combination of pure titanium with the alloy that we use has a habit of forming titanium hydrides at the weld face, which can give you a creep-type failure under sustained load. This has been determined as the cause of the accident.

This is an artist's sketch (fig. 3) of where the various pieces of the debris landed. The explosion occurred down at the intersection between the LOX and hydrogen tanks. The engine and the thrust structure were pushed downward, everything else went up. Some of the upper skirt equipment is not even singed. The damage to the stand approximates 10 percent. This stand cost in the order of $8 million 2 or 3 years ago. It's estimated it will require something close to a million to refurbish it. The ground support equipment replacement cost is of the same order of magnitude.

Mr. ABLE. You might mention the fact that we were not only looking at the data, but also the burst tests we conducted on a series of bottles in order to try to reproduce the conditions.

Mr. SMITH. We have probably spent 5,000 engineering manhours since the accident in correlating the data available, and we have mountains of data from a static test like this. As we zeroed in on various possibilities, we initiated test programs.

We have now located all the helium bottles that were bad. We have devised a test that will tell us whether or not the correct weld wire was used. We find the vendor's documentation was accurate. The 12 bottles that his records show he made the wrong bundle of wire are verified and have been impounded. All the other bottles have been checked and we are now sure they have been welded with the right wire.

We have absolute confidence that the cause has been determined. As a result of this, we feel there will be certain things we will do with all our vendors to prevent any such thing from ever happening again.

The basic fundamental error was the receiving inspector's accepting a bundle of wire into stock without checking the certificate that the supplier sends with this kind of material against the purchase order. The purchase order clearly called for the alloy wire, the certificate coming with the wire clearly stated he was filling that purchase order with another wire, in error. The vendor made an error in sending the wire; the person receiving the wire failed to check and cross-check his documentation. He accepted the wire, and put it into stock. A very unfortunate circumstance.

Mr. DOUGLAS. Well, I think we learned one very fundamental thing; that bottle was supposed to be good for burst of 8,000 pounds, but, this proof test unfortunately didn't tell the whole story, due to the "creep." That's why we developed a new testing technique.

Mr. SMITH. Unfortunately, the proof test took this particular metal combination right to ultimate. Once you've had a metal up to ultimate strength, you don't know how many cycles are left in it. The next time it can go at half strength.

Mr. PETTIS. Don, what do you mean when you use the word "creep"?

Mr. DOUGLAS. "Creep"? The creep failure is when you have a certain piece of material under force, under sustained load—and they had to have a hold in this case—and it just means it starts to give slowly, and stretches so to speak, and then—boom.