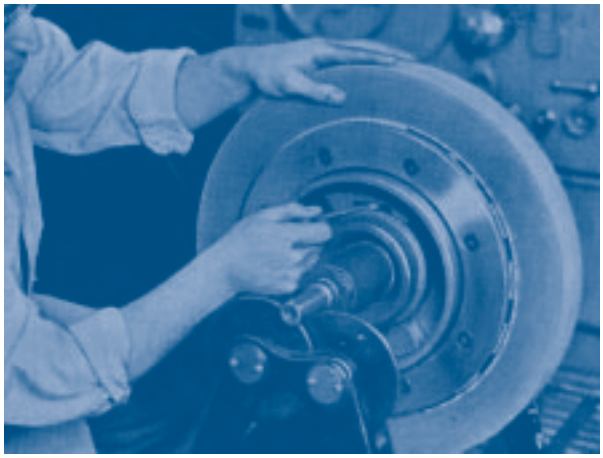
The Balancing of Grinding Wheels

BALANCING GRINDING WHEELS.... WHEN AND HOW ?

For satisfactory work, the grinding wheel and its sleeve or mount must be in a reasonably good state of balance. Except for extremely high precision work, the wheel assembly does not need to be in, or corrected to, precise balance. The reason for this is that the well designed grinding machine is so rigid that vibrations due to normal wheel imbalance within the close inspection limits are of practically no consequence. Proper design and construction will also have eliminated any possibility of the wheel spindle operating at, or near the resonant or natural frequency of any machine component.



Balancing a grinding wheel
Fig. 1

While grinding wheels today are held to very close limits with respect to structural uniformity and grade duplication, some manufacturing tolerance, however small, must be observed for grinding wheels, as for any manufactured product, and therefore some imbalance may be present.

Besides, even if a wheel conceivably, were in perfect balance when made, some imbalance is inevitable when the wheel is mounted, for the simple reason that if the Standard Safety Code is to be observed, the wheel must not fit tightly on the spindle. Clearance must be provided so that any possible expansion of the spindle or sleeve due to grinding heat or bearing heat cannot exert outward pressure or stress at the hole. This is very important as it has been clearly established that the maximum stresses in a rotating body are tangential at the edge of the hole and any additional stress might lead to breakage.

This mandatory hole-to-spindle clearance thus means that any grinding wheel of necessity will be mounted eccentrically – only a few thousandths of an inch, to be sure, but still enough to produce a certain amount of imbalance (see illustration below).

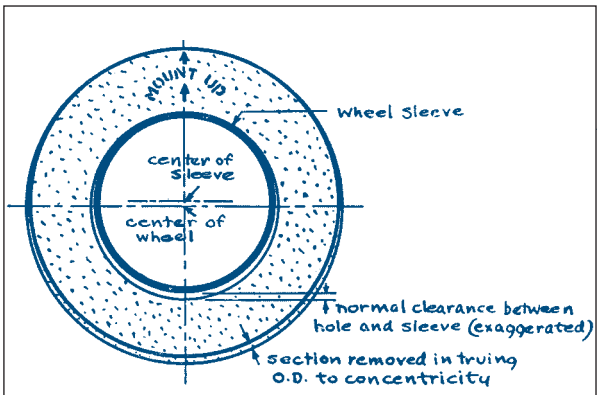


Fig. 2

If refinement of balance is vital to the success of work regularly ground, then an automatic wheel balancer should be considered for use on cylindrical grinders. Conventional balancing procedures can be time-consuming. In contrast, since the automatic wheel balancer is built into the wheel head, this allows balancing in place on the machine and the operator merely pushes a button. The balancing cycle is automatically terminated after about 5 seconds. Thus, precise wheel balancing can be accomplished at any time, except during actual grinding, with no special operator skill required.

A photograph of an Automatic Wheel Balancer, manufactured and marketed by our collaborator (M/s. Norton International Inc., USA) is shown here.

Norton Automatic Wheel Balancer
Fig. 3

A detailed study on the subject of wheel balance must include :-

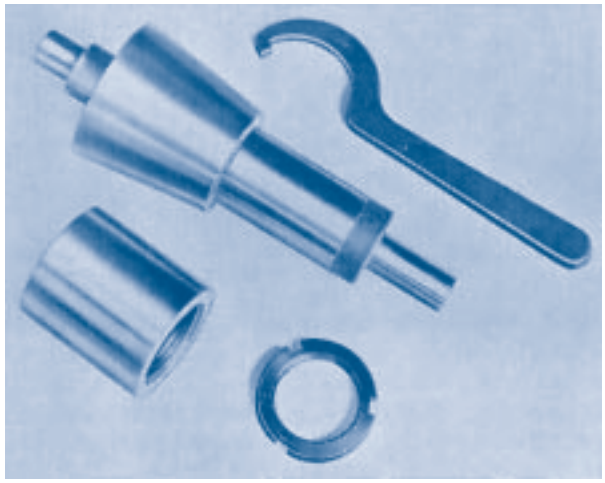
1. the development of mathematical formulae to determine and isolate the amount of imbalance due to physical dimensions along;
2. the employing of electronic equipment to determine realistic balance requirements for various types of grinding machines;
3. the development and installation of the most advanced wheel manufacturing equipment and methods to ensure the utmost in wheel structural uniformity and duplication. The results of this will enable us to effect significant improvements in wheel balance.

CHECK WHEEL SLEEVES FOR BALANCE

To translate the results of the study of wheel balance into practical benefits to the user, the following procedure should be adopted by the wheel user.

All wheel sleeves and flanges should be checked for balance with standard balancing equipment for grinding wheels; if found to be out of balance it must either be corrected or the location and amount of imbalance clearly marked, so that it can be subsequently allowed for. It has been our experience that much valuable time is lost and excessive cost incurred, in attempting to balance a grinding wheel where the sleeve itself is out of balance and the exact location of either the light or the heavy side is not known.

Please see photograph shown below and you



Balancing Arbor for use with Balancing wheel Sleeve
Fig. 4

will observe that wheel sleeves for grinding machines are checked for balance (dynamically) in the course of manufacture, in one of the machine manufacturer's plants.

Wheel Sleeves for Norton Grinding Machines, in the course of manufacture, are checked for balance (dynamically)
Fig. 5

With the uniform structure and balance built into Grindwell precision grinding wheels today, refined wheel balancing is seldom required in the general run of production grinding. Nevertheless, almost any wheel when suspended on arbor and allowed to turn will invariably show a light side.

Wheels for precision grinding, which are over 14" in diameter are at times marked with an arrow (-) showing the light side, together with the instruction "mount up" see Fig. 6). This means that if the wheel to be mounted is hung on a fixed spindle, as would normally be the case, the wheel should be positioned so that the arrow points upwards.

Wheels are stencilled with an arrow for mounting purposes
Fig. 6

By mounting the light side up, the heavier side of the wheel will be at the greatest distance from the final centre of rotation. This means that when the outer diameter is trued to concentricity, the excess material will be removed from the heavier side of the wheel, which of course, is desirable.

As there must always be some clearance between the hole diameter and sleeve or spindle, the cavity thus caused, though ever so slight, will result in a certain amount of imbalance, which we call residual imbalance. By mounting the wheel with its light side up, this residual imbalance will always be diametrically opposite to the heavier side, thereby acting as a corrective factor.

If, on the other hand, the wheel were to be mounted up, with the heavy side upwards, then the excess material would be trued off the light side, thus aggravating the amount of imbalance.

As the light side is at the top of the wheel, it can be readily located and accurately marked by the wheel manufacturer in the course of inspection. That is optional and often left to his discretion. Likewise, when mounting the wheel, the operator finds it more convenient to work from the top or light side of the wheel and by using the same reference point, as that used when inspecting the wheel, the best grinding results can normally be expected.

In the case of a wheel 500mm x 200mm x 304.8mm (20" x 8" x 12") for example, with a normal hole-to-spindle clearance of 0.254mm (010") it has been observed that by simply mounting the light side up, a reasonable self corrective action can be obtained at no extra cost, after truing the O.D. concentric. If additional correction is required, it is a simple matter to move the two balance weights away from the light spot by equal amounts, until a satisfactory state of operative balance is obtained.

STEPS IN BALANCING A WHEEL

Standard equipment for balancing grinding wheels consists of a balance stand and balancing arbors to fit various sizes of wheel sleeves.

The procedure to follow in balancing a wheel is as follows:

1. Mount the wheel on its sleeve. (In case of wheels with arrow markings, the stencilled arrow should point upwards). Tighten the flange bolts evenly and only enough to hold the wheel firmly.
2. True the wheel so that it is in running truth on its own sleeve.
3. Remove the wheel and sleeve assembly from the grinding machine. Insert the proper size balancing arbor and then place the arbor with the wheel on the balancing stand.
4. Remove the two balance weights from the wheel sleeve.
5. Allow the two wheel to turn until it has come to rest with the heavy side down.
6. Draw a chalk mark on the side of the wheel at the exact top (directly opposite the heavy side).
7. Replace the two balancing weights in the flange groove with their adjacent ends

meeting under the chalk mark. Tighten the weights just enough to hold them in position temporarily.

8. Give the wheel a quarter turn. The wheel may not remain at rest in this position; move the weights gradually and equally from the chalk mark until the balance is established.
9. Give the wheel a half turn. Test for balance and then keep turning the wheel for a complete revolution, stopping and checking for balance at about eighth of a revolution.
10. Now tighten the balancing weights securely.
11. Carefully rest the wheel on the floor, remove the balancing arbor and mount the wheel in the grinding machine. Finally retrue the wheel preparatory to grinding.

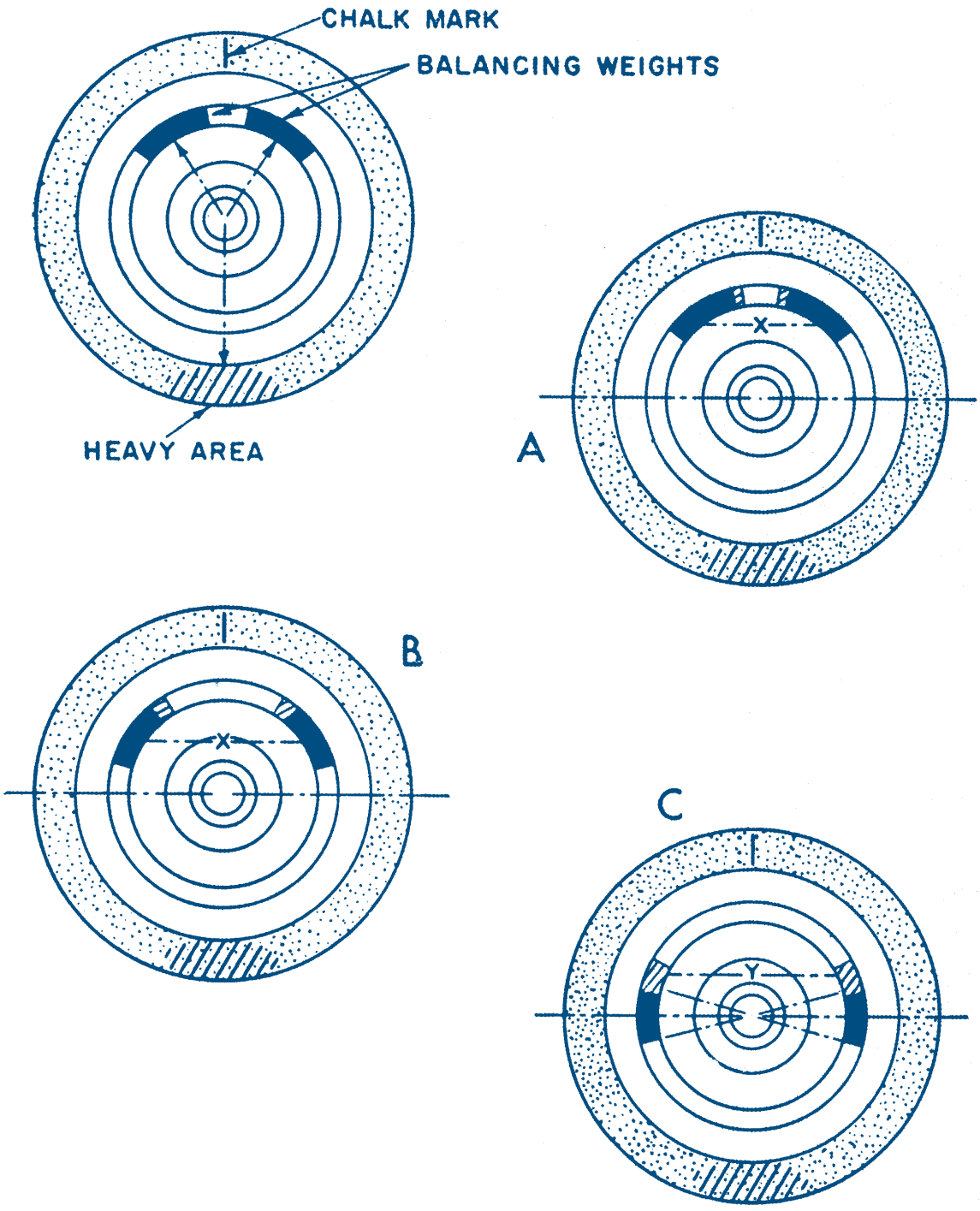
The sketches in Fig. 7, show the balancing weights, the chalk mark and where the heavy spot are first located; then how counter-balancing is accomplished as the weights are moved apart and down equal distances.

The two balance weights are much heavier than any imbalance in the wheel assembly, so only a portion of their weight is utilized to counter-balance it; this portion is represented by the shaded or the cross-hatched areas on the weights.

In view A, we see that combined shaded portions on the weights counter-balancing the original heavy side of the wheel; but the remaining dark portions of the weights now combine to create a new heavy section represented as X, a point.

As the weights are moved apart (shown in view B), this newly created heavy spot becomes lighter, because it is closer to the axis of the wheel assembly. For the same reason the slightly more shaded portion of the weights is needed to offset the heavy spot in the wheel.

In view C, dark portions, show two weights counter-balancing each other and the shaded areas combining in effect at Y, to counter-balance the original heavy spot in the wheel assembly.



Showing the principle of adjusting the balancing weights to obtain a range from the maximum to the minimum counter-balance

Fig. 7