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SOVIET TUNNELING ROCKETS

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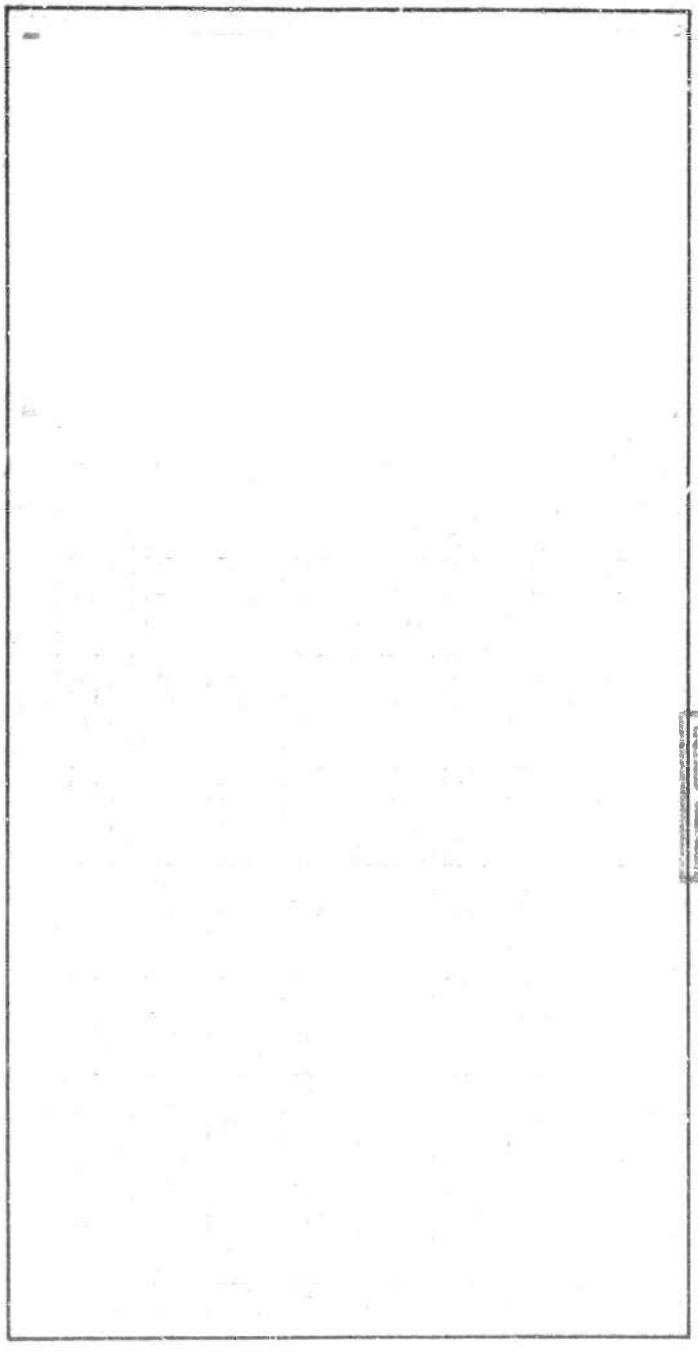

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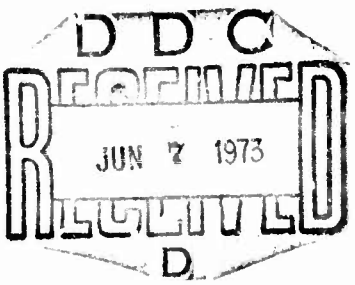

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INTRODUCTION

An operational tunneling rocket is described which has been developed by a Soviet army officer. The information is mainly from one article in a semipopular journal, and hence is largely descriptive without giving precise performance data on the rocket. Present and future uses of this technique are discussed for a variety of drilling tasks.

SOVIET TUNNELING ROCKETS

Drilling machinery and associated equipment used in mining, oil and gas prospecting, geological and geothermal research, and municipal construction, require special design and operator training. In addition, the conventional drilling or excavation for urban construction and laying of communication and utility lines represents the largest single item of construction cost, disrupts regular communication, requires special safety measures, and is time consuming.

The Soviets are experimenting with unconventional tools to modernize drilling and bring excavating costs to a minimum. Engineer M. I. Tsiferov*, an expert in explosives and, since 1948, a pioneer in underground drilling with unconventional equipment, has designed a tunneling rocket. In 1948 he conducted preliminary tests to determine the ballistic effects of high-temperature flame, using an old cannon on a firing range near Moscow. The cannon was loaded with a blank charge which produced a very powerful flame jet through a narrow slit in the sealed muzzle and which was capable of cutting through rocks, concrete slabs, brick walls, and limestone blocks in fractions of a second. This test was favorably commented on by Academician A. A. Skochinskiy and Professor G. I. Pokrovskiy corroborating that a high-temperature flame can greatly assist in drilling exploratory boreholes, constructing water wells in deserts, laying underground communication and pipe lines, and building canals and roads without disturbing the surface. Some Soviet scientists refer to this method as "Engineer Tsiferov's hyperboloid" [1].

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* Major General, Technical Engineering Service (ITS), Soviet Army.

After several years of experimentation, Tsiferov, capitalizing on results from his earlier cannon tests, turned his attention in the 1960's to the task of drilling by means of a fully self-powered thermal drill. After several designs and recomputations, a tunneling rocket without any mechanical connection to the surface and capable of penetrating deep into the earth was finally developed. The unique rocket head releases a gas stream which rotates the rocket and simultaneously disintegrates the soil encountered. The flame vortex drives the rocket forward and ejects the disintegrated material. After ignition (see Fig. 1) the rocket attains a penetration speed of 1 m/sec, creating an opening about one meter in diameter at the surface [1].

Fig. 1. Ignition of a Tunneling Rocket [1]

The tunneling rocket, registered under Soviet Patent No. 79119, is described as a device for drilling by the intense crushing of rocks with a gas stream (at a pressure between 500 and 2500 atm) produced by a generator built into the device. In addition, the device is designed to use small charges of high explosives instead of the gas stream [2].

In spite of differing opinions among some specialists the tunneling rocket has withstood all criticism and has demonstrated its great potential. A noted Soviet geologist and academician, V. I. Smirnov, conceded that this rocket is a revolutionary contribution and a great innovation in drilling technology. Such an authoritative opinion has "legitimatized" the rocket and as a result, it has attracted the attention of petroleum specialists, mining and railroad engineers, and geophysicists [1].

Based on drilling rate, it is evident that the tunneling rocket can accomplish more in one hour than conventional equipment can in one month. The rate average speed of the rocket exceeds the present speed of a conventional drill by about 100 times, with a potential drilling depth range of 20-25 kilometers without concern for the destruction of the rocket by the very high temperature encountered at such depths. Beyond a depth of 7 kilometers or more, where temperatures can reach 200° C, conventional drills encounter a "critical barrier," beyond which the drilling tempo decreases, while technical difficulties increase considerably. Thus on the average about 7 years are required to drill a 7-kilometer borehole with conventional equipment [1].

The tunneling rocket has an equivalent blasting energy of about 10,000 to 50,000 horsepower, with a potential of 100,000 horsepower or more. The degree of directional control of the rocket is not specified in [1], other than to say that the rocket is highly maneuverable. When the last blast charge or other fuel is used up, a special "retrieval" charge is triggered to bring the rocket to the surface at a moderate speed, where it

is replaced by another rocket to continue the drilling. Operating in sequence, a number of these rockets could be used to reach the depth of dry geothermy and other natural resources. In this regard, the rocket has been a main discussion topic at many meetings of the USSR Academy of Sciences, and has been considered as the best prospective tool for deep drilling. The above figures are not only the inventor's claims but are also the product of accurate computations verified by various investigating groups and scientists [1]. According to N. A. Chinakal, Corresponding Member of the USSR Academy of Sciences, the speed of this rocket enables a drilling capacity of over 10 kilometers per month.

Tsiferov is presently working on several new models with different ranges and diameters. After witnessing many rocket tests and recomputing all the engineering data, the Ministry of the Gas Industry approved a special decision to use the tunneling rocket for laying gas pipe lines in the near future. Based on this, there are speculations by various scientists from Novosibirsk and Moscow that natural gas could be delivered to Europe from Soviet Central Asia through 3-m-diameter mains [1].

The erection of electric transmission lines is another example of work done under very difficult conditions, usually involving deforestation, the construction of new roads for transportation of material, etc. The tunneling rocket could accelerate this type of operation and eliminate unnecessary cost and hardship [1].

For the construction of industrial plants and various community developments, thousands of holes for foundation piles are required, which for conventional drilling represents a costly, hard, and time consuming operation. It has been documented that the tunneling rocket can dig a foundation hole

800 mm in diameter within 10 seconds. Recently, Tsiferov proposed the use of his rockets at the KamAZ* Plant construction site. This suggestion is presently under consideration by the construction project management [1].

Presently, about 90% of prospecting boreholes are drilled manually. The tunneling rocket offers an unlimited service not only by producing fast, clean, accurate and perfectly cylindrical boreholes, but also by eliminating transportation or hauling of cumbersome equipment and machinery needed by geologists, hydrologists, and others. In addition, the diameter of an 800 mm borehole would permit a geologist to be lowered down for visual study of strata instead of using conventional coring devices [1]. In summary, the underground rocket offers a very broad range of applications in various fields of construction and other aspects of the national economy, such as:

- to reach deep confined geothermal heat and other natural resources;
- to prepare initial shafts and galleries for explosive charges used in mining and quarrying;
- to drive horizontal holes for communications and electricity, or laying pipe lines for hot water, steam, and compressed air; and
- to drill under railroads, highways, streets, and other obstacles (buildings, plants, etc.) without disturbing the surface.

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* Kamskiy avtomobil'nyy Zavod (Kama Motor Vehicle Plant) at Naberezhnyye Chelny (Tatar ASSR) now under construction.

At present, no additional data are available regarding the material used for the construction of the rocket, the type of explosive (liquid, solid or atomic), dimensions and graphical descriptions of the rocket, or the retrieval of the rocket in case of technical defect.

Besides the described self-propelled tunneling rocket, the Soviets are experimenting with drills of smaller size and capacity for laying communication lines under buildings, railroads, and highways, in order to eliminate expensive earthwork and interruption of regular communications. These drills use gas jets, compressed air, or liquid as the prime mover; since they are similar to those used in other countries, they have been omitted in this report. One such item of interest, however, is the new GB-500 horizontal drill powered by electricity. This drill is manufactured by the Ul'yanovsk Construction and Highway Equipment Repair Plant; it is designed for the horizontal drilling of boreholes for communication cables, water conduits, and gas pipes under streets and railroad beds. By means of cutters and a special multisectional cylinder 0.5 m in diameter, this drill penetrates with a speed of 5.5 meters per hour and has a range of 15 to 17 meters [3].

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