NASA TECH BRIEF

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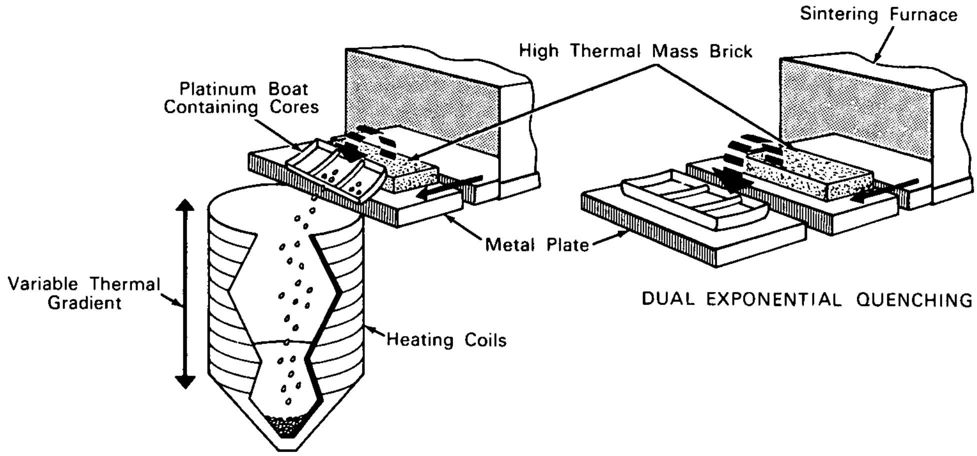
New Sintering Process Adjusts Magnetic Value of Ferrite Cores



The problem: Manufacturing control of the magnetic characteristics of ferrite cores used in memory systems of computers and data processing equipment. For these purposes it is essential not only to obtain the proper threshold coercivity of the magnetic core, but also to secure optimum ratio of "one" to "zero" electrical response. Standard quality-control procedures dictate that each core be tested before assembly and cores not meeting specifications be discarded.

The solution: A sintering technique based on time and temperature that permits reversible control of the coercive threshold of sintered cores. The technique, called the Quench Rate Annealing Cycle (QRAC), is a two-phase sintering process. The first phase is "zero" firing and the second phase is the Quench Rate Annealing Cycle. Reversible control of the threshold coercivity is achieved through control of the quench rate of the core when it is removed from the sintering temperature.

How it's done: First step in the two-phase cycle is to place the cores in a sintering furnace for about 60 minutes. The "zero" firing is stopped within the time range corresponding to the temperature-time product that will produce the optimum zero response characteristic. For a given material the cycle may be held down by setting the furnace temperature to cause the desired temperature-time product to occur within 75 minutes. Following this treatment, cores can be stockpiled or reprocessed by the QRAC to establish the desired coercive force.

For the second step, or Quench Rate Annealing Cycle, the temperature of the cores is raised to a figure not exceeding the temperature of the first cycle firing. One of the methods of quenching which produces good results, the dual exponential technique, has a within-specification yield rate of about 90 percent. Dual exponential quenching is actually begun in the sintering furnace at the end of the "zero" firing.

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In this process, hot sintered cores are contained in a platinum boat, which rests on a substantial thermal-mass brick. The platinum boat is extracted from the hot zone of the sintering furnace by sliding the brick along the hearth plate and onto a similar hearth plate. The platinum boat is then placed on a metal slab to cool. Cooling time is determined by a formula which includes the temperature of the boat, ambient temperature, time constant of the platinum boat in contact with the metal slab, and thermal conductivity between the boat and the metal slab.

Quenching of sintered cores may also be accomplished by the free-fall method. Cores on platinum boats are removed from the hot zone of the sintering furnace in the same manner as in the double exponential technique. Instead of allowing the cooling to take place in thermal contact with a metal plate, cores are allowed to fall freely down a metal cylindrical chamber. The height of the chamber is sufficient to allow cores to cool sufficiently before striking a funnel-shaped collector at the bottom.

As an extension of the free-fall technique, the temperature gradient along the axis of the cylinder may be adjusted through the use of a surrounding radiant energy source to yield a specified thermal contour.

Threshold coercivity may be controlled over a substantial range of values by selective control of the cooling rate. Reversible control of coercivity is possible through repetition of the QRAC, utilizing time and temperature values selected to yield the desired product characteristics. For example, cores exhibiting a coercive threshold of 1.3 oersteds may be lowered below 0.9 oersted and then raised above 2.0 oersteds by recycling the cores through the annealing cycle.

Notes:

1. Salvage of cores rejected for improper values of coercivity may be accomplished at less cost than manufacture of new cores.
2. Since this process has a higher and more predictable rate of yield, automation of the entire process may now be considered feasible.
3. For further information about this innovation inquiries may be directed to:
   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B63-10606

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA Headquarters, Washington, D.C. 20546.

Source: International Business Machines
under contract to
Goddard Space Flight Center
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