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O T T A W A November 3, 1945.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1957.

Investigation of the Cause of "Burn-in" on Steel Castings.

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(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
of
MINES AND RESOURCES

Mines and Geology Branch

OTTAWA November 3, 1945.

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Origin of Request and Object of Investigation:

Samples of burnt-on sand from heavy steel castings were received from the Hull Iron and Steel Foundries Limited, Hull, Quebec, with the request that an examination be made to determine possible causes for this condition.

Description of Samples:

Four samples of burnt-on sand were received, identified as follows:

Core Sand from 7-Ton Casting.

2 wheelbarrows of #57 sand (approximately 700 lb.).
$\frac{5}{4}$ gal. bentonite.
2 gal. cereal flour.
3 gal. core oil.

(Description of Samples, cont'd) -

HOB-8 Core Sand - Outside (Hymac).

2 wheelbarrows #57 sand.
150 lb. silica flour.
2 gal. No-vein.
5 gal. bentonite.
1½ gal. cereal flour.
2½ gal. core oil.

HOB-8 Core Sand - Inside.

HOB-8 Moulding Sand.

2 wheelbarrows #57 sand.
50 lb. silica flour.
4 gal. bentonite.
1½ gal. Casco.
1¼ gal. core oil.

Macroscopic Examination:

All samples were an intimate mixture of metal and core sand. The 7-ton casting had the greatest depth of metal penetration, about 2 inches. This sample also had some solid metal veins, where the sand had cracked, allowing the metal to penetrate.

The HOB-8 moulding sand had the next worst penetration.

X-Ray Examination:

An X-ray examination did not indicate the presence of iron in the form of silicates or oxides.

Microscopic Examination:

Microspecimens were made and examined in direct and indirect illumination. Photomicrographs of these are shown in Figures 1 to 5. In direct illumination the sand appears dark and the metal bright; in the indirect light, the reverse is the case.

Figure 6 is a photomicrograph of the sand next to a heavy casting which peeled perfectly.

DISCUSSION:

The microscopic examination of these specimens indicates that this burn-in was of the mechanical type, as none of the grains appears to be fused. Note, in contrast, the fusion of the sand grains from the casting with good peel, as shown in Figure 6. Apparently this incipient fusion forms a glaze which resists metal penetration. This appears to indicate that the sand from the burnt-in specimens was too refractory and requires some material to lower the sintering point.

There appear to be other factors besides the fusion point of the sand which affect the burn-in characteristics. Penetration is worse on inside sections of a casting, even if the same sand is used as on the outside. Factors which may account for this phenomenon are:

1. The length of time during which molten metal is in contact with the sand would be expected to influence burn-in. The metal on the outside of the casting would solidify first, and there would be the least amount of burn-in.

2. Mould gas pressure probably influences the amount of burn-in. Some experts hold the theory that a partial vacuum is created in internal cores soon after the metal is poured. This vacuum is thought to be formed when the moisture which is produced by the cracking and oxidation of the hydrocarbons next to the molten metal reaches the cooler portions of the core and condenses. Any such lowering of gas pressure would certainly facilitate burn-in. This theory is being checked at these Laboratories.

3. Flowability of the sand certainly affects the amount of metal penetration. If the sand contains too much binder the grains will not slide over each

(Discussion, cont'd) -

other, and voids are left in the sand. If the flowability is too low the moulded sand will contain a high number of voids, even with hard ramming, and penetration will be experienced.

However, until more research has been done on metal penetration, the most hopeful angles of attack are (a) control of sintering point and (b) flowability of the sand. Apparently the sintering point of the sand used in these castings was too high, and some materials should be added to lower the refractoriness. Materials which lower the sintering point are:

1. Bentonite.

This is a necessary constituent of moulding sand, but its use in excess should be avoided. Too much bentonite lowers the flowability, and causes voids in the sand. Bentonite also increases the plasticity at high temperature, and if too much is used the sand is likely to deform, causing outsize and cracked castings. Another disadvantage of excess bentonite is that the used sand is difficult to recondition to the best green moulding properties.

2. Silica Flour.

The effect of silica flour on sintering point is limited. The fusion point of silica flour is not much below that of silica sand. The use of large amounts of silica flour is an effort to fill the voids in the sand, which are caused by low flowability. If small castings are poured hot, the silica flour will sinter and prevent burn-in, but probably this does not occur on large castings poured at a lower temperature. Silica flour causes very high hot strength, and even if the metal does not penetrate, the sand will be very hard to clean off.

(Discussion, cont'd) -

3. Iron Oxides.

This appears to be the most desirable material to add to lower the sintering point in this type of casting. Sintering point can be controlled by controlling the addition of iron oxide. This material has the effect of raising the strength of the sand next to the casting without increasing appreciably the strength at 2000° F. It does not increase hot deformation below 2500° F.

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CONCLUSION:

The burn-on is probably caused by:

1. High sintering point.
2. Voids in sand, resulting from low flowability.

Recommendations:

1. Lower the sintering point by the use of iron oxide.

2. Keep bond additions as low as practicable for good moulding.

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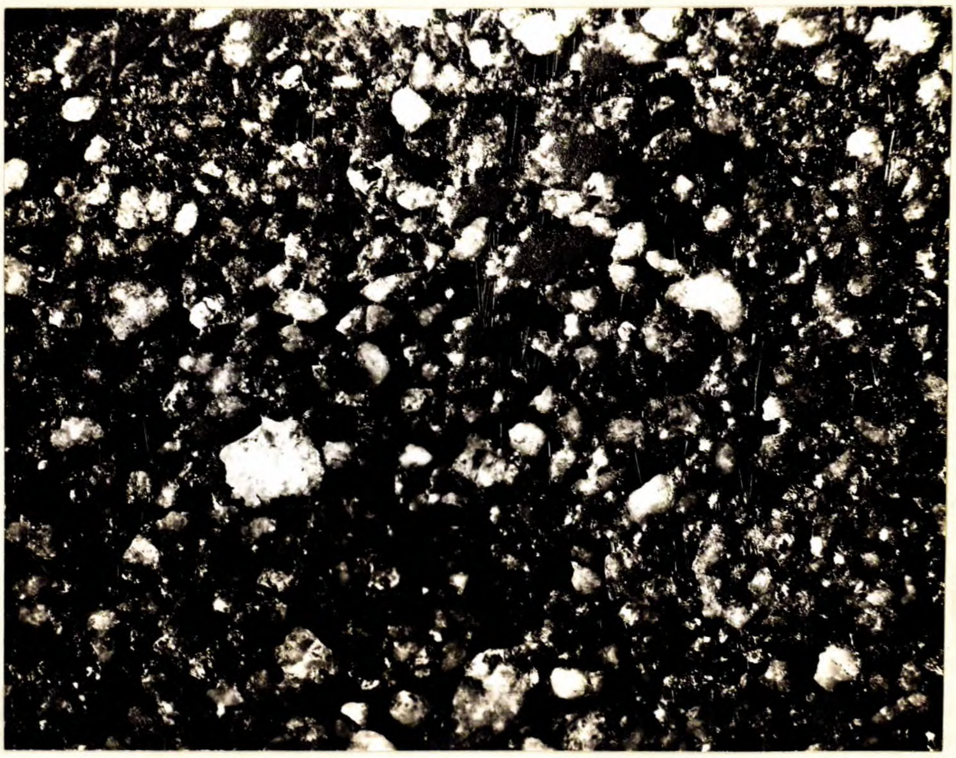
(Figures 1 to 6 follow,)
(on Pages 6 to 8.)

AEM:LB.

Figure 1.

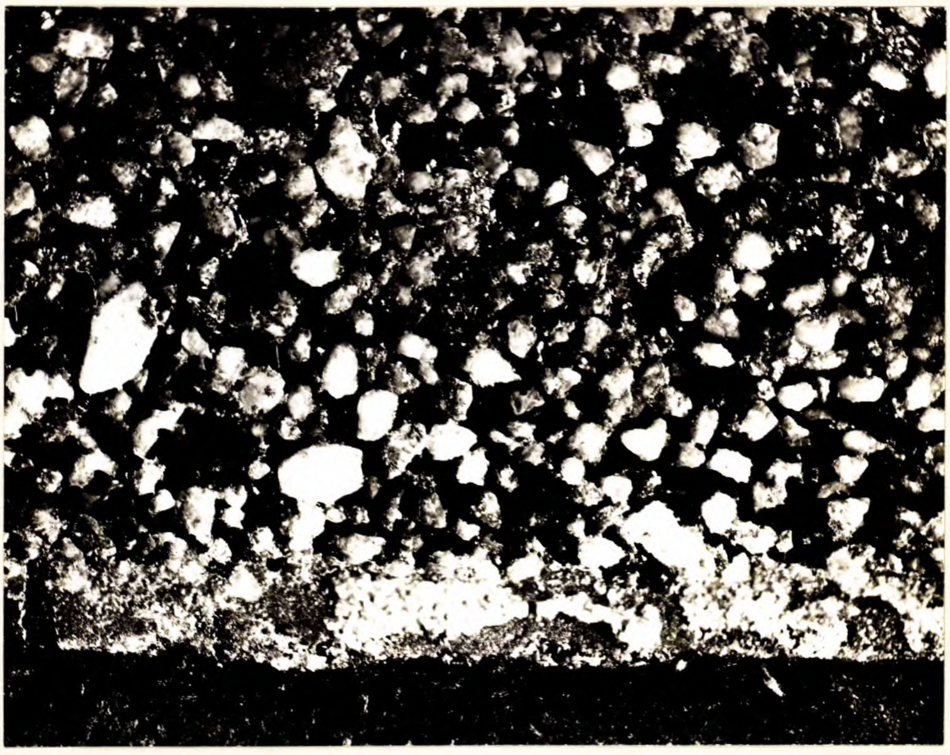


X20. Dark field.

CORE SAND FROM 7-TON CASTING.

Sand grains, light; metal, dark.

Figure 2.

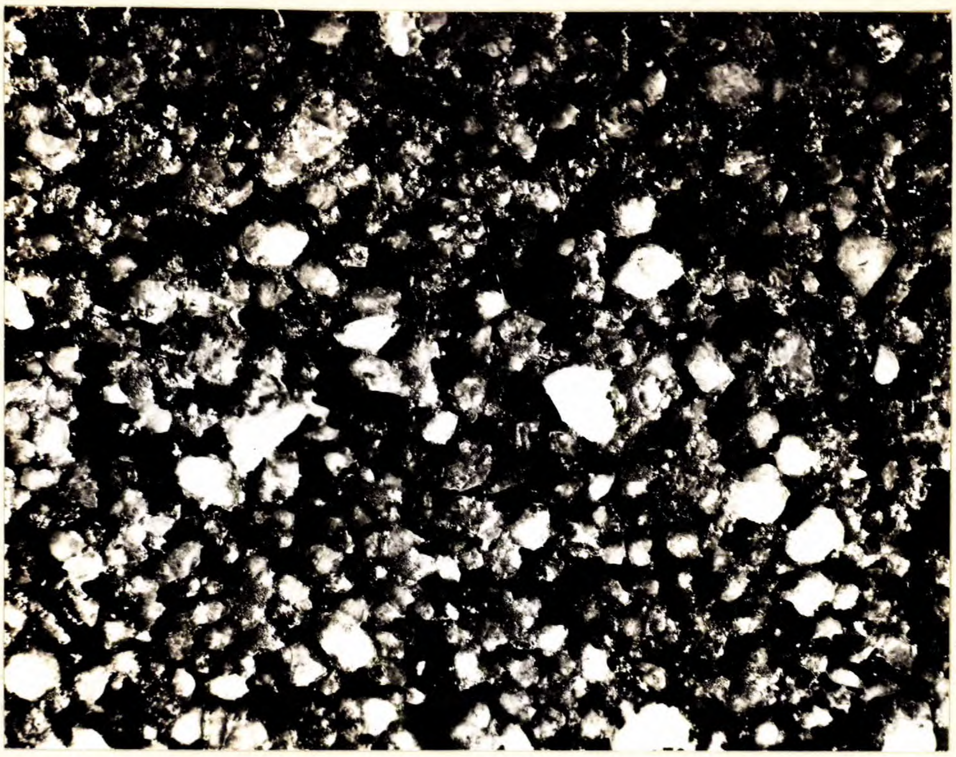


X20. Dark field.

HOB-8 CORE SAND - OUTSIDE (HYMAC).

Sand grains, light; metal, dark.

Figure 3.



X20. Dark field.

HOB-8 CORE SAND - INSIDE.

Sand grains, light; metal, dark.

Figure 4.

X20 Dark field.

HOB-8 MOULDING SAND.

Sand grains, light; metal, dark.