

ARTIFICIAL SOLUTIONS FOR DOUBLING OR TRIPLING THE WEIGHT OF A STEEL PIECE, BY BALLASTING

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Summary: The significant increase in weight of a mobile steel piece, with an essential function in generating the percussions with high impact energy, cannot be approached without radically changing the inner structure of the piece. Keeping the geometric shape of the piece, combined structures, bi or tri-polar , can be created, able of doubling or even tripling its weight, using the technique of ballasting with known super heavy materials.

Key words: super heavy materials, combined, bi or tri-polar, used for building the pneumatic rocket (phoresy, pneumatic hammer).

At this moment, in car-building, they stress upon the use of super heavy materials, able of major energetic performances in the main work body, as an alternative to similar pieces, made only of steel.

1. Theoretical aspects

With the aim of increasing the energetic parameters of percussion in the pneumatic rocket (phoresy) for assembling the underground pipes, without a groove, a simple, original solution was used, for artificial increase of the steel-made pieces.

By ballasting (filling a well-established cavity in the spatial geometry of the piece) and using, in the first stage, an accessible metal, the melt and solidified lead, they have obtained an weight increase in the percutory piston, with ΔG :

$$\Delta G = (\rho_{Pb} / \rho_{OL} - 1) \cdot 100 \{ \%$$

where:

$$\rho_{Pb}=11,34 \text{ Kg/dm}^3 \text{ lead density}^1$$

$$\rho_{OL}= 7,85 \text{ Kg/dm}^3 \text{ steel density}$$

that is $\Delta G=(11,34 / 7,85-1).100 = 45\%$

¹ F. T. Tanasescu s.a. Agenda tehnica, Editura Tehnica 1990, Bucuresti, pagina 192

The multiplying factor for the impact energy, obtained by ballasting the steel piece with lead, was of:

$$f= G_{pOL} / G_{pPb}$$

where:

$$G_{pOL}= \text{steel piece weight ; } G_{pOL} = 9 \text{ Kg}$$

$$G_{pPb} = \text{lead piece weight; } G_{pPb} = 13 \text{ Kg.}$$

Hence: $f=13/9 = 1,45$

One can easily notice that the simple ballasting with lead, on the mobile piston that generated percussions, had an extra energetic impact, as the weight was increased with 45% and, implicitly, the impact energy, on the same piece shape. Obviously, superior performances are expected, by only replacing the ballasting material.

2. Description on the building solution

We propose the replacement of the bipolar steel-lead material, initially used, with a much more performant one.

The peak stage of the research will be the study of the assembling possibilities, in the same cavity of the piece, of an hermetic, recoverable capsule, filled with high density mercury $\rho_{Hg}=14,24 \text{ Kg/dm}^3$ ($\rho_{Hg}=13,55 \text{ Kg/dm}^3$ in liquid silver- white mercury).

One can obtain an increase with 90% in the weight of the rocket mobile piece, by ballasting with mercury. High impact energy percussions will result, essential in reaching maximal speeds of underground advancement of the rocket, in soils with difficult geological structures.

After minutely studying the technical limits, regarding the access to super heavy materials of the group of mercury, rare heavy soils, precious materials (platinum), wolfram or osmium, and , obviously, because of basic economical limitations and restraints – buying price - , the mercury use was chosen. Obviously, the mercury in its pure, natural, liquid state is very hard to use: it is toxic, explosive, it has a high coefficient of expansion.

In order to avoid the human contact with the mercury in its pure state, a simple, original and efficient solution was chosen.

Into a steel capsule, an elastic body is put, with a neutral reaction to mercury, with the role of expansion vessel. The volume of the elastic body will not exceed 7% of the useful cavity of the capsule. The inner of the capsule is filled with liquid mercury and then is hermetically closed. The elastic body will float free in the mercury. In

working order, the ballasted mobile piston, having the mercury capsule incorporated, makes an oscillatory move (coming and going), in the rocket carcass.

There is friction with lubrication between the piston and the rocket body. They have proposed the performant system of assembling the bearings, done with Teflon guidance rings. In the compressed air, produced by a moto-compressor, controlled quantities of oiling liquid are introduced. In dynamic working condition, of underground operation, a stabilized thermal state is reached, after 5-10 minutes of working. The heat given off by friction is transferred to the soil on which the rocket is working. The rocket body advances through percussions and plastically deforms the soil. Thus, the micro-tunnel is generated, into which also the pipe can be drawn (simultaneously or in separate sequence), in the top technology of this branch, without a groove open to the surface.

The temperature of the capsule, in a stabilized dynamic working condition, can reach 50-60 degree, in work on soil. The mercury in the capsule can expand itself based on the elastic element inside the capsule. The elastic body will proportionally reduce its volume.

Another simple technical solution for compensating the thermal expansion of the mercury in the capsule is to laminate the latter through an orifice with a small diameter and to pass the volume excess, resulted from the expansion, into the space separate from expansion, of the same capsule. The principle is similar to the hydraulic shock absorber from the car suspension.

Significant is the effect obtained. On the same shape of the piece made of the proposed material (steel-mercury), comparatively to the bipolar material previously used (steel-lead), the following performances are obtained:

The multiplication factor of the impact energy, obtained by changing the ballasting material of the piece (lead and mercury) will be:

$$f = G_{pHg} / G_{pPb}$$

where

G_{pHg} = weight of the steel-mercury piece; G_{pHg} = 16, 9 Kg.

G_{pPb} = weight of the steel-lead piece; G_{pPb} = 13 kg.

Hence $f = 16, 9 / 13 = 1, 3$

One can notice that the replacement of the ballasting material (lead with mercury) can have a significant energetic impact, as it has increased the weight of the piece with 30% more and implicitly the impact energy on the same piece shape.

The mere comparison of the classical solution, of realizing the piece only of steel, with the original solution of ballasting with mercury, can lead to a much better multiplication factor of the weight and of the impact energy:

$$f = G_{pHg} / G_{pOL}$$

where

G_{pHg} = weight of the steel-mercury piece; $G_{pHg} = 16,9$ Kg.

G_{pOL} = weight of the steel-lead piece; $G_{pPb} = 9$ Kg.

Hence: $f = 16,9 / 9 = 1,9$

One can easily notice that, by using steel-mercury bipolar material, in the structure of the percutory piston, a major energetic impact can be obtained, upon the pneumatic rocket, as the multiplication factor of weight and implicitly of impact energy, increases with 90% (it almost doubled), on the same piece shape, compared to the classical solution, with a steel piece.

We propose for analysis, in table 1, possible combined materials for ballasting the percussion piston on the pneumatic rocket for assembling underground pipes, without a groove.

Table 1. The density of the proposed materials and the f factor for artificial multiplication of the percutory piston weight

Crt. no.	Material	Density (Kg/dm ³)	f	notices
1	Lead	11,34	1,45	
2	Mercury	14,24	1,9	Toxic
3	Wolfram	19,3	2,5	Expensive
4	Platinum	21,45	2,7	Exorbitant
5	Gold	19,24	2,5	Exorbitant
6	Iridium, Osmium	22,4	2,9	Exorbitant

The performant solution can be a steel capsule filled with wolfram when the factor for piece multiplication increases maximum 2.5 times.

A tri-polar structure (steel-wolfram-mercury) can be a more practical and accessible solution, as the steel-osmium solution can reach a record weight increase of about 3 times.

In the civilian, technical engineering, they usually do not work with the materials previously proposed. For an efficient utilization of their density and their integration to the structure of the percutory piston, a multi-

disciplinary approach is needed, which implies an applicative research in two branches: special materials engineering and car building.

The study phase of the mercury behavior towards a floating neutral elastic element, or of the mercury lamination at temperatures of 50-60 Celsius degree, imposes a specific research, for which we require a professional co-operation.

The quality of the materials used for making the percutory piston on the pneumatic rocket for assembling underground pipes without a groove, is essential in reaching superior energetic values on the main working body, with the aim of the operative plastic deforming of the soil and of generating a micro tunnel.

For the same piece shape, by changing the quality of the material initially used (steel) with a bipolar structure (steel-wolfram, steel-mercury) or tripolar (steel-wolfram-mercury), artificial increases in the piece weight can be done, by ballasting, with the (f) multiplication factor:

- 1, 45 - lead ballasting
- 1, 9 - mercury ballasting (recoverable hermetic capsule)
- 2, 5 - wolfram ballasting
- 2, 7 - hypothetical ballasting, not realistic, with platinum

With a theoretical, absolute maximum, of 2, 9 for a ballasting with osmium (of the platinum family), the heaviest metal ever known on Terra, with the density 22, 48 Kg/dm³

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