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MOLD

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This invention relates to the formation of molds for casting articles from molten metal and the selection of materials for such molds with particular reference to the selection of materials which will minimize the expansion and contraction due to temperature changes during use, thereby increasing the length of life of the mold.

It is the principal object of the present invention to provide a mold for formation of articles from molten metal which when subjected to temperatures above 1000° F. will afford a minimum of expansion and contraction, thereby to minimize fatigue of the metal caused by repeated expansions and contractions and resulting in a longer useful life for the mold.

The importance of long life in a mold of semi-permanent character (so-called "permanent" to distinguish from once-used molds) is particularly apparent in attaining maximum advantage from the centrifugal casting of steel parts. In centrifugal casting of steel parts, molten metal is poured into the central opening of a rotating mold, an apparatus for centrifugal casting being described in a co-pending application Serial No. 287,584, filed July 31, 1939. In fact, the use of material such as gray iron, widely used in many types of permanent molds, although it could be used with some degree of success for experimental centrifugal molds, would never be satisfactory for the peculiar requirements of the centrifugal mold where a reasonable period of service is required. It is also true that low carbon steel is possible of use but the life of this material in constant service would be entirely too low from an economical view point. Due to the excessive heat to which centrifugal molds are subjected when molten metal is poured into them, it is important to have a mold with a minimum amount of expansion and contraction. This feature is important not only for holding the proper size and shape of a casting being made, since a mold that is excessively expanding and contracting will get out of shape rapidly, but also because the life of centrifugal permanent molds comes to an end due to surface cracks and in some cases much deeper cracks which are directly attributable to expansion and contraction. These cracks are in reality fatigue cracks caused by repeated expansion and contraction of the mold parts subjected to the most heat and greatest change in temperature. Every precaution is taken to design the mold in such a way that abrupt changes in temperature are minimized but nevertheless these changes in temperature cannot be eliminated, and furthermore, the fact that certain sections of the mold reach higher temperatures is not eliminated.

In centrifugal casting practice after heat changes in the mold were minimized by proper design as much as possible, it was found that successful centrifugal casting required a mold material which would lessen the expansion and contraction experienced with molds constructed of straight carbon and alloy steels of the usual type. These steels, it was found, go through violent expansions and contractions in the temperature range around 1000° F. and above. On consideration of well-known metallurgical data it is evident that these violent expansions and contractions in the metal are characteristic of steel when it passes through the certain critical ranges of temperature when the carbon bearing constituents change their state, this change taking place whenever the steel is heated through a certain temperature range. It is true, however, that molybdenum when used in sufficient quantity ties the carbon present in the steel into complex carbides which go into solution very slowly at the higher temperatures, and this renders the carbon in the alloy less effective in producing violent changes at the critical temperatures where a change would normally take place. The result is that with steel so composed the expansion and contraction is materially reduced around the critical temperature ranges.

With the problem presented of producing a mold with a minimum of expansion and contraction in the temperature range around 1000° F. and above the recognition of the fact that this undesirable expansion and contraction might be materially reduced by proper selection of mold material was an important initial step in the present invention. The next step was the selection of a suitable composition for this mold material which would materially reduce the expansion and contraction in the temperature range at 1000° F. and above. After testing many steels it was determined that a low carbon molybdenum iron alloy steel in the range of from 0.75% to 5% molybdenum provided a low expansion and contraction for a considerable range above 1000° F. and therefore was particularly suitable for the manufacture of the centrifugal molds under consideration. It is this discovery that is the basis of the present invention.

More specifically, it has been found that a steel having a carbon content in the range of from .05% to .35% and molybdenum in the range of from .75% to 4.00% was preferable in giving the desired properties above outlined at the critical

temperatures around and above 1000° F. Manganese within reason is immaterial to the properties but generally should be held within the range of .10% to 1%. In a steel of the above specified composition, it is considered that the reason for the improved properties was the use of the molybdenum in sufficient quantity to tie the carbon present in the steel into complex carbides thus reducing the tendency of the carbon to produce violent changes near the critical temperature. The result is that the expansion and contraction in the range above mentioned is about half that of ordinary carbon steel molds, and although it does not eliminate the expansion or contraction, it reduces it to an amount which renders the mold practical for use. The solid solution of the molybdenum in iron is an alloy that is tough enough to stand the fatiguing action of many expansions and contractions of the magnitude encountered in the described alloy.

While, for the purpose of illustration, specific disclosure has been made of the invention in the above description thereof, it is understood that the details may be varied within the scope of the following claims:

We claim:

1. In a mold for forming articles from molten metal, said mold being formed of alloy steel showing a composition comprising:

	Percent
Molybdenum	3.00–3.50
Carbon	.05– .25
Manganese	.25– .45

and the balance iron with the normal impurities and deoxidizers.

2. In a mold for forming articles from molten metal, said mold being formed of alloy steel showing a composition:

	Percent
Molybdenum	3.00–3.50
Carbon	.05– .25
Manganese	.10–1.00

and the balance iron with the normal impurities and dexodizers.

3. In a mold for forming articles from molten metal, said mold being formed of alloy steel showing a composition:

	Percent
Molybdenum	3.00–5.00
Carbon	.05– .35
Manganese	.10–1.00

and the balance iron with the normal impurities and deoxidizers.

4. In a mold for forming articles from molten metal, said mold being formed of an alloy steel resistant to distortion and cracking due to temperature changes at high temperatures and having a composition comprising molybdenum 0.75 to 5%, carbon 0.05 to 0.35%, and not more than 1% manganese, the balance being iron with the normal impurities and deoxidizers, said alloy containing molybdenum in an amount at least several times the amount of carbon.

5. In a mold for forming articles from molten metal, said mold being formed of an alloy steel resistant to distortion and cracking due to temperature changes at high temperatures and having a composition comprising molybdenum 0.75 to 5%, carbon 0.05 to 0.35%, and manganese 0.10 to 1%, the balance being iron with the normal impurities and deoxidizers, said alloy containing molybdenum in an amount at least several times the amount of carbon.

6. In a mold for forming articles from molten metal, said mold being formed of an alloy steel resistant to distortion and cracking due to temperature changes at high temperatures and having a composition comprising molybdenum 0.75 to 4%, carbon 0.05 to 0.35%, and manganese 0.10 to 1%, the balance being iron with the normal impurities and deoxidizers, said alloy containing molybdenum in an amount at least several times the amount of carbon.

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