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INSTALLATION FOR CENTRIFUGAL CASTING OF BIMETALLIC JACKS

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ABSTRACT

This issue presents an bronze casting technology of steel jack by centrifuging as well as it's installation. We try to realize a machine by date theme for mechanization of technological operation. The constructive solution for bimetallic jacks with graphite blocks insertion, by enunciation advantages , can get a high fiability to this reference points.

1. Casting technology of bimetallic jacks

Centrifugal casting represents a method to obtain the pieces and blanks, which is applied in foundries in very many technological ways.
In machinery industry, bimetallic pieces likes jacks, allow to obtain a massive reduction of nonferrous alloy norm consumption on unit production.
In the same time their characteristic properties exploitation is getting higher. So tin-lead-alloy jacks can resist to a peripherical speed of 1,5 m/s and a pressure till 300 kgF/cm^2, while the bimetallic jacks can resist to a speed of 2,0 m/s, and a pressure of 500 kgF/cm^2.
From the antifriction alloys who made the bottom layer of bimetallic jacks are the bronzes (tin bronzes, lead bronzes, tin-phosphorous bronze, aluminum bronze), brass, aluminum alloy and jack metal. As basic material is use soft steel blank which contain until 0,30 % carbon.
Practice shows that a high steel carbon content or alloyed steels utilization, doesn' t ensure the right adherence of base with antifriction alloy.
In case of using a cast iron base, this must contains a minimal graphite quantity.
The cast iron bases hardness must be HB=280-200.
For the double layer with smalls diameters, bases is made by drown pipe, and for bigger diameters by forgings or castings and preliminary annealed.
The melting of interior layer inside the machine is made with the burner flame help.
The interior surface of base doesn' t present the scratches and ruggedness, who ensure the minimal iron dissolvation in bronze. To ensure the strong bronze joint, the interior surface of the base doesn' t must contain at the surface rust and oil. For this reason the surface is constrained to a minute treatment of processing.
Initially, base is subdue to the pickling in 20 % chlorine acid solution followed by a neutralization with alkali liquor 10% and washing with warm water at 80^0 C. Then it follows again the pickling in chlorine acid solution of 20% and is washing in cold water stream. After this, the base' s inner surface must have the bright color of steel and being absolutely clean. Instead of the chemical treatment can be done the sand-blasting clearing.
The charge used is made by bronze cuttings, collected in mechanical shops, and it is clean out of iron by double separation and is calcinations at 400^0 C for eliminate the oil. The completely degreasing of the cuttings is made by washing it for 5–10 min in a bath with 20% caustic soda or ammonia soda at 80-90^0 C, after that it washed by alkali for 5-7 min in water stream and then is dry very well. For steel jacks with the diameters till 100, 100–200, 200–350, 350–450 and over 450 mm, the bronze layer thickness is respectively 4, 5, 7, 9, 10 mm, and after processing is 1.5, 2, 2.5, 3 and 4 mm.
The bronze portion that is load is establish with the formula:

$$G_b = \frac{\pi \cdot \left(D^2 - d^2\right)}{4} \cdot l \cdot \gamma \qquad (1)$$

where: D = clear width of jack' s base;
d = clear width of bronze layer from casting piece;
l = length in cm.
γ - alloy' s specific gravity on gf/cm^3

After charge arrangement the base is heating in an flame furnace with an reduction atmosphere. The heating process is recommended to be in two steps: preliminary till 700^0 C, in furnace, who prevents bronze melting with a heating speed about 50–70 grad/min. The forced heating condition decrease the iron dissolvation effect in bronze. It doesn't admit the blank superheating because it's causing the bronze saturation with iron.
Immediately after the bronze melting, the blank is roll and intensely-cooled on the external surface of base for a few minutes, until the temperature of 500^0 C. After that the rotation is turned-off. The blank remains catch between shifting head and headstock, the heating furnace opens and moves, allowing to the cooling basin to be return and lift up to the piece level. This will constantly roll and cold.
To verify the adherences resistance of bronze layer with the base, every jack is verify by beat. At beating the tone must be a pure metallically one – if it is a muffled one, results that the adherence is unsatisfactory and the casting piece will be reject.
For the structural analysis, from jack will cut up a ring-shaped sample with the height of 15-20 mm.
At bronze exfoliation test, the jack cutter ring is subdue to an compression till the cracks are appearing in the bronze layer.
If the bronze layer was joint with the base on the entire surface, the cause of the reject is the steel mark inadequate chosen, or insufficient heating of the jack in furnace. If the bronze layer doesn't joint with base in some isolated places, then the reject is due to inferior quality of base's chemical processing.

The speed rotation of mould is an important technological parameter of centrifugal casting. At too small speeds rotations or bigger shows up a lot of defects in casting process as like in proper pieces. At low speeds rotation the inner surface doesn't came straight, and the metal isn't driven sufficiently by the rotated mould and the piece result with nonferrous inclusions. If the speed rotation is to big the liquid metal pressure increase too much and appears crevices, dross, gatherings of the alloy components after density, machine vibration and fast wear of it.
Optimal speed rotation correspond to the minimal speed which ensure the casting pieces obtain with an appropriate quality. It's a wrong opinion that a speed rotation choose must be done with a height precision and any small abnormalities attract after them the appearance of the unpleasant phenomena. Experience shows that the abnormalities of 10-15 % given the optimal verified speed doesn't exert an sensible influence on the casting process and tow piece's quality.
The rotation inferior limit at blanks casting with horizontal axes is determinate with the next conditions: the casting metal on first rotation time around the axis, must get an acceleration that's out –of „g" value. The unaccomplished condition determinate the kindling rain influx of metal.
To calculate the rotation speed of metal around the horizontal axis casting it's used in many types of formulas:
Kammen's formula:

$$n = \frac{C}{\sqrt{r}} \qquad (2)$$

where: n – number of rotation on minute
C – a factor that depends the alloy type; for steel – 1350, gray cast iron and bronze – 1675, and for aluminum – 2250
r – interior surface radius
L.S.Constantinov's formula:

$$n = \frac{5520}{\sqrt{\gamma \cdot r}} \qquad (3)$$

where: γ - alloy's specific gravity on gf/cm ^{3}
r - interior surface radius of casting piece
From this relation is easy to find the k expressions, who represent the dependent expressions of rotations number of gravity factor, in Krammen's case formula:

$$k = \left(\frac{1.59 \cdot C}{300}\right)^2 \qquad (4)$$

and L.S.Constantinov's formula:

$$k = \frac{340}{\gamma} \qquad (5)$$

Bringing in Constantinov's formula the γ value we can determinate the gravity factor.

Table 1

Alloy	$gf\gamma / cm^3$	K
Steel	7.8	44.0
Gray cast iron	7.0	49.0
Bronze	**8.4**	**40.5**
Aluminum	3.1 – 3.6	95 - 110

The gravity factor is connected by the physical essence of centrifugal casting process and for that the choose of rotation speed based on k factor have a real base. However, is beneficial to keep in mind the fact that this method is based of presumption that the metal is rotated with the angular speed of mould.

With increasing the casting temperature of the metal, of casting speed and the walls thickness, the rotation speed of interior layers can be considerably distinguished by the rotation speed of the mould, and in this case the gravity calculation factor has an conditional character.
The formula insufficiency is: the gravity factor who stand on formula’s base is constantly for every kind of alloys and doesn’t care of big variations of technological conditions.
The choose of rotation speed on gravity factor base can drive to obtain the certainness results. The properly gravity factor and the inner surfaces radius of the new casting’s piece are introduced in formula:

$$n = 300\sqrt{\frac{k}{r}} \tag{6}$$

and is determinate the rotation speed.

2. Installation for centrifugal casting of bimetallic jacks

With a view to applying the centrifuging casting technology of bimetallic jack was elaborated an execution project presented in fig 1. The pipe blank is catch between shifting head (2) and headstock having inside an laid-down quantity of bronze boring with the rotation possibility of angular variable speed. The furnace of two semi rings-shaped (1) with the hydraulic possibility of closing and opening can cover the pipe blank.
The heating is made with an methane burners help. With a view to controlled solidification there is an frontal ventilation system (12). The furnace (1) is opening and is moving due to displacement carriage (4). The refrigeration basin (5) is moving under the piece with the help of the device (7) after that is rising with the hydraulic cylinders help. All that time the piece is rotate with an variable speed of servomotor (10).
In figure 1 is presented the hydraulic diagram of that installation who permit their automation. Technical dates of the installation are presented in figure 2.
Technical parameters:
- Maximum diameter of casting piece 500 mm.
- Maximum length of casting piece 600 mm
- Maximum heating temperature 1150^0 C
- Maximum methan gas consumption 60 m^3/h
- Maximum gas pressure 550 mm CA.

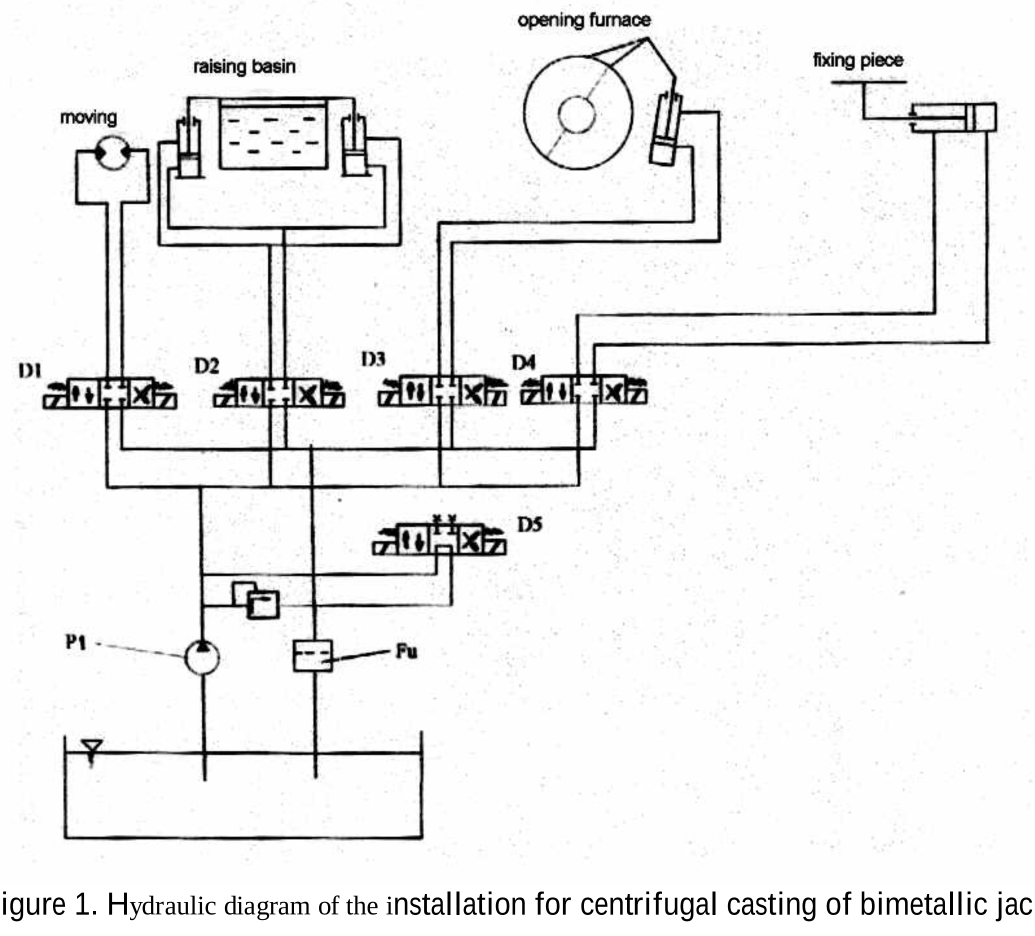

Figure 1. Hydraulic diagram of the installation for centrifugal casting of bimetallic jacks

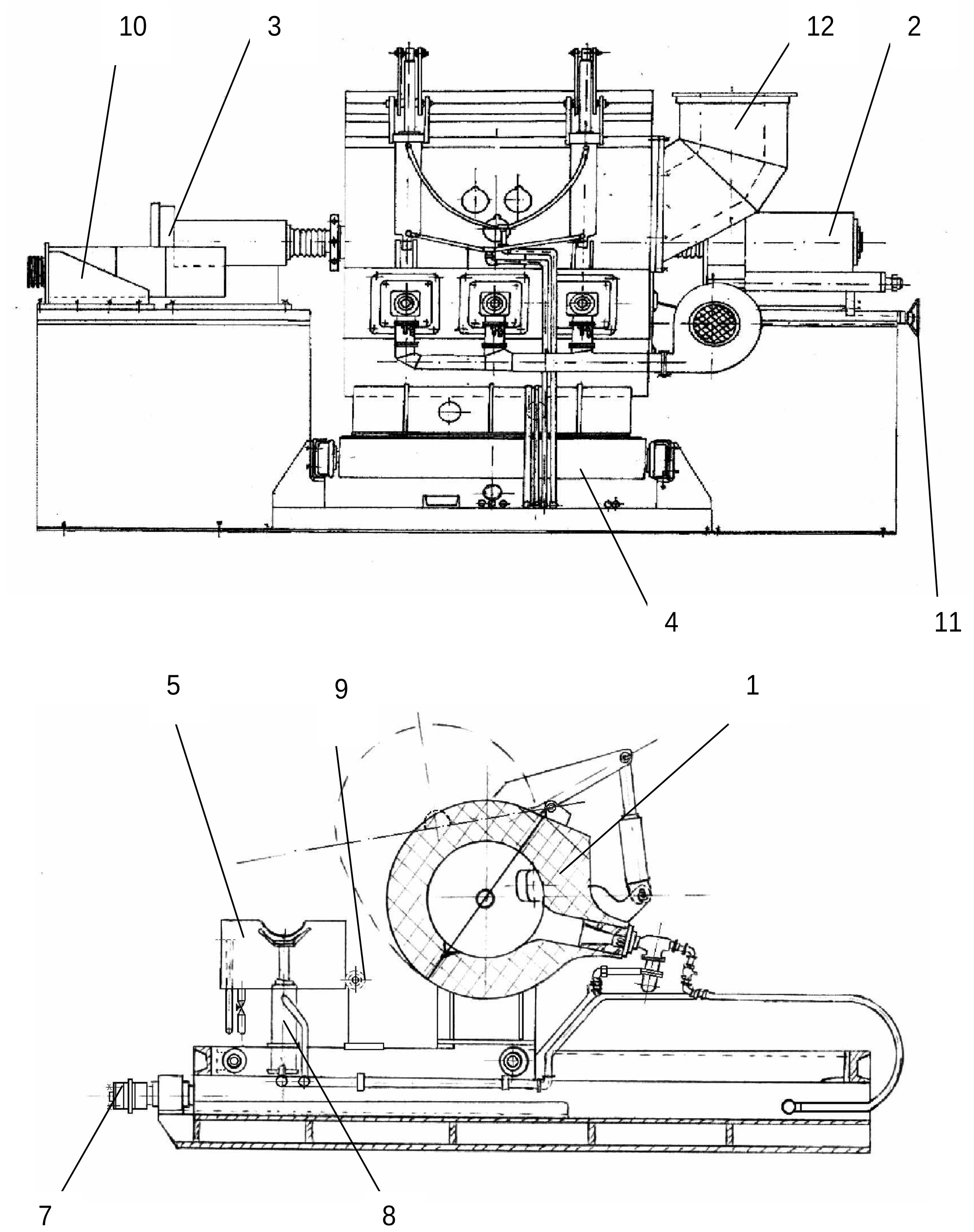

Figure 2. Installation for centrifugal casting of bimetallic jacks: 1. Heating furnace; 2. Shifting head; 3. Headstock; 4. Heave carriage; 5. Cooling basin; 6. Cardan coupling; 7. Heave attachment; 8. Hydraulic cylinder; 9. Independent time control device; 10. Booster; 11. Disaligment device; 12.Ventilation system.

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