The Benefits of Automated Armature Balancing

Jake Schlaegel

About Us

Headquartered near Ann Arbor, Michigan (USA), Balance Technology Inc **BTI** is a thriving Precision Measurement and Testing company with a strong domestic and international presence. Since 1968, **BTI** has set the standard in industrial Precision Measurement & Testing systems. With 13,000 plus systems shipped worldwide, our team approach to customer satisfaction and technical innovations has forged our reputation as an industry leader and trusted partner.

BTI World Headquarters.
All our equipment is engineered & manufactured in the USA.

BTI engineers and manufactures a complete line of industrial precision measurement and testing equipment, including static and dynamic balancing equipment, dimensional gages, mass centering equipment, eddy current crack detection systems, surface finish measurement equipment, NVH equipment (noise vibration and harshness), functional test stands, spinners, motor testers, and resonant frequency measurement systems. We also engineer and manufacture specialized test systems, including torque-to-turn, backlash, end play, and destructive test equipment.

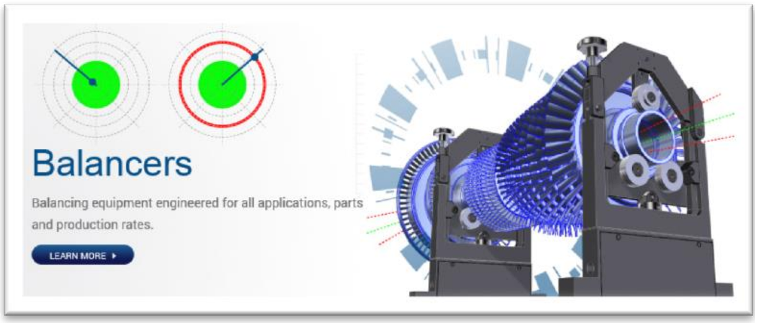
Additionally, **BTI's** unique ability to combine the aforementioned technologies into one fully integrated system enables our clients to reduce capital expenditures, increase product quality, and minimize floor space requirements.

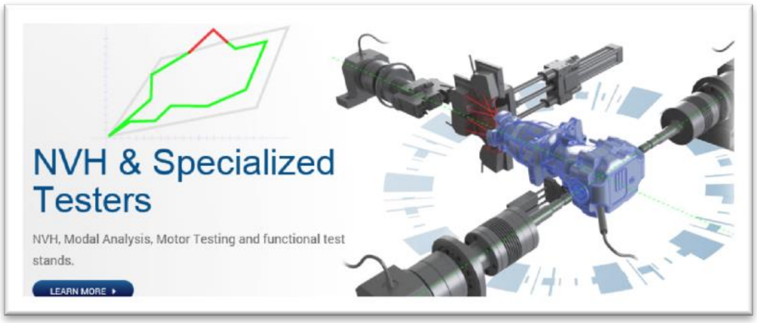
Let our staff of over 50 engineers design a custom solution for your specific requirements. Furthermore, our commercial Measurement & Testing Services Group (M & T Services) can assist with everything from prototype testing, R&D work, master certification to running small to medium production runs.

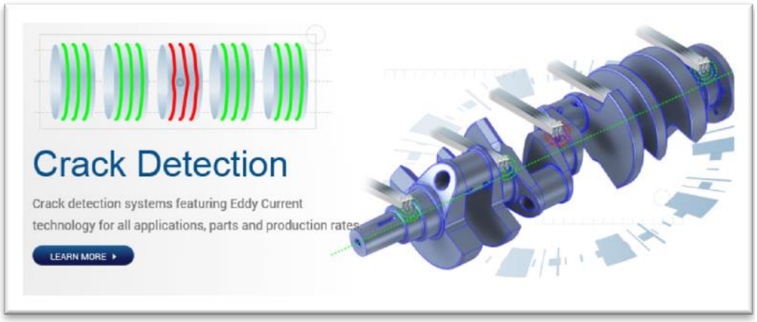
Our service department is available 24 hours a day, 365 days a year. We also offer remote diagnostics for "real time" software updates.

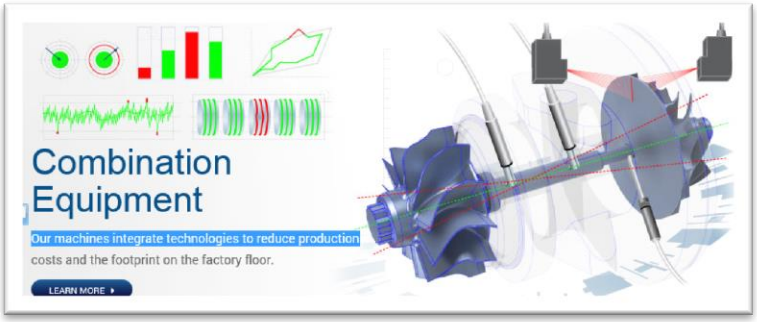
What we do…

We engineer custom equipment for all your Precision Measurement & Testing Needs









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THE BENEFITS OF AUTOMATED ARMATURE BALANCING

Bruce J. Mitchell, Jr.

BALANCING BASICS

Virtually all rotating components experience significant quality improvements if balanced. Balancing is the process of minimizing vibration, noise and bearing wear of rotating bodies. It is accomplished by reducing the centrifugal forces by aligning the principal inertia axis with the geometric axis of rotation through the adding or removing of material.

In today's global market, consumers look for the best products available for their money. They demand maximum performance, minimum size, and lower cost. In addition, everything must be smaller, more efficient, more powerful, weigh less, run quieter, smoother and last longer.

As consumer demands continue to increase, balanced components will become even more essential ingredient in providing the highest quality components and products at competitive prices.

CHOOSING THE RIGHT BALANCER AND PROCESS TO MEET YOUR NEEDS

Today, there are so many choices when it comes to armature balancing. There are manual, semiautomatic, and fully-automatic armature balancers available. You must choose whether you want material added or removed. If you decide to add material, do you want to use a two-part epoxy, a one part heat cure, or do you want to use ultraviolet light curable resin, or how about weight insertion? If you want to remove material, are you going to mill in both planes or are the planes so close together that you must mill in one and nibble on the fan in the other. Do you want to use a contour shaped cutter or a "V" cutter, and if you choose a "V" cutter do you want a single or gang cutter? What about production rates, how many parts per hour do you need; 150, 360, or 600?

The following information will give you the confidence necessary to make one of the many decisions associated with armatures and balancing equipment. Discussed will be some of the negatives associated with manual balancing as well as the benefits associated with automatic balancing.

AUTOMATIC VS MANUAL

Automatic armature balancing is the most cost effective means of producing higher quality products, in less time and for less money. There are many reasons to automate your balancing process, some of which include; higher production rates, the use of less floor space, the reduction of skilled labor, better quality control, a higher quality final product, the elimination of multiple shifts, and the ability to take on more business with increased capacity.

In addition, automatic balancing can increase the marketability of your products with the ability to showcase your "state of the art" equipment for the production of their "state of the art" products. Thus, automatic armature balancing can give your company a competitive edge by increasing your production and lowering your costs while producing higher quality products. As balance tolerances continue to tighten, manual balancing will become increasingly more difficult, and less practical. Although a manual machine has the capability of measuring unbalance as well as an automatic machine, an operator cannot consistently balance as quickly or as accurately as an automatic machine.

DISADVANTAGES ASSOCIATED WITH MANUAL BALANCING OPERATOR INTERPRETATION

Since most fractional horsepower manufacturers correct armature unbalance by milling, we will focus on metal removal and the two of the most common errors associated with manual balancing.

Although for the most part analog meters and equipment are no longer available, there are many manufacturers still running old analog manual machines. Aside from analog drift, the main disadvantage associated with analog equipment and manual balancing is the inability of an operator to accurately read/interpret both the analog meter for amount and the strobe light for angle. Operator interpretation combined with "operator feel" depth control and visual angle location make manual balancing inaccurate.

New balance computers can display the unbalance as a digital amount and angle of unbalance, thus eliminating operator read errors. The unbalance can be expressed as the weight of mass to be added or removed at various radii and planes and can be expressed in any combinations units to specify the unbalance. Such as; ounce-inches (oz-in), gram-inches (g-in), gram-millimeters (gmm), gram-centimeters (g-cm), and kilogram-meters (kg-m).

Although the computers of today can be easily tailored to display the information of choice, the operator is still required to accurately interpret and perform the balance correction. Consequently, the human error exists in the correction; they must still remove the precise amount of unbalance at the specified angle.

ANGLE MISSALIGNMENT

How does this happen? For this part of our discussion, we will assume an operator can remove the exact amount of unbalance from an armature but is off in angle by a mere 12 degrees (only 2 minutes on a clock). Surprisingly, this seemingly insignificant error will create over a 20% amplitude error. Consider the following example:

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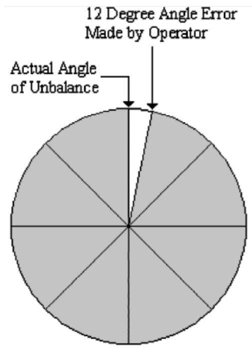
An armature with a 2" diameter lamination, a balance tolerance of 0.0015 ozin, and 0.020 ozin of initial unbalance (a 13:1 correction ratio). As discussed above, the operator removed the exact amount of material, but was off angle by 12 degrees, consequently the result of the correction made represent only 0.0158 ozin of the 0.020 ozin. Thus a residual unbalance of 0.0042 ozin will exist, and the workpiece will remain out of specification.



For small angular errors the percentage error can be calculated by multiplying the sine of the error angle (x) in degrees by 100 to get percentage.

Percentage Error = (Sin(X))(100)

In other words, the armature will still be out of the 0.0015 oz-in specification by 0.0027 oz-in. This seemingly small error made by the operator will now require the removal of additional material and thus a minimum of second and possibly third correction pass that would not otherwise be necessary. In addition, to the time it takes to make the corrections is the extra time it takes to reaudit the armature after each correction.

Most automatic armature balancers have the capability of locating the angle of unbalance to approximately 1/3 of a degree. This level of accuracy is over 30 times more accurate than the realistic example demonstrated above.

The resolution listed above can be achieved using many different orienting devices, such as servo motors, encoders, or stepper motors. With a typical 1024 pulses per resolution, and approximately a .33 angle error (ignoring belt slippage, possible transfer errors, etc.), an automatic armature balancer induces only 0.5% amplitude error as compared to the over 20% error by the operator and her manual machine.

AMOUNT ERRORS TAKE TIME AND CAN NEGATIVLY EFFECT MOTOR PERFORMANCE

Amount errors are another common disadvantage associated with manual balancing. The operator must read the display and determine the appropriate amount of material to remove. Typically, through experience a seasoned operator can remove the approximate amount of unbalance by "feel", but it is still only a good guess. It is easy to see the major problem associated with the "feel" technique is the requirement of a skilled operator who "knows" how much material to remove by controlling the depth of the cut.

Even with an experienced operator, it is not uncommon to see overcorrected armatures, where too much material is removed and the unbalance shifts 180 degrees out of it original phase. Remember, all unnecessary corrections take costly time and can negatively affect motor performance.

Studies show that operators balancing manually typically remove more material than required caused by both phase misalignment and depth errors. Consequently, motor performance is compromised and the electromagnetic characteristics of the motor are negatively affected. These changes in the magnetic field, caused by excess material removal, can actually induce forces that simulate unbalance in a final assembly!

Some automatic armature balancers combat amount errors by utilizing effective part contact sensors and adaptive feedback systems. The result is an automatic machine with the capability of greatly exceeding the performance of a manual machine and an operator.

Another advantage of automatic balancing is the capability of the computer to rapidly sense and adjust for things like tooling wear and production trends inherent in the manufacturing process of armatures.

Without exceeding your work piece parameters, an automatic armature machine can produce higher quality parts in less time and with fewer rejects.

ADVANTAGE – AUTOMATIC

As discussed, there are many types of operator errors and inaccuracies typically associated with manual balancing. These errors combined, cost time and money, as well as the possible reduction of overall motor performance.

As production rates increase and balance tolerances continue to tighten, manual balancing will become increasing more difficult and impractical. Automatic armature balancing will become a necessity for the consistent production of high quality armatures. Automatic armature balancing is a good investment in your company’s future.