

less of how it is excavated. If he has incentive and imagination to buy one of these machines and make a profit, then he will make a profit. This is motivation. Not very many contractors are willing to invest money in a machine of unknown character. Therefore, they continue excavating under conventional method because the man is paid and he gets paid and is not losing anything. To venture into a new device is a risk not very many want to undertake except the imaginative ones in the Navaho tunnels and those cases.

Senator ANDERSON. That is right. But what I am trying to say is that industry is interested enough to go out and bid on these contracts and the Government has not a penny in them. Does the Government need to invest in this?

Mr. MERMEL. The Government is not investing anything in the machine. It is purely a deal between the contractor and the Hughes Manufacturing Co.

Dr. HIBBARD. This is where the green line goes——

Senator ANDERSON. The big tunnel machine does not know whether it is red or green. It just digs a hole.

Dr. HIBBARD. However, the machine would not have been built if it had not been a Federal contract.

Mr. MERRILL. The contractor's own initiative brought about the use of this machine.

Senator ANDERSON. Exactly.

Dr. HIBBARD. Because he was trying to make a profit and find faster excavating methods. None of the savings from the machine development went to the taxpayer. If the Government does the research in this field to develop new techniques of excavation therefore they will make it more efficient and more economical to bore tunnels, the savings will accrue to the taxpayer in the contract price—not to the contractor in lower cost and high profits.

Senator ANDERSON. This tunnel was bored and built without Government incentive for a new machine.

Dr. BATES. Senator, if I may make a statement. If we rely on what companies have been doing by their own initiative we will progress by 1982—according to Dr. Hibbard's chart—from a rate of 400 feet per week without continuous boring machines to about 750 a week with such machines. However, if the Federal Government is willing to put in additional research and development, we can jump this rate to about 1,750 feet per week.

Senator ANDERSON. The water supply eventually carried in this tunnel will be, what, about 110 acre-feet? Would that not be big enough? Will not the tunnel they now have carry all that water? Why should it be bigger?

Dr. BATES. I think the truth of the matter and the point Dr. Hibbard was trying to make was that in terms of the total amount of tunneling done, all of the uses we have for tunneling, we have to do it more effectively and more rapidly.

Senator ANDERSON. But you would not have to in the case of the San Juan Tunnel. Why would it be necessary to have the Federal Government do it?

Dr. BATES. I think we are talking about relative progress, moving much faster if we are willing to put in a certain amount of Federal money to stimulate industrial activities.