NORAX INDUCTION ANNEALING SYSTEMS

MEDIUM CALIBER INDUCTION ANNEALING

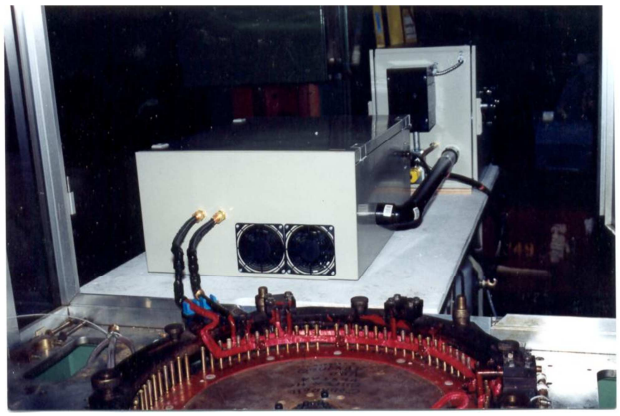
March 6th, 2012

The efficiency and productivity of induction technology is well established in the small cartridge manufacturing industries. With Norax induction systems, electrical operating cost for body and mouth anneal of 100,000 pieces small cartridges (such as 5.56 & 7.62) is roughly $12. In addition, due to ability of induction coil to deliver energy to specific areas, generating desired hardness profile is easier and more consistent than conventional flame annealing. However, there are some limitations for applying this technology to larger cartridges as described below:

COMMON CARTRIDGE ANNEALING COILS

The photographs below show common induction coils used for body and mouth anneal of small cartridges. The shape of the coil can be curved (for rotary type cartridge feeders) or be straight for linear type (screw type) cartridge feeders. The length and radius of the coil is determined by the feeder PPM and induction power. The most common type coils have only one turn or two. This is due to internal design and limitation of the conventional induction power supplies. They are mostly designed for low impedance coils and thus coils should have as few turns as possible. Norax has many 2 turn coils installations for annealing small cartridges in Canada, US, and Malaysia as requested by customer specifications.

The side effects of coils with few turns is that when used for larger diameter cartridges, the annealed area could be too narrow and the annealed zone may not be as wide as by the ones by gas, especially for body and mouth annealing. The radial annealing uniformity could also be an issue.



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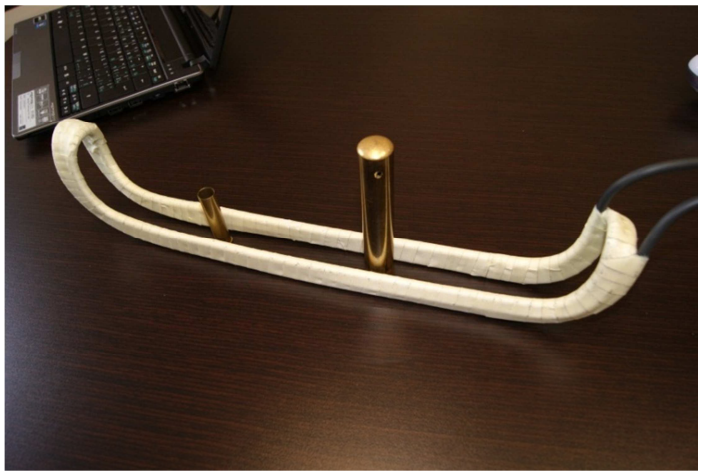
NORAX INDUCTION ANNEALING COILS

NORAX induction power supplies are manufactured based on a patented technology (US#5-715155) and among its advantages is its flexibility to energize almost any size coils. Norax induction power supplies can easily be designed for coils with any physical specifications and its advanced electronics instantly and automatically adjust and calibrate the critical internal induction parameters. For more detailed presentation of the power supplies please visit our website at www.noraxcanada.com.

With this in mind, Norax Induction coils for body and mouth annealing can be designed for both 2 turn coils as well as multi turn coils as needed for any annealing applications. Photograph below shows a typical coil with 4 turns used for 50 calibers or 20 mm with (Screw type) linear feeder. Obviously, curved coils with multi turns can also be manufactured for rotary feeders as needed.

The main advantages of using multi turns coil is that induction energy can be distributed on larger area as needed for large cartridges. The coil can be manufactured with height of up to 3" or more and thus the whole section of the cartridge body can be annealed as required by specifications. In addition, as the number of coil turns increase, the efficiency of the coil and thus total efficiency of induction heating increases. In average, the operating cost for total body and mouth anneal of 50 calibers or 20 mm can be as low as $20-30 for 100,000 parts.



- Multi turn coil for linear feeder

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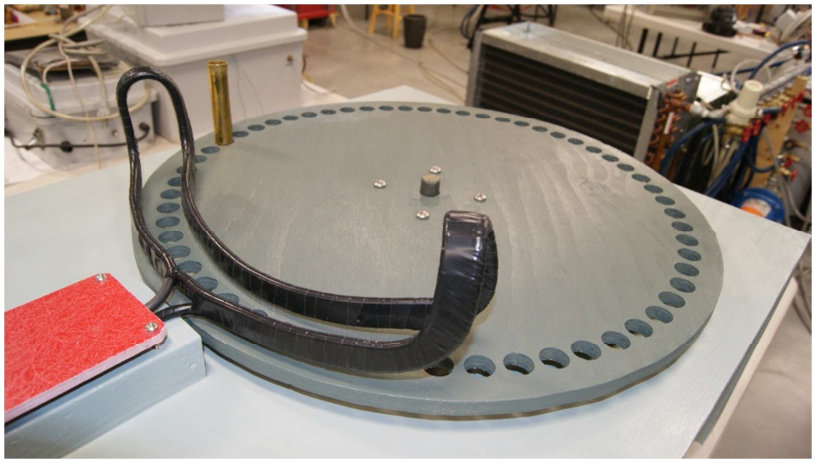
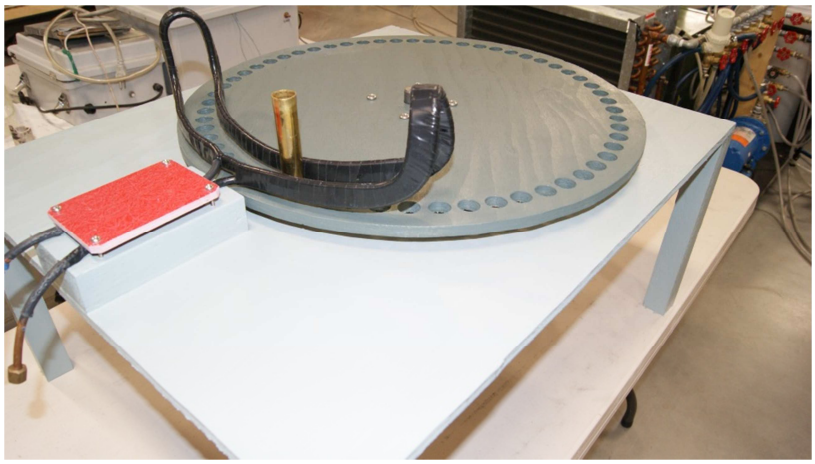
It is therefore possible to apply almost any hardness profile (annealing degree) by selecting the proper height of the coil, its length, and its position angle .The hardness can then easily be controlled by the proper induction power delivered to the coil.

It should be mentioned that all the detailed hardness parameters can be determined and controlled by the production & quality engineer allowing the customer to keep such details proprietary.

At Norax we have a prototype circular feeder for customer tests and evaluations. The induction coil is powered by adjustable 50 kW induction systems with enough power for complete annealing of the parts up to 100 ppm. The rotating table turns counter clockwise and parts after passing through the coil are dropped through a hole on the base into collecting box.





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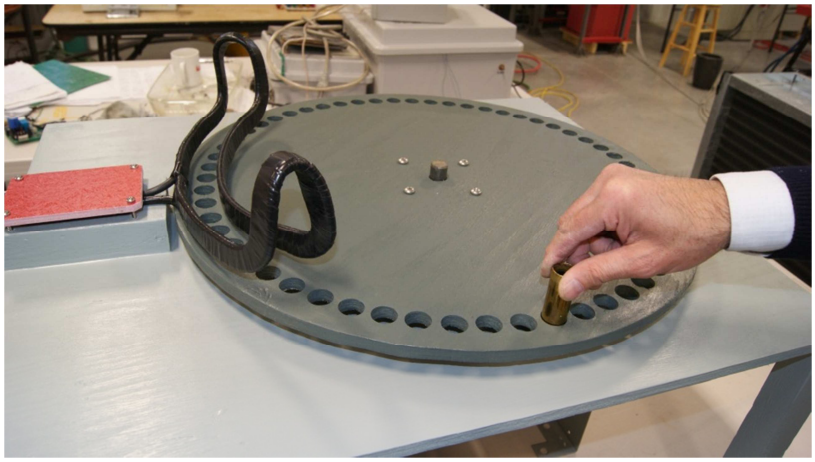

Both the speed of the motor (RPM) and induction power can be controlled based on production specfications and requirements. In addition, exact location of the coil and its angle with the table adjust the annealing profile. This unit is available for use at Norax or can bne transported to customer plant for evalaution and characheteristation of cartridges annealing. Please note that oriented cartridges and feeder should be supplied by customer or done manuallly at lower speed.

BODY ANNEAL AND SECOND DRAW ANNEAL

There are two <u>common methods</u> for conventional second draw (inter draw) anneal used in industry.

The first method is known as batch processing:

Here a large quantity of parts is placed inside metallic baskets. These baskets are then placed inside a gas fired (or electric) furnace at the temperature set very close to the annealing temperature. It is a common practice to keep the parts in the furnace for extended period of time. This is to assure that all the parts, either those placed at the exterior of the basket and those in the middle reach the same temperature and thus have a uniform degree of annealing.

If cycle time is reduced, parts in the middle may not have had time enough to reach the proper annealing temperature. In other hand, if furnace temperature is raised above the annealing temperature to speed up the cycle, the parts at the exterior may become too soft or over annealed.

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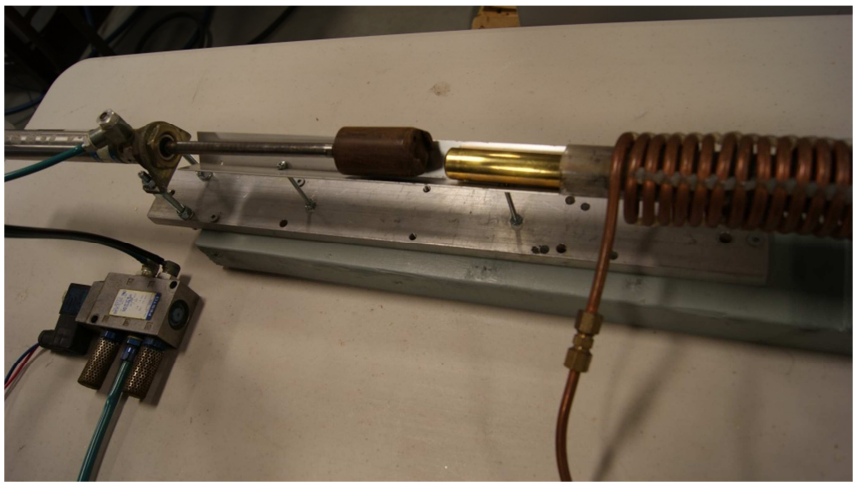
In addition, there is no individual control on the degree of annealing of mixed parts and mixed charges.

The second method for inter draw anneal is the gas fired belt furnace.
Here parts are poured on the moving stainless belt passing under the flames burners. Again the problem is the parts placed on top of each other may receive different radiant and convection energy and thus no individual control on the degree of annealing of parts. Furnace must be kept ON at all time to maintain it thermal stability and they are low in efficiency and consume huge amount of gas and are expensive to operate.

NORAX Spiral Tube Fed Annealing System (STFAS)

NORAX has developed and conducted tests and designs especially for second draw and body anneal of larger calibers. Here, parts are directly fed into a quartz tube by simple mechanical (pneumatic) pusher.



- From Left to right: Pneumatic pusher, 20 mm second draw cartridge, Quartz tube & induction coil

The induction coil is wound around the quartz tube. Here, each part (50 caliber, 20 mm etc.,) is exposed to identical amount of induction power and time. The radial annealing of each part and thus exact hardness profile is achieved accurately by selecting the proper coil length and power. In addition, thanks to its special design, no part rotation is necessary and radial annealing uniformity of cartridge is maintained (details not shown in the picture).

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Norax has conducted many tests using above settings and has been confirmed that the parts have successfully been manufactured, tested and verified according to the customer's specific requirements. However NORAX is not involved or aware of the exact characteristic of the individual hardness profile specified by the project.

- The photo shows a 50 caliber during annealing

The operating cost of second draw anneal of 10,000 parts at the rate of 60 PPM using NORAX *spiral tube fed annealing system (STFAS)* is roughly $10.

A prototype unit at Norax, with the speed of 60 PPM is available for customer tests and evaluations. Please note at this set up, parts have to be fed semi automatically (placed manually in front of the pneumatic pusher). Norax can install a system as above for customer evaluation in their plant and do necessary modifications to adapt it to customer feeding system and production rate up to 120 ppm.

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NEXT GENERATION NORAX ANNEALING SYSTEM

NORAX is offering a very unique *Turbo annealing system* for induction processing of almost any components. We are working on the installation of this unit with couple of manufacturing companies. The new concept is under patenting pending and it consists of a rotary stainless tube heated by induction coil. The production rate, its efficiency and annealing uniformity is far superior to existing belt or batch furnaces.

A demo unit with total power of 50 kW (1:2 scale) capable of anneal processing of different parts up to 150 kg/Hr. is available at Norax for customer evaluation.

- Photo shows the induction Turbo Annealing System with loading magazine with a 50 kW power supply/pyrometer.

Parts to be annealed are poured into feeding magazine on left side of the photo.

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➢ Back view of the Turbo Annealing System.

Parts are collected at the end of annealing tube in a metallic basket.

Technical Specifications

Induction Power	50 kW
Average Annealing Temperature	Up to 600℃
Average Production Rate	150 kg/Hr.
Average Operating Cost	3-4 $/Hr.

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