TECHNICAL REPORT NO. 73-06

LOCKING DEVICE FOR MILITARY VEHICLES

Final Report

By

Robert P. McGowan
Mobility Branch

December 1972

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U. S. ARMY LAND WARFARE LABORATORY
Aberdeen Proving Ground, Maryland 21005

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FOREWORD

This development task was conducted by personnel of the Mobility Branch of the US Army Land Warfare Laboratory, during the period May - September 1971. After initial feasibility investigation, and definition of characteristics, a prototype steering wheel locking device was designed by and procured from the Toepfer Lock Co., Milwaukee, Wisconsin.

A user evaluation was subsequently conducted by the 4th Transportation Command in the Republic of Vietnam during the period October 1971 to June 1972.

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INTRODUCTION

Military tactical vehicles are not produced with locking devices as are commercial-type vehicles. The thinking has been that military vehicles should always be available for use. However, in normal non-tactical situations, for example in base areas, theft and misuse of vehicles is a problem. In response to expressions of interest from field units, an investigation was made to determine the feasibility of an accessory locking device which could be installed in the field on existing vehicles, but which could be deactivated again when the vehicle is in a tactical situation.

An accessory steering wheel lock was developed for the most common tactical wheeled vehicles in the field. A prototype quantity was procured for a battalion sized field evaluation.

CONCLUSIONS

The vehicle locking device was judged by field units to be effective in the reduction of thefts and unauthorized use of tactical wheeled vehicles.

Several design deficiencies should be corrected prior to production.

Since the keys are of a special design, there must be provision for controlled availability of key machines in the Army inventory.

DESCRIPTION

The Steering Wheel Lock, with slight differences in models, fits the M151A1, M37B1, M35A1, M35A2, M54A1, M54A2, M52, M52A1, and M52A2 vehicles. With a change in the portion of the lock which engages the steering wheel hub, the locking device could fit other model vehicles.

The Steering Wheel Lock is a cylindrical assembly which installs on the steering jacket (column). Figures 1 and 2. One portion is pinned to the steering jacket, and the other engages the steering wheel hub and spokes. A locking bolt engages the two sections so that the steering wheel cannot be turned. The steering wheel locks in any of three positions. Modifications to the vehicle are required to prevent forcing of the lock by applying enough force to turn the steering jacket. The lock cylinder requires a cylindrical-type key which is not readily duplicated. This lock type is widely used in vending machines and public telephones. When unlocked, the key cannot be withdrawn. When unlocked, the lock cylinder may be removed to deactivate the locking device.

The Steering Wheel Lock is furnished as a complete kit for field installation. Provisions are made for re-attachment of the turn signal, and (if the vehicle has one) the air-brake control.

The complete kit consists of the following (Figure 3):

Locking Housing (two halves) . . . . . 1 ea
Steering Wheel Hub Adaptor . . . . . 1 ea
Locking Cylinder, Housing and Cam Assembly . . . . . 1 ea
Teflon Strip . . . . . 1 ea
Keys. . . . . 3 ea
Bolt, Break-Off Security, Flat Head, 3/8-16 x 1 1/4 inch . . . . . 4 ea
Roll Pins, 1/4 x 2 1/2 inch . . . . . 2 ea
Roll Pins, 1/4 x 1 1/2 inch . . . . . 2 ea
Set Screw, 5/16-18 . . . . . 1 ea
Band Clamp, #80 . . . . . 1 ea
Decal . . . . . 1 ea
Nut, 5/16-18, Special (all models except M35) . . . . . 1 ea
Bolt, Break-Off Security, Round Head, 5/16-18 x 1 11/16 inch
(all models except M35). . . . . 1 ea
Bolt, Break-Off Security, Round Head, 5/16-18 x 1 inch (M151 only) . . . 1 ea
Drive Screw, #10 x 3/8 inch (M151 and M37) . . . . . 4 ea
Drive Screw, #14 x 1/2 inch (M35, M52, and M54) . . . . . 2 ea
Bolt, Hex Head, 3/8-16 x 1 inch, with lock washer (M52 and M54) . . . . 2 ea

Installation time is approximately one hour per vehicle. The following installation tools are required:

#2 Drill
#20 Drill

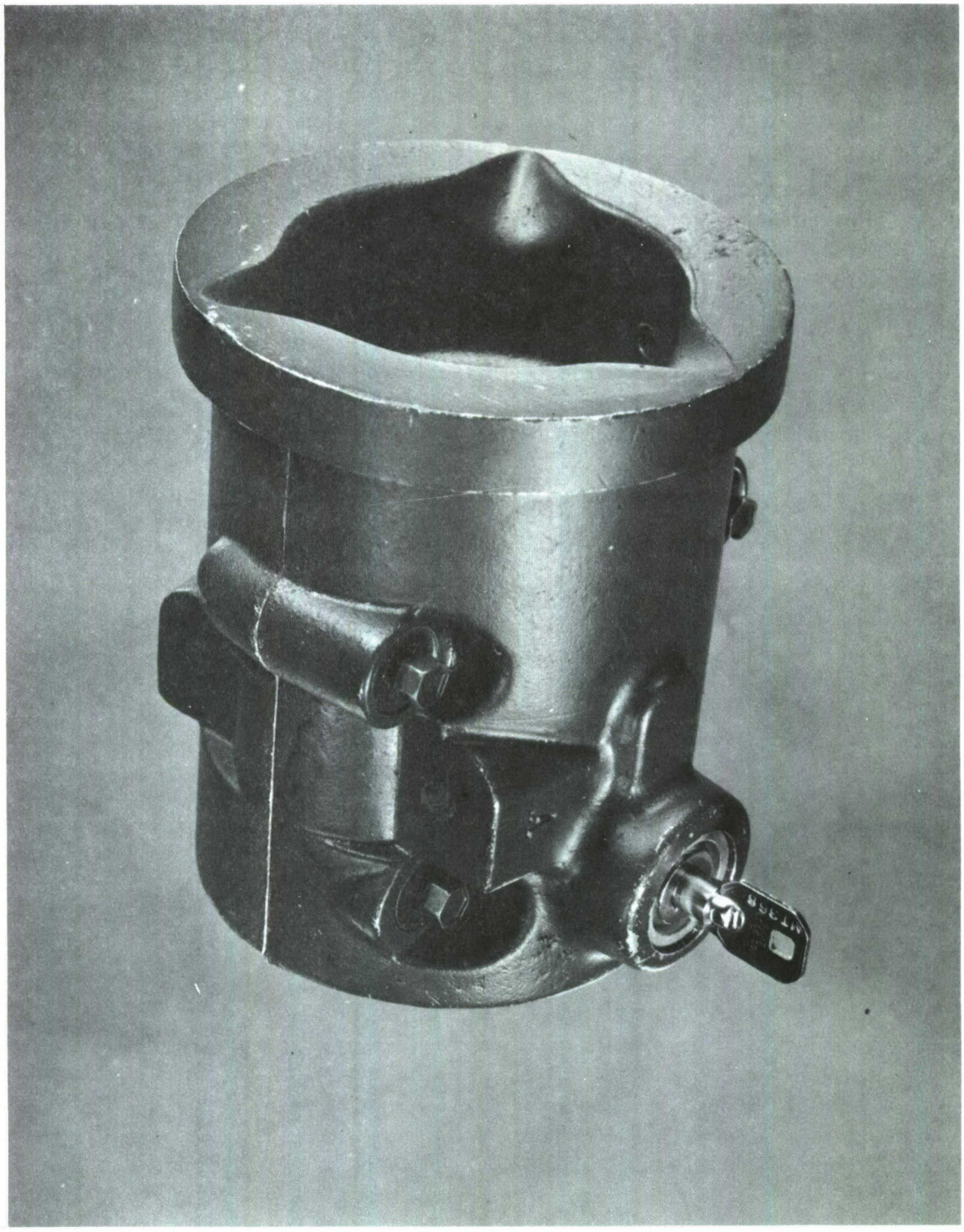

FIGURE NO. 1: Steering Wheel Lock

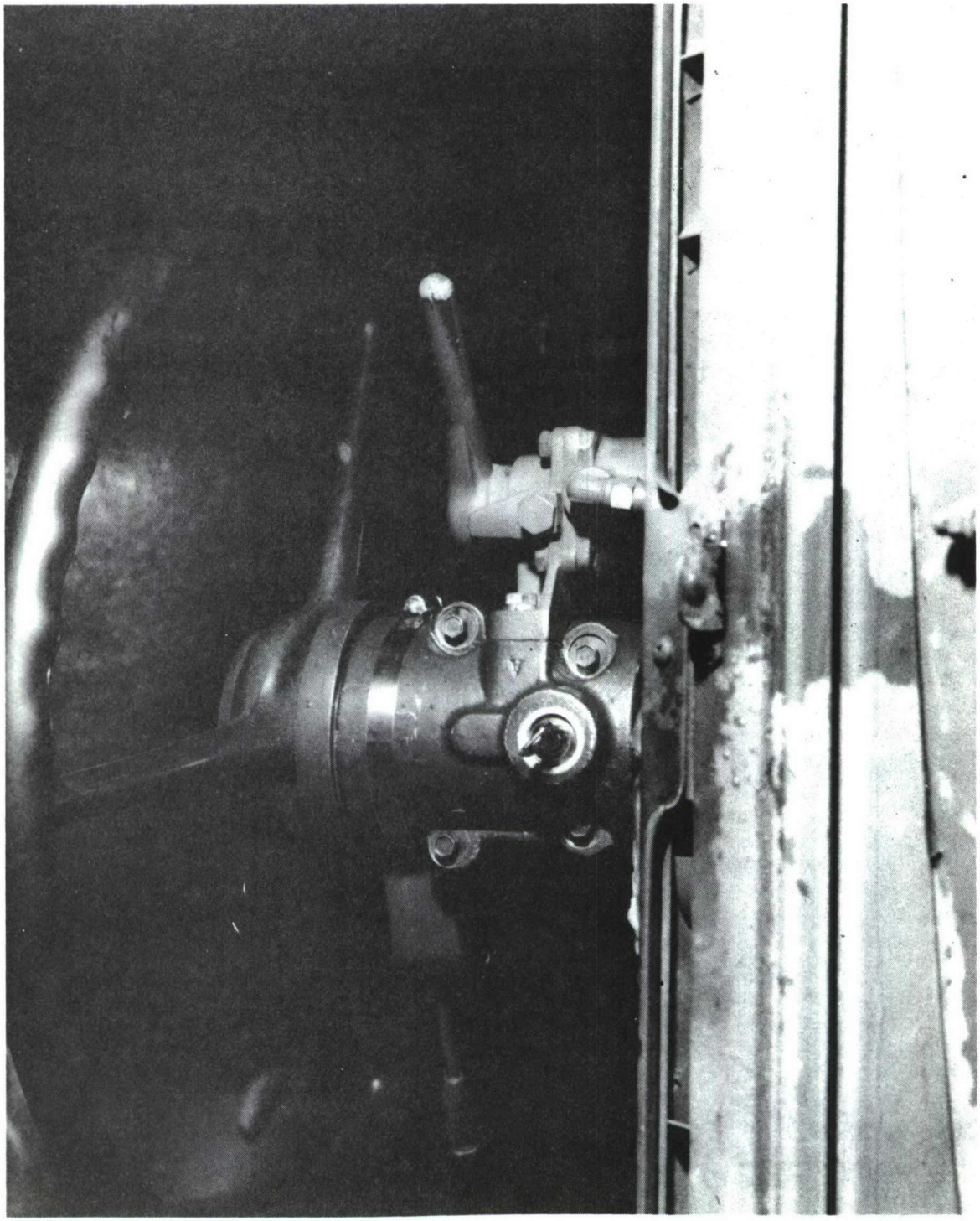

FIGURE NO. 2: Steering Wheel Lock Installed In M52

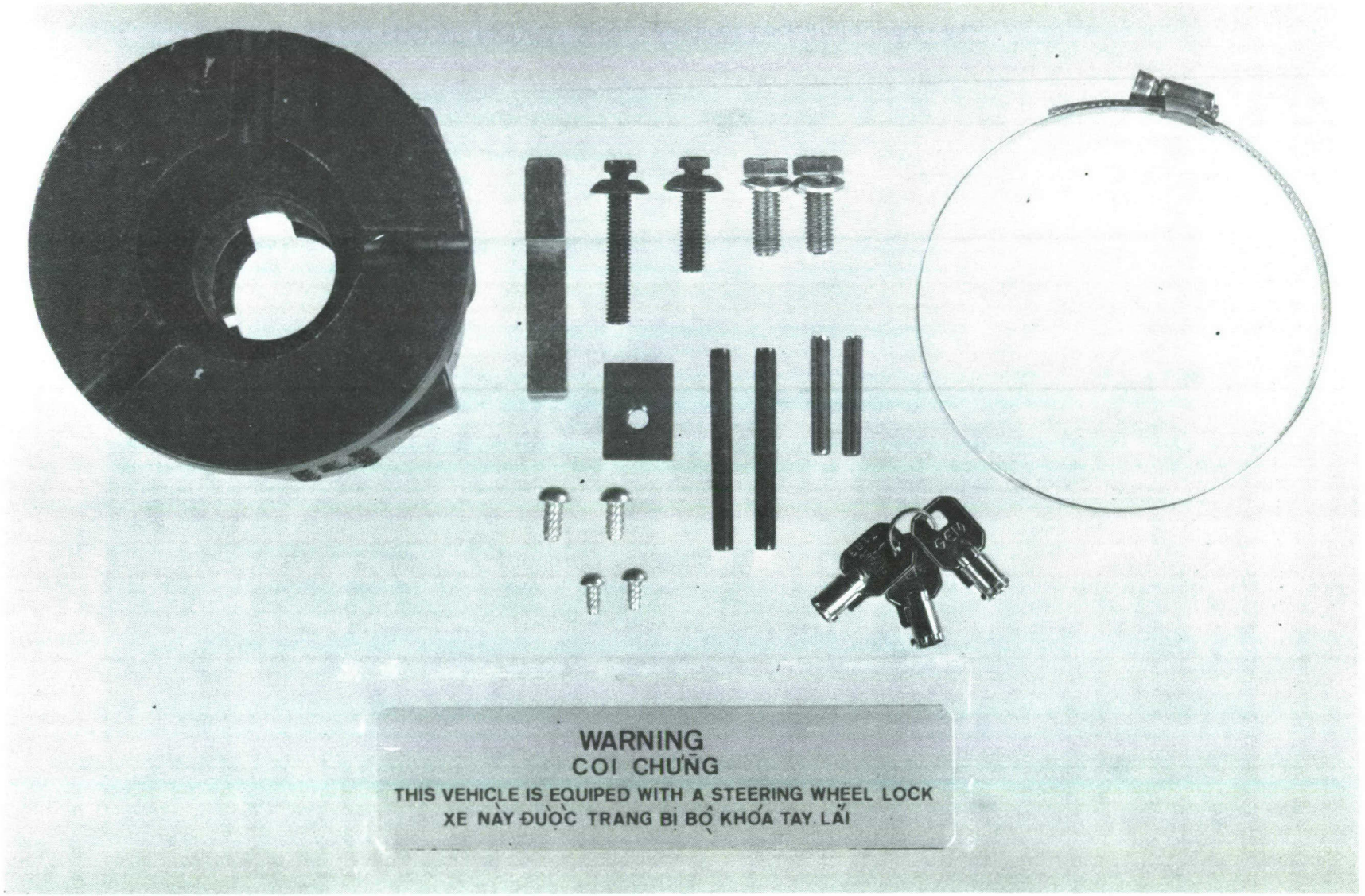

FIGURE NO. 3: Steering Wheel Lock. Component Parts For M151A1

1/4 Inch Drill
1/2 Inch Drill (turned down for 1/4 inch drill motor, and, preferably, shortened to approximately 3 1/2 inches over-all length)

DEVELOPMENT AND TEST

Based on comments from field units, a requirement statement of characteristics was drafted. Appendix I. A survey of existing vehicle locking devices was made. It was determined that an accessory steering wheel lock, similar in function to commercial steering wheel locks, was feasible, and could provide a convenient locking capability for all tactical wheeled vehicles. A combination push button lock was considered, but user units indicated a preference for a key lock.

A feasibility design was checked for compatibility with the most common vehicle models. A means was developed, for each model vehicle, for remounting the turn signal and air-brake controls. Also, it was necessary to provide a means for securing the steering jacket to prevent over-powering the lock by turning the jacket. After determination of feasibility and desired characteristics, a prototype design was submitted by a lock manufacturer. A quantity was procured for test, and 380 locks were furnished to a field unit for a battalion sized user evaluation.

From tests, and from the user evaluation, it was judged that the locks provided a reasonable degree of security against theft and unauthorized use, comparable to that provided on commercial automobiles. Appendix II, Suitability Statement and User Evaluation. In one test, a mechanic was able to remove the four locking bolts that install the locking housing in fifteen minutes. This exceeds the commercial standard for by-passing an automobile lock, which is eight minutes. Tests were not conducted on picking the lock, but it has proved in commercial use to be very difficult to pick by all but the most skilled.

The main design correction required as a result of the user evaluation is the relocation of the lock cylinder from the top of the housing. Location so that the key opening faces sideways or partly downward would eliminate collection of dirt and the rapid key wear which was reported. Appendix II.

DISCUSSION

This accessory locking device can provide a locking capability for tactical vehicles already fielded. When the requirement for these vehicles is satisfied, the same capability can be provided by producing the vehicles with a steering wheel lock similar to the automobile type, except with provision for removal of the lock cylinder to deactivate the lock.

APPENDIX I

DRAFT PROPOSED REQUIRED OPERATIONAL CAPABILITY FOR LOCKING DEVICE FOR MILITARY VEHICLES

1. STATEMENT OF NEED:

a. Descriptive Title: Locking Device for Tactical Military Wheel Vehicles.

b. Statement of Requirement: Theft of vehicles is a problem in base camps and non-combat areas. Units in RVN, Korea and Europe have indicated the need for an accessory device which can be used to conveniently and securely lock tactical wheeled vehicles. The device must be capable of being easily mounted on existing vehicles and being deactivated for combat.

c. Recommended CDOG Paragraph Number: 1412 B (3).

d. Proposed CDOG Priority: II.

2. TIME FRAME: There is an immediate requirement for this item in the field.

3. THREAT/OPERATIONAL DEFICIENCY: Vehicle theft is a common problem. Tactical vehicles do not have an installed lock. Field expedient methods in common use do not provide adequate security and are usually not designed to include a positive control feature such as not being able to remove the key unless the vehicle is secured.

4. OPERATIONAL/ORGANIZATIONAL CONCEPT:

a. Operational Employment: The proposed locking device should provide a convenient means of locking tactical wheeled vehicles when they are in base camps and non-combat areas. When the vehicles are in combat, the device should be simple to deactivate so that it cannot be locked.

b. Geographical Areas of Intended Use: Climatic categories 1 through 7 in accordance with AR 70-38.

c. Type Using Units: All military units that use tactical military wheel vehicles which are presently located in high incident areas as well as units which have contingency missions to deploy to these areas.

5. ESSENTIAL CHARACTERISTICS:

a. Performance: The locking device must:

(1) Incorporate a key lock.

(2) Retain the key in the lock when not locked.

(3) Provide security comparable to that of commercial automobile steering wheel locks.

(4) Incorporate a key which cannot be duplicated by common key-making machines.

(5) Be compatible with turn signals, air brake controls, and other standard equipment installed on standard military vehicles.

(6) Be capable of being easily deactivated so that the vehicle cannot be locked. (E.g., this may be accomplished by permitting removal of the lock cylinder when unlocked.) Time to deactivate will not exceed 5 minutes.

(7) Have interchangeable lock cylinders.

(8) Have maximum commonality of parts for the locks which fit the various standard vehicles.

b. Physical. The size and weight must be compatible with the vehicles on which installed.

c. Reliability: Not Applicable.

d. Availability: The device shall be durable to the extent of the life of the vehicle.

e. Maintenance: Direct support maintenance will consist of direct exchange of the lock cylinder. Field maintenance will consist of lock cylinder exchange and a key making capability with a special key machine.

f. Health and Safety: The device shall not affect the operation of the vehicle and not have protruding surfaces which would be likely to cause injury to personnel.

g. Human Engineering: The device shall be convenient to lock and unlock - comparable to commercial automotive steering wheel locks.

h. Command and Control. Vehicle control is accomplished thru key control.

6. TECHNICAL ASSESSMENT: An accessory locking device has been developed by the US Army Land Warfare Laboratory for field installation on 1/4-ton, 3/4-ton, 2 1/2-ton and 5-ton vehicles. A battalion sized field evaluation was conducted in RVN and the item received a suitability statement from USARV. This device could be procured on a one-time basis to satisfy the requirement for any already-produced wheel vehicles. New vehicle production could incorporate an integrally produced device with the same functioning characteristics. The integrally produced item would be lower in cost. U.S. Army Tank Automotive Command has been designated as the AMC Parent Agency for the USALWL device.

7. COST ASSESSMENT:

a. RDT&E:

(1) Obligated ----------$35,000

(2) Type Classification, Estimate ---------- $30,000

b. Investment, Non-recurring:

(1) Initial procurement for existing vehicles (in lots of 1,000) ----- $20. each

(2) Key reproducing machines ---------- $200. each

c. Investment, Recurring:

(1) Replacement Cylinders ---------- $1.75 each

(2) Integrally Manufactured Device ---------- to be determined

d. Theft reduction and cost and time savings over existing field expedient methods are expected to more than off-set all costs.

APPENDIX II

HEADQUARTERS, UNITED STATES ARMY VIETNAM

SUITABILITY STATEMENT FOR VEHICLE LOCKING DEVICE (USALWL TASK 01-M-71)

1. Purpose. To evaluate the suitability of USALWL Vehicle Locking Device for installation on Army Tactical vehicles.

2. Description of Material. The vehicle locking device is an accessory steering wheel lock which can be installed on tactical vehicles. The device consists of a housing collar affixed to the steering column and a steering wheel hub adaptor that fits between the collar and steering wheel. In the unlocked position, the hub adaptor rotates in the housing allowing normal usage of the steering wheel. In the locked position, the hub adaptor is locked to the collar and prevents the steering wheel from being turned. The collar is affixed to the steering column by shear bolts which prevent removal by ordinary means. The devices were designed for installation on the M151A1, M37131, M35A1, M35A2, M54A1, M54A2, M52, M52A1, and M52A2 vehicles. The locking cylinder can be easily removed to inactivate the locking device in tactical situations.

3. Period of the Evaluation. The vehicle locking devices were evaluated by units of the 4th Transportation Command (TMLC) during the period Jan-Apr 72.

4. Results of the Evaluation.

a. The vehicle locking device proved effective in preventing theft of all vehicles on which it was installed.

b. The locking devices fit all of the vehicle models for which they were designed. The 5-ton tractor did require local fabrication of a mounting bracket for the trailer brake control.

c. There were several unexplained instances in which the device locked the steering wheel while the vehicle was being driven (Incl 1).

d. The feature of the device retaining the key when the device is unlocked is highly desirable, as this prevents operators from leaving the vehicle unlocked when the key is removed for turn-in to the key control point.

e. The twist off bolts used to secure the housing collar to the steering column were of such hard metal that drilling them out to remove the collar was extremely difficult.

f. The keys for the locking device appear subject to excessively rapid wear.

g. The keys are of a special design which cannot be duplicated by key machines normally available to Army units.

h. The provision of spare lock cylinders at unit level is essential.

i. A deficiency not brought out by the evaluation report, but apparent to personnel monitoring the evaluation was the location of the lock cylinder on top of the steering column. The location could allow foreign matters to enter the cylinder causing possible malfunction of the lock mechanism.

5. Conclusions.

a. The vehicle locking device should prove highly effective in reduction of theft and unauthorized use of tactical wheeled vehicles.

b. There are several apparent design deficiencies which should be corrected prior to further production.

(1) Excessively rapid wear of keys.

(2) Location of the lock cylinder on top of the steering column.

(3) Possibility of the device inadvertently locking the steering wheel while the vehicle is being driven.

c. The problem of removing the locking devices due to the excessive hardness of the shear bolts should be corrected if a softer metal bolt would not compromise the strength or security of the device. Since the majority of the devices removed during the evaluation were removed for administrative reasons, such as turn-in of the vehicles, this problem is not considered a serious deficiency.

d. Since the keys are of a special design, provisions for controlled availability of key machines in the Army inventory must be included in plans for operational use of the locking device. Provision must also be made to provide a small quantity of spare lock cylinders at unit level.

6. Recommendations. It is recommended that:

a. Action be taken to correct the deficiencies listed in para 5b above.

b. Locking devices be designed for the M-151A2 and other tactical wheeled vehicles not included in the evaluation quantity.

c. Upon completion of the above, the locking devices be scheduled for Engineering and Service Test (ET/ST) with type classification upon successful completion.

d. When type classified, the vehicle locking device be issued on the basis of one per tactical wheeled vehicle in such areas as RVN, Korea and other overseas areas where vehicle theft and unauthorized usage are at a high incidence level.

1 Incl
Final Report, Locking Device

FINAL REPORT
HEADQUARTERS 4TH TRANSPORTATION COMMAND
9 JUNE 1972

STEERING WHEEL LOCK

INSTALLATION QUESTIONNAIRE
(Use a separate sheet for each model vehicle, if necessary)

1. Dates of Installation: October 1971 - January 1972

2. Location and Unit Designation:

HHD, 6th Transportation Battalion (Truck) APO 96491
233rd Transportation Company (Heavy Truck) APO 96491
86th Transportation Company (Medium Truck) APO 96491
261st Transportation Company (Light Truck) APO 96491
321st Transportation Company (Medium Truck) APO 96491
379th Transportation Company (Medium Truck) APO 96491
446th Transportation Company (Medium Truck) APO 96491

3. Were the locks received complete? Yes, the locks were received complete.

4, Was the installation hardware furnished complete?

The hardware was received complete, however the trailer brake control could not be mounted on the locking device due to the design of the trailer brake control on our 5-ton tractors. The units manufactured their own special bracket which bolted to the locking device and the trailer brake control bolted to the bracket.

5. Were the Installation Instructions Adequate?

The booklets containing installation instructions which we received were missing a picture of the lock installed. The text of the instruction booklet made reference to the picture but it was not in the book. Also, initially only two instruction booklets were received by this battalion. It was felt that several more should have been available in order to dispense instruction to more personnel at one time and cut down on installation time.

6. Did the locks fit the intended models of vehicles and accessories (turn signal and brake controls), were there any variations in models not covered by the instructions, and did the locks work properly when installed? List and detail any problems:

The locks fit the intended models of vehicles with the exception mentioned in part 4. Most of the locks worked properly when installed, however, there were five or six which locked up on the driver when the vehicle was being driven. Upon examination no apparent reason could be found. Other problems encountered were:

a. The twist off bolts in the locks were of such tough material that when steering problems developed on the vehicle the lock itself had to be cut off rather than drilling out the bolt.

b. After the locks had been in constant use for a couple of months, several experienced excessive wear on the thin portion of the circular key or the tumblers. This was corrected by replacing the lock mechanism assembly.

7. What suggestions can you make to improve the lock design or installation?

It is recommended that one be manufactured for the M151A2 model. Some further suggested improvements might be:

a. Manufacture twist off bolts of softer metal so that they may be removed by drilling (see part 6.a.)

b. Manufacture keys of tougher material to preclude excessive wear.

c. Install locks at point of manufacture.

d. Consider issue of more than two keys as they become easily lost.

It is the general opinion of the maintenance personnel in this battalion that they would recommend their installation of this type lock on all military vehicles applicable. They further find that they are particularly well suited for the M151 1/4-ton vehicle.

ALLAN B. CLUSTER
CPT, ORD
S-4, 6th Trans Bn

STEERING WHEEL LOCK

FINAL EVALUATION QUESTIONNAIRE

(Use a separate sheet for each model vehicle, if necessary)

1. Do you think the Steering Wheel Lock is an effective means of preventing or controlling theft? Answer with respect to casual theft or misuse by GI's and theft by criminals.

Yes! the steering wheel lock is effective in all respects (misuse by GI's, criminal theft, etc.)

2. Do you think military tactical vehicles should be manufactured with a locking device? Is it essential in your opinion that it be capable of being deactivated?

I believe military tactical vehicles should have some installed method of securing the vehicle. This type of locking device is effective and thus would provide the needed security. Less malfunction would probably occur if the locks were factory installed. The lock should be capable of being deactivated.

3. Do you think that a locking device is worth the time, cost and inconvenience of key control? Do you think vehicle control should be exercised by administrative methods instead?

The locking device is worth the inconvenience of key control due to the fact that some other method such as a chain welded to the body and a padlock and normally used to secure the vehicles which also presents the problem of key control. Administrative methods are not effective if vehicles are to be left in unsecure areas while on authorized dispatches or if vehicles are widely dispersed when in use.

4. Do you think that an anti-intrusion device which makes a loud alarm noise would be effective?

A loud alarm would not be nearly as effective as an anti-intrusion device because it could be easily deactivated.

5. What improvements do you think should be made to the locks?

I believe the present lock is an excellent device. It is particularly well suited to wheel vehicles and most especially the 1/4-ton M151 vehicle. As it was discussed in the Installation Questionnaire some improvements might be:

a. Factory installation to preclude facility installation at unit level.

b. Installation bolts which could be drilled out.

c. Tougher key material to preclude wear.

6. If you had a choice, would you continue to use locks in a situation similar to the one you are in now, or in other situations?

Yes, I would definitely continue to use this lock in our present situation.

7. Is the "key-retained when locked" feature desirable?

Yes, I believe the key-retained when UNLOCKED feature is very good since key control and accountability is a necessity.

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UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION: Unclassified
	2b. GROUP: N/A

3. REPORT TITLE

Locking Device for Military Vehicles

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

Robert P. McGowan

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
November 1972	16	

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	Technical Report No. 73-01
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	USA Land Warfare Laboratory Aberdeen Proving Ground, Maryland 21005

13. ABSTRACT

A steering wheel locking device was developed for military tactical wheeled vehicles. The lock is an accessory which can be field installed. The lock cylinder, when unlocked, can be removed to deactivate the device. An user evaluation was conducted which concluded that the device was suitable for the intended use, and after correction of minor deficiencies be type classified.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Locking Device Steering Wheel Lock Military Tactical Vehicles						