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September 23, 1958

Dear Sir:

This is a summary letter report on Work Order No. VII, Task Order No. R, that describes the activity performed under this program from June 11 through August 10, 1958.

On April 16, 1958, we began a 10-month research program under Task Order No. L that was directed toward the design and development of two prototypes of an electrically powered trenching unit that would trench to a depth of 18 inches, the preparation of two prototypes of a power-supply unit for the electrically powered trenchers, and the adaptation of one of the power-supply units to a Volkswagen. This equipment was to assist in laying wire underground and was being developed to provide an implement that was appreciably quieter in operation than the gasoline-engine-powered trenching unit that had been developed under Research Order No. 21.

The program under Work Order No. VII, Task Order No. R, was directed toward accomplishing the following in regard to the trenching equipment that was developed under Task Order No. L: (1) the repair of damaged parts; (2) the selective modification and further evaluation of the equipment; (3) the preparation of color movies and color slides on the operation of the equipment; and (4) the preparation of the Volkswagen for delivery to the Sponsor.

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Summary

Under this program, the dirt deflectors and trenching chains were repaired, a motor enclosure was fabricated for the second trencher unit, the Volkswagen engine was inspected and tuned up, and a new battery was installed. Further work comprised the fabrication of a guard for the timing-belt drive, the installation of a trencher-motor air-inlet screen, the closure of lightening holes to reduce the noise level of the operating trencher motor, and the removal of material from the bearing housing to increase the clearance between the trencher tire and the bearing housing.

Trenching-rate tests were made at engine speeds of 1,225 and 2,250 rpm, in an attempt to evaluate the effect of operating at a higher engine speed. Unfortunately, these trenching tests were not finished because the gears on the trencher-motor armature shaft were shearing during the tests. However, it was concluded that, although the engine seemed to run hotter and the noise level was increased appreciably, the trenching rate would probably be significantly improved at the 2,250-rpm engine operating speed.

At the end of the program, the Volkswagen automobile, two trencher units, color motion pictures and color slides, four standard chains, and related components were provided to the Sponsor.

Engineering Activity

Several modifications were made on the trencher units. Figure 1 shows a modified unit without the dirt deflector. General reference is made to the Summary Report on Task Order No. L, dated February 14, 1958, in connection with the discussion presented below.

During the trenching-rate studies and the demonstration of the trenching equipment, several chains were broken and these tore the dirt deflectors. These chains were repaired. Subsequently, when the torn dirt deflectors were used, the dirt from the trenching operation was thrown through the torn holes and interfered with the operator. Some of the dirt was also thrown onto the timing belt and was carried into the timing-belt pulley grooves to the extent that, occasionally, the trencher motor became overloaded and stalled.

We used two methods to repair the dirt deflectors because we were not sure which was better. In one, the dirt deflector was covered with 0.031-inch-thick vinyl-plastic-coated fabric, with a piece of fine-mesh screen located between the cover and an extra thickness of material that was added in the probable damage region. It was believed that, if this cover was punctured during a field operation, the screen would permit temporary closure of the hole until permanent repairs could be made. The second deflector was covered with a 2-ply neoprene-coated nylon fabric, which was 0.032-inch thick and was a much tougher material than the

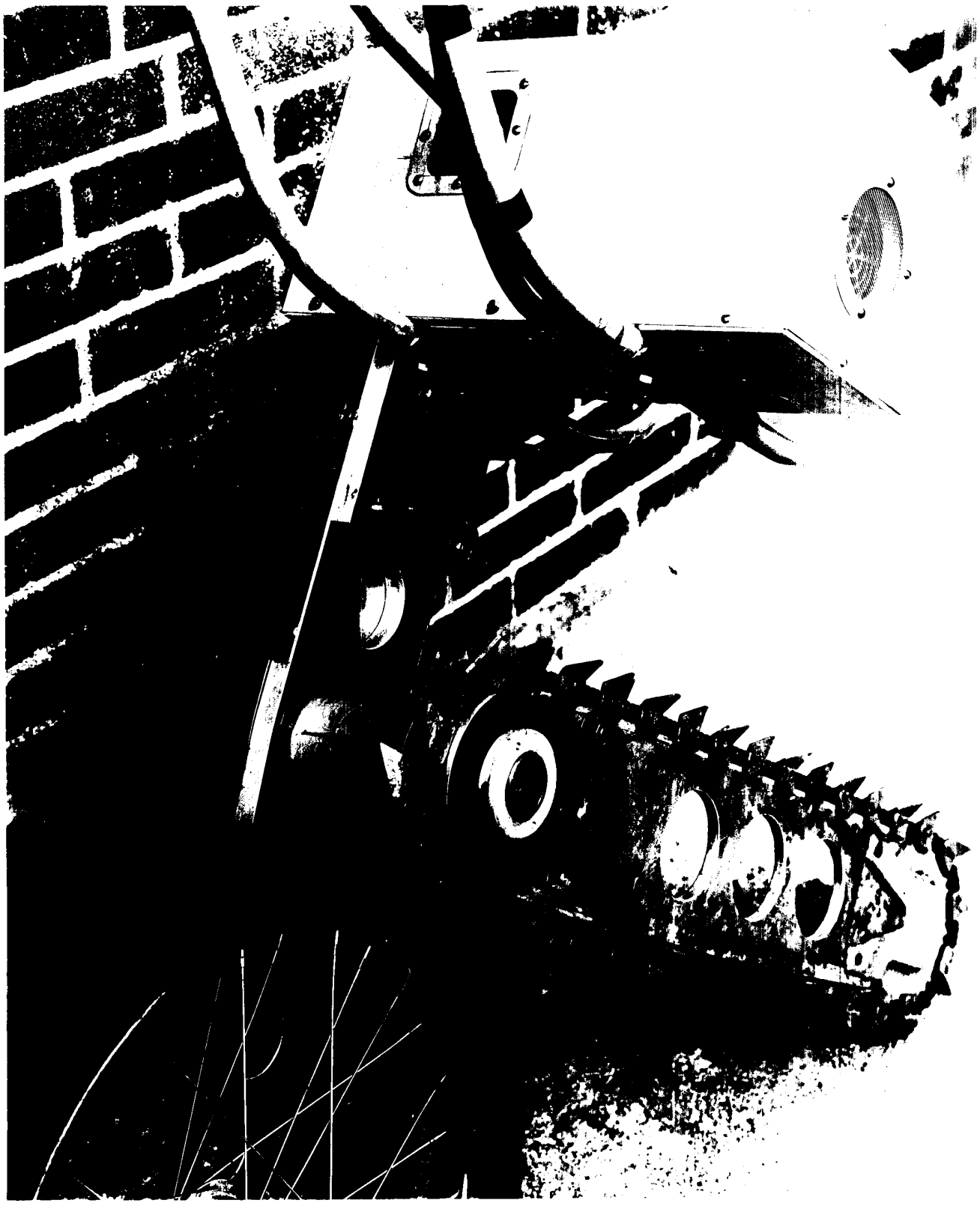

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Figure 1. Modified Electric-Trencher Unit Without Dirt Deflector

vinyl-plastic-coated fabric. In the course of our limited evaluation tests, neither deflector was damaged, so both types were provided to the Sponsor for field testing, in order to determine the relative merits of these deflector covers.

Since the dirt deflectors may still be punctured occasionally, a cover was made to enclose the timing belt and another cover was placed over a lightening hole in the front support part, to prevent dirt from being thrown onto the belt or through the hole.

During our evaluation tests, it became apparent that under certain conditions foreign matter could enter the air inlet to the fan-cooled motor and cause motor stoppage. To reduce this hazard, a fine-mesh screen was added to the motor enclosure, to protect the air-intake opening.

As part of the work under Task Order No. L, one trencher gearhead electric motor had been enclosed to reduce the noise level of the operating motor. A second enclosure was fabricated under Work Order No. VII, for the other trencher unit. In a further attempt to reduce the noise, covers were placed over the lightening holes in the base plate of each trencher unit.

In the fabrication of the trenchers, a heavy-duty bicycle tire had been used on the front-wheel assembly in place of a standard bicycle tire. The heavier tread on the heavy-duty tire reduced the clearance between the tire and the bearing housing from approximately 1/4 inch to 1/8 inch. To prevent interference

between the tire and the bearing housing in the event that the wheel should become damaged, material was removed from the bearing housing so as to increase this clearance to 3/8 inch.

Some of the evaluation testing under Task Order No. L had indicated that the trenching rate could probably be increased appreciably if the operating speed of the Volkswagen engine could be increased to approximately 2,500 rpm. To investigate this effect, a second set of timing-belt pulleys was purchased and installed on the Volkswagen, to increase the allowable engine operating speed from 1,225 to 2,250 rpm. These pulleys were installed on the crankshaft and the No. 1 jackshaft. Trenching tests were made in damp clay soil, in the same location and on the same day, using engine operating speeds of 1,225 and 2,250 rpm. Unfortunately, the results of these trenching-rate tests were incomplete because the gear teeth on the trencher-motor armature shaft were shearing during these tests and consequently the power output from the trencher motor to the trenching chain was reduced. However, on the basis of the testing accomplished, it was apparent that, at the higher speed, the Volkswagen engine ran much hotter and louder, but maintained a much steadier power output. We believe that if the gear teeth had not failed, the trenching rate obtained at the higher engine-operating speed would have been appreciably increased.

After the failure of the gear teeth, as indicated above, the second trencher motor was examined and the gear teeth on the armature shaft of this unit were found to be partially sheared. When the motor manufacturer was contacted, he requested that the

trencher motors be returned for immediate repair, because the armature shaft had not been heat treated as had been specified. Since the Sponsor wanted the Volkswagen and the one trencher unit that was still operative for demonstration purposes, this equipment was turned over to the Sponsor's representative on August 11, 1958. In the meantime, the other trencher motor was returned to the manufacturer for repairs; when it is returned to us, the second trencher will be assembled and shipped to the Sponsor. The unrepaired trencher motor will then be returned to the manufacturer for repairs and subsequently re-shipped to the Sponsor.

Since the equipment was sent to the Sponsor before the trencher motors were repaired, no additional trenching-rate tests were run. However, the rate obtainable with the higher engine speed can be determined by using a different belt and a different set of pulleys; these items have been sent to the Sponsor. We strongly recommend that this arrangement be experimented with and evaluated by the Sponsor.

Color motion pictures and color slides were prepared on the use of the trenching equipment. These pictures were taken in the laboratory and in the field, and were edited to provide a clear and accurate coverage of the complete field operation of the equipment. In addition, the Volkswagen was given a general inspection and engine tune-up, and a new battery was installed.

CONFIDENTIAL

September 23, 1958

We would appreciate any comments that you or your associates might care to make with regard to the research.

Sincerely,

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In Triplicate