

dual movement ceases. The contraction ceases, if we use fresh cut—and that “if” must always be put in in speaking of alloys—and when I say fresh cut I mean within one hour after the cutting, not longer. We must be exact. At that point, 60 of silver and 40 of tin, we get no shrinkage. With 65 of silver and 35 of tin there will be a slight expansion, that expansion will increase with the proportion of silver until we have reached about 74 of silver. At that point we will get a large expansion, but an expansion that may be removed by annealing. An annealed alloy of about that constitution will neither shrink nor expand. Adding more silver we will be unable to remove the expansion entirely. By annealing we will remove it in large degree, but it will still expand some. Therefore, in the unmodified silver-tin alloys we are confined closely to our formula. Heating it in the open fire some will want a little more silver and some less, depending on how much oxidization we get. But when we come to use the electric crucible I think we will have no reason to do that. If we add other metals, then we have the conditions changed immediately. For instance, copper increases the expansion very materially. Lead diminishes it a little. For instance, taking 65 of silver and 35 of tin on such a basis for trial we found that the gross expansion was 1 point, then adding gold we got 4 points expansion; adding platinum it was 1 point expansion again; adding copper we got 23 points expansion; adding zinc we got 68 points expansion; adding cadmium we got 100 points expansion; adding bismuth we got no expansion. These additions were 6 per cent. in each case. Adding aluminum, 5 per cent., we get 445 points expansion. With aluminum, 1 per cent., we get 166 points expansion. Dr. Noyes will show you a tube filled with aluminum alloy (tube shown). Now, you will see with these modifications by different metals we can obtain a large range of formulæ and yet have alloys that will neither shrink nor expand when fully annealed. We are not confined to any one alone by any means.

Q. When you add copper, that will permit a larger per cent. of silver, as I understand?

Dr. BLACK—You mean a larger per cent. of tin?

Dr. J. B. WILLMOTT—Yes.

Dr. BLACK—It modifies it also in making it very much harder. Copper increases the strength of the alloy. Also zinc makes the amalgam stronger. I found that nickel did not do as I thought it ought. Nickel simply ruins it. It has no strength at all. One per cent. of nickel simply ruins an alloy.

Q. What effect has gold?

Dr. BLACK—It makes it work a little bit softer, that is about the only effect it has.