USE AND CARE OF

ANALYTICAL • MICRO • SEMI-MICRO

AINSWORTH BALANCES

INDEX

WM. AINSWORTH & SONS, INC.

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Section 1

Unpacking Your Ainsworth Balance

A Removing from Carton

On opening the outer carton, first remove any accessories, weight sets, etc., which may have been packed in the excelsior. Next, open the inner carton and carefully remove the folded liners. A box marked "balance parts" containing the beam and other parts will be found in one of the liners. It should be removed and put in a safe place until needed. The balance itself is next taken by both ends, at the top, and lifted from the carton. Before discarding the packing, double check to make sure that no small parts or accessories are being thrown away. If unpacking two or more balances at the same time, keep the parts for each balance separate. Many parts are adjusted individually to the balance, and are not interchangeable.

B Locating

After removing the paper from around the case, place the balance in its permanent location. Selection of the location is very important. The balance should be placed away from windows, radiators, air-conditioning outlets, etc., which would cause rapid temperature changes around the balance, or at one end of the balance. Direct sunlight falling on the balance is particularly bad. The location should also be as free from vibration as possible. An unsteady bench or table will be an endless source of trouble. If there is unavoidable vibration in the building, the balance should be insulated from it as much as possible. Special balance feet mounted on sponge rubber help. In other cases it may be necessary to put the balance on a heavy slab of stone or other non-magnetic material which in turn rests on rubber, cork, or other vibration-absorbing supports. The particular material or combinations of materials to be used, and the weight of the slab, depend on the frequency and amplitude of the vibrations encountered.

The location should also be away from electric motors and equipment which might set up magnetic fields.

C Setting Up The Balance

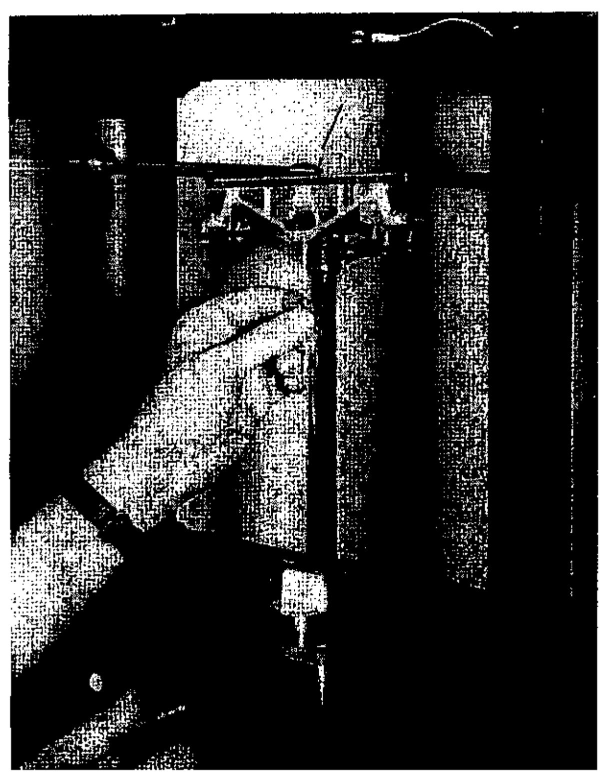
1. Plain Balances

Cut the strings which secure various parts inside the balance case during shipment. Use of scissors is recommended both to avoid marring the finish and to avoid putting any unnecessary strain on parts which might be bent by careless handling. The operating knobs, which will be found in the drawer or in the beam box (don't touch the beam yet!) are slipped on their proper rods. If the balance is equipped with magnetic dampers, get the magnets out of the way by pulling the attached knobs which protrude from the ends of the case. The ends of the M-shaped spring on the back of the top of the column are hooked over the studs on the back of the drop levers.

The balance is levelled by using the four levelling screws under the base to center the two spirit levels which are mounted in the base of the column. It will be found easier to use two hands to turn two levelling screws simultaneously. Do not unscrew any of the levelling screws any more than is necessary to level the balance, and check to see that all four screws are bearing their share of the weight. The balance then will be very stable, and will not tip easily.

Before installing the moving system, lift the front door completely out of its guides and lay it on top of the case. Inspect the plane agate center bearing and, if necessary, remove any dust or lint from it with a camel's hair brush. Also clean, if necessary, the agate planes in the stirrups and the 3 agate knife edges of the beam. The next step is to place the beam in position. This operation requires great care. It must be remembered that a balance beam is delicately adjusted, and that the damper vanes (if any) and the pointer tip can be bent fairly easily.

Figure H



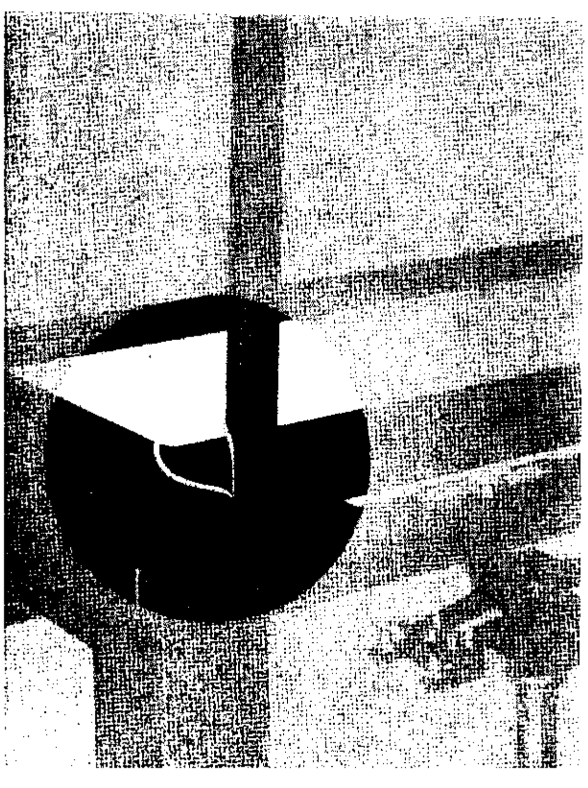
In handling the beam, always grasp it by the upper part of (continued) the pointer near where it joins the beam proper. Holding the beam thus with one hand, use the other to rotate the knob on the front of the case to lower the drop levers. Then put the beam in position, being careful not to hit the agate knife edges or the pointer tip against anything. (Fig.A) Hold the beam up so that the center knife edge is clear of the center agate plane and raise the drop levers up under it. After the drop levers are in the fully raised position, lower the beam carefully on its supports.

The supports hold the knife edges a few thousandths of an inch from the agate bearings, so when the above procedure is followed carefully, the edges have not come into contact with the planes at all.

After the beam is in place the stirrups are slipped over the adjusting nuts on the ends of the beam and lowered into the V-shaped stirrup supports. The #1 stirrup goes on the left side, the #2 on the right, with the numbers toward the front of the balance. Next, suspend the #1 hanger from the upper hook of the left stirrup, with the number (on the hanger wire) facing front. The #2 hanger is hung in the same way from the right stirrup.

The door may now be replaced. To avoid damaging the counterweight cords, pull them gently into loops alongside the door while it is lowered into its guides so that the cords slide freely down into the grooves without being pinched. (Fig.B)

Figure B



Balances equipped with magnetic dampers at one or both ends of the beam must be checked to see that the dampers are in line. While looking down thru the top of the case, carefully push the knob on the outside of the case to slide the magnet in. The vane should be about midway between the poles of the magnet.

The riders, or the beam weight of chainweight balances, may now be placed on the beam. Use weight forceps to put them directly on the beam, or to put them on the rider pick-up arm which will lower them onto the beam. When the beam is graduated with the zero in the center, the right-hand "weighing" rider is placed on zero. The "adjusting" rider is put near the 5 mark on the left side of the beam.

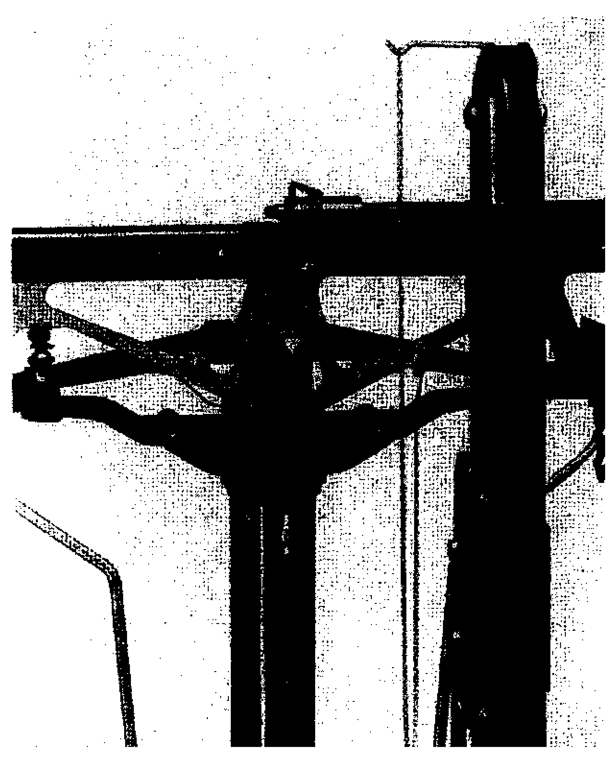
2. Chainweight Balances

In addition to the above procedure, the chain must be installed on all chainweight balances.

Do not stretch or damage chain when taking it from the box. Bend back the cardboard points holding the chain so that it can be lifted out easily. Use forceps to grasp the square ring at one end of the chain and lift it out carefully, avoiding kinks. Have the hook on the graduated tape of the balance in its highest position, and using the forceps, hang the square ring of the chain over the hook. Allow the other end of the chain to hang freely until any twist in the chain removes itself.

With the forceps holding the wire at the lower end of the chain, place the jewel bearing on the pivot attached to the beam. When at rest, the wire hook attached to the jewel should not touch the supporting member but should be in approximately the same vertical plane as the loop of the chain itself. (Fig.C) If not, the chain probably contains a twist or kink. To remove them it may be necessary in extreme cases to suspend the chain by one end and draw a smooth matchstick or similar non-metallic rod gently along the length of the chain. The stick should not pull the suspended chain more than 20-30° from vertical, which is sufficient to move each link of the chain as the stick is drawn past it, so that each link will take its proper position in relation to the adjoining links.

Figure C



3. Keyboard Balances

The next step in setting up a balance with keyboard-operated weight carrier is to put the carrier weights on the rack. First, push in and release the push button on the front of the case which operates the pan arrests. Repeat this a couple of times until the hangers are hanging straight. Then push all the keyboard keys on the front of the case about half-way down so that the numbered arms they operate are on the same level with the notched rack attached to the right-hand stirrup. Sight down through the top of the case to see that the stirrup rack has not been bent in handling. The rack should be about 1/32" in front of the weight-lifting arms and very nearly parallel to their front surface. If so, remove the right hanger. Then use forceps to put the carrier weights in position, being careful not to confuse the proper sequence of the weights.

Ainsworth carrier weights are packed with a cardboard rectangle between each weight. The denomination of the weight is marked on the cardboard under each weight. In placing the weights, use forceps to hold the weight midway between the bend and the end. Put it in the notch which is engraved with the denomination of that weight. One leg of the M-shaped weight hangs in front of the stirrup rack and the other in back of the lifting arm. (Fig.D) When the arm is lowered, one notch in the top of the carrier weight rests on the stirrup rack; when the arm is raised, the other notch in the weight rests on the arm. After all the weights are in position, the hanger is replaced. Finally, push the "reset" key to lift all weights off the rack.

In case the carrier weights become mixed up, they can be put in proper sequence by first separating the gold (50 milligrams and larger) from the aluminum (30 milligrams and smaller.) Each group can be arranged visually in series from the heaviest to the lightest. The heaviest weight (which may be 100 milligrams, 1 gram, or 2 grams, depending on the type of balance) is put in the notch marked with the highest denomination. The next largest weight in the notch with the next highest number, etc. The heavier weights are located near the center because in this position they have the least tendency to swing the rack out of alignment. If there is any question of the denomination of any carrier weight, it can be checked against a conventional weight.

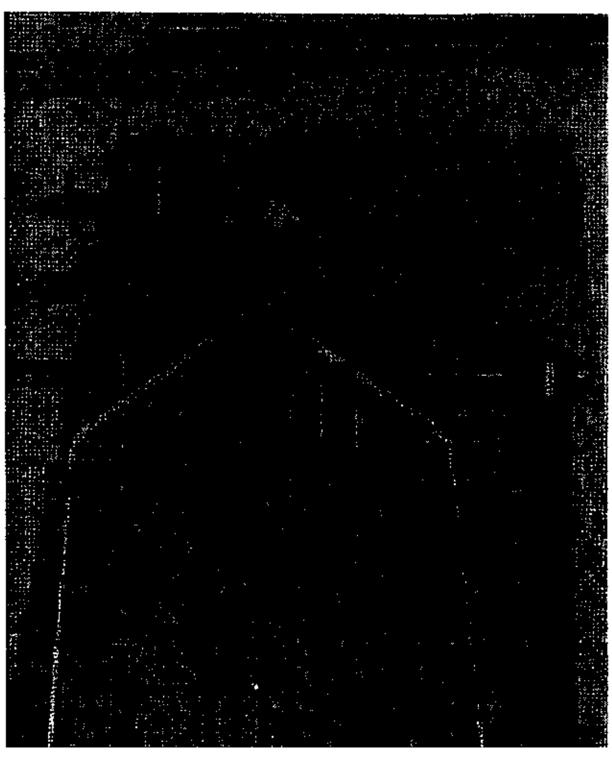


Figure D

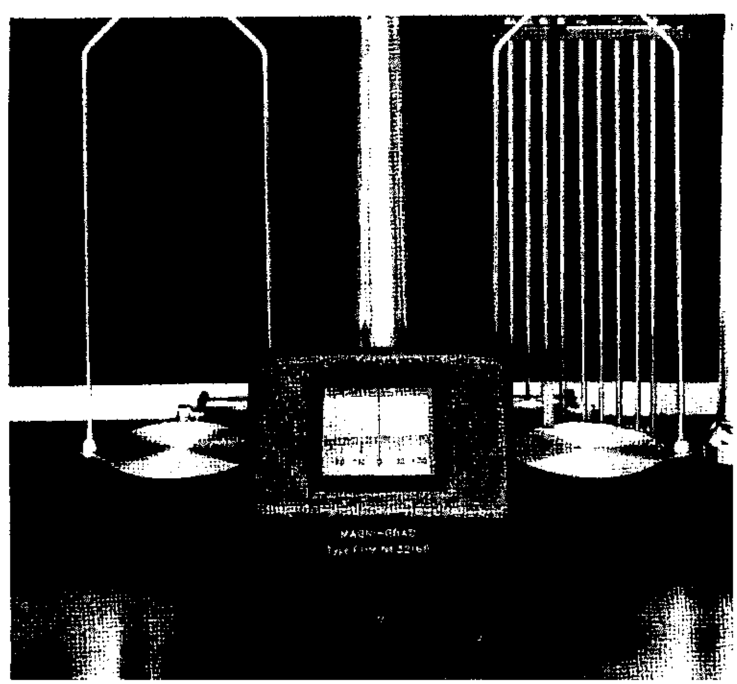
4. Magni-Grad Micro Balances

On micro balances with magni-grad projection systems, the light shield tube assembly and transformer are packed in a separate carton. After both the balance and accessories are unpacked, remove the cork from the light receptacle hole in the rear of the balance base. If the cork tends to stick, remove the drawer from the front of the balance case and push the cork out from the inside. The wipe out the hole with a dry cloth and insert the light tube in the hole and push in until the tape, which is a factory reference marker, is flush with the hole. Since the tube fits snugly, a slight twisting motion will facilitate pushing the tube up to the reference marker. Curved portion of the light housing upward.

After this is done, attach the two leads from the light to the terminals of the transformer. The transformer should be plugged into a power source of 110 to 120 volts, 60 cycles A. C. only. Next turn on the light by means of the snap switch in the cord and examine the illumination on the balance screen. New remove the tape from the light tube, and if necessary adjust the tube in and out to suit, staying in the approximate area where the tape originally was. Caution--IF THE TAPE SHOULD LEAVE A RESIDUE, REMOVE THE RESIDUE BEFORE PUSHING THE TUBE FARTHER INTO ITS RECEPTACLE. This can be done with alcohol, since the tube is not lacquered. Avoid getting alcohol on the gold-plated receptacle which is lacquered.

In the final adjusted position the bottom of the light element should be approximately parallel to the glass base of the balance. Rotating the light element slightly to one side or the other may give illumination which you prefer, but any great misalignment will cause shadows.

The lamp used in the light element is a standard, 6-volt, automobile bulb, Westinghouse #87 or equal, which should be easily obtainable from any automobile supply store.



Section II

OPERATION

(A) Operating Controls

The moving system of the balance is released by, first, rotating the large knob in the front of the case. This lowers the drop levers which deposits the center knife edge of the beam onto its bearing, and also deposits the stirrups on the end knife edges of the beam. (Always lower the drop levers fairly slowly to avoid damage to the agate edges.) Second,, depress the push button on the front of the case. This button is in the middle of the knob on some types of Ainsworth balances, and to the left of it on others. (Fig. F) It lowers the pan arrests, allowing the beam, stirrups, and hangers to swing freely. The pan arrests can be locked in the depressed position by turning the button to the left after pushing it in. The pan arrest button should be pushed in firmly, almost sharply, to release the moving system evenly.

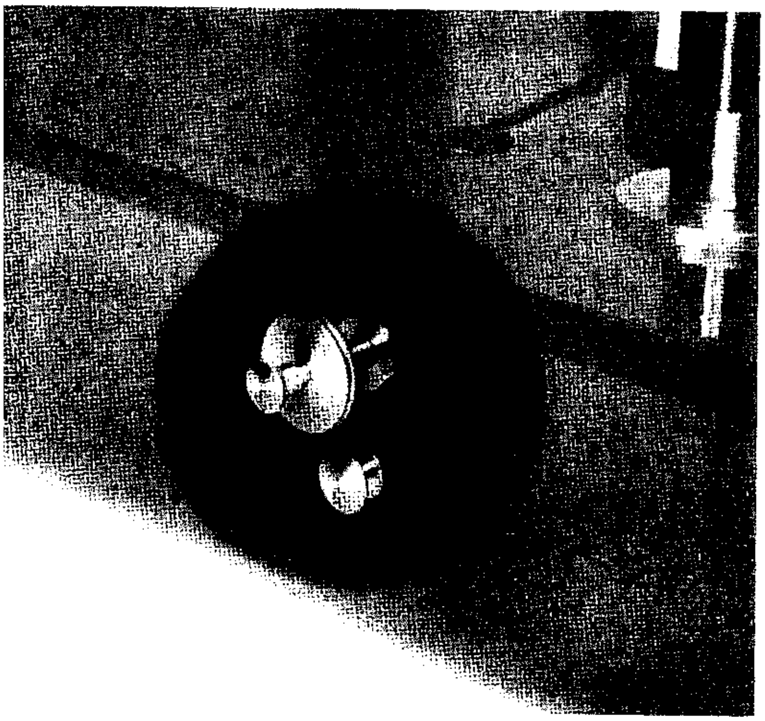


Figure F

In weighing, the beam is always released first and then the pans. In arresting the swing, the order is reversed providing the pans can be arrested at a moment when the pointer is near the center of the scale. It is often better, however, to arrest the beam first, and then the pans.

The drop levers should always be raised when loading or unloading the pans. When the balance has been re-leveled and whenever one or both pans have been loaded or unloaded, it is advisable to push in and release the pan arrest a couple of times when the drop levers are raised. This allows the hangers to readjust themselves so that they will not "pendulum" when released.

Modern balances do not have any auxiliary device to start the beam to swing, although this can be done by manipulating the pan arrest. When the beam and pans are released, the balance will move of its own accord to seek its proper rest point, providing the balance is in usable condition. It will be noted, however, that the start of the swing and the period of the swing will be slower on the more sensitive balances, also when the load on the pans is increased, and when dampers are used.

The beam weight and riders on the beam are handled by the rider carrier arm. It is operated by sliding and rotating the knob at the end of the case. Always lift the riders from position to position. Do not try to slide them, or to roll the beam weights of chainweight balances. After using the rider carrier, always turn it up out of the way so that the beam or rider cannot swing up against it. When not using the balance, it is advisable to push the rider rod in as far as it will go to prevent it from being hit accidentally.

The chain of chainweight balances is operated by rotating the large knob on the lower right end of the case. This knob actuates the tape from which one end of the chain is suspended. The effective weight of the chain on the right side of the beam is read from this movable tape against a stationary vernier. The vernier can be adjusted, when required, by rotating the knob on the lower left end of the case.

The weight carrier on Ainsworth "keyboard" balances is operated by depressing keys on the front of the case. This deposits weights on the right hand stirrup, which has exactly the same effect as putting the same weight on the right pan. Lifting the key raises the weight from the moving system. All weights can be lifted at once by pushing the "reset" key.

Magnetic dampers, when installed, are engaged by moving the magnets to straddle the vane. Magnets attached to the ends of the case are operated by knobs outside the case which slide the magnet along guide tubes. For maximum damping, the poles of the magnet should straddle the middle of the vane. (Fig. G)

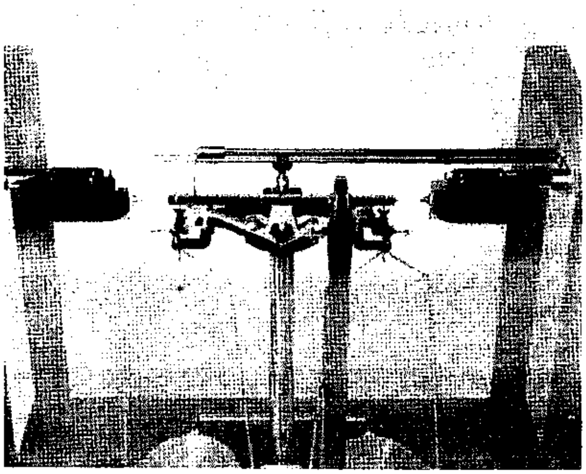


Figure G

(B) Bringing the Balance Into Equilibrium

Analytical and semi-micro balances have beams graduated with 100 divisions on each side of a center zero. Two riders go on these beams. Put one exactly on the zero mark and the other on the "5" mark on the left side of the beam. Then release the beam and pans. If the pointer swings clear off the pointer scale, arrest the beam, then turn one or both thumb nuts at the extreme ends of the beam to bring the moving system into approximate equilibrium. The final and finer adjustment is accomplished by moving the left hand rider either to the left or right of the #5 position until the beam is in exact equilibrium with the pointer on zero or at an arbitrary zero on the index plate. Any subsequent small change in equilibrium noted from time to time can be corrected simply by moving the left hand rider. This is the purpose of the left hand rider. It is not moved at all when actually weighing.

Chainweight Balances are brought into equilibrium by a simple and sound method of using the chain itself. First, put the beam weight in the left hand, or "zero" notch. Release the moving system and note the direction of the swing. Turn the operating knob on the right end of the case to raise or lower the chain until the moving system is in equilibrium. Then rotate the knob on the left end of the case to move the vernier up or down so that the zero line of the vernier coincides exactly with the zero line on the chain-actuating tape. Subsequent movement of the tape in weighing is measured accurately from this setting of the vernier. Whenever the equilibrium needs readjusting, it can be done quickly by again moving the chain and then resetting the vernier.

If, after long use, the vernier does not have sufficient travel to accomplish this adjustment, return the vernier to a central position with respect to its limits of travel. Move the tape so that its zero is approximately at the zero of the vernier. Then use the thumb nuts on the ends of the beam to bring the moving system into approximate equilibrium. The final adjustment is made by using the regular method of setting the chain, then the vernier.

Micro Balances are brought into equilibrium in essentially the same way as regular analytical balances by using the thumb nuts on the beam, and the left hand rider. The beam of micro balances is graduated with the zero on the left end, 5 in the middle, and 10 on the right. The right hand, or weighing rider, is placed on the zero graduation. The left hand, or checking rider, is put in the middle of the little extension on the left end of the beam. It is used to make the final equilibrium adjustment. Since the checking rider is light, and can travel over only a very short distance, the adjustment of the thumb nuts must be done carefully in order to bring the equilibrium point within the range of the checking rider.

There are two adjustments of the Magni-Grad which can be made by the user. First is lateral movement of the zero line on the ground glass screen. This can be adjusted by turning the thumbscrew that extends out from the right side of the projection housing. THIS ADJUSTMENT SHOULD BE ATTEMPTED ONLY WHEN THE DROP LEVERS ARE RELEASED AND THE MOVING SYSTEM IS ARRESTED BY THE PAN ARRESTS. Observance of this procedure assures that the beam will always begin its swing from zero. A slight movement or shift of the zero point when the beam is arrested by the drop levers is nothing to be concerned about. The magnification of this projection system is 50x and a movement of one division on the ground glass screen is approximately only .0007 of an inch actual movement of the pointer.

The second adjustment is the focusing of the graduated scale. Normally this should not be necessary but it can be accomplished by turning the screw in the hole immediately below the ground glass screen at the front of the Magni-Grad housing. A small screw driver is required for this operation.

It is advisable to leave the light on for a short period of time before using the balance and leave it on continuously, as long as there is a probability that the balance will be used during that day.

In replacing bulbs it may be necessary to try the new bulb in the two possible positions, since the filaments are not always exactly centered and one position may give a better light than the other.

A binding post is located on the rear of the balance base for attaching a ground wire. It is recommended that the instrument be well grounded to facilitate static dissipation.

(C) Reading the Balance

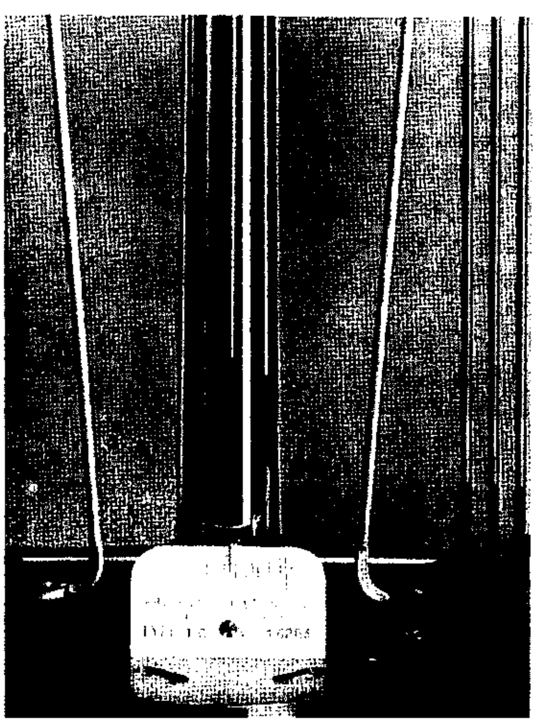
1. Pointer Scale (Fig. I) formerly was used simply to indicate when the moving system was in balance. It can be used thus on analytical balances for approximate weighings, particularly on chainweight balances. It is usually more convenient to read the pointer deflection and interpret it into weight. There are three methods of reading the pointer.

Mean of swings method gives the calculated rest point by averaging the swings in each direction. The turning point of three consecutive swings is read. The two readings in one direction are averaged. This average is added algebraically to the reading of the intervening swing in the other direction. One-half of this sum gives the calculated rest point.

In most cases it is not necessary to divide the sum of the left and right swings to get the calculated rest point. The algebraic sum is used since it can be interpreted into weight as easily as half this amount.

Reading only two swings is not exact because of the error introduced by the continual decrement of the swing. This decrement is due to the damping effect of any friction in the agate bearings, air resistance of the pans, friction between links of the chain, etc. It is not important on new balances with sharp knife edges, but it is a factor on older balances, particularly when heavy loads are on the pans.

Figure I



Single deflection reading is gaining in popularity because it is fast and simple. With this method, the first swing of the pointer is read. It is always advisable to let the pointer swing back through the second half of its cycle to make sure that the release was even. The pointer should return almost to zero but not beyond. This requires that the pan arrest arms be adjusted accurately so that their release does not give the pans a "kick" in one direction or the other.

The first swing is nearly twice the rest point and can be determined as accurately. The turning point of the first swing can be read to one-quarter division as easily as the rest point can be read to one-eighth division. When used consistently, the single deflection method gives reliable results quickly and easily.

Rest point method is to read the position of the pointer after it has come to rest. It is usually not practical unless the swing is damped. It is the only method that can be used when magnetic or air dampers are employed.

Interpretation of the pointer reading depends on both the method used and on the sensitivity of the balance. The sensitivity determines how far the pointer will swing for a given excess load on one pan. (See table.) The sensitivity changes somewhat when the total load on the pans is varied, and also changes when the knife edges become worn from use. So, for the most precise work, the sensitivity of the balance should be determined for the particular balance at the approximate load which will be weighed. It may be advisable to chart the sensitivities at various loads for ready reference.

TABLE

Balance Types	Rated Sensitivity (mg.)	1 Division Swing of Pointer Equals (mg.)	1 Division Change in Rest Point Equals (mg.)	Weight of Rider (mg.)	No. of Graduations One Side of Beam	Moving Rider 1 Graduation Equals (mg.)
LC	1/10	4/10	8/10	10	100	1/10
LCB	1/10	4/10	8/10	500±		100
DL, B, BT	1/20	2/10	4/10	10	100	1/10
BB, DLB	1/20	2/10	4/10	500±		100
BCT	1/20	2/10	4/10	None	None	......
T, TC	1/40	1/10	2/10	10	100	1/10
TX	1/200	1/20	1/10	10	100	1/10
TCX	1/200	1/20	1/10	1	100	1/100
FH	1/1000	1/1000	2/1000	5	50	1/10
FHM	1/1000	1/1000	2/1000	½	50	1/100

It will be seen from the table that the rated sensitivity of analytical balances is the amount of weight which will cause the pointer to swing one-fourth division, or change the rest point one-eighth division. Rated sensitivity is, in general, the smallest change in weight the balance will detect with a capacity load on both pans. It is assumed that the average user will have no trouble in reading the pointer swing of analytical balances to one-fourth of a division. On micro and semi-micro balances, a different system is used for rating sensitivity since magnifiers permit estimations to one-tenth division.

On any balance the sensitivity can be determined by first bringing the balance into equilibrium, then adding a small known weight on one pan (or moving the rider a measured amount) and noting the deflection resulting from the excess weight on one side. Users are cautioned not to make major adjustments of the gravity bob to increase the sensitivity of the balance. This is only one of the adjustments affecting the sensitivity, accuracy and over-all behaviour of the balance beam.

2. Beam graduations (Fig. J) are read by noting the location of the rider on the beam and considering the weight of the rider. Moving a 10 mg. rider from 0 at the center of the beam to 10 at the right has the same effect as putting a 10 mg. weight on the right pan. Moving it 1/100 of the way is equivalent to 1/10 mg. on the pan. On a micro balance, moving the 1/2 mg. rider from 0 at the left to 10 at the right is equivalent to adding 1 mg. on the right pan. Similarly, moving the 5 mg. rider from the left end to the right end is equivalent to 10 mg.

The riders should always be on the beam. Removing them, or using heavier or lighter riders, changes the center of gravity of the moving system; hence, the sensitivity. This is not usually too important on analytical balances but can be a factor in micro and semi-micro work.

3. Chainweight Balance graduations on the beam and tape are read directly in milligrams although the pointer swing has to be interpreted. Each notch on the beam represents 1/10 gram (100 milligrams.) For readings

up to 100 mgs., the chain is used and the effective weight of the chain is shown on the actuating tape in milligrams. Tenths of a milligram are read by using the vernier. This direct reading is achieved by careful correlations since the values of the chain and beam weight are not absolute.

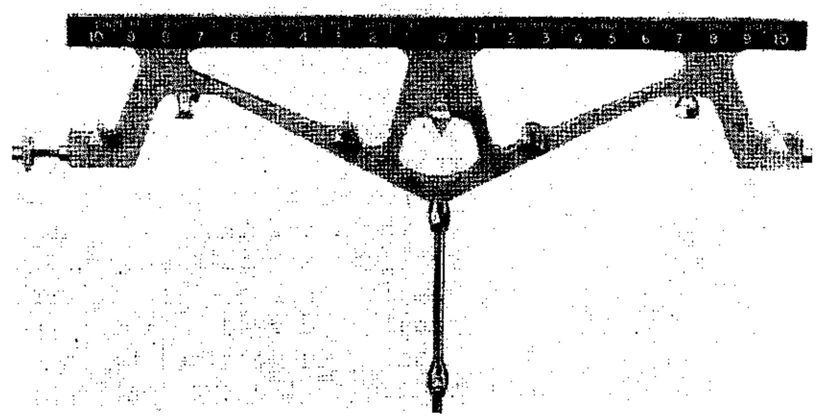


Figure J

4. Ainsworth Keyboard-operated weight carriers are read by noting which keys have been depressed. The keys, as well as the weight-carrying arms, just below the right stirrup, have numbers on them to show the denomination of the carrier weight each one handles. The sum of the keys depressed is the total of the weights so added to the right side of the moving system.

(D) Weighing Methods

1. Direct weighing is the method used for most regular laboratory work. It consists of putting the unknown mass on the left side of the balance and counter-balancing it with known weights on the right side. Gram or milligram weights are placed on the right hanger plate and the beam released sufficiently to indicate whether the weights are too light or too heavy to counterbalance the unknown. Until the total weights on the two hangers are within three to five grams of being equal, the pointer will move without releasing the pan arrests. After the two sides are nearly in balance, the pan arrests will have to be released also. The weights are added to the right side until the difference in weight is within the range of the right hand rider on the beam, or if the balance is a chain-weight or keyboard type, until the difference in weight is within the range of the weights controlled by these devices. The right hand rider and/or the chainweight, beam weight, and carrier weights are manipulated until the pointer does not go beyond the last graduation on the scale when the beam and pans are released. The total weight on the left hanger is then the sum of: (1), the weights on the right side plus (2), the effective weight of the rider or beam weight determined by its position; (3), plus or minus the swing of the pointer interpreted in milligrams. On chain-weight balances the effective weight of the chain, read from the tape and vernier, must also be included.

2. Transposition weighing is the second method. The procedure is, first, to get the weight of the unknown by the direct-weighing method. The loads are then transposed so that the known weights are on the left side and the unknown on the right. A second reading is taken. The true weight of the unknown is then the square root of the product of the two weighings. The average of the two weighings will be found accurate enough for all practical purposes and is simpler to use. The differences of the two weighings will usually be read on the pointer scale. If so, the average reading is obtained by taking one-half of the algebraic difference of the two readings; i.e., by changing the sign of the smaller, adding it to the larger, and dividing the sum by two.

3. Substitution weighing is the third method. The unknown is placed in the right pan. It is then counterbalanced with weights in the left pan. These weights do not have to be of high quality, but metal weights should be used. The use of miscellaneous material which might be at hand will often cause inaccuracies. The balance is brought into approximate equilibrium by adding the weights to the left pan, and by moving the left hand rider while the right hand rider remains at zero. Then the unknown is removed from the right pan and replaced by known weights of high quality. These weights are added and the right rider moved until the same equilibrium point is reached. The weight of the unknown is the sum of the weights substituted for it, plus the reading of the rider.

Section III

WEIGHING TECHNIQUES

Laboratory balances are extremely accurate devices. The ratio of their sensitivity to their capacity is one part in several million, whereas most types of instruments are not expected to read closer than one part in a hundred, or one part in a thousand. To take full advantage of this ratio of sensitivity to capacity and to get results with an overall accuracy approaching the limits of the sensitivity of a balance, various minor factors have to be considered.

Selection of weighing method to suit the job is important. Direct weighing is usually preferred for most routine work. This method is fast, simple and direct. It is convenient to use with tare weights as when a container, for example, in the left pan is counterbalanced by a tare weight in the right to simplify the determination of the weight of the contents. Another advantage of the direct weighing method is that it is simplest to use with chainweights, etc. which are designed to use primarily with this method.

The disadvantage of the direct method of weighing is not important on high grade American balances except when the balance must be used to its full sensitivity. In that case, any inequalities in the lengths of the two sides of the beam introduce inaccuracies in the results. This error increases as the load on the pans increases. A very small difference in "beam arm ratio" can result in an appreciable error in weighing. For example, a 100 gram weight 3.00003 inches from the fulcrum exerts a force of 300.003 gram-inches. If the other arm of the beam is exactly 3" long (3 one hundred thousandths of an inch shorter) it will take 100.001 grams to exert a counterbalancing 300.003 gram-inches, making the weighing error 1 milligram.

To eliminate this beam arm ratio error, the transposition method may be used. This is the reason for transposition weighing, which has no other advantage over direct weighing and takes nearly twice as long.

Substitution weighing also eliminates errors due to beam arm ratio. It also eliminates other theoretical sources of error, except the buoyant effect of the surrounding air, and so is the most accurate method. It has another advantage in that the first equilibrium point, with the unknown on the pan, can be reached rather quickly. Then after the unknown is "weighed," sufficient time and care can be taken in substituting the known weights. It is not necessary that the equilibrium point be the center line on the scale. Any point on the scale can be used provided this reading is duplicated on the second weighing.

Ainsworth keyboard balances are particularly suited for using the substitution method. Depositing the carrier weights on the right stirrup has the same effect as placing them in the right pan, as far as beam ratio and other similar considerations are concerned. Further, when only small changes in weight are to be determined, the substitution method can be used routinely on keyboard balances without loss of time. The loss of weight after equilibrium has been established can be determined easily by depositing enough carrier weights to bring the balance into equilibrium again. If a gain in weight is to be determined, all the carrier weights should be lowered before the balance is brought into equilibrium. The gain in weight is then determined by raising sufficient carrier weights, substituting the unknown for known weights instead of vice versa. With this procedure it is usually easier to use the left hand rider as the weighing rider.

Magnetic dampers arrest the swing of the pointer by means of the non-magnetic vane cutting across the field of a magnet. They simply put a brake on the swing and should not pull it in one direction or the other. In case there is a speck of magnetic material on the surface of the vane, or a minute inclusion of magnetic material in the vane, the magnet will pull the vane out of its correct position. Comparing the rest points with damper engaged and disengaged without changing anything else will show the bias given by the damper. This should be tried with the rest point in several positions.

Chainweight Balances are limited in accuracy by variations in weight in various segments of the chain. If the chain varies in weight along its length, due to stretching, contamination, etc., its arbitrary calibration will not give true results. The chain readings can be checked by comparing them to known weights added to the left pan. The beam weight, too, is a possible source of error. This relatively heavy weight on the beam must seat accurately in the notches and the notches must be carefully spaced if the beam weight is to give true values. The closer the notches, the heavier the beam weight, and the more critical their correlation is. The calibration of the beam weight can be checked, like the chain, by comparing its effective weight as it is moved from notch to notch against known weights on the pan. When a chainweight balance must be used beyond the limits of accuracy of the chain and beam weight, they can be left in a constant position and the weighings made with weights in the pan.

Zero Drift, or change in rest point, is not usually a problem on analytical balances. The zero point stays fairly constant until it is changed by foreign material on the moving system, moving the rider, etc. It is good practice, however, to check the zero before and after each weighing.

In micro, particularly, and to a lesser extent in semi-micro work, considerable care must be used to avoid difficulty from changes in rest point. These changes are, in general, due to two factors which are not present in ordinary weighing. First, the balances are sensitive to the forces exerted by very tiny units of mass. Second, the utilized sensitivity of the balance is a very small amount in proportion to the total weight on the pans. This means that the mechanical adjustment of the balance must be very exact and also brings into play things effecting the surface or volume of the moving system. Temperature, humidity, static, air currents in the case, etc., can all have their effect and, unfortunately, the balance being purely mechanical cannot distinguish between a change of weight on the pan and an equally effective force from some other source. It follows that a sensitive balance should be isolated as much as possible from disturbing conditions. Particular precautions are called for by glass containers on the pans.

The presence of the operator in front of the balance, for example, has a considerable effect on the zero point of a micro balance. Two techniques are used to get around this "personal effect." One is to stay away from the balance as much as possible, approaching it only to make the weighings. The other is to stay at the balance for fifteen minutes or so before weighing so that the effect becomes stabilized and the balance settles down to a stable or slowly changing zero point. The "mean of swings" method is recommended for reading the pointer of micro balances. This permits more accurate reading of these ultra-sensitive balances, and reveals any significant change in zero point that occurs while the reading is being taken.

Riders can be a source of minor difficulty on finer work. The riders should always be on the beam when using the balance for two reasons. First, removing the riders changes the sensitivity. Second, if the weighing rider is removed when establishing equilibrium, replacing it on the center mark may shift the equilibrium point slightly if the center graduation on the beam is not exactly over the center knife edge. Similarly, any difference in distance between the center and end graduations of the beam and the distance between the center and end knife edges will show a proportionate rider error. On high grade American balances, these rider errors are seldom a factor, but they should be considered when using delicate balances to their full sensitivity. Reproducible readings are difficult to obtain when the riders are bent or twisted and placed carelessly on the beam so that they tilt.

Density of the material being weighed compared to the density of the standard weights can be a factor due to the buoyant effect of the air.

Weights are an obvious but occasionally overlooked source of weighing difficulties. Analytical balances can be read to much smaller values than the tolerances allowed by the U. S. Bureau of Standards on even the finest weights, in the larger denominations. The corrections for the weights employed should be applied whenever the results will be effected significantly. The mass of the weights, particularly lower quality weights, can change because of wear, corrosion, contamination, and other factors. Weight sets should be cleaned and intercalibrated when necessary.

Section IV

CARE

(A) Cleaning

It is advisable to use some sort of cover over the case at all times when the balance is not in use. This will avoid much unnecessary cleaning. Periodic cleaning of the balance is advisable, but too frequent cleaning is unwise since the possibility of damaging the instrument is greater the more frequently its parts are handled.

When cleaning is necessary, first remove the riders, chain, and carrier weights, then the hangers and stirrups. The beam is then removed by the reverse of the instructions for installing it. (See Page 3.) Place the beam where it will not be damaged. First clean the inside of the case, then the column, etc. Special care should be directed to the center bearing, removing any accumulation of dust or dirt. A camel's hair brush is recommended for removing dust from any small surfaces.

The agate center bearing and the agate bearings in the stirrups may be cleaned with a soft cloth or tissue slightly moistened. Solvents such as alcohol may be used, but extreme care should be taken lest the solvent remove the lacquer from adjacent metal surfaces. The knife edges of the beam may be cleaned with a soft cloth or tissue held in the fingers or wrapped around a toothpick or similar small piece of wood. Use of any sort of metal probe is not advisable.

Any accumulation of small particles on the magnets of magnetic dampers should be removed by scraping lightly with a small strip of soft iron or annealed steel. The strip is drawn through the gap of the magnet, allowing it to drag first against one pole and then the other. The vanes of the damper may be brushed lightly with a camel's hair brush to remove any magnetic particles which might be adhering to the surface. Care must be used so that the vane is not bent or twisted in any way.

(B) Lubrication

After long periods of use, a small amount of lubrication may be required by the balance operating mechanism underneath the case. One drop of high-grade, light-weight mineral oil is suggested for each bearing. Absolutely no lubrication should be used at any time on the agate knife edges or bearings.

(C) Replacing Parts

Tapes for Ainsworth chainweight balances are installed as follows:

1. Depress the top pulley gently with the right hand, using a piece of folded cloth or tissue paper for a pad, and insert pin (furnished with each tape) thru holes shown at (A) Fig. 1, with the left hand.

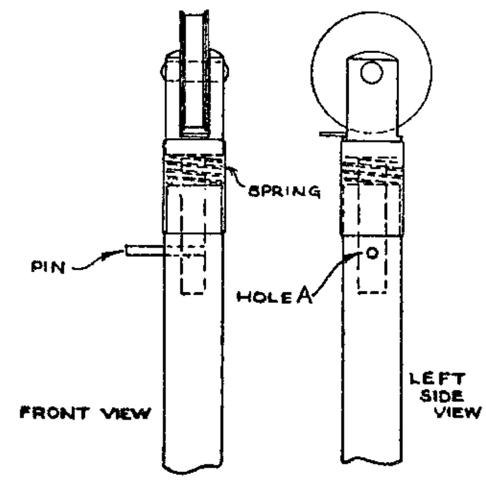
NOTE: In balances manufactured before April, 1936, there is no hole for the pin. In this case, the easiest method is to have someone hold the upper pulley in the depressed position while removing the old tape and attaching the new.

2. Remove nut and bolt, shown at (B) Fig. 2 (with small socket wrench furnished with new tape.) Also remove stop nut and bolt shown at (C) Fig. 2.

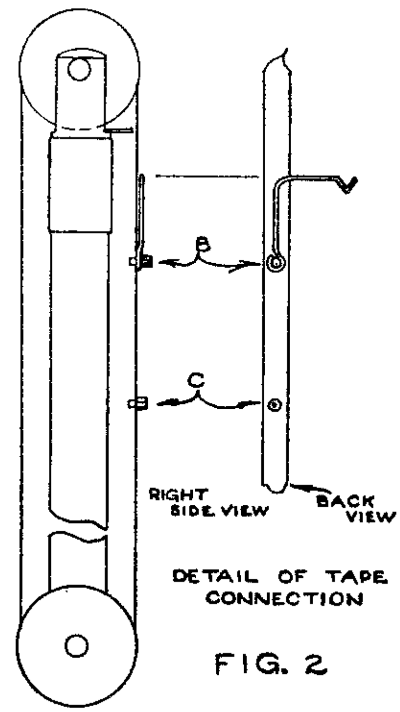
3. Replace nut, bolt and washer (C) Fig. 2, in new tape.

4. Pass zero end of new tape down thru the rear slot in the balance base, around lower pulley and up thru front slot. Then pass tape up over top pulley, join ends and replace nut, bolt, hook, and washers shown at (B) Fig. 2. Be sure that the chain hook extends to the left when facing the front of the balance.

5. Depress top pulley as in Fig. 1 and remove pin allowing the tape to assume the spring tension. Try the tape to be sure it functions properly.



DETAIL OF TOP PULLEY BRACKET
FIG. 1



DETAIL OF TAPE CONNECTION
FIG. 2

<u>Chain.</u> To install a new chain on chainweight balances, follow the instructions given on page 5. (D).

The new chain may be slightly heavier or lighter than the one it replaces. If so, an adjustment must be made, as follows:-

With the beam weight in the zero notch, turn the chain-operating handle until the equilibrium point of the empty balance is the center line of the pointer scale. Arrest the beam and turn the knob on the left of the case until the zero of the vernier coincides with the zero line on the tape.

Put an <u>accurate</u> 100 mg. weight in the left pan and turn the tape to the 100 mg. mark, release the beam and note the swing of the pointer.

If the pointer moves to the left, the chain is, in effect, too heavy. This is corrected by moving the supporting pivot on the beam closer to the center of the beam. Similarly, if the pointer moves to the right, the pivot should be moved to the right towards the end of the beam to increase the effective weight of the chain.

To move the pivot to the right, carefully loosen left locknut on the supporting arbor an eighth turn and tighten right locknut correspondingly. Use an 1/8" open-end wrench. Before turning the nuts, be sure the beam is arrested. Hold the pointer just below the beam with one hand to steady it when turning the nuts. It is not necessary to remove the beam from the balance.

Reset the zero and check the chain against the weight. If necessary, repeat the above procedure until exactly 100 divisions on the graduated tape equal 100 mgs.

The adjusting nuts on the ends of the beam may be turned so that the vernier is near the center of its range of travel when the balance is in equilibrium with the pointer on the center line.

Beam weights for Ainsworth Chainweight Balances do not require any instructions for installation, but when ordering them for replacement, the serial number of the balance must be given. Beam weights are adjusted individually to the balance and are not interchangeable. Riders and carrier weights can be ordered without giving the serial number of the balance provided the denomination, grade, and shape is specified.

Other operating or major parts for Ainsworth balances should be installed only by men who specialize in balance repairs. Parts can be supplied by the factory provided a complete description of the part and its function, and the serial number of the balance is given. On older balances, it is advisable to send a sample of the part required.

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