EA-1

The TORBAL Model EA-1 uses the null weighing principle. Many who take the theoretical approach to weighing agree that the null type weighing system is inherently more accurate than a deflection system, all other things being equal. Also, null weighing will produce essentially either more accuracy for any given set of weighing conditions or will maintain a better degree of accuracy for a longer period of time and suffer less from random disturbances. The principle of null weighing is demonstrated in the conventional equal arm balance. Balances of this type have a pointer and index. All weighing operations are performed to return the pointer to a rest point coincident with the center of the index plate.

In the Model EA-1, instead of the pointer and fixed index, an electronic sensor called an E-core is used. The E-core through an amplifier, senses the rotation of the beam and produces a meter needle deflection proportional to the amount of beam deflection. All of the weighing operations on the EA-1 are performed to return the meter needle to the original point of equilibrium or zero.

The E-core sensor consists of a stack of soft iron laminations, each lamination having the shape of the capital letter E. These laminations are stacked together similarly to the iron laminations in a common transformer. Copper wire is wound on nylon bobbins to form circular coils and a coil is glued in place on each outside leg of the E-core. A piece of soft iron is attached to the upper beam at the center and this part is designated the armature of the E-core assembly. When an electrical current is passed through a coil of wire, there is produced a magnetic field and this magnetic field is reasonably semetrical about the coil of wire. This magnetic field is made up of many lines of flux and when a piece of soft iron having a high degree of permeability is brought into close proximity to the coil of wire, the symmetrical magnetic field around the coil is distorted and concentrated because of the closeness of the iron pole piece. The E-core with its laminations and coils of wire is attached to the base plate in such a way that there is a small air gap between the legs of the "E" and the armature, which is part of the upper beam. As the beam rotates and as

the air gap is reduced, a current which is applied to the E-core coils will flow more readily through the coil where the air gap is smaller than through the coil with the larger air gap. The two electrical coils are so connected that the current flow through each one is opposed to the other. This difference in electrical current is amplified in the E-core electronics system and the result produced by these electronics is a current applied to an electrical meter. Since the E-core electronics provide a DC signal to the meter through a rectifier circuit, the meter is capable of sensing the direction of deflection of the balance, as well as the amount of deflection. In the case of the EA-1, if the weighing pan moves downward, the air gap between the forward leg of the E-core and the armature is increased and the meter will have a point of deflection to the left or to the side marked "increase".

In order to arrive quickly at the proper bracket of mass, we depend upon the ability to manipulate previously calibrated weights of various denominations. We first operate a loader going from zero to 150 grams by 10 gram increments, a second loader going from zero to 9 grams by 1 gram increments and the third loader going from zero to 0.9 grams by 0.1 gram increments. Having bracketed the unknow mass to within 100 mgs., we now go to a reasonably new system which allows for the determination of final weight digitally to the fourth decimal place. The mechanical operation of this system consists of turning the operating hand wheel on the right hand side of the balance case so that the meter needle is brought back to the null position. As the operating handle is turned, the counter wheels are positioned so that when one finally does achieve an equilibrium at zero, the counter is capable of showing 999 mg, broken into 999 parts, with the last significant figure representing 1/10th of a milligram. As the hand wheel is operated to change the counter reading, we are electrically developing a restoring force acting at the rear of the beam and this force is proportional to the weight on the commodity pan, which we are attempting to counterbalance. Electrically, as the hand wheel is rotated, we are rotating the operating shaft of a 10-turn precision potentiometer, which is connected to a stable 5 V. DC source. The electrical current flowing through the force coil is being changed, which in turn changes the magnetic effect resulting in a change in restoring force. The explanation for this is as follows: If a D.C. current is passed through a coil of wire, there is developed a magnetic field which exhibits magnetic polarity. In the EA-1, copper wire is wound around the long cylindrical form and when current is passed through this coil, a magnetic field is produced, having a north pole and a south pole. Inside the coil is suspended a permanent magnet cylindrical in shape and suspended such that the north pole of the magnet is nearest to the developed south pole of the coil of wire. An increase in the current in the coil of wire

increases the pulling force. Conversely, if we decrease the current flow in the coil of wire, the attractive force between the permanent magnet and the developed magnet field of the coil is reduced. On the EA-1, this change produces a change in restoring force exerted by the force coil on the beam and we are then able to adjust the amount of restoring force to be just sufficient to overcome the amount of unbalanced mass on the hanging pan which had not been counterbalanced by the manipulation of the calibrated weights with the weight loader mechanism.

The balance is properly sensitized when starting from a zero equilibrium and zero on the counter half scale meter deflection can be obtained by rotating the counter to any value between 150 and 180. Since the EA-1 is a null balance, the primary concern is that the pointer shall for 1/10 milligram move a sufficient amount to be easily visible to the human eye. With the above adjustment, this meter movement will be from 8 to 10 thousandths of an inch for each 10th of a milligram.

The ragge potentiometer, which is on the rear of the balance case, must be carefully set because this establishes the amount of current which can be sent through the force coil when the counter is turned up to its extreme value of 999. This adjustment controls this current to provide for restoring force to counterbalance the effects of 99.9 milligrams of mass on the weighing pan.

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EA-1

REPLACING COUNTER ASSEMBLY (VERNIER ASSEMBLY)

FOR BALANCES WITH SERIAL NUMBER 21639 AND UP (NEW VERNIER ASSEMBLIES)

Before making a vernier assembly replacement, please make sure that the binding is not at the bearing in the sidewall of the base. To check this, remove the crank and loosen the two screws in the bearing and see if when the crank is replaced, the shaft rotates freely. If it does, it would indicate that the crank might have been struck and the bearing moved slightly.

If a replacement is necessary, the procedure is as follows:

(1) Remove the dash pot from the balance.

(2) Tape doors closed.

(3) Tip the balance gently so it rests on its' back.

(4) Remove the leveling screws.

(5) Take out the screws and remove the bottom cover.

(6) Remove the crank from the shaft.

(7) Remove the two screws and take out the bearing in the sidewall of the base.

(8) Remove the green wire ties around the wires.

(9) Remove the wires from the potentiometer, remembering in what order they were attached.

(10) Remove the two screws holding the vernier assembly to the base. (One of these screws is slotted and the other has a hex head).

(11) Remove the vernier assembly.

TO INSTALL NEW COUNTER -

(1) Fasten the vernier assembly to the base. Snug up the screws at this point, but do not tighten too tightly.

(2) Insert the bearing in the sidewall. As you tighten screws holding this bearing, move the big gear on the operating shaft with your finger as you tighten the bearing. This insures proper alignment.

(3) Tighten bearing screws tight. (You may find the shaft binds when you do this.) If so, loosen the two screws holding the vernier assembly to the base and shift the assembly slightly until the shaft becomes free.

(4) Tighten the two screws holding the assembly.

(5) Resolder the pot connections.

(6) Retie the wires with the green wire ties. (Caution - make sure that the wire from the pilot light is not tight against the counter or the gears.)

(7) Replace the cover.

(8) Replace leveling screws.

(9) Put balance in the upright position and install the dash pot.

FOR BALANCES WITH SERIAL NUMBER BELOW 21639 (OLD VERNIER ASSEMBLIES)

The procedure for making the replacement of the old vernier assembly is similar to that for the new assembly, except that there is no bearing in the side wall. To install the new counter, follow the following sequence:

(1) Install the counter to the base and line up the shaft so it is approximately in the center of the opening in the base sidewall.

(2) Check and make sure that the counter numbers line up in the bezel.

(3) Tighten firmly the two screws holding the assembly.

(4) Resolder the pot connections.

(5) Retie the wires with the green wire ties, making sure that these wires are not against the counter or the gears.

(6) Replace the cover.

(7) Replace leveling screws.

(8) Put balance in upright position and install dash pot.

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TO REPLACE PILOT LIGHT

#101409 IN EA-1

1. Remove piston and unscrew dashpot.
2. Remove counter weights
3. Remove pan weight rach and weights
4. Tape doors closed
5. Gently tip balance back on its back
6. Remove bottom cover
7. Remove wire ties and disconnect pilot light
8. Push light out of console
9. Push new light into console and reconnect, replace wire ties
10. Retrace steps 6, 5, 4, 3, 2, 1

*NOTE: Make sure wires do not interfere with counter

RANGE COUNTER ADJUSTMENT PROCEDURES FOR EA-1

As an EA-1 ages, or when replacing a circuit board, it may be necessary to adjust the range-counter adjustment potentionmeter. Even though each board is tested and calibrated before leaving the factory, small differences between balances may call for this adjustment.

To check the counter range follow the procedure below: (The balance should be fully assembled with all covers on.)

1. Turn on the power switch and make sure that the pilot light is on. Let the balance "warm up" for 15 minutes.

2. Set all weight control knobs to zero and rotate the counter control knob to 000 on the counter. Bring the null indicator needle to the center line or null by operating the coarse tare and zero adjustment knobs.

3. Place a 100 mg. class S wight on the balance pan, close the balance door, and operate the counter control knob to a setting of 999. The null indicator needle should come to rest at center or within a needle width to the left of center. If the instrument does not operate as outlined above, refer to COUNTER ADJUSTMENT PROCEDURE.

If class S 100 mg. weight is not available, place a small object, such as a ten cent piece, on the balance pan and make a mass determination as described under "Weighing Procedure," except that the counter should be left at zero and the needle brought to null by manipulating the coarse tare control and zero adjustment knobs. If the number on the weight control knob to the right of the decimal point is between one and nine, reduce this number by one and then rotate the counter knob to set the counter at 999. The null indicator needle should be at center or not more than a needle width to the left of center. If the instrument does not operate as outlined above, refer to COUNTER ADJUSTMENT PROCEDURE.

TO SET RANGE - COUNTER ADJUSTMENT PROCEDURE

If, in checking the counter range as described above, the counter setting of 999 causes the pointer to be more than a pointer width to the left or at any point to the right of null, it will be necessary to adjust the range control potentionmeter. (An access hole is provided in the lower portion of the rear shroud of the balance.) Use a screwdriver and rotate the slotted shaft slowly until the pointer returns to the null position.

Reset the counter to 000, remove the 100 mg weight or advance the right weight control knob one number, and use the zero adjust knob to place the needle at null. Repeat the test and readjust if required.

Even though the "Range" remains constant for extended periods, it is good weighing practice to check it periodically and adjust if necessary.

THE TORSION BALANCE CO.

CLIFTON, NEW JERSEY 0701

ECCENTRIC LOAD ADJUSTMENT (EA-1 or ET-1)

If, when checking an EA-1 or ET-1 balance it is found that the interna weights do not check standard weights of known accuracy, the discrepan may be due to inaccurate internal weights or to the fact that the trus are not parallel (Eccentric Load Error).

To check for, and correct an eccentric load error, the procedure is:

1 - Level the balance and zero it with the number wheels at zero and th counter at 100. (Having the counter at 100 will permit the increas or decreasing of weight by means of the counter).

2 - Place a good 20 gram weight of known accuracy on the balance pan, t the number wheels to 20 and rezero the balance.

3 - Remove the 20 gram weight and place it on the top of the truss in t position marked "A" on the enclosed drawing. Not more than 10 coun (1.0mg on the EA-1 and 10mg on the ET-1) should be required to bri the balance back to its zero position.

4 - If the error exceeds the amount mentioned in paragraph 3, and the indication with the 20 gram weight on the truss is that it is heavy, the front truss is not parallel to the center truss and the distance from the center truss to the right end of the front truss is greater than the distance from the center truss to the left end of the front trus

5 - If the indication with the 20 gram weight on the truss is that it i light, the distance from the center truss to the right end of the front truss is less than the distance from the center truss to the left end of the front truss.

6 - Referring to the drawing and examining the EA-1 (or ET-1) skeleton, you will note that by loosening the four nuts marked 1, 2, 3 and 4, the front truss may be rotated about point B. Before loosening the four nuts screw the two small adjusting screws into the threaded plat at points C & D until the screws just touch the truss.

7 - Loosen slightly the four nuts (1, 2, 3, 4) (about ½ turn).

8 - Depending on which direction the front truss is to be rotated to make it parallel to the center truss, loosen slightly one of the screws at C or D and tighten slightly the other screw. (Do not tighten one screw without first loosening the other).

9 - Retighten the four nuts 1, 2, 3 and 4.

10 - Back off slightly the two adjusting screws.

11 - Rezero the balance and repeat procedure starting with Step 2 until the eccentric load is within the tolerances (10 counts on the counter, e.g 1.0mg on the EA-1, 10mg on the ET-1).

ECCENTRIC LOAD TEST AND CORRECTION

(Refer to figure 2c in Assembly Instructions)

In order for the balance to weigh accurately it is necessary to adjust the forward truss of the balance skeleton so that it is parallel to the center truss (or so that it is perpendicular to the skeleton beams).

Testing for this condition requires a 20 gram weight; the accuracy of the weight is not important.

Place the 20 gram weight on the balance pan and use the weight loaders and tare controls to null the balance indicator. Transfer the 20 gram weight so that it is placed on the right end of the front truss as shown on the reference figure.

Observe the movement of the null meter. If the needle moves toward "Decrease" the end of the truss on which the 20 gram weight is resting should be adjusted to be closer to the center truss; this end of the truss should move to the rear. If the error causes the meter to move toward "Increase", adjust the front truss to move that end on which the 20 gram weight is placed to the front of the balance.

The front truss is attached to the upper and lower beams such that when the four attaching screws are loosened it pivots around the center of the four-screw pattern.

Make an adjustment, tighten, and then retest. A truss that appears perpendicular to the beams, judging by eye, will usually have an error small enough such that the null meter needle stays on scale.

For best weighing results adjust to a difference of 20 gram weight position indications of not more than 1.0mg.; this represents about .080 inch pointer travel from null.

EA-1 PRINTED CIRCUIT BOARD INSTALLATION

DESIGN CHANGES HAVE BEEN MADE IN THE EA-1 PRINTED CIRCUIT BOARD WHICH REQUIRE THAT THE TERMINAL STRIP INTO WHICH THE BOARD IS INSERTED BE LOWERED SLIGHTLY. THIS MODIFICATION IS ACCOMPLISHED AS FOLLOWS:

1. EXPOSE THE PRINTED CIRCUIT BOARD BY REMOVING THE FOUR SCREWS WHICH SECURE THE REAR SHEET METAL COVER, AND THEN TILT THE COVER BACK. THIS IS THE COVER THROUGH WHICH THE KNURLED RANGE ADJUSTMENT KNOB EXTENDS. DO NOT DISCONNECT ANY WIRES, RAISE THE REAR OF THE BALANCE TO FACILITATE TILTING THE COVER BACK.

2. REMOVE THE SLOTTED SCREW IN THE CENTER OF THE BOARD APPROXIMATELY 3" UP FROM THE BOTTOM. PULL DOWN ON THE P/C BOARD TO REMOVE IT FROM THE TERMINAL STRIP.

(WITH THE NEW SHORTER P/C BOARD IT IS NECESSARY TO LOWER THE PLASTIC HARNESS STRIP SO THE RANGE ADJUSTING SCREW IS ACCESSIBLE THROUGH THE HOLE IN THE REAR SHEET METAL COVER.

3. REMOVE THE SCREWS WHICH SECURE THE TERMINAL STRIP TO THE ALUMINUM EXTENDERS. PULL THE TERMINAL STRIPS DOWN GENTLY AND INSERT THE NEW SPACERS PROVIDED ON TOP OF THE TERMINAL STRIP. SECURE THE STRIP IN PLACE BY USE OF THE TWO LONG SCREWS PROVIDED.

4. PLUG IN THE REPLACEMENT BOARD (PART #281069) - BE CERTAIN THE RANGE POTENTIOMETER KNOB IS FACING THE REAR OF THE BALANCE. REPLACE SCREW IN LOWER MOUNTING POST.

5. REINSTALL REAR COVER.

P/C BOARD 8 3/8" LONG	PART #280653
P/C BOARD 7 1/4" LONG	PART #281069

T O C H E C K A N D A D J U S T R A N G E

1] With no load on pan and all digits reading zero, null or zero balance using coarse and fine tare.

2] Turn milligram knob to "one" position indicating 100 mg. This causes needle to deflect to decrease side.

3] Using coarse and fine tare knobs, zero or null balance.

4] Turn 100 mg. knob to "zero" position.

5] Turn 0.1 mg. counter knob to 999 position. If range is properly set, needle should return to center of meter, or to within a needle width to the left of the center line. If not, an access hole is located in lower portion of rear shroud. Use a screw driver and rotate slotted shaft slowly until needle returns to zero or null position.

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#101409 IN EA-1

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10. Retrace steps 6, 5, 4, 3, 2, 1

*NOTE: Make sure wires do not interfere with counter