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METHOD AND APPARATUS FOR COMPACTING MAGNETIC POWDER

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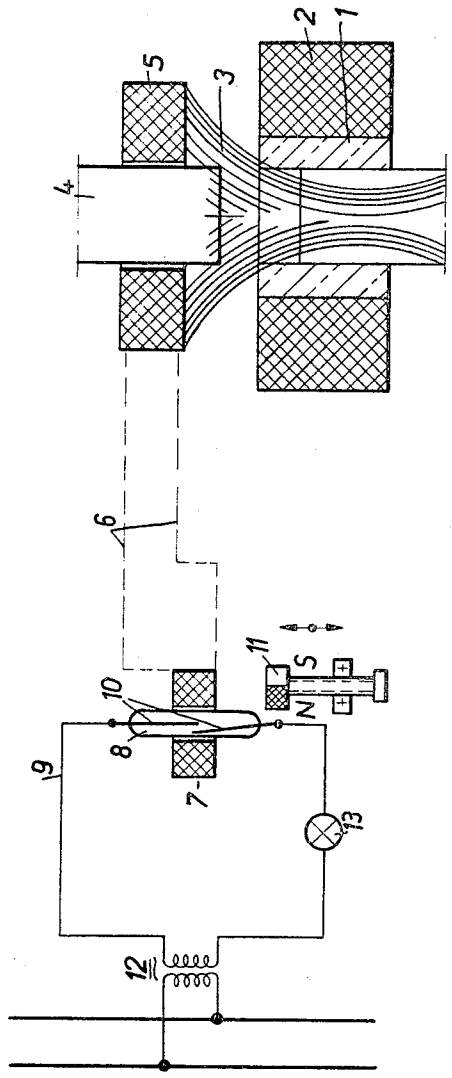

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METHOD AND APPARATUS FOR COMPACTING MAGNETIC POWDER

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ABSTRACT OF THE DISCLOSURE

The invention relates to a method and an apparatus for pressing powder into a magnetic blank whereby a magnetic field is produced in the region of a die so that powder is sucked into the die and oriented therein and a pressing punch is moved through the field to press the powder into a blank. A coil is wound about the punch, which then acts as a core, with the result that current is induced in the coil as the punch moves through the field, the magnitude of the current induced being a function of the strength of the magnetic field. The coil is then connected to signal producing means which produce a signal, indicating the strength of the field so that blanks pressed when the field is less than a given value can be discarded.

The invention relates to a method and apparatus of monitoring the strength of a magnetic field, for instance in powder presses in which the powder is sucked into a die and pressed therein under the action of a magnetic field. The invention also relates to apparatus for performing the method.

In powder presses used for the production of permanent magnet blanks from anisotropic barium ferrite in dies surrounded by an electric coil for the generation of a magnetic field which sucks the powder into the die and orients the powder particles, it is desirable continuously to monitor the intensity of the magnetic field during the process of pressing. A short circuit in the coil, fouling of the relays by dust or failure of individual switching devices may not necessarily prevent the magnetic field from being created but the field may not be strong enough to suck the powder properly into the die and to orient the powder particles inside the die. On the other hand, in the mass production of pressed magnet blanks it is of material importance to maintain a magnetic field of uniform strength because any reduction in the intensity of the field leads to unsatisfactory orientation of the powder particles and to the production of permanent magnets which fall considerably short of the properties. Unfortunately any deterioration in the magnetic properties caused by a reduction of the intensity of the magnetic field is generally not discovered until the permanent magnets have been installed and are in operational use. The makers of unsatisfactory permanent magnets lay themselves open to subsequent claims by dissatisfied customers and the damaging effects on their reputation may be considerable. The lack of a suitable monitoring device is also a severe inconvenience to makers because magnet blanks which are not up to standard and which should be discarded are usually also subjected to all the following manufacturing stages to the completion of the finished permanent magnet, the inferiority in quality of the magnet not being discovered until it is too late.

In order to eliminate these drawbacks the invention proposes a method which permits the magnetic properties of the magnet blanks produced in powder presses to be continuously checked whilst they are actually still in the

press. As soon as the monitoring apparatus detects any fall in the intensity of the magnetic field, a magnet blank that has been exposed to such a field can be discarded immediately before it has undergone all the treatments necessary for the completion of the finished permanent magnet.

The method proposed by the present invention is characterised in that the motion of a coil or of its core in the magnetic field is used for the induction of a voltage pulse in the coil and that the peak voltage of the pulse is arranged to control, e.g., close a switch in a signalling circuit for the activation of a signal. For performing this method the invention proposes apparatus comprising two coupled coils of which one is exposed to the magnetic field, whereas the other surrounds an electric switch incorporated in the signalling circuit, preferably in the form of contacts in a tubular screen, elastically biased by a permanent magnet.

In automatic powder presses in which the coil for generating the magnetic field surrounds the cavity in the die, it is usually the upper punch that is raised and lowered. During its ascending and descending motions it cuts the magnetic lines of force of the coil. The invention therefore proposes to associate a coil with the upper punch. The coil itself may be stationary or it may be attached to the punch, so that in any case either the movement of the upper punch which then forms the core of the coil or movement of the coil itself causes a voltage pulse to be induced in the coil. This coil is electrically coupled with a third coil which in turn acts upon an electric contact included in a signalling circuit. This circuit includes a voltage source as well as a signalling means, such as a lamp. The current due to the voltage pulse induced in the coil which cuts the magnetic lines of force of the field flows into the coupled coil which causes the contacts of the signalling circuit to close and to complete the circuit for activating the signalling means.

It is the object of the arrangement proposed by the invention not simply to check the existence of a magnetic field in the press but more particularly to check whether the intensity of the magnetic field is as high as required. The voltage pulse induced in the feeler coil when the upper punch of the press descends has the approximate shape of a sine wave. For checking the intensity of the magnetic field it is the peak voltage of the pulse that is primarily used. The apparatus is not intended to respond unless a prescribed peak value is reached. The make-and-break contacts included in the signalling circuit may be contained in a screening tube and the contact blades elastically biased by a permanent magnet that can be adjustably shifted, the blades being biased in such a way that they will not close until the voltage pulse reaches a given peak value.

If the magnitude of the pulse decreases because the magnetic field has become weaker then the contacts will not close and the fact that the lamp does not flash will indicate that the magnet blank that has at that instant been pressed will not have the required magnetic properties.

An embodiment of the monitoring apparatus proposed by the invention is illustratively and schematically shown in the drawing. The application of the proposed monitoring apparatus is exemplified in the drawing in the case of a powder press for pressing permanent magnet blanks. However, it will be understood that the apparatus could be used with advantage in other devices and machines.

The die **1** is surrounded by a coil **2** which generates the magnetic field for sucking the powder into the die and for orienting the powder particles in the die during pressing. The magnetic lines of force **3** are schematically indicated. The upper punch **4** which can be raised and lowered is surrounded by a coil **5** which may either be rigidly attached thereto and participate in the reciprocating

motions of the punch or attached to a stationary part, in which case the punch **4** forms a core which generates a voltage pulse in the coil **5** as it moves through its centre, whereas in the alternative case the voltage pulse is due to the movement of the coil itself. The coil **5** is connected by electrically conducting leads **6** to a further coil **7**. Coil **7** surrounds a make-and-break contact pair in a tubular screen **8**, said contacts forming part of a signalling circuit **9**. The contact blades **10** are elastically biased in the arrowed direction by a permanent magnet **11** and they cannot close the circuit unless the biasing force is overcome. The signalling circuit **9** contains a voltage source **12** which causes a signalling means **13**, preferably a lamp, to be activated when the contact points **10** close. Lamp **13** is located on the press in a position in which the workman can easily see it and in the course of each pressing it lights when the voltage pulse reaches the prescribed peak. The lamp thus indicates that the intensity of the magnetic field in the press is as desired.

What we claim is:

1. A method of sucking and pressing powder into a die under the action of a magnetic field and with the aid of a punch comprising the steps of:

moving a coil in said magnetic field, said coil being disposed about said punch so that said punch forms a core for said coil, and so that a voltage pulse is induced in said coil, and

utilizing said voltage pulse to produce a signal indicating the strength of said magnetic field.

2. A method of producing a permanent magnet blank comprising the steps of:

applying a magnetic field in the region of a die,

supplying particles of powder to said die so that said particles are oriented in said die,

moving a punch, having a coil wound about it, through said field, inducing a current in said coil, and pressing said particles in said die into a magnet blank,

utilizing said current induced in said coil to produce a signal indicating the strength of said magnetic field, and

rejecting said blank if said signal indicates that the strength of said magnetic field is less than a given value.

3. Apparatus for pressing powder material into a magnetic blank comprising:

a die,

magnetic field producing means for producing a magnetic field for sucking powder into said die,

a pressing punch, said punch being movable through said magnetic field for pressing said powder material into said blank,

a first coil wound about said punch so that said punch forms a core for said first coil and so that when said punch moves through said field, current is induced in said first coil,

a second coil electrically connected with said first coil so that said pulse is communicated to said second coil, and

signaling means associated with said second coil for producing a signal indicating the value of said magnetic field.

4. Apparatus as in claim **3** wherein said signaling means includes a switch having a first and second electrical position and wherein said second coil surrounds said switch so that said switch assumes said first position when said current exceeds a given value and assumes said second position when said current is less than said given value.

5. Apparatus as in claim **4** wherein said switch is enclosed in a screening tube and wherein said signaling means includes permanent magnet means mounted adjacent said switch for biasing said switch in said second position.

6. Apparatus for pressing powder into a magnetic blank comprising:

a die,

magnetic field producing means for producing a magnetic field which sucks said powder into said die, and orients said powder,

a pressing punch, said punch being movable through said field for pressing said powder material into said blanks,

a coil associated with said punch so that said coil moves through said field with said punch with the result that a current is induced in said coil the magnitude of which is a function of the strength of said magnetic field, and

signal producing means electrically connected to said coil for producing a signal indicating the strength of said field.

7. Apparatus as in claim **6** wherein said signal producing means produces a first electrical signal when said current exceeds a given value and produces a second electrical signal when said current is less than a given value.

8. Apparatus as in claim **7** wherein said coil is wound about said punch so that said punch forms a core for said coil.

9. Apparatus as in claim **8** wherein said signal producing means includes a switch having a first and second electrical position, a second coil coupled to said first coil and wound about said switch, and a permanent magnet mounted near said switch so that said switch remains in said first position until said current exceeds a given value and in said second position until said current is less than a given value.

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