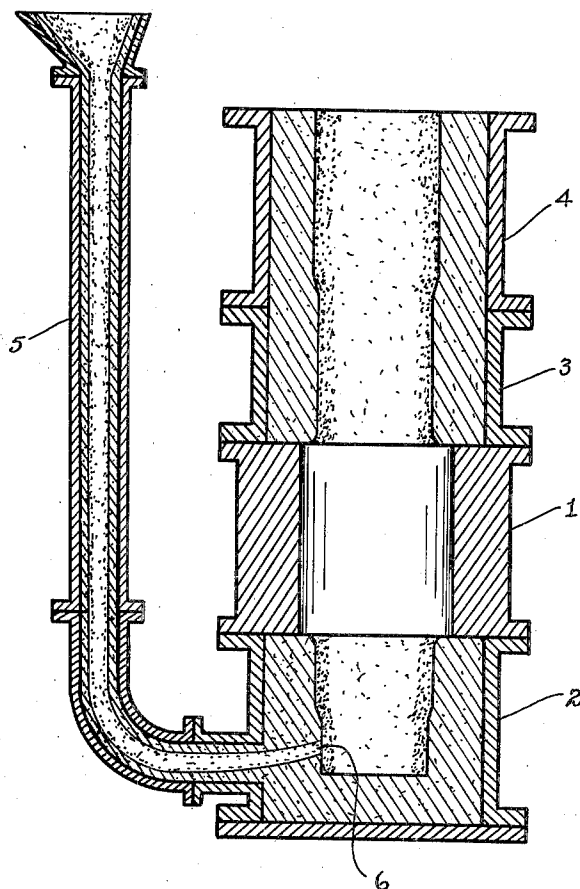


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METHOD OF ROLL CASTING
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METHOD OF ROLL CASTING

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This invention relates to the casting of metal-working rolls.

The object of the invention is to provide a simple and satisfactory method of making cast-iron metal-working rolls having a relatively hard roll body and relatively soft and machinable necks. Various methods of effecting this same general purpose have previously been employed and my invention specifically considered is proposed to provide a method simpler than some of those previously employed and to give more satisfactory results than other prior methods for obtaining the same general effect.

For example, one previously employed method has been to make rolls having a hardened body surface or chill and necks which are softer and more readily machinable than the hardened surface of the roll body, by washing out from the mold all of an initially poured hot metal, save that which is included in the hardened surface or chill depth of the roll body. It is frequently, however, unnecessary or undesirable to make a roll having the interior of its body composed of metal of different composition than that of the body surface or chill. Also, the casting of a roll by initially pouring a hard metal and washing out the still molten portion, after metal to the desired depth has been congealed against the surface of the chill, or surface of the body portion of the mold, is a procedure requiring accurate timing and delicacy of operation. This is particularly a fact since there is a tendency to wash out a portion of the initially congealed metal, and thus to give a chilled shell of unequal or unpredictable depth, in pouring the second metal to wash out all the uncongealed initial metal in the mold.

A procedure used, to make a roll having necks more machinable than the body portion of the roll, has been to bottom-pour a mold charge up to a level slightly above the body region of the mold; and, after a chill has formed against the surface of the body portion of the mold, enough softer metal is added to fill the drag neck and wobbler portion of the mold, and the displaced metal is run off at a level just above the body portion of the mold, initial metal being displaced upwardly by the softer metal poured into the lower, or drag, portion of the mold. In such procedure the tap hole, by which the surplus metal is drawn off, is then closed and the upper, or cope neck of the roll is individually poured. This last method involves running off from the mold metal of the initial charge which is usually

metal of high alloy content and relatively expensive, in a quantity equal to the weight of metal initially included in the drag neck, drag wobbler of the roll, and the vertical runner of the mold.

The method of my invention is such that the entire weight of metal introduced into the mold at various stages in the roll casting operation is retained in the mold. There is no flow off of metal from the mold. In the practice of my method, therefore, there is no scrap loss of the relatively expensive high alloy metal of which the hardened body of the roll is formed, and there is no danger of washing out metal which it is desired to include in the surface chill of the roll body. Only about one-half as much metal is required as an additive in the cope neck and sinkhead, as in a method in which the initially poured metal is inhibited from rising substantially in the neck cavity and sinkhead in the cope portion of the mold.

The accompanying drawing, which is to be taken as a conventional representation of a mold assembly for roll casting, shows in vertical section a conventional structure in which my method may advantageously be practiced. In the drawing there is shown in vertical section a vertically positioned roll casting mold. As illustrated, the mold comprises a central body portion formed as a body chill 1, a sand drag 2 providing the mold for one roll neck and the wobbler or coupling structure associated with it, a sand cope 3 providing the mold for the other roll neck and its associated wobbler or coupler structure, and a sinkhead 4 providing an upward extension of the mold assembly. A vertical runner 5 communicates with the lower region of the lower or drag portion of the mold cavity by way of a gate 6 in the drag mold 2.

In conducting my method the mold cavity is, by pouring through the vertical runner in the conventional manner, initially filled with metal to a level above the upper extent of the roll body cavity and below the upper level of that portion of the cavity within the mold cope which provides space for the metal of the roll neck and its associated parts. After waiting until centrifugal motion in the metal teemed into the mold has ceased and the metal has become quiet, I pour in through the runner 5, and down gate 6 in the drag mold, a soft machinable iron in a weight sufficient to replace the original hard metal in the drag mold, and in the vertical runner and gate. This different metal I pour with

sufficient rapidity bodily to displace the original metal upwardly in the mold, so that in the upper region of the mold cavity the level of molten metal is to a corresponding extent raised. As the level of the initially poured metal rises in the mold cavity, none of that metal is run off.

The initial metal, which is of a harder composition, and is the metal of which the roll body is to be composed, then extends from a level just below the lower level of the body cavity to a level lying approximately at the upper end of the cavity for the cope neck and wobbler. As this would give a roll having one soft and machinable neck and one neck of the same hard metal as the roll body, I pour into it through the sinkhead a dilutant metal of softer composition. During the time of all the previous steps the original metal is being congealed by the body mold chill and has now solidified to some 2" to 6" in depth, so much so, that it is undisturbed by the addition of the dilutant when it is added well above the body cavity of the mold.

If the metal which has been poured to form the drag neck is of a sufficiently soft composition, it may be used to dilute the metal of the cope neck. Commonly I add this metal in a weight equal to the weight of metal lying in the neck cavity of the cope mold. If desired, the sinkhead may be made of sufficient capacity to accommodate a weight of metal greater than that included in each of the roll necks, and the dilutant metal may be added in the upper mold region in a weight greater than that of the metal initially standing therein. It is, however, unnecessary in this mixing step to overflow any of the metal at any stage poured into the mold.

As exemplary of this simplest procedure in accordance with my method, I may use for the initial charge, and for the additive charge, metals corresponding generally to the following formulae:

	Si	S	P	Mn	C	Ni	Cr
Initial charge.....	1.04	.048	.093	0.46	3.42	4.18	1.96
Additive charge.....	1.62	.064	.085	0.68	3.86	-----	-----

In the finished roll the roll body will have, save in blending zones at the junction of the body and necks, the approximate composition of the initially cast metal, and the drag neck will have the approximate composition of the additive metal. The cope neck, assuming that it consists in equal proportions of the initially cast metal and of the additive metal, will have approximately the following composition:

Si	S	P	Mn	C	Ni	Cr
1.33	0.056	0.89	0.57	3.64	2.09	0.98

It will be recognized by those skilled in the art of roll making that this latter composition, produced by diluting the hard initially cast metal with the softer additive metal, is sufficiently soft to be readily machinable. As explained, a somewhat softer cope neck may be obtained, without varying the compositions of the metals, by adding the dilutant metal of the additive composition to the cope mold in a weight somewhat exceeding the weight of the initial hard metal therein.

The following is another exemplary set of formulae, illustrating a case in which there is

greater diversity between the roll necks, but in which the cope neck of the roll is nonetheless readily machinable:

	Si	S	P	Mn	C	Ni	Cr	Mo
Initially cast metal.....	.51	.082	0.42	0.26	3.38	4.48	0.76	0.48
Additive.....	1.72	.084	0.46	0.64	3.76	-----	-----	-----

When the metal of the additive charge is mixed in an equal weight with the initially cast metal lying in the cope mold, the resultant composition of the cope neck will be—

Si	S	P	Mn	C	Ni	Cr	Mo
1.12	.083	0.44	0.45	3.57	2.24	0.38	0.24

As above explained, this composition is without difficulty machinable.

In some instances it is desirable to effect a low graphite content in the roll necks. In such case the additive metal will be of a sort which is in itself machinable, but which is not capable, when added in any reasonable quantity, of use as a dilutant to provide a machinable cope neck when mixed with the initially cast metal of which the roll body is composed. In such case, the additive metal would have some such composition as—

Si	S	P	Mn	C
0.70	0.083	0.44	0.45	3.00

Under such circumstances, I employ one of two variant procedures in rendering the cope neck machinable.

One such procedure, assumes that there is available a melt of softer metal than that poured for the drag, such as the metal given above, as exemplary of a composition for machinable roll necks, and corresponding approximately to the formula:

Si	S	P	Mn	C
1.36	0.056	.56	0.57	3.64

If added in a weight equal to that of the metal previously standing in the cope portion of the mold, and assuming that the initial metal responds to the formula for the roll body metal first above given, the dilution would give in the cope neck a final composition corresponding approximately to the formula:

Si	S	P	Mn	C	Ni	Cr
1.20	.057	.327	.52	3.53	2.09	0.98

If, however, no satisfactory second dilutant metal is readily available, I follow an alternative procedure. This procedure consists in pouring initially so that the molten metal stands in the mold at a level slightly above the body cavity of the mold. An additive metal of moderate graphite-forming tendency is then poured to replace the initial metal in the drag mold, displacing metal upwardly of the mold to fill the cavity for the cope neck. At this stage, and before making any further addition I stir finely divided ferrosilicon into the initial metal standing in the cope

cavity. If, for example, the initial metal and the additive metal respond to the formula:

Si	S	P	Mn	C	Ni	Cr
1.04	.048	.093	.46	3.42	4.18	1.96
1.10	.066	.095	.60	3.72	-----	-----

I may add sufficient ferro-silicon, to give, as a resultant a composition having a higher silicon content, for example I usually add sufficient ferro-silicon to bring the metal of the upper roll neck into approximate correspondence with the formula:

Si	S	P	Mn	C	Ni	Cr
1.27	.057	.094	.53	3.56	2.09	0.98

Other graphitizing agents, such as a silicon-manganese-aluminum alloy may be used, and, if desired, the graphitizing agent may be added to the additive metal in the ladle, rather than added to metal already in the mold.

It will be understood that numerous modifications may be made in the compositions used, and in procedural steps, without going beyond the principles of my invention, as above set forth, and as defined in the appended claims. Thus, for example, the dilutant metal may be added to the initial metal in the cope mold in a weight less than that of the metal with which it is mixed, rather than in a weight equal to or greater than the weight of the initial metal, if the nature of the compositions renders such proportioning desirable.

The gist of my invention resides in the discovery that I may make a roll with necks of metal more machinable than the metal forming the body of the roll by replacement in one roll neck, and may effect dilution without removal of any of the initial metal in the other roll neck. This is in marked distinction to previous methods for attaining the same purpose which have included as a matter of supposed necessity a step in which initially-poured metal is run off from the upper neck cavity of the mold as the level of metal in the mold rises by displacement of the initial metal with a different metal in the lower neck cavity of the mold. By dilution in the upper neck cavity of the mold in distinction to replacement of metal therein, I insure the formation of a perfect bond between the roll body and the upper roll neck, while obtaining in the upper roll neck as well as in the lower roll neck a composition and quality of the metal which is within the bounds of what the art considers to be a readily machinable metal. This I have found I can do, while obtaining a roll body adequately hard for many conditions of use, by a simple apportionment in the composition of the initially-poured metal and of the additive metal. Since the additive metal of the lower roll neck serves upwardly to displace the metal initially standing in the mold there is no washing effect resultant from that action; and the addition in the upper neck cavity of the mold being effected by mixing in distinction to replacement, washing in the metal of the roll body is not caused by this latter addition. The economy of my method of making a roll having readily machinable necks and relatively hard body over methods in which all of the uncongealed initial metal is washed from the mold, and methods in which initial metal

is run off from the upper neck cavity in the mold and replaced with a different metal, is obvious to those skilled in the art.

It may be explained that as used herein, the terms "lower" roll neck and "upper" roll neck refer to the position of those necks in a vertical mold contoured for roll casting; and that where the terms "neck" and "neck cavity" are used without qualification, they are to be taken as designating not only the roll neck proper, but the structure associated therewith to provide wobblers, couplings, and the like. Where I have spoken herein of metal as being "machinable" or "readily machinable", both of these terms are used to define an ease of machinability which those skilled in the art consider to lie within the bounds of economical commercial practice, and I do not herein intend by either of those terms to make distinction from an unmachinable nature of absolute sort.

I claim as my invention:

1. In making a cast-iron roll having a body of one composition and necks of different and more readily machinable composition, the steps of pouring into a vertically positioned mold contoured for the casting of rolls metal of a sort not readily machinable to be included in the roll body to a level slightly above the body cavity of the mold and below the upper end of the upper neck cavity of the mold, by pouring rapidly a different metal of more readily machinable sort into the lower neck cavity of the mold displacing the initial metal upwardly in the mold and replacing it in the lower neck cavity of the mold with the different metal while retaining all the initially poured metal in the mold, and mixing with the initially poured metal in the upper neck cavity of the mold a different metal of more machinable sort in quantity and composition adequate in admixture with the initial metal to give a machinable upper roll neck.

2. In making a cast-iron roll having a body of one composition and necks of different and more readily machinable composition, the steps of pouring into a vertically positioned mold contoured for the casting of rolls metal of a sort not readily machinable to be included in the roll body to a level slightly above the body cavity of the mold and below the upper end of the upper neck cavity of the mold, by pouring rapidly a different metal of more readily machinable sort into the lower neck cavity of the mold displacing the initial metal upwardly in the mold and replacing it in the lower neck cavity of the mold with the different metal while retaining all the initially poured metal in the mold, mixing with the initially poured metal in the upper neck cavity of the mold a different metal of more machinable sort, and supplementing the effect of the additive metal in producing a machinable upper roll neck by adding to the mixed metal in the upper neck cavity a graphitizing composition adequate in conjunction with the additive metal to give a machinable upper roll neck.

3. In making a cast-iron roll having a body of one composition and necks of different and more readily machinable composition, the steps of pouring into a vertically positioned mold contoured for the casting of rolls to a level slightly above the body cavity of the mold and below the upper end of the upper neck cavity therein a relatively unmachinable metal for inclusion in the roll body, by pouring rapidly a different metal of more readily machinable sort into the lower

neck cavity of the mold displacing the initial metal upwardly in the mold and replacing it in the lower neck cavity of the mold with the additive metal while retaining all the initially poured metal in the mold, and mixing with the initially poured metal in the upper neck cavity of the mold additive metal of the same composition as that secondarily poured to form the lower mold neck in quantity adequate in admixture with the initial metal to give a machinable upper roll neck.

4. In making a cast-iron roll having a body of one composition and necks of different and more readily machinable composition, the steps of pouring into a vertically positioned mold contoured for the casting of rolls to a level slightly above the body cavity of the mold and below the upper end of the upper neck cavity therein a relatively unmachinable metal for inclusion in the

roll body, by pouring rapidly a different metal of more readily machinable sort into the lower neck cavity of the mold displacing the initial metal upwardly in the mold and replacing it in the lower neck cavity of the mold with the additive metal while retaining all the initially poured metal in the mold, mixing with the initially poured metal in the upper neck cavity of the mold additive metal of the same composition as that secondarily poured to form the lower mold neck, and supplementing the effect of the additive metal in producing a machinable upper roll neck by adding to the mixed metal in the upper neck cavity a graphitizing composition adequate in conjunction with the additive metal to give a machinable upper roll neck.

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