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AD-A953 782

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*[Handwritten notes and signatures at the bottom of the page]*

May 21, 1936

GALVANIZED 1/2" x 2" MACHINE BOLTS & NUTS

DIAMOND EXPANSION BOLT COMPANY

AD-A953782

One bolt and nut selected at random from a lot sent by the Diamond Expansion Bolt Company was sectioned to study the extent of alloying and the uniformity of thickness of the zinc coating. It is understood that after hot dipping in molten zinc the bolts and nuts are centrifuged. It is the claim of the Company that this centrifuging removes the excess zinc and a uniform thickness of coating results which does not require a rechasing of the threads after galvanizing.

Conclusions

1. The thickness of the coating is non-uniform especially in the threads.
2. Two iron-zinc alloys were found -
  - (1) a thin alloy layer next to the bolt possibly  $\text{FeZn}_3$  about .00015" thick;
  - (2) a thin alloy layer, between alloying (1) and the unalloyed zinc, possibly  $\text{FeZn}_7$ , unbroken

for about .0005" and extending intermixed with zinc for about .0008". The thickness of these two alloys was fairly constant throughout all the sections examined.

3. The total thickness of the coating (alloys plus zinc) varied greatly from .001" on some of the thread apexes to complete filling in of the space between threads in a few instances. In general, however, the bottom of the threads had a maximum coating of about .006".

4. There were numerous voids in the coating at or close to the bolt possibly due to insufficient cleaning at these areas.

5. The zinc impurities are very prominent and break up the continuity of the zinc coating badly.

#### Discussion

It is believed that although considerable excess zinc was removed by centrifuging, the zinc coating froze before all of the excess was removed. This would account for the non-uniformity of the coating, especially if the bolts or nuts were dumped in a cold centrifuge in a helter-skelter manner. It is suggested that some means of heating the centrifuge

to a temperature (determined by experiment) probably somewhere near, but below, the freezing point of zinc. This would slow down the rate of freezing and give more time for the centrifugal force to act before the zinc froze. Care should also be taken not to overload the centrifuge, that is, a too thick layer of bolts or nuts should be avoided so as to allow time enough for the zinc along the inner surfaces of the charge to find its way through the charge before freezing.

Fig. 1 x500 Unetched, shows the variation of the coating found on the bolt. MK11,-16

Fig. 2 x500 Etched, shows a thick and thin coating found on the bolt. Two alloys are shown of about the same thickness. The variation in coating thickness is practically entirely confined to the excess zinc not removed by centrifuging. MK12,-13

Fig. 3 x500 Unetched, shows the coating thickness variation at the top and bottom of the threads in the nut. MK20,-22

Respectfully submitted,

H. G. Carter  
Associate Metallurgist

BOLT

Non-threaded Section

x500 Unetched. Coating is non-uniform in thickness  
and contains many small voids at or near the  
bolt. Impurities in the excess zinc are  
numerous. MK11

Threaded Section

x500 Unetched Apex of a thread. Coating is non-  
uniform in thickness. MK16

Fig. 1



88A2BB  
X500 MKII



88A2BT  
X500 MKII

BOLT

Non-Threaded Section

x500 Etched\*. Thick and thin non-uniform coating.  
FeZn<sub>3</sub> alloy layer - very small crystals next  
to the bolt about .00015"  
thick.

FeZn<sub>7</sub> alloy layer - unbroken white layer close  
to bolt but separated by  
FeZn<sub>3</sub> crystals about .0005"  
thick.

FeZn<sub>7</sub> + Zn mixture about .0008" thick.

Excess Zn balance of coating. MK12

x500 Etched\*. Another area, coating is quite uni-  
form. See above for description of crystals  
in coating. MK13

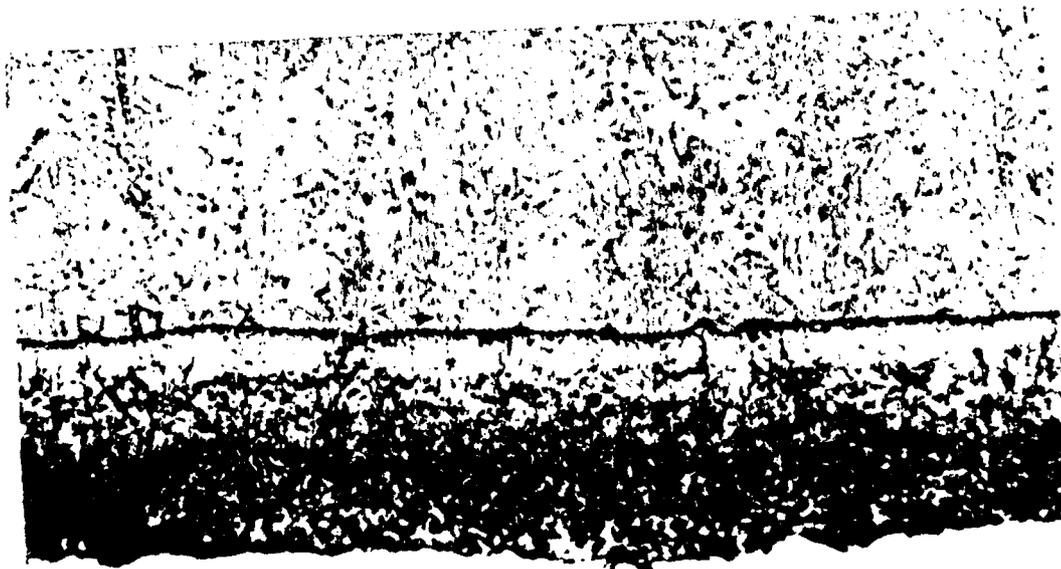
\*Etching Reagent

Chromic acid..... 120 g.  
Sodium sulphate.. 5.5 g.  
Water..... 100 cc.

Fig. 2



88A2BB  
x500 MK12



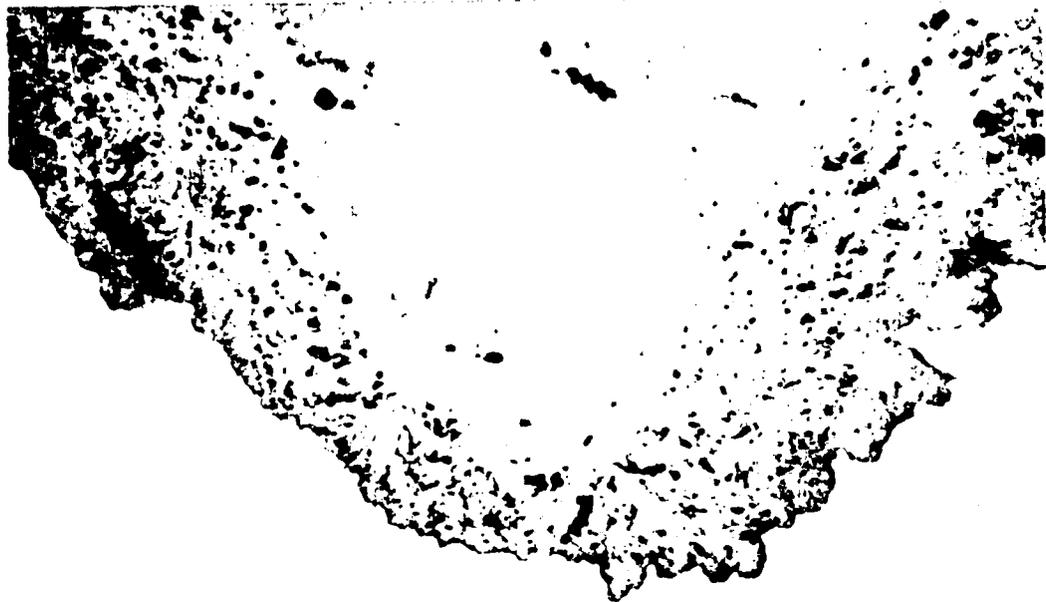
88A2BB  
x500 MK13

NUT

x500 Unetched. Top of a thread. Non-uniform  
thickness of coating. Alloying indicated  
by unbroken layer next to nut. Excess  
Zn balance of coating. MK20

x500 Unetched. Bottom of a thread. Non-uniform  
coating. Description of coating see above.  
MK22

Fig. 3



88A2NT  
X500 MK20



88A2NT  
X500 MK20