So* at 0 knots.
- 4 Turn *Sh* from 0 to 400 knots.

The *dR* dial should remain at 0 while *Sh* is run from 0 to 400 knots.

If the *dR* dial does not remain at 0, the vector gear of the target component solver is incorrectly positioned.

Note:

If the dR dial reading varies from 0 by only a slight amount, turn the target angle handcrank until the dR dial moves back to 0.

Read A when dR equals zero.

If the A dial reading is then off 90° by less than half the width of a dial graduation line, do not adjust the A dial until further checks have been made. This apparent slight error may have been introduced purposely to improve C test results.

Check the lead screws of the dH and dRh Component Solvers

- 1 Set Br and A at 90° .
- 2 Set So , Sh , and dH at 0.
- 3 Turn E from 0° to 85° .

The dR dial should remain at 0 while E is turned from 0° to 85° .

If the dR dial does not remain at 0, either the dH or the dRh lead screw is incorrectly positioned.

- 4 Make sure that E is at 85° .
- 5 Turn the dH handcrank until the dR dial reads 0.
- 6 Turn E down from 85° to 0° .

If the dR dial reading then remains at 0 while E is decreased from 85° to 0° , the dH lead screw is incorrectly adjusted to the dH dial. The error equals the amount dH was turned from 0.

If the dR dial moves off 0 and then returns to a 0 position while E decreases from 85° to 0° , the dRh lead screw is incorrectly positioned and the zero adjustment of dR is incorrect.

Check the vector gear of the dRh Component Solver

- 1 Set Br at 90° .
- 2 Set A at 0° .

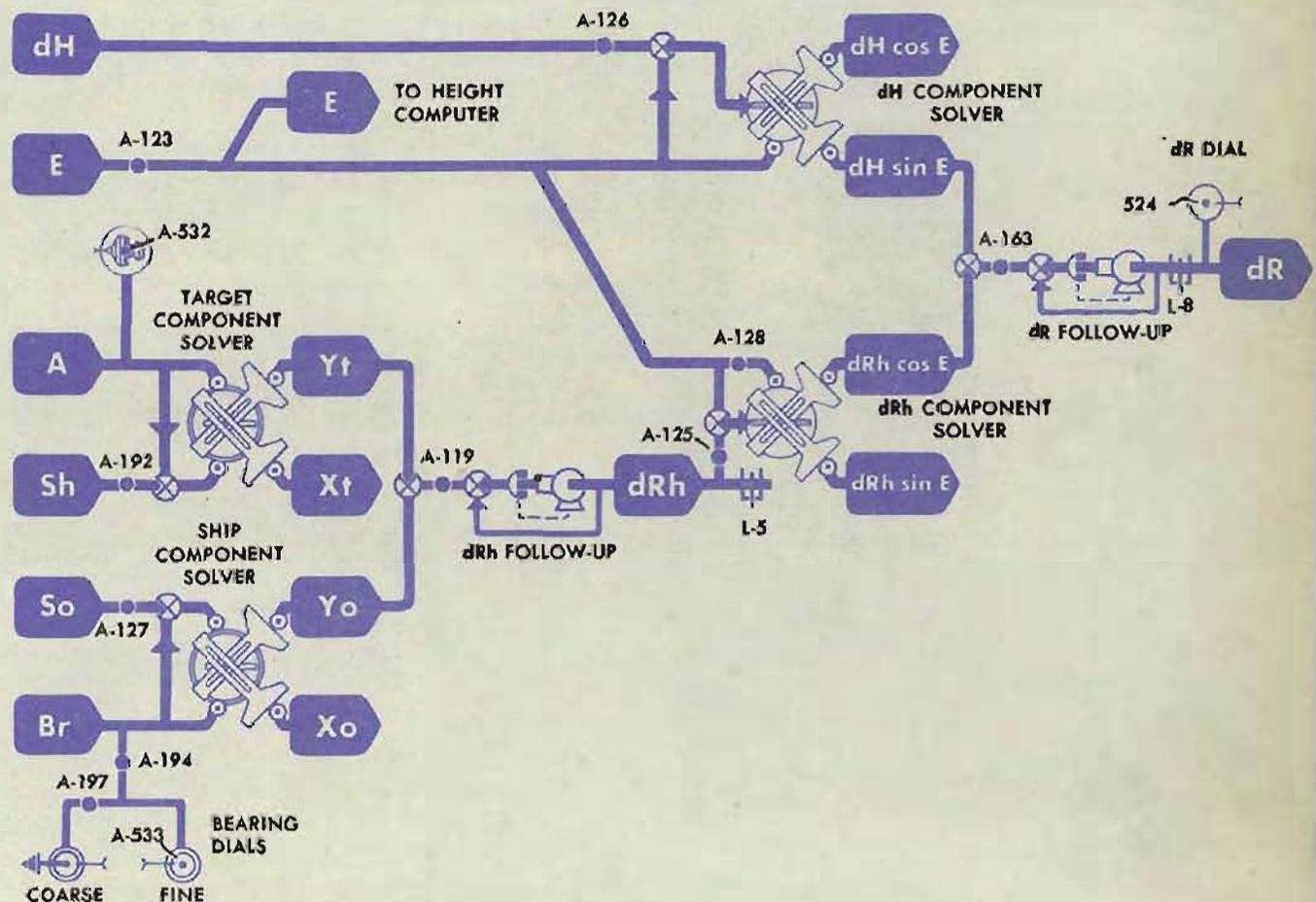
- 3 Set S_o and dH at 0.
 - 4 Set Sh at 400 knots.
 - 5 Set E at 60° .
- The dR dial should read -200 knots.

If the dR dial does not read -200 knots, the vector gear of the dRh component solver is incorrectly positioned.

Check the vector gear of the dH Component Solver

- 1 Set Br and A at 90° .
 - 2 Set S_o and Sh at 0.
 - 3 Set E at 30° .
 - 4 Set dH at DIVE 240 knots.
- The dR dial should read -120 knots.

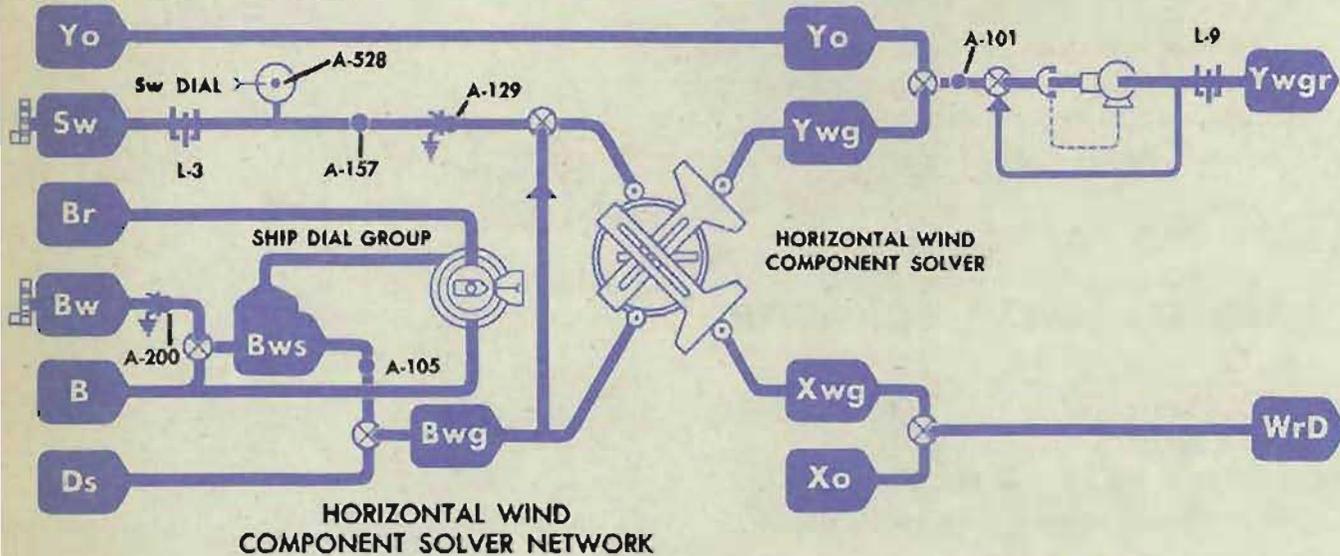
If the dR dial does not read -120 knots, the vector gear of the dH component solver is incorrectly positioned.



HORIZONTAL WIND COMPONENT SOLVER CHECK TEST

Method A using the Ywgr Follow-up

FROM SHIP COMPONENT SOLVER



Check the Speed Pin

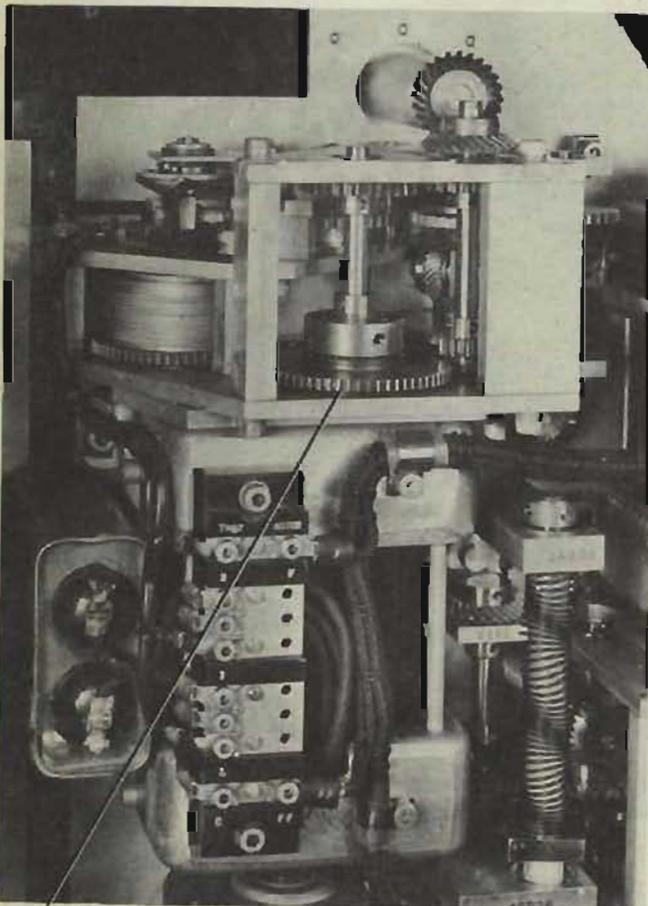
- 1 Turn the power ON.
- 2 Set *Sw* at 0 knots.
- 3 Mark the *Ywgr* follow-up output gearing for use as an indicator.
- 4 Turn *Bw* through 360°.

If there is any movement of the *Ywgr* follow-up output gearing during travel of *Bw* through 360°, the speed pin of the horizontal wind component solver is incorrectly positioned. (Allow movement of 5 teeth at friction gear.)

Check the Vector Gear

- 1 Set *Ds* at 500 mils.
- 2 Set *Bws* at 90° as follows:
Set *Co*, *Br*, and *Bw* at 0, carefully lining up *Bw*. Turn *Br* to 90°, bringing the whole dial group around, thus setting *Bws* at 90°.
- 3 Run *Sw* from 0 to 60 knots.

If there is any movement of the *Ywgr* follow-up output gearing during travel of *Sw* from 0 to 60 knots, the vector gear of the horizontal wind component solver is incorrectly positioned. (Allow movement of 10 teeth at friction gear.)



OBSERVE *Ywgr* OUTPUT
GEAR FOR MOTION
(UNDER COVER 5)

Method B

using the Star Shell Deflection Counter

Check the Speed Pin

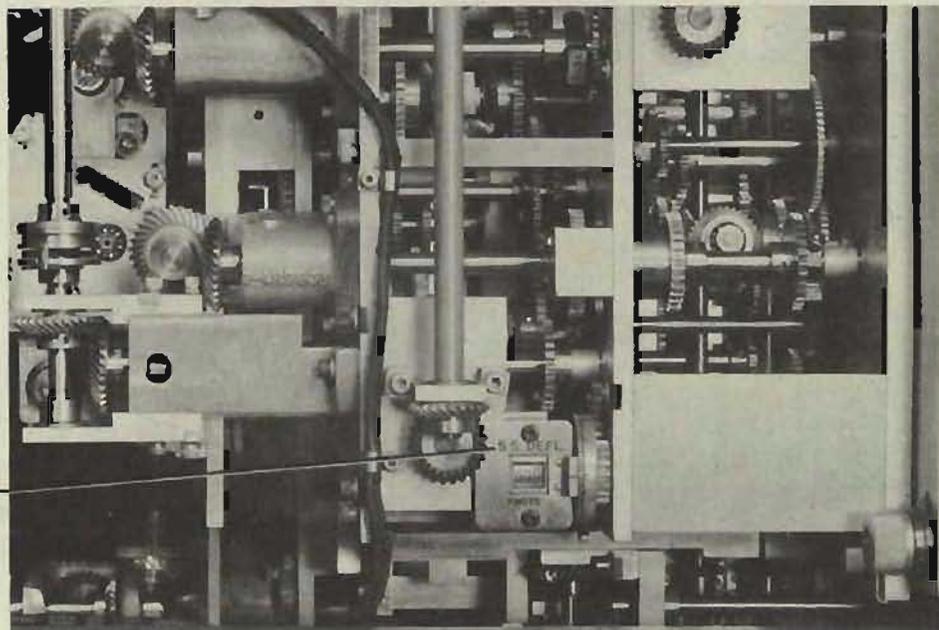
- 1 Turn the power ON.
- 2 Set S_o , S_h , S_w at 0 knots.
- 3 Remove cover 3 and read the star shell deflection counter.
- 4 Turn B_w through 360° .

If there is any movement of the star shell deflection counter when B_w is turned through 360° , the speed pin of the horizontal wind component solver is incorrectly positioned (Allow 0.1-knot error, i.e., one small division on the counter drum.)

Check the Vector Gear

- 1 Set D_s at 500 mils.
- 2 Set B_{ws} at 0° as follows:
Set C_o , B_r and B_w at 0° , carefully lining up B_w , thus setting B_{ws} at 0° .
- 3 Run S_w from 0 to 60 knots.

If there is any movement of the star shell deflection counter when S_w is run from 0 to 60 knots, the vector gear of the horizontal wind component solver is incorrectly positioned. (Allow 0.2-knot error.)



S.S. DEFLECTION
COUNTER
(UNDER COVER 3)

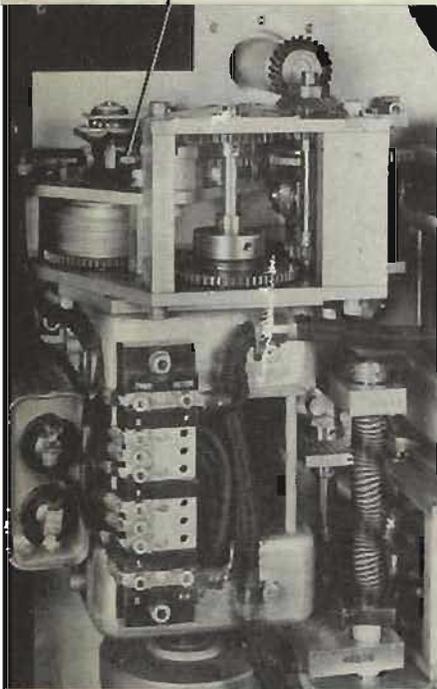
ELEVATION WIND COMPONENT SOLVER CHECK TEST

Check the Lead Screw

- 1 Turn the power ON.
- 2 Turn the control switch to LOCAL.
- 3 Set B_r , A , and B_{ws} at 90° .
Set S_o , S_h , S_w , and dH at 0 knots.
Set D_s at 500 mils.
Set E_2 at 80° with sync E handcrank at CENTER.
Set dR at 0 with the dR handcrank IN.
Set $I.V.$ at 2550 f.s.
- 4 Set cR at 17,000 yards to give a large value to Tf .
 R_2 should read approximately 17,000 yards.
- 5 Turn E_2 from 80° to 0° .
The reading on the R_2 counter should not change while E_2 is decreased from 80° to 0° .

If the reading on the R_2 counter changes, the lead screw of the elevation wind component solver is incorrectly positioned.

Ywgr FOLLOW-UP CONTACTS (BEHIND COVER 5)



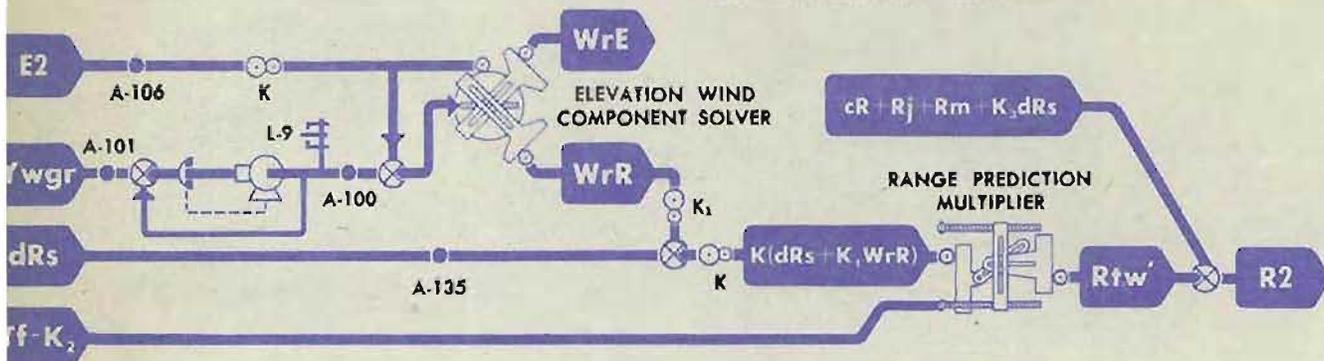
Check the Vector Gear

- 1 Set E_2 at 78.95° .
Put the V_s handcrank IN.
- 2 Offset the contacts of the $Ywgr$ follow-up control to run $Ywgr$ slowly through its full travel, and observe the R_2 counter.

If there is any movement of the R_2 counter during full travel of $Ywgr$, the vector gear of the elevation wind component solver is incorrectly positioned.

CAUTION:

Do not run the $Ywgr$ follow-up by offsetting the contacts if the lead screw and limit stop are not correctly adjusted.



HEIGHT COMPUTER CHECK TEST

Check the Height Dials

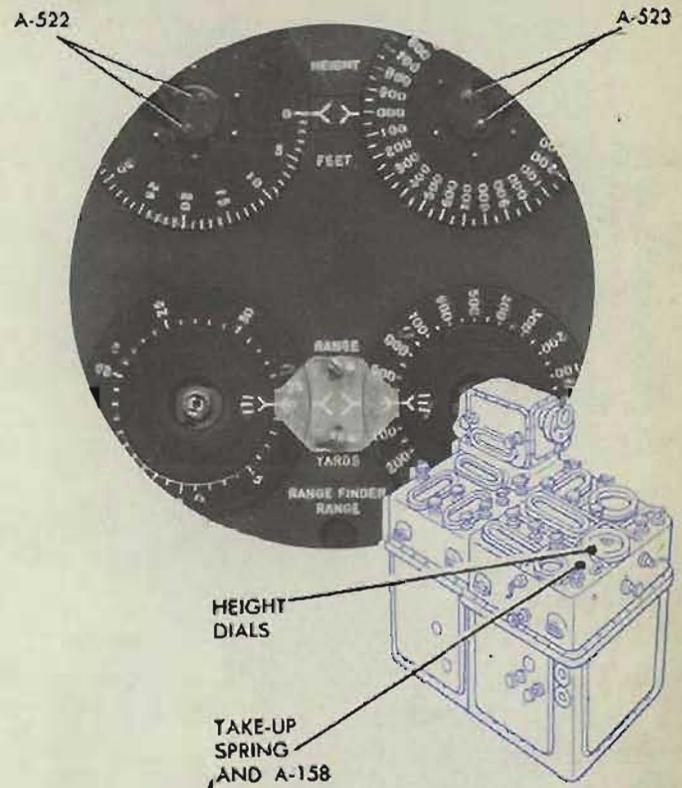
- 1 Turn the power ON.
- 2 Set E at 0° .
- 3 Set cR at 0 yards.

The height dials should read 0000 feet.

If the height dials do not read 0000 feet:

- 1 Check the gearing for sticks.
- 2 Check the dials for binding against the dial mask.
- 3 Check the tension on the take-up spring. See readjustment of A-158 on page 402 before attempting to change the spring tension.

If the spring has sufficient tension, and there are no sticks in the gearing, check A-522 and A-523.

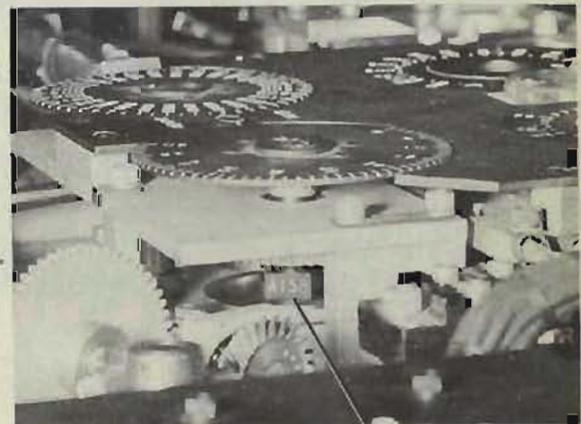


Check the Vector Gear

- 1 Set E at 0° .
- 2 Turn cR from 0 to 35,000 yards (the upper limit of cR).

The height dials should read 0000.

If the height dials do not read 0000, the vector gear of the height computer is incorrectly positioned.



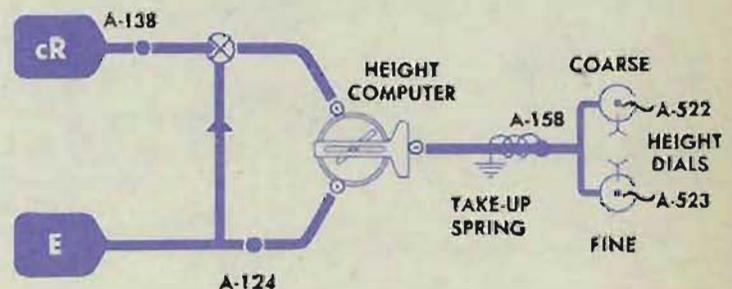
A-158

Check the Cam

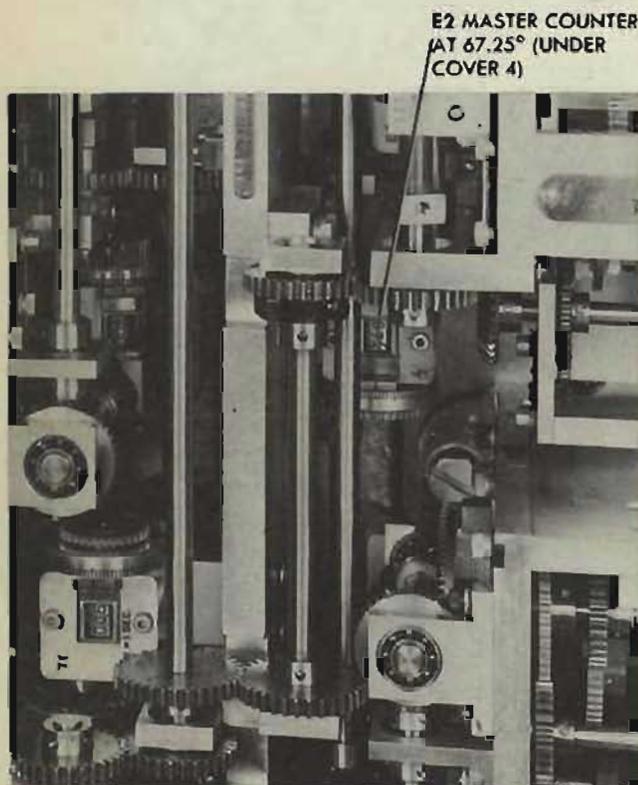
- 1 Set E at 30° .
- 2 Set cR at 10,000 yards.

The height dials should read 15,000 feet.

If the height dials do not read 15,000 feet, the cam of the height computer is incorrectly positioned.



COMPLEMENTARY ERROR CORRECTOR CHECK TEST

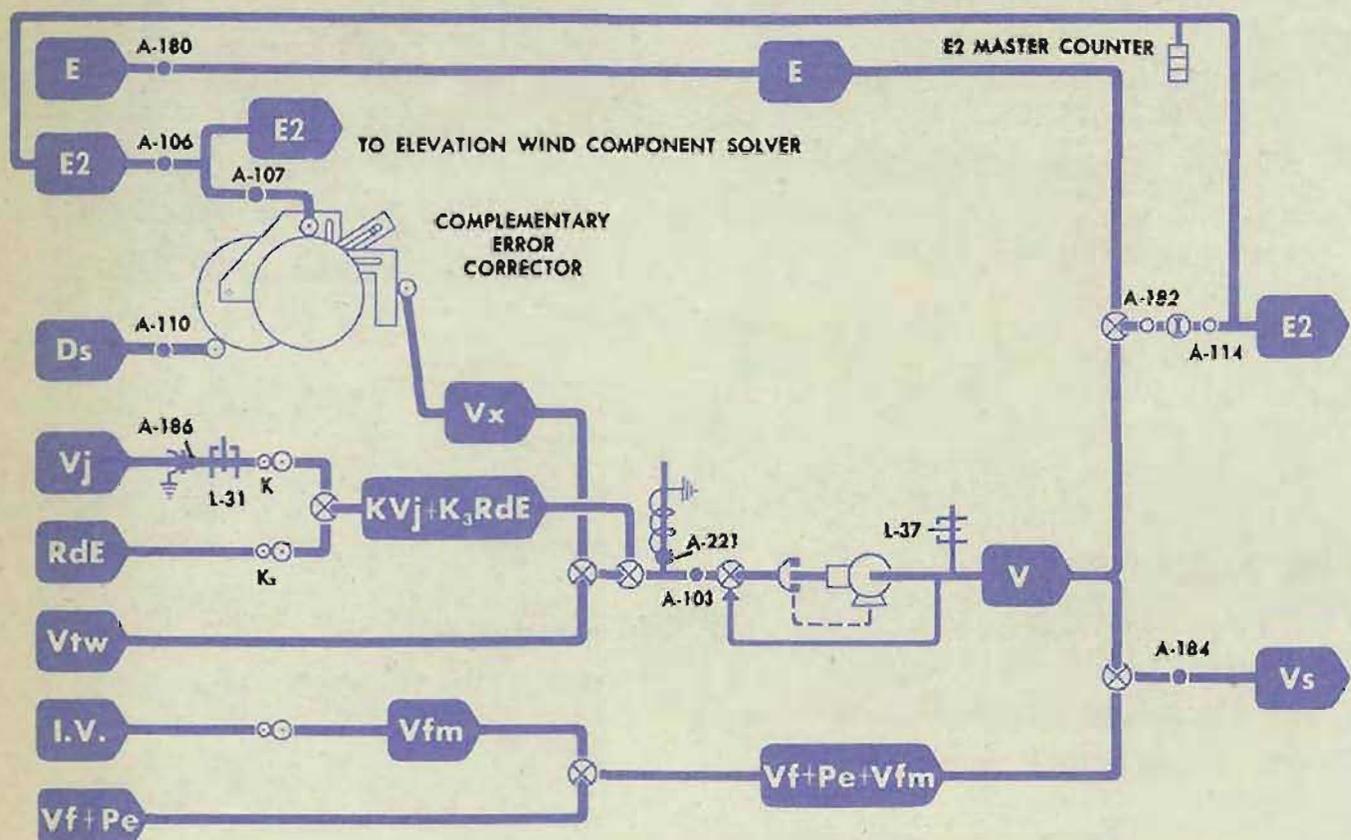


- 1 Turn the power ON.
- 2 Pull the V_s handcrank OUT.
Set S_o , S_h , S_w , and dH at 0 knots.
Set $I.V.$ at 2550 f.s.
Set V_j at 0.
Set D_s at 500 mils.
Set $E2$ at 80.00° with the sync E handcrank at CENTER.
- 3 Decrease D_s until the D_s counter reads 100 mils. Then read the $E2$ counter and record the reading.
- 4 Increase D_s until the D_s counter reads 900 mils. Again read the $E2$ counter and record the reading.

Compare the readings of $E2$ obtained in steps 3 and 4. If the readings are not equal, the D_s cam is incorrectly positioned. (Allow 0.05° difference.)

The readings of $E2$ obtained in steps 3 and 4 should be 67.25° . However, if they are equal to each other, but are not 67.25° , the $E2$ cam is incorrectly positioned. (Allow $\pm 0.05^\circ$ error in $E2$.)

COMPLEMENTARY ERROR CORRECTOR NETWORK



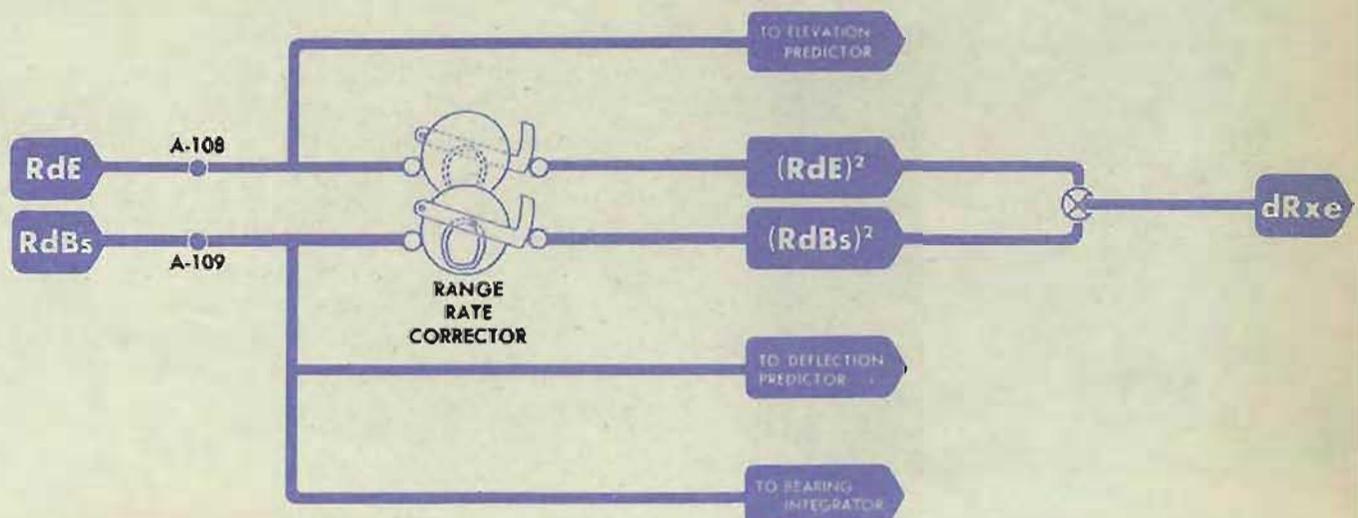
RANGE RATE CORRECTOR CHECK TEST

- 1 Turn the power ON.
- 2 Set S_o , S_h , and dH at 0.
- 3 Insert a 1/16-inch diameter setting rod through the holes in both cams, both followers, and the mounting plate. The rod should enter to a depth of 2 inches.

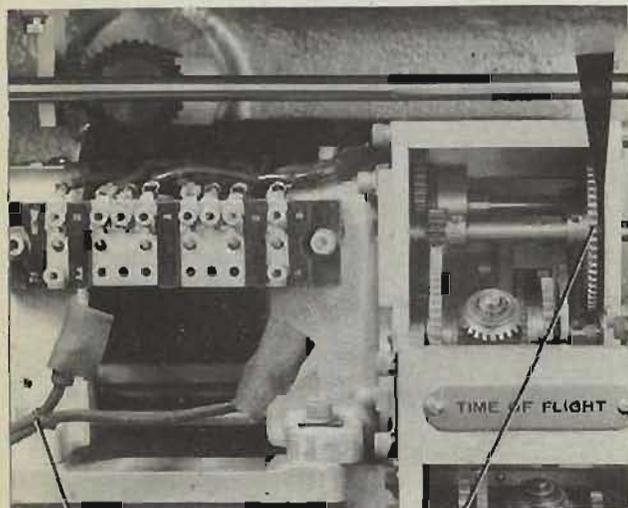
If the setting rod cannot be inserted through the $(RdE)^2$ cam, the RdE input is incorrectly positioned.

If the setting rod cannot be inserted through the $(RdBs)^2$ cam, the $RdBs$ input is incorrectly positioned.

CAUTION:
DO NOT DISTURB ANY COMPUTER SETTING WHILE THE SETTING ROD IS INSERTED, OR THE UNIT MAY BE DAMAGED. REMOVE THE SETTING ROD WHEN THE CHECK TEST IS COMPLETED.

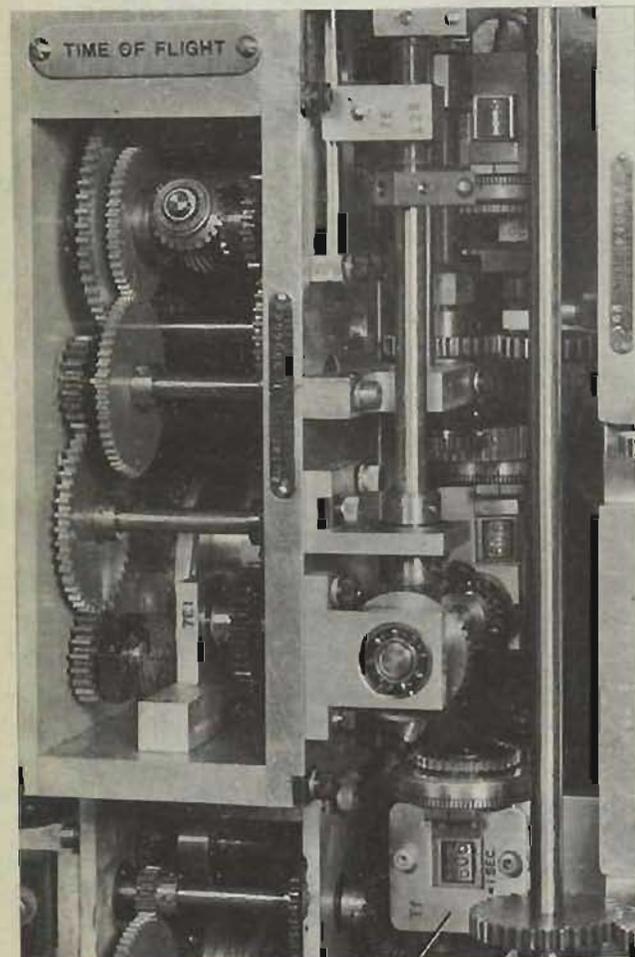


RANGE PREDICTION MULTIPLIER CHECK TEST



POWER LEADS A AND AA
REMOVED

TF FOLLOW-UP
OUTPUT GEARING WEDGED



TF COUNTER

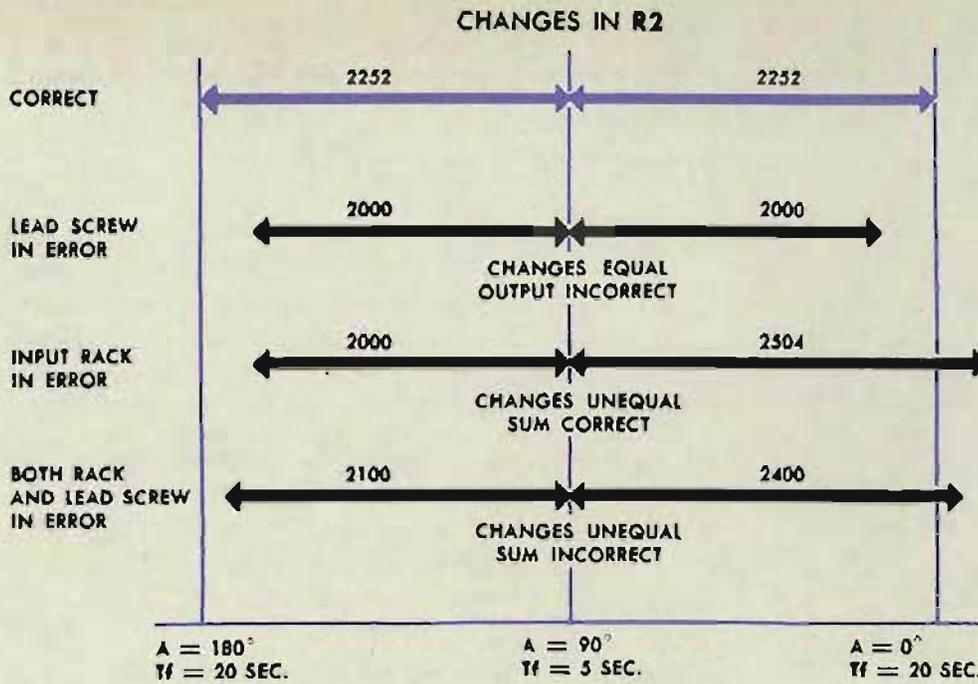
Preliminary check

- 1 Remove power leads A and AA from the *Tf* follow-up. Turn the output gearing to set the *Tf* counter at 5.00 sec. (050) and wedge the line.
- 2 Turn the power ON.
- 3 Turn the control switch to LOCAL.
- 4 Set *Br*, *A*, and *Bws* at 90° .
Set *E* at 0° .
Set *So*, *Sh*, *Sw*, *dH*, and *Rj* at 0.
Set *I.V.* at 2550 f.s.
Set *Ds* at 500 mils.
Turn the *dR* handcrank to AUTO.
Set *cR* at 8000 yards.
R2 should read 8000 yards. Record the actual reading.

If the *R2* indicating counter does not read 8000 yards, check all *R2* counters and the *R2* follow-up control. (Refer to *A Test Analysis*, page 122.)

Checking the Range Prediction Multiplier

- 1 Remove the wedge and turn the *Tf* follow-up output gearing until the *Tf* counter reads 20.00 sec. Rewedge.
- 2 Check the previously made settings.
Change *A* to 0° .
Change *Sh* to 200 knots.
R2 should decrease 2252 yards to make the *R2* counter read 5748 yards. Record the actual change from the reading taken in step 4 above.
- 3 Turn *A* from 0° to 180° .
The *R2* counter should now read 10,252 yards (2252 yards more than 8000). Record the actual change from the reading taken in step 4 above.



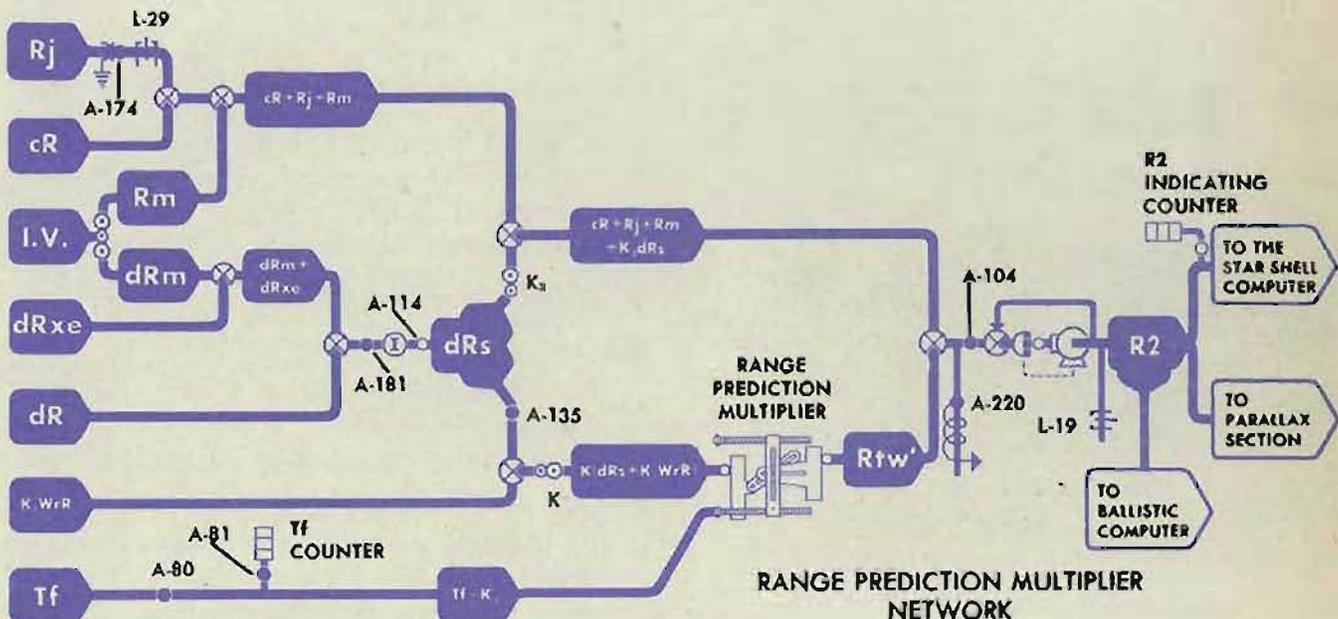
If both changes in $R2$ are not equal to 2252 yards, either the input rack, or the lead screw, or both, may be in error.

If the changes are equal, but greater or less than 2252 yards, the lead screw is incorrectly positioned.

If the sum of the two changes is 4504 but the changes are unequal, the input rack is incorrectly positioned.

If the sum of the changes is greater or less than 4504 yards, and the changes are unequal, both the input rack and the lead screw are incorrectly positioned.

Remove the wedge from the Tf line, and reconnect the power leads on the follow-up.



ELEVATION PREDICTION MULTIPLIER CHECK TEST

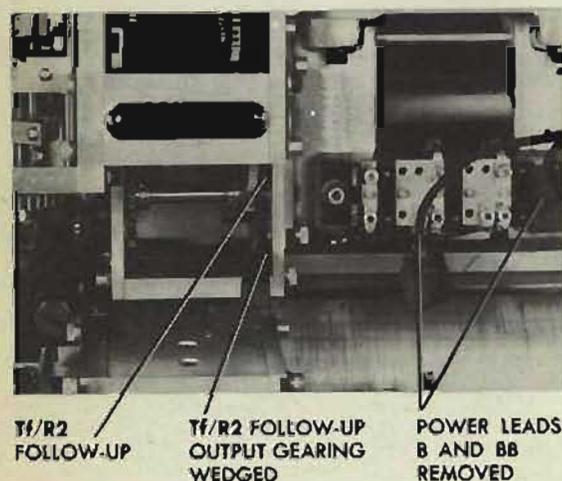
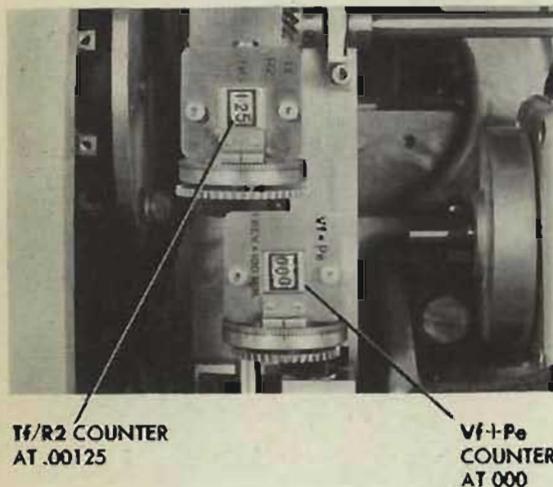
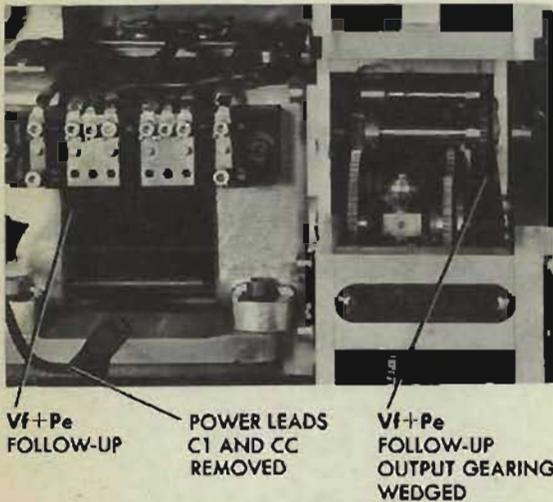
Preliminary check

- 1 Remove the power leads C1 and CC on the $Vf + Pe$ follow-up. Turn the output gearing to set the $Vf + Pe$ counter at 0, and wedge the line.
- 2 Remove the power leads B and BB from the $Tf/R2$ follow-up. Turn the output gearing to set the $Tf/R2$ counter at .00125 and wedge the line.
- 3 Turn the power ON.
- 4 Turn the control switch to LOCAL.
- 5 Set So , Sh , Sw , and Vj at 0.
Set Br , A , and Bws at 90° .
Set E at 0° .
Set dH at 0 knots.
Set $I.V.$ at 2550 f.s.
Set Ds at 500 mils.
Pull the Vs handcrank OUT.
The Vs indicating counter should read 2000'.
Record the actual reading.

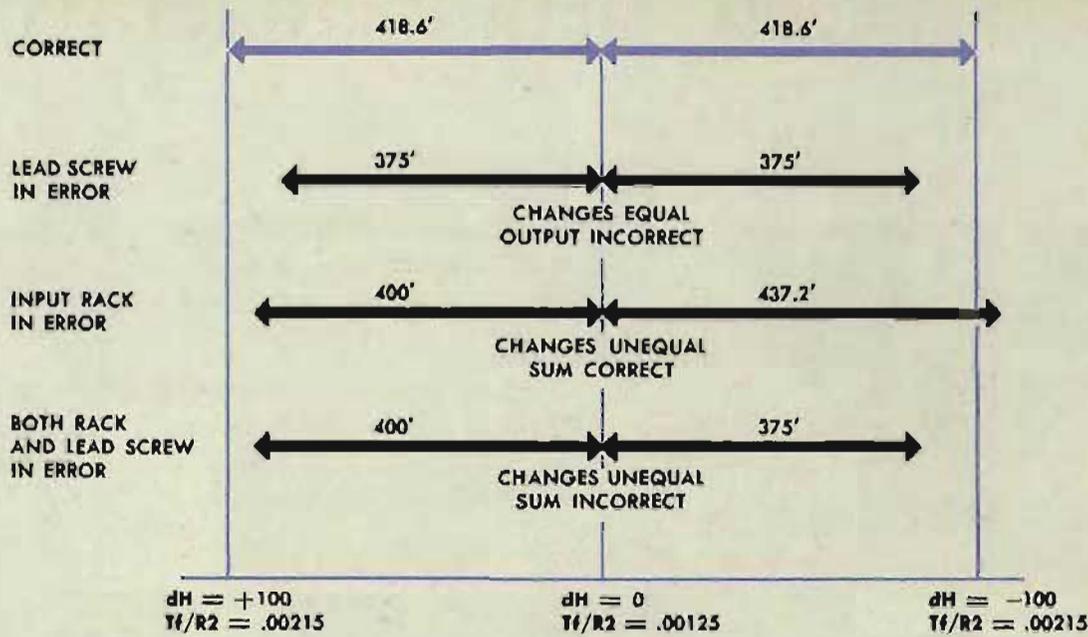
If the Vs indicating counter does not read 2000', check the V follow-up, A-103, and A-55.

Checking the Elevation Prediction Multiplier

- 1 Remove the wedge and turn the $Tf/R2$ follow-up output gearing to set the $Tf/R2$ counter at .00215.
Rewedge the line.
- 2 Check the previously made settings.
- 3 Set dH at +100 knots.
 Vs should increase 418.6' (the Vs counter should read 2418.6'). Record the change from the reading obtained in step 5 above.
- 4 Set dH at -100 knots.
 Vs should decrease 418.6' (the Vs counter should read 1581.4'). Record the change from the reading obtained in step 5 above.



CHANGES IN V_s



If both changes in V_s are not equal to 418.6', either the input rack or the lead screw, or both, may be in error.

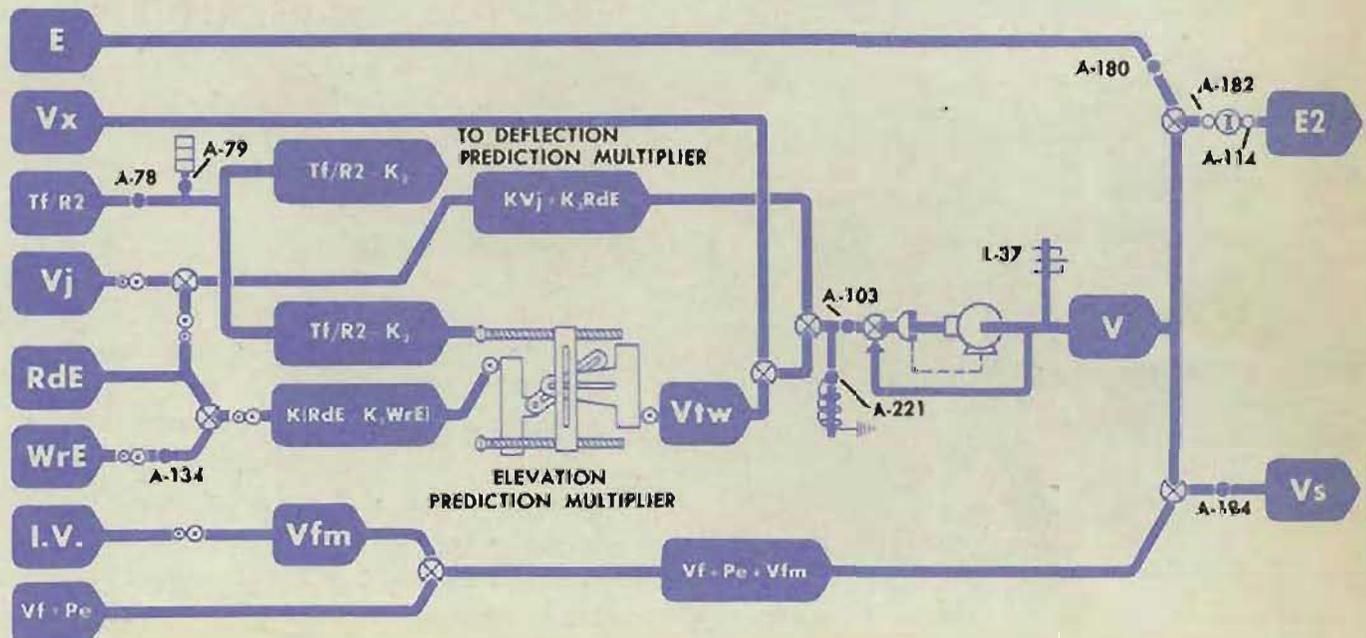
If the changes are equal, but greater or less than 418.6', the lead screw is incorrectly positioned.

If the sum of the two changes is 837.2', but the changes are unequal, the input rack is incorrectly positioned.

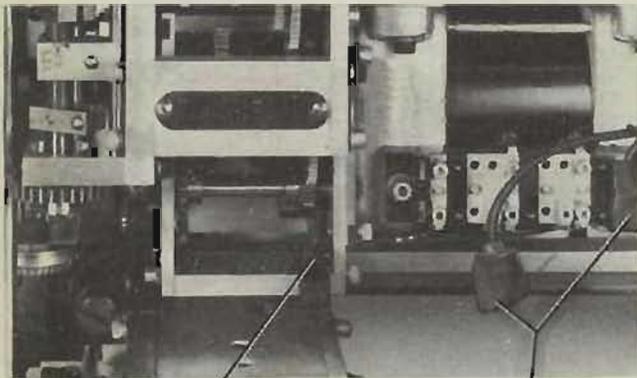
If the sum of the changes is greater or less than 837.2', and the changes are unequal, both the input rack and the lead screw are incorrectly positioned.

Remove the wedges from the $Vf + Pe$ and $Tf/R2$ lines, and reconnect the power leads on both follow-ups.

ELEVATION PREDICTION MULTIPLIER NETWORK

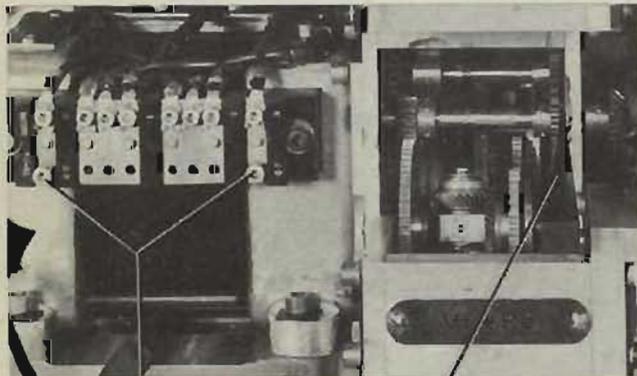


DEFLECTION PREDICTION MULTIPLIER CHECK TEST



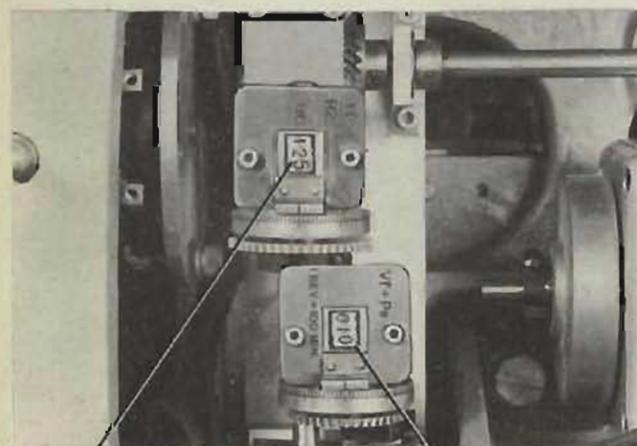
T1/R2 FOLLOW-UP OUTPUT
GEARING WEDGED

POWER LEADS
B AND BB REMOVED



POWER LEADS C1 AND CC
REMOVED

T1+Pe FOLLOW-UP
OUTPUT GEARING
WEDGED



T1/R2 COUNTER
READING .00125

T1+Pe COUNTER
READING 100 MIN.

Preliminary check

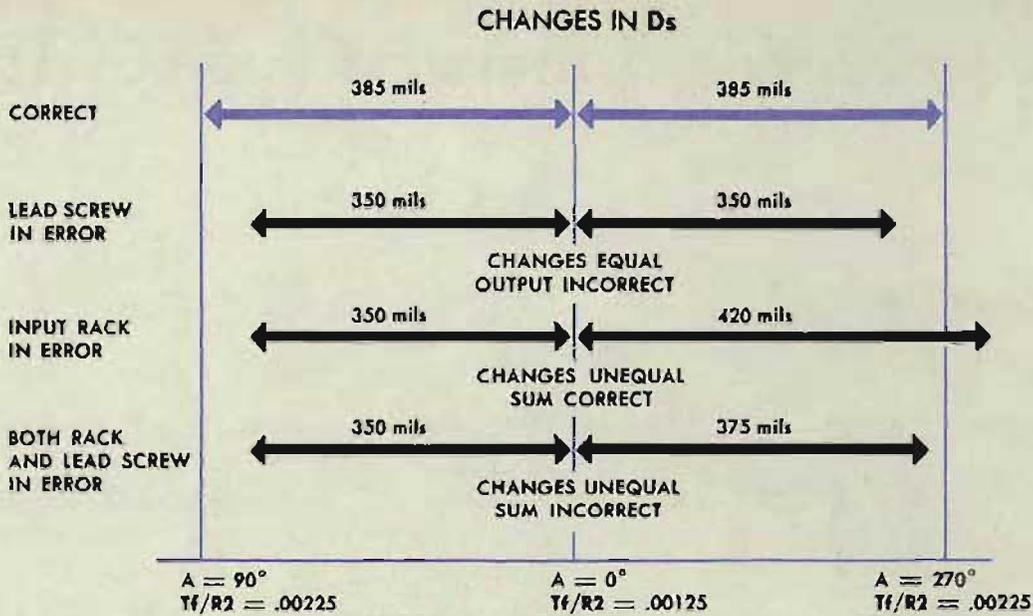
- 1 Remove power leads C1 and CC on the $Vf + Pe$ follow-up. Turn the output gearing until the $Vf + Pe$ counter reads 100' (010) and wedge the line.
- 2 Remove power leads B and BB from the $T1/R2$ follow-up. Turn the $T1/R2$ line until the $T1/R2$ counter reads .00125 and wedge the line.
- 3 Turn the power ON.
- 4 Turn the control switch to LOCAL.
- 5 Set Br , A , and Bws at 0° .
Set So , Sh , Sw , and Dj at 0.
Set $I.V.$ at 2550 f.s.
Pull the Ds handcrank OUT.
The Ds counter should read 500 mils.
Record the reading.

If the Ds counter does not read 500 mils, check A-89, A-102, and the $Dtwj$ follow-up.

Checking the Deflection Prediction Multiplier

- 1 Remove the wedge and turn the $T1/R2$ line until the $T1/R2$ counter reads .00225, and rewedge.
- 2 Set Sh at 300 knots.
- 3 Turn A from 0° to 90° .
 Ds should increase 385 mils. (The Ds counter should read 885 mils.) Record the change from the reading obtained in step 5 above.

Turn A from 90° to 270° . Ds should return to 500 mils and then decrease 385 mils. (The Ds counter should read 115 mils.) Record the change from the reading obtained in step 5 above.



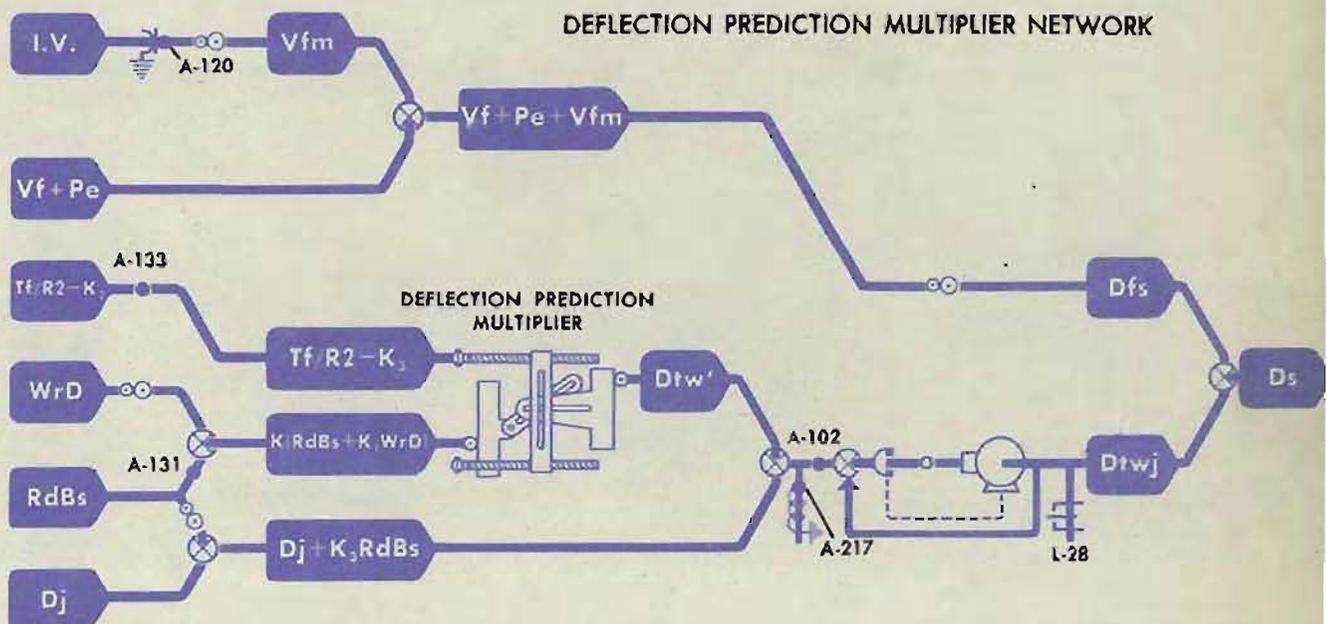
If both changes in D_s are not equal to 385 mils, either the input rack, or the lead screw, or both, may be in error.

If the changes are equal, but greater or less than 385 mils, the lead screw is incorrectly positioned.

If the sum of the two changes is 770 mils, but the changes are *unequal*, the input rack is incorrectly positioned.

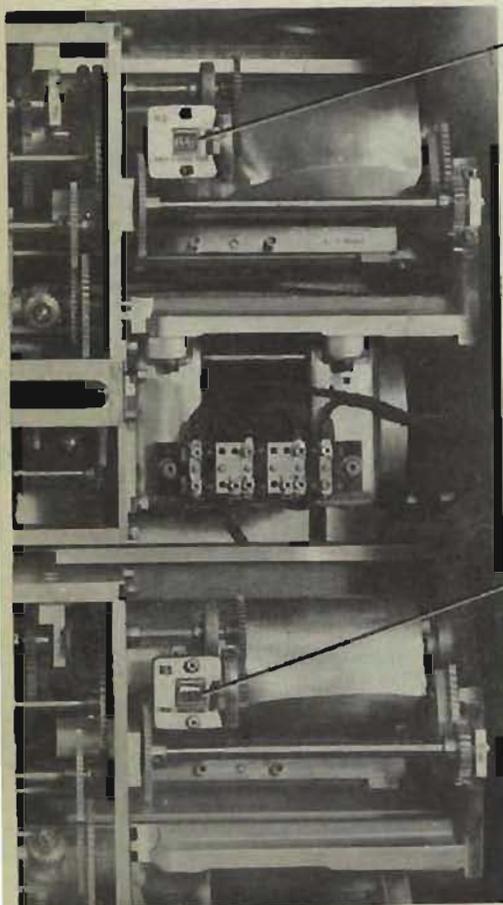
If the sum of the changes is greater or less than 770 mils, and the changes are unequal, both the input rack and the lead screw are incorrectly positioned.

Remove the wedges from the $Vf + Pe$ and $Tf/R2$ lines, and reconnect the power leads on both follow-ups.



DEAD TIME PREDICTION MULTIPLIER CHECK TEST

Preliminary check



R2 COUNTER
OF T1/R2
BALLISTIC
COMPUTER

R3 COUNTER
OF FUZE
BALLISTIC
COMPUTER

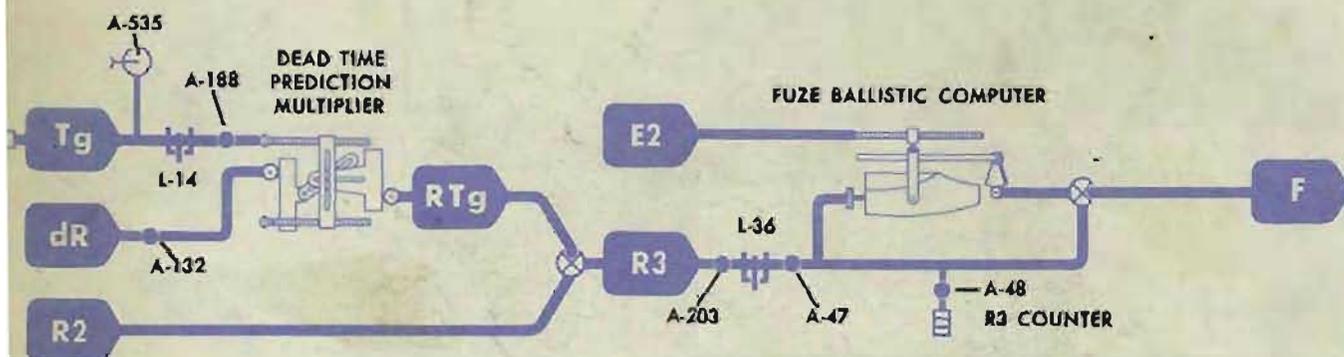
- 1 Turn the power ON.
- 2 Set the dR handcrank at AUTO.
- 3 Set S_o , S_h , and dH at 0.
- 4 Set Tg at 0.
- 5 (Ser. Nos. 781 and higher.) Set $I.V.$ at 2500 f.s.
- 6 (Ser. Nos. 781 and higher.) Disconnect the power leads on the fuze ballistic computer follow-up, and set F equal to Tf .

The $R3$ counter in the fuze ballistic computer should agree with the $R2$ counters. If the $R3$ and $R2$ counters do not agree, check the input rack and the lead screw of the dead time prediction multiplier.

Check the Input Rack

- 1 Using the generated range crank, set $R3$ at 3000 yards.
- 2 Turn Tg to 6 seconds.
- 3 (Ser. Nos. 781 and higher.) Increase F to its upper limit of travel.

The value on the $R3$ counter should not change while Tg or F is increased. If it does change, the input rack of the dead time prediction multiplier is incorrectly positioned.



SER. NOS. 780 AND LOWER

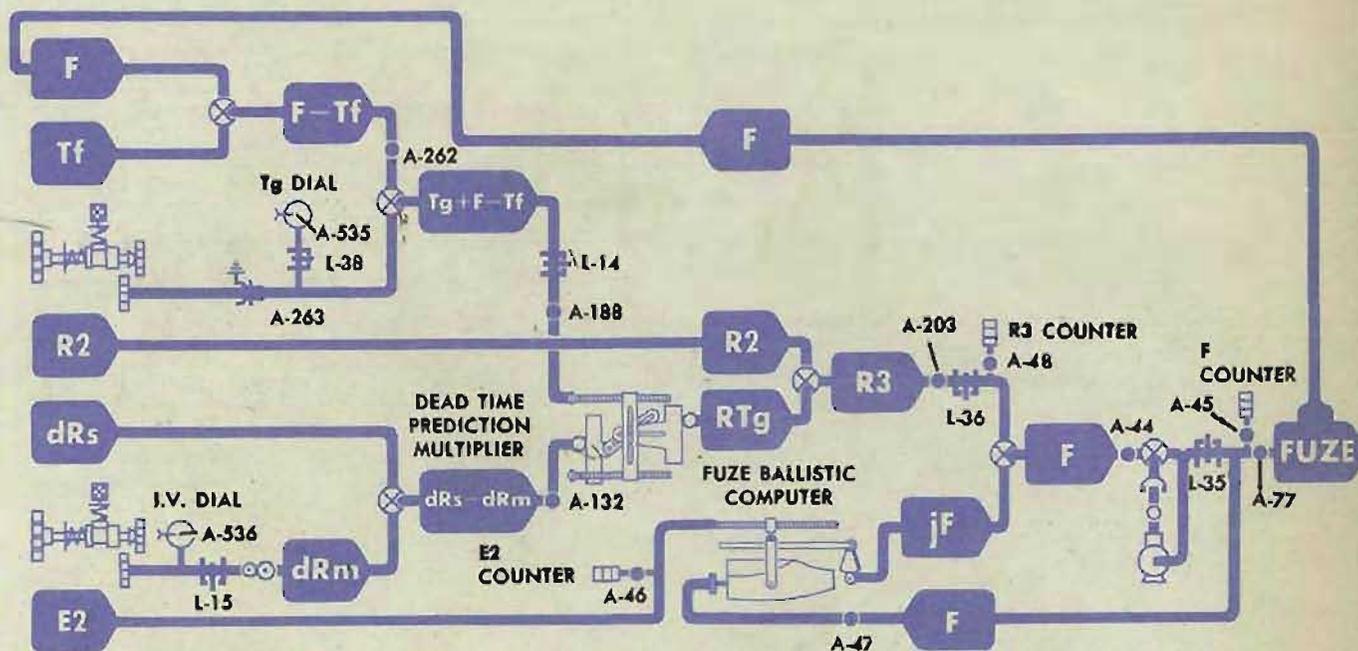
Check the Lead Screw

- 1 Set T_g at 0 seconds.
- 2 Disconnect the power leads from the $R2$ follow-up, and wedge $R2$ at 3000 yards.
- 3 (Ser. Nos. 781 and higher.) Set F equal to T_f .
- 4 With the dR handcrank IN, turn the dR line from -450 knots to $+450$ knots.

The value on the $R3$ counter should not change while dR is turned. If it does change, the lead screw of the dead time prediction multiplier is incorrectly positioned.

After the multiplier check is completed, remove all wedges and replace the power leads on the F and $R2$ follow-ups.

If the dead time prediction multiplier shows no errors, check A-203.



SER. NOS. 781 AND HIGHER

BALLISTIC COMPUTER CHECK TESTS

The four ballistic computer units are:

- The $Vf + Pe$ ballistic computer
- The $Tf/R2$ ballistic computer
- The Tf ballistic computer
- The Fuze ballistic computer

Test data required for making the ballistic computer check tests may be obtained from the record of N.I.O. factory acceptance tests supplied with each instrument. A sample test form is shown below.

COMPUTER MK. 1
MOD. 7, 11, 13

RESTRICTED

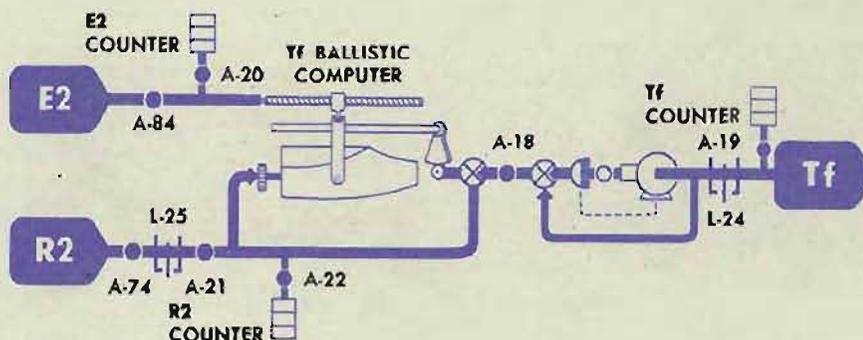
ORD. SK. 104371-5
FICO DRG. NO. 36096-5

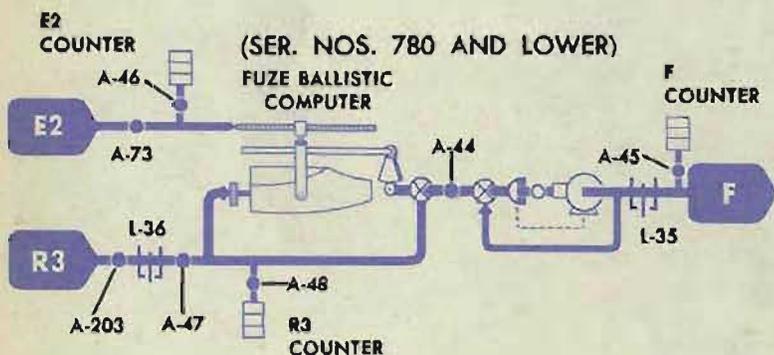
BALLISTIC COMPUTER TEST												
TIME OF FLIGHT (SEC.)												
R2	600 YDS.			3000 YDS.			6000 YDS.			8000 YDS.		
E2	CALC.	READ.	ERROR	CALC.	READ.	ERROR	CALC.	READ.	ERROR	CALC.	READ.	ERROR
0°	0.73			4.14			9.92			15.07		
30°	0.74			4.24			10.41			15.94		
50°	0.74			4.28			10.54			16.23		
70°	0.74			4.29			10.53			16.24		
TOTAL ERROR												
R2	10000 YDS.			12000 YDS.			14000 YDS.			16000 YDS.		
E2	CALC.	READ.	ERROR	CALC.	READ.	ERROR	CALC.	READ.	ERROR	CALC.	READ.	ERROR
0°	21.22			28.37			36.54			46.47		
30°	22.78			31.47								
50°	23.48			34.16								
70°	23.75											
TOTAL ERROR												
GRAND TOTAL ERRORS(25)												
ALLOW. .02					AVG. ERROR							
ALLOW. .02					MAJ. ERROR							
ALLOW. .06					MAX. ERROR							
N.I.O. LIMITS												

Checking the Ballistic Computer

The check tests of all four ballistic units are made in the same manner, except that the input and output values are read on the counters in the particular unit being checked. The procedure for making the *Tf* ballistic computer check test is given below:

- 1 Remove cover 4.
- 2 Turn the power ON.
- 3 Set the *E2* check counter in the *Tf* ballistic unit at 0.00° with the sync *E* handcrank at CENTER.
- 4 Set the *R2* check counter in the *Tf* ballistic unit at 600 yards. Because changing *R2* may change *E2*, check *E2* after each setting of *R2*.
- 5 Read and record the value of *Tf*.
- 6 Set *R2* at 3000 yards, 6000 yards, etc., as indicated on the test form.
- 7 Read and record the value of *Tf* for each setting of *R2*.
- 8 Complete the unit test with *E2* at 30° , 50° , and 70° .
- 9 Compute the errors by comparing each reading with its calculated value.
- 10 Calculate the average, majority, and maximum errors.
- 11 Compare the average, majority, and maximum errors with the allowable limits.



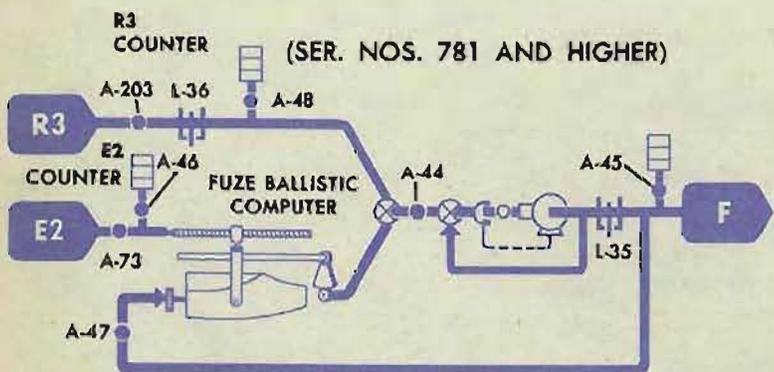


Correcting the errors

If the errors greatly exceed the allowable limits, check the ballistic computer for mechanical troubles. Refer to *Ballistic Computers*, OP 1140A. Check the ballistic computer follow-up.

If the errors exceed the allowable limits by a small amount, the ballistic computers can usually be readjusted without removal.

If the errors are constant (same magnitude and same sign) proceed as follows:

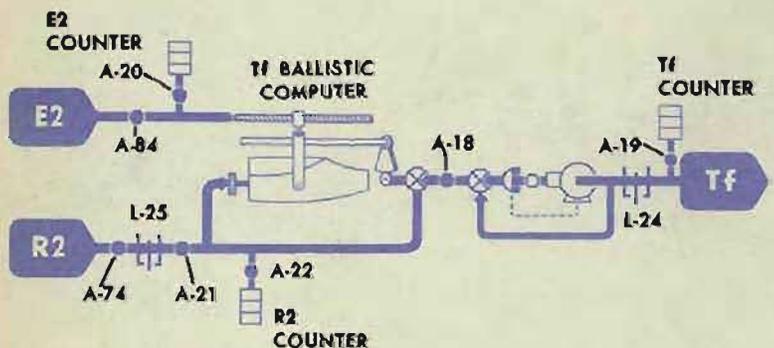


For the Fuze ballistic unit, in computers with Ser. Nos. 780 and lower, check A-44 and A-45. In computers with Ser. Nos. 781 and higher, check A-45.

For the *Tf* ballistic unit, check A-18 and A-19.

For the *Tf/R2* ballistic unit, check A-37 and A-38.

For the *Vf + Pe* ballistic unit, check A-13 and A-14.



If the errors change progressively as $R2$ (or $R2m$ or $R3$) is changed while $E2$ is kept constant, proceed as follows:

For the Fuze ballistic unit in computers with Ser. Nos. 780 and lower, check A-48. In computers with Ser. Nos. 781 and higher, check A-47 and A-44.

For the Tf ballistic unit, check A-22.

For the $Tf/R2$ ballistic unit, check A-42.

For the $Vf + Pe$ ballistic unit, check A-17.

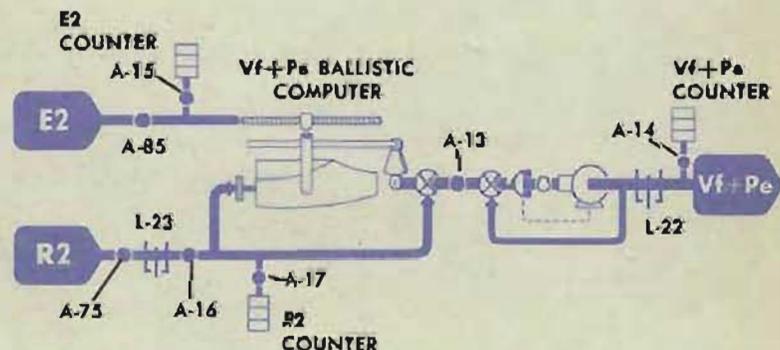
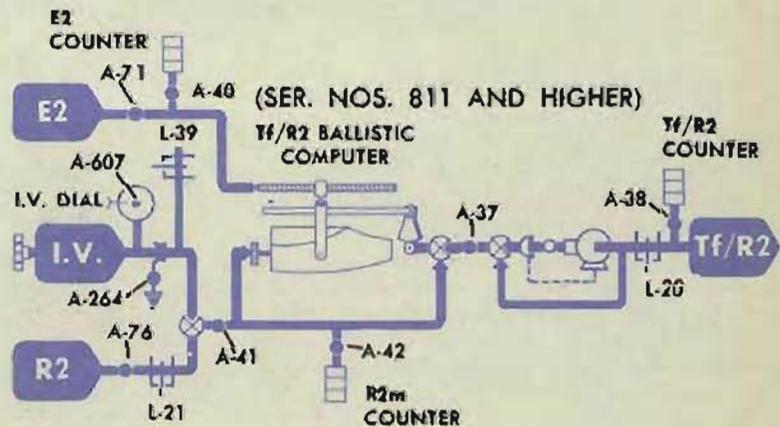
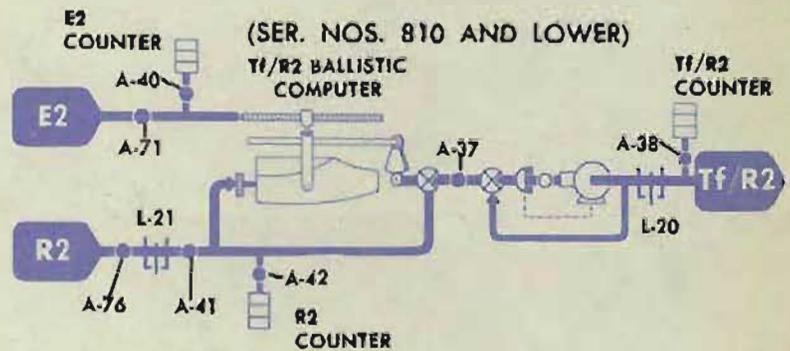
If the errors change progressively as $E2$ is changed while $R2$ is kept constant, proceed as follows:

For the Fuze ballistic unit, check A-46.

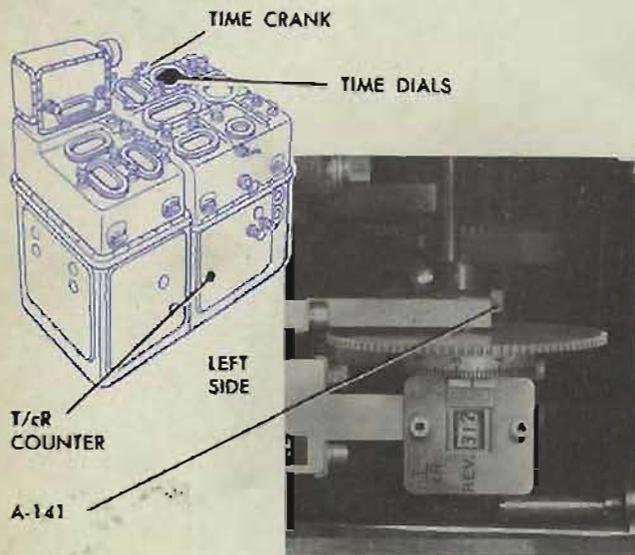
For the Tf ballistic unit, check A-20.

For the $Tf/R2$ ballistic unit, check A-40.

For the $Vf + Pe$ ballistic unit, check A-15.



T/cR INTEGRATOR CHECK TEST



T/cR COUNTER READS 312.34 AT START OF TIME INTERVAL

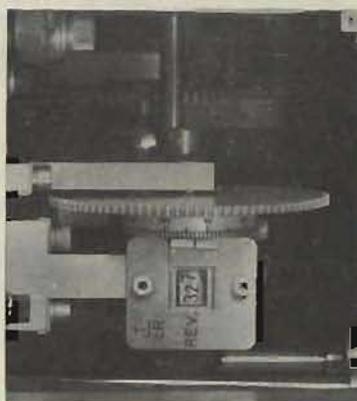
PART OF RECORD FORM PROVIDED IN NAVORD 1229

TROUBLE ANALYSIS TESTS		INTEGRATOR TIMING					
T/cR INTEGRATOR TEST							
CALC.		14.99	19.98	29.97	39.96	49.94	199.81
RANGE		20000	18000	10000	7500	5000	1500
DATE	CH. BY	R.R.M. OF T/cR COUNTER					
		15.03					

CALCULATED NUMBER OF REVOLUTIONS

RECORD HERE THE DIFFERENCE BETWEEN THE INITIAL READING AND THE READING AFTER ONE MINUTE

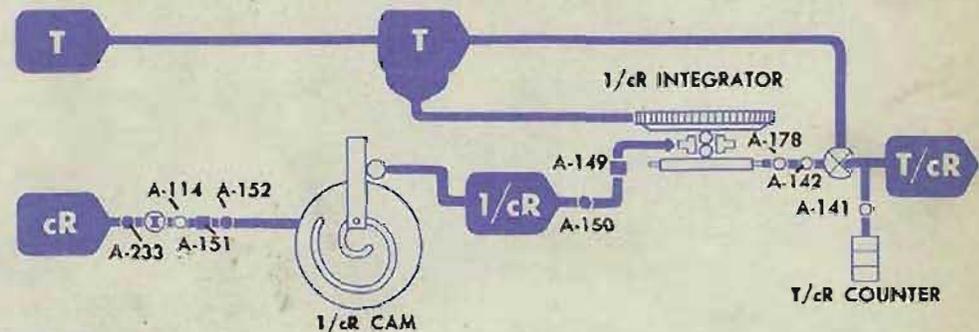
T/cR COUNTER READS 327.37 AFTER ONE MINUTE



- 1 Remove cover 3.
- 2 Turn the power ON.
- 3 Turn the control switch to SEMI-AUTO.
- 4 Disconnect the range integrator or establish a zero range rate. (For this procedure, refer to *B Tests*, page 33.)
- 5 Tighten A-141 with the gear in mesh.
- 6 Set cR at 20,000 yards.
- 7 With the time crank in the OUT position; turn the time line until the index on the half-second dial lines up exactly with the fixed index.
- 8 With the time crank in the IN position, turn the time line until the seconds dial reads 0 against the fixed index.
- 9 Read the value on the T/cR counter.
- 10 Turn the time crank in the OUT position to increase the speed on the time line *gradually*. Then turn the time motor ON.
- 11 Allow the time line to turn until the seconds dial reads approximately 55 sec. Then turn the time motor OFF.
- 12 Turn the time crank in the OUT position, until the seconds dials reads 0 and the index on the half-second dial is lined up *exactly* with the fixed index.
- 13 Read the T/cR counter. Compute and record the difference between the initial and the present reading.

For example: Suppose that the T/cR counter reads 312.34 when the seconds dial reads 0 before the time line is turned, and that after one minute, the T/cR counter reads 327.37. The difference between these two counter readings is $327.37 - 312.34$, or 15.03. This indicates that the T/cR counter has made 15.03 revolutions for one revolution of the time-seconds dial. Record the number of revolutions in the space provided.

- 14 Complete the T/cR integrator check test in the same manner with cR at 15,000 yards, 10,000 yards, etc.
- 15 Compute the errors by subtracting the calculated values from the recorded values. For example: Suppose a reading of 15.03 is recorded in the 20,000-yards range test for which the calculated value is 14.99. The error is $15.03 - 14.99$, or $+0.04$.

THE T/cR INTEGRATOR NETWORK

Correcting the errors

Before correcting any errors, compare them with previous values from tests run after satisfactory B test results were obtained. Reduce the errors to these previously recorded values. If no records are available, reduce the errors to an average near $+0.05$. In either case, reduce the errors by following the procedure given below.

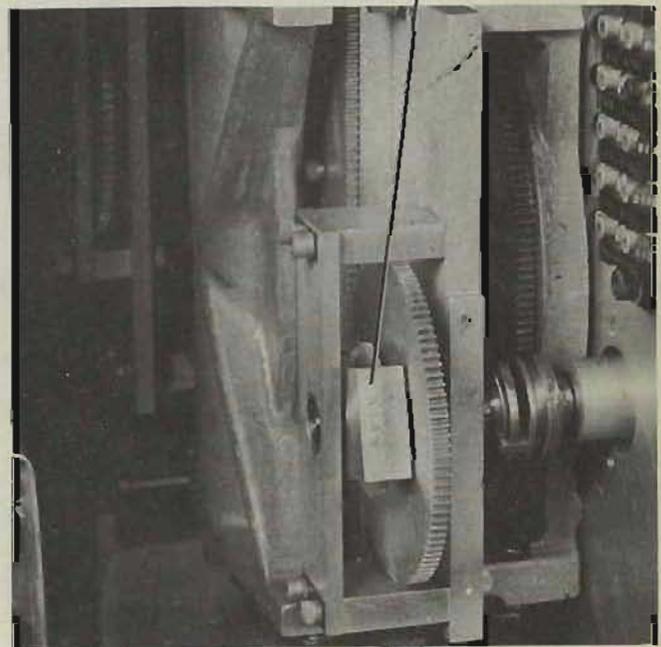
If there are errors of several complete revolutions of the T/cR counter, check for mechanical trouble. Check the cR line, the $1/cR$ cam, and the $1/cR$ integrator. Refer to *Locating Casualties* and to OP 1140A. If these units have been removed and reinstalled, tighten A-114 and readjust A-233, A-151, and A-150. If there is no A-150 on the instrument, readjust at the gear mesh.

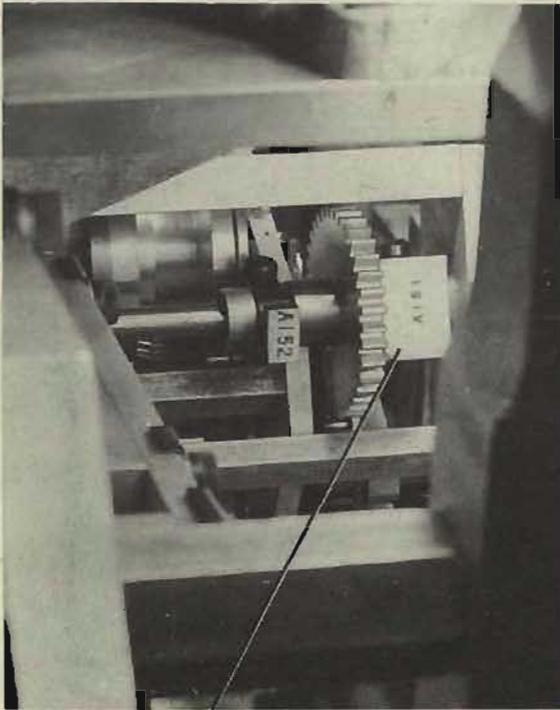
Repeat the T/cR integrator check test.

If the readings differ from the desired values by relatively small amounts, refine the vernier adjustments A-149 and A-151 as follows:

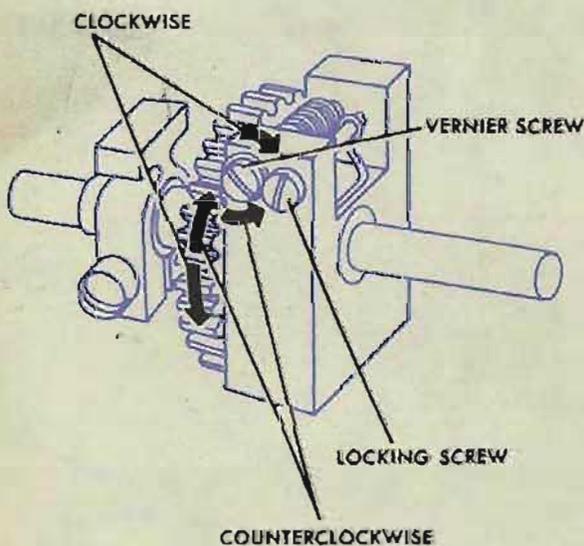
- 1 Loosen the locking screw on A-149. Turn the vernier screw counterclockwise to increase the integrator output, i.e., to correct a negative error. Turn the vernier screw clockwise to decrease the integrator output, i.e., to correct a positive error. Tighten the locking screw.

VERNIER ADJUSTMENT
A-149 (UNDER COVER 5)





VERNIER ADJUSTMENT
A-151 (UNDER COVER 5)



- 2 Set cR at 20,000 yards. Run the T/cR check test at this range only, and refine A-149 until the desired test value is obtained.
- 3 Set cR exactly at 1500 yards. Run the T/cR check test at this range only.
- 4 Loosen the locking screw on A-151. Turn the vernier screw counterclockwise to increase the integrator output, i.e., to correct a negative error. Turn the vernier screw clockwise to decrease the integrator output, i.e., to correct a positive error. Tighten the locking screw.
- 5 Again run the T/cR check test with cR set exactly at 1500 yards. Refine A-151 until the desired test value is obtained.
- 6 Repeat the full T/cR integrator check test.

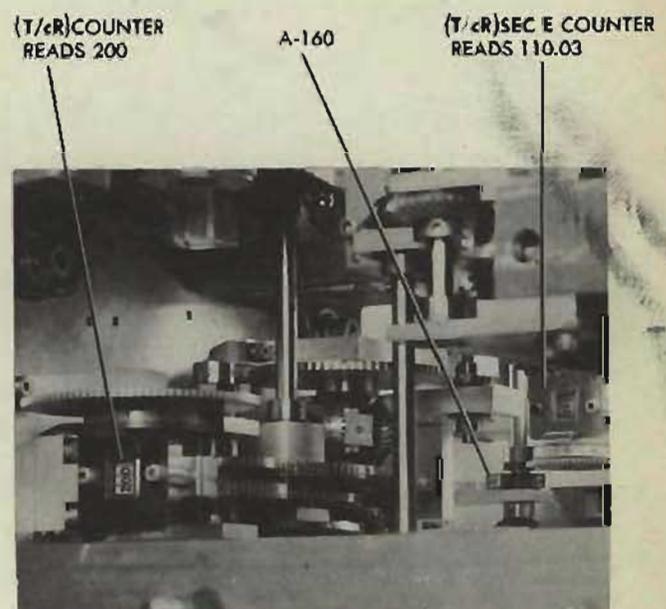
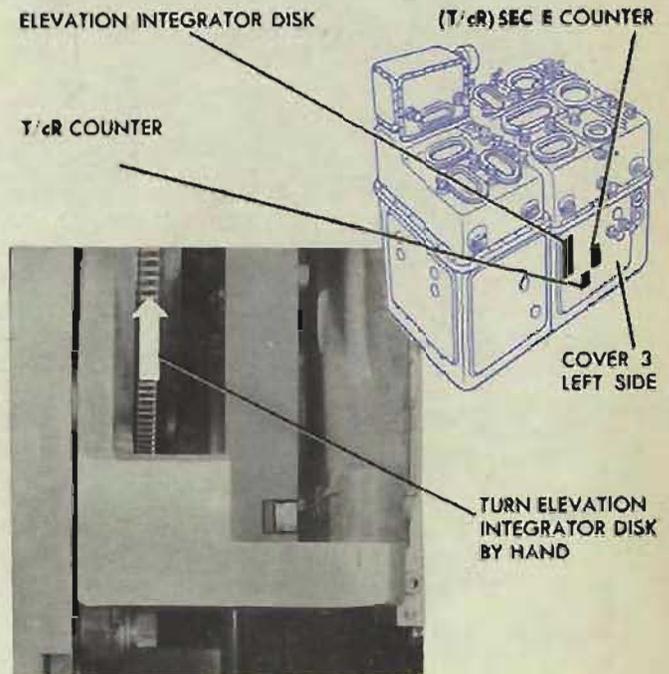
If the results are still unsatisfactory, further refine A-149 and A-151. If the results tend to be unstable at a fixed value of range, refer to *Disk Integrators*, OP 1140A.

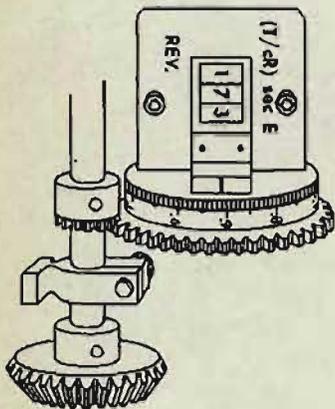
After the check test is completed:

- 1 Reconnect the range integrator if it was disconnected.
- 2 Disconnect the T/cR counter if there is a sliding gear for the purpose (on later instruments only). To do this, loosen A-141, unmesh the gear, and tighten A-141.
- 3 Replace cover 3.

(T/cR) sec E INTEGRATOR CHECK TEST

- 1 Turn the power ON.
- 2 Turn the control switch to SEMI-AUTO.
- 3 Disconnect the range integrator, or establish a zero range rate. (For this procedure, refer to *B Tests*, page 33.)
- 4 Remove cover 3. Tighten A-160 and A-141 with the gears in mesh.
- 5 Set cR at 1500 yards.
- 6 Set *E* at 0°. Turn the disk of the elevation integrator by hand until the *T/cR* counter reads a whole hundred.
- 7 Read the (T/cR) sec *E* counter.
- 8 Turn the time motor ON. When the *T/cR* counter has made approximately 90 revolutions, turn the time motor OFF. Turn the disk of the elevation integrator by hand, until the *T/cR* counter has made *exactly 100 revolutions* from the original value.





(T/cR) SEC E COUNTER READS 172.91

PART OF RECORD FORM PROVIDED IN NAVORD FORM 1229

TROUBLE ANALYSIS TESTS		INTEGRATOR TIMING					
T/cR SEC E INTEGRATOR TEST							
CALC.		89.04	88.07	87.03	85.74	83.48	80.73
E		0°	20°	40°	60°	80°	90°
DATE	CK BY	REVOLUTIONS OF T/cR SEC E COUNTER PER 100 REVOLUTIONS OF T/cR COUNTER					
		62.88					

RECORD HERE THE DIFFERENCE BETWEEN THE INITIAL READING OF (T/cR) SEC E AND THE READING AFTER 100 REVOLUTIONS OF T/cR.

9 Read the (T/cR) sec E counter. Compute and record the difference between the initial and the present (T/cR) sec E counter reading.

For example: Suppose that the (T/cR) sec E counter reads 110.03 when the T/cR counter reads 200.00 and that after 100 revolutions of the T/cR counter the (T/cR) sec E counter reads 172.91. The difference between the two readings, therefore, is 172.91 - 110.03, or 62.88. This indicates that the (T/cR) sec E counter has made 62.88 revolutions for 100 revolutions of the T/cR counter.

10 Complete the (T/cR) sec E integrator check test in the same manner with E at 20°, 40°, etc., as indicated on the test form.

11 Compute the errors by subtracting the calculated values from the recorded values.

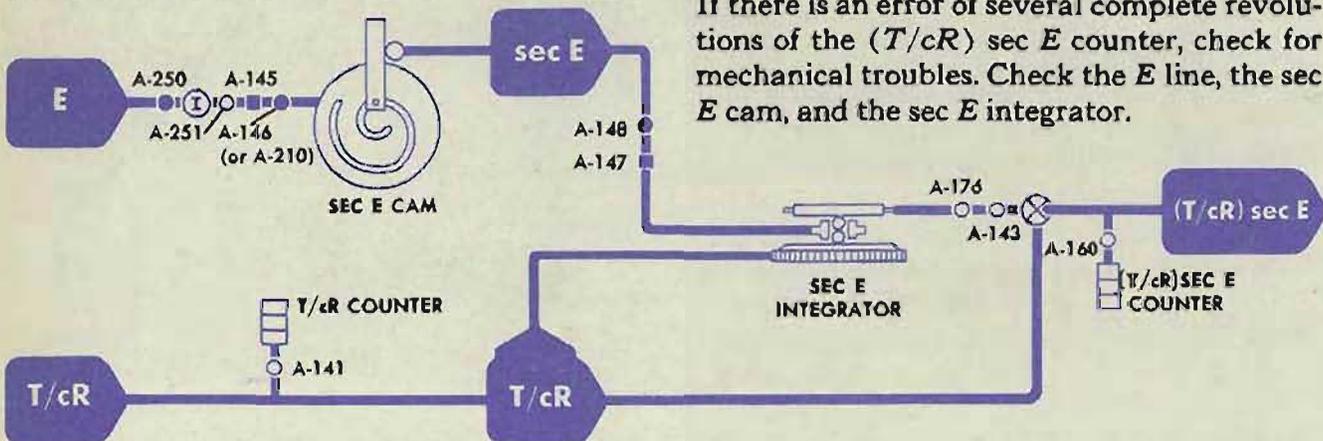
For example: Suppose that a reading of 62.88 is recorded in the 0° elevation test for which the calculated value is 62.84. The error is 62.88 - 62.84, or +0.04.

Correcting the errors

Before correcting any errors, compare them with previous values from tests run after satisfactory B test results were obtained. Reduce the errors to these previously recorded values. If no records are available, reduce the errors to an average near +0.05. In either case, reduce the errors by following the procedure given below.

If there is an error of several complete revolutions of the (T/cR) sec E counter, check for mechanical troubles. Check the E line, the sec E cam, and the sec E integrator.

(T/cR) SEC E INTEGRATOR NETWORK



If these units have been removed and reinstalled, tighten A-251 and readjust A-250, A-146 (or A-210), and A-148. If there is no A-148 on the instrument, readjust at the gear mesh.

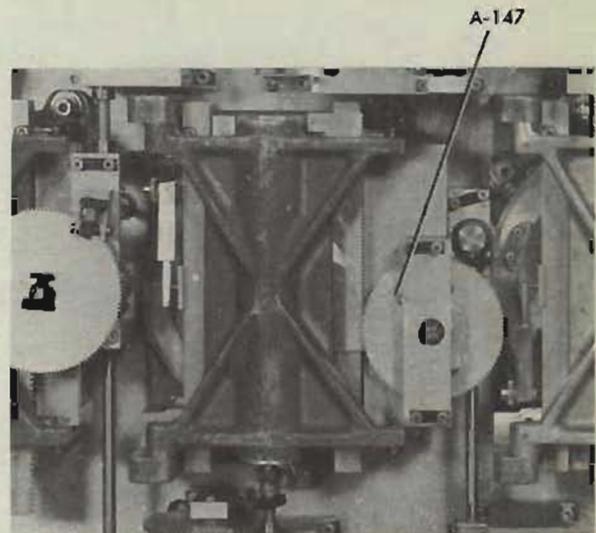
If the readings differ from the desired values by relatively small amounts, refine the vernier adjustments A-147 and A-145 as follows:

- 1 Loosen the locking screw on A-147. Turn the vernier screw counterclockwise to increase the integrator output, i.e., to correct a negative error. Turn the vernier screw clockwise to decrease the output, i.e., to correct a positive error. Tighten the locking screw.
- 2 Set E at 0° . Run the (T/cR) sec E check test at this elevation only, and refine A-147 until the desired test value is obtained.
- 3 Set E exactly at 70° . Run the (T/cR) sec E check test at this elevation only.
- 4 Loosen the locking screw on A-145. Turn the vernier screw counterclockwise to increase the integrator output, i.e., to correct a negative error. Turn the vernier screw clockwise to decrease the integrator output, i.e., to correct a positive error. Tighten the locking screw.
- 5 Again run the (T/cR) sec E check test with E set exactly at 70° . Refine A-145 until the desired test value is obtained.
- 6 Repeat the full (T/cR) sec E check test.

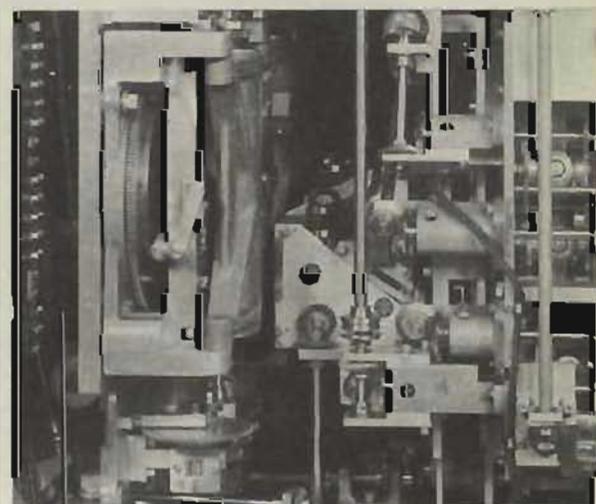
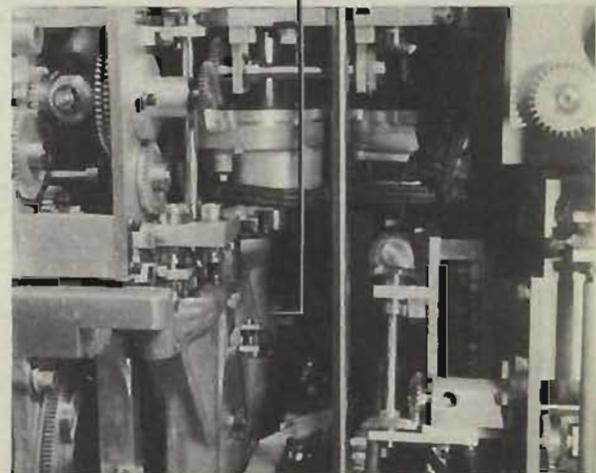
If the results are still unsatisfactory, further refine A-147 and A-145. If the results tend to be unstable at a fixed value of elevation, refer to *Disk Integrators*, OP 1140A.

After the check test is completed:

- 1 Reconnect the range integrator, if it was disconnected.
- 2 Disconnect the T/cR and (T/cR) sec E counters if sliding gears are provided for the purpose (on later instruments only). To do this, loosen A-141 and A-160, unmesh the respective gears and tighten A-141 and A-160.
- 3 Replace cover 3.



ACCESS TO A-147



ACCESS TO A-145 (UNDER COVER 3)

PARALLAX CHECK TEST

This parallax check test is arranged for use with instruments in which gun train order, $B'gr$, drives the parallax component solver.

If director train, $B'r$, drives the parallax component solver, the same check test may be used by substituting $B'r$ for all readings of $B'gr$. To do this, hold Dd at 0 and read $B'r$ on the $B'gr$ dial. Refer to the adjustment of A-242, page 461.

Check the Ph Dial

- 1 Turn the power switch ON.
- 2 Set $B'gr$ and $E2$ at 0.
- 3 Set L at 2000'.
- 4 Set $R2$ at 18000 yards.

The Ph dial should read 0. If it does not, check A-517 and A-52.

Check the vector gear of the Parallax Component Solver

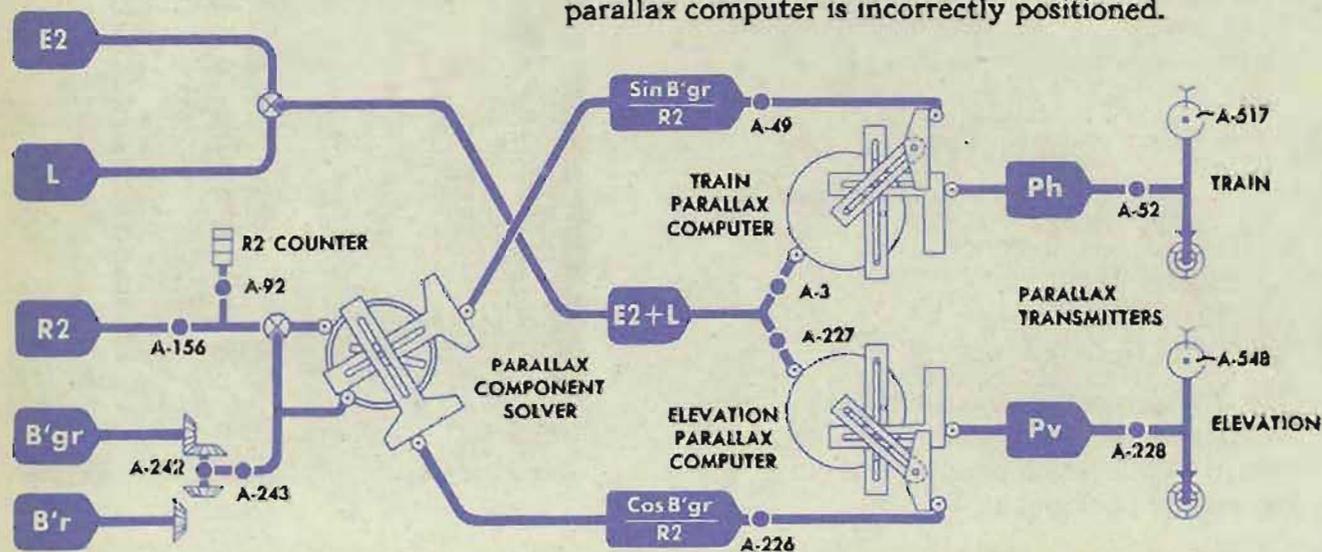
- 1 Check that L is at 2000' and $B'gr$ is at 0.
- 2 Set $E2$ at 70°.
- 3 Turn $R2$ from 18000 yards to 500 yards.

The Ph dial should remain at a fixed value during full travel of $R2$. If it does not, the vector gear of the parallax component solver is incorrectly positioned.

Check the input rack of the Train Parallax Computer

- 1 Check that L is at 2000' and $B'gr$ is at 0.
- 2 Set $R2$ at 18000 yards.
- 3 Turn $E2$ from 0 to 90°.

The Ph dial should remain at a fixed value during full travel of $E2$. If it does not, the input rack of the train parallax computer is incorrectly positioned.



Check the cam of the Parallax Component Solver

- 1 Check that L is at 2000'.
- 2 Set $B'gr$ and $E2$ at 90° .
- 3 Set $R2$ at 1560 yards.

The Ph dial should read RIGHT $10^\circ 59'$. If it does not, the cam of the parallax component solver is incorrectly positioned.

Check the cam of the Train Parallax Computer

- 1 Check that L is at 2000', $R2$ is at 1560 yards, and $B'gr$ is at 90° .
- 2 Set $E2$ at 60° .

The Ph dial should read RIGHT $7^\circ 20'$. If it does not, the cam of the train parallax computer is incorrectly positioned.

Check the Pv Dial

- 1 Check that L is at 2000' and $B'gr$ is at 90° .
- 2 Set $R2$ at 18000 yards.
- 3 Set $E2$ at 0.

The Pv dial should read 0. If it does not check A-548 and A-228.

Check the input rack of the Elevation Parallax Computer

- 1 Check that L is at 2000', $B'gr$ is at 90° , and $R2$ is at 18000 yards.
- 2 Turn $E2$ from 0 to 90° .

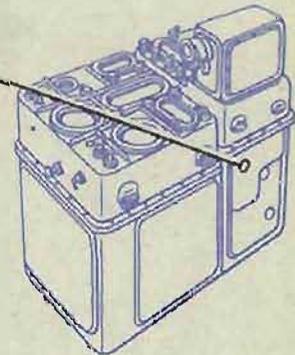
The Pv dial should remain at a fixed value during full travel of $E2$. If it does not, the input rack of the elevation parallax computer is incorrectly positioned.

Check the cam of the Elevation Parallax Computer

- 1 Check that L is at 2000'.
- 2 Set $E2$ at 0° .
- 3 Set $R2$ at 1500 yards.
- 4 Turn $B'gr$ from 90° to 0° .

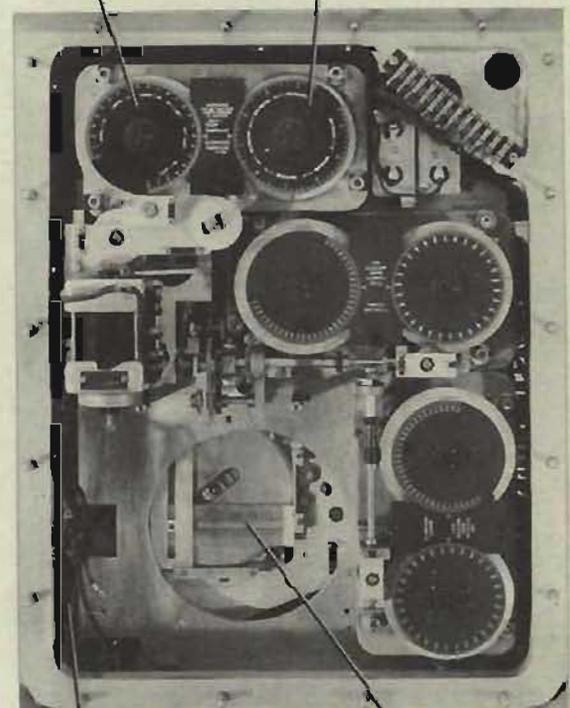
The Pv dial should remain at a fixed value during the travel of $B'gr$. If it does not, the cam of the elevation parallax computer is incorrectly positioned.

Ph AND Pv DIALS



PH DIAL

Pv DIAL

TRAIN AND
ELEVATION PARALLAX
COMPUTERS (HIDDEN)PARALLAX
COMPONENT SOLVER