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**CONTINUOUS CASTING VIBRATING SYSTEM**  
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This invention relates to vibration apparatus for molds for the continuous casting of metal rods or tubes.

Machines for the continuous casting of metals and alloys to form rods or tubes supply a continuous stream of such molten material to an open-ended, usually fluid-cooled casting mold. An embryo casting is formed by the mold and the casting is withdrawn by a tensioning means such as pinching-rollers.

There are advantages in vibrating one or more of the components of such casting systems to cause relative movement between the mold and casting, continuously or during a portion of the casting period. Sticking of the cast in the semi-solidified state to the mold surfaces is overcome or eliminated by such vibration, which also improves and controls the surface quality of a casting and its grain structure. The displacement of the components being vibrated are usually of quite limited amplitude, usually not exceeding 1/4 inch, with frequencies of several hundred to several thousand cycles per minute.

The mode of vibration can be sinusoidal, some non-linear relation other than sinusoidal, and by a periodic impact as by a blow from a spring-loaded trip hammer or the like.

In tube casting, particularly tubes of materials comprising copper and copper alloys, there is need for a wide range of different modes of vibration in order to obtain optimum casting qualities and grain size, in addition to avoiding or overcoming sticking.

The principal objective of the present invention is to provide an improved continuous casting system capable of vibrating in a wide variety of modes and adjustable as to the frequency and amplitude of each of its vibration modes.

According to the present invention, a mold is mounted on a first platform which is releasably attached to a second platform. Spring means are positioned between the two platforms and supports the first platform upon the release of the rigid connection. Controllable vibrators are operatively connected to each platform. The mold is vibrated in accord with a plurality of possible vibrations of the first platform alone, or in combination with the second platform rigidly or resiliently connected thereto.

These and other features and objects of the invention will be apparent from the following description of a preferred embodiment of the present invention as illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is the front elevation of a vibrating support for a mold;

FIGURE 2 is a side elevation of the bottom portion of the support as viewed along section line 2—2 of FIGURE 1;

FIGURE 3 is a sectional plan view as viewed along section 3—3 of FIGURE 2 with certain portions shown in dot and dash lines representing portions located above the sectional line; and

FIGURE 4 is a sectional elevation as viewed along sectional line 4—4 of FIGURE 2.

In the drawings, like reference characters refer to identical parts.

The vibrating mechanism of this invention is useful in any continuous casting system where continuous or in-

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errupted relative vibratory movements are desired between the mold and the casting. Our invention may be used in the casting of dense objects, such as rods, or hollow objects, such as tubes. It gives special advantages for objects of copper or copper alloys as their surface and grain size may be controlled by use of it.

According to the preferred embodiment of the invention we provide a plurality of vibration modes that are controllable, even during the actual casting of the objects, by relatively simple adjustments.

As shown in FIGURE 1, a mold 12 is supported on a platform system 11. The platform motion 11 is responsive either to one or two vibrators or to both. One of the vibrators, 20, provides a very high frequency sinusoidal vibration and effects vertical vibratory forces on the platform. Another vibrator, 21, is connectable to the platform system 11 and provides low frequency non-sinusoidal vibrations which effect an upstroke or vertical rising of the platform that is different in force or duration to the downstroke.

A second, auxiliary platform system 10 is releasably connected to platform system 11 and either rigidly or resiliently support the mold 12. Platform system 10 is connected to a third vibrator 25. The mold and vibratory apparatus is supported on a rectangular frame formed from channel beams 36.

Referring now to the apparatus as illustrated in greater detail in FIGURES 2 and 3, upper platform system 11 is formed by a pair of elongated rectangular plates 31. Plates 31 are spaced sufficiently apart to provide a space beneath the mold 12 for passage of the bar or tube (not shown) to be cast in the mold. The withdrawal apparatus (not shown) is located beneath the mold 12. The usual apparatus for supplying molten metal to the mold 12 (not shown) is located above mold 12. Mold support plates 31 are welded to the inner pair of cross-bars 38a, perpendicular to plates 31. Cross-bars 38a are welded to a pair of bottom plates 39 spaced outwardly from plates 31. A second pair of cross-bars 38 is welded to the bottom of plates 39. A pair of plates 40 spaced beneath and parallel to plates 39 are welded to the opposite face of bars 38 and 38a. Four antifriction ball bearings are provided in apertures in the plates 39 to receive the four posts 14. The four posts 14 are respectively guided in vertical movement by four L-shaped brackets 16 each having an enlarged cylindrical end portion 15 within which are ball bearings or roller bearings for easy axial sliding therein. A similar roller bearing carrier 15a is provided to guide the lower end of rods 14, see FIGURE 4. L-brackets 16 are connected to the lower plate assembly 10 by bolts and nuts 17.

The lower plate assembly 10 is formed from a pair of spaced rectangular plates 30 welded to a pair of cross-member plates 34 which in turn are carried by pinions 42. Pinions 42 are rocked on a curved path approximately vertical by vibrator 25 through a pair of linkages 26 and 26a spaced on opposite sides of the channel member 36. The linkage arm 26a is oscillated back and forth a few degrees on a curved path by means of an eccentric cam on vibrator 25. Each of the linkages 26 is at its end pivotally attached to channel 36 (which is channeled to accommodate the generally vertical motion of pinions 42) and this converts the vibrator motion into generally vertical motion of the pinions 42. In order to effect symmetrical forces generated by the vibrator 25, a connecting rod 44 connects the pinions assembly on the right with a comparable pinions assembly on the left side of the lower plate assembly 10. Rod 44 is pivotally connected by connectors 46 at one end to linkage 26 and at the opposite end to a triangular plate 48.

Plate assembly 11 is resiliently supported on the lower plate assembly 10 by four springs in opposing pairs, 13A