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MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY EVALUATION.(U)
MAR 80 M A COULOMBE

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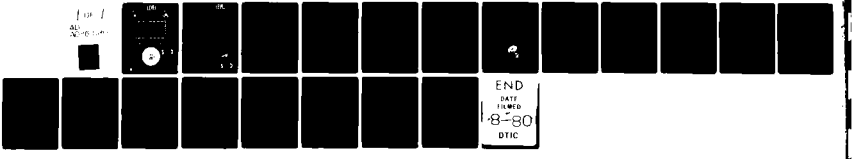

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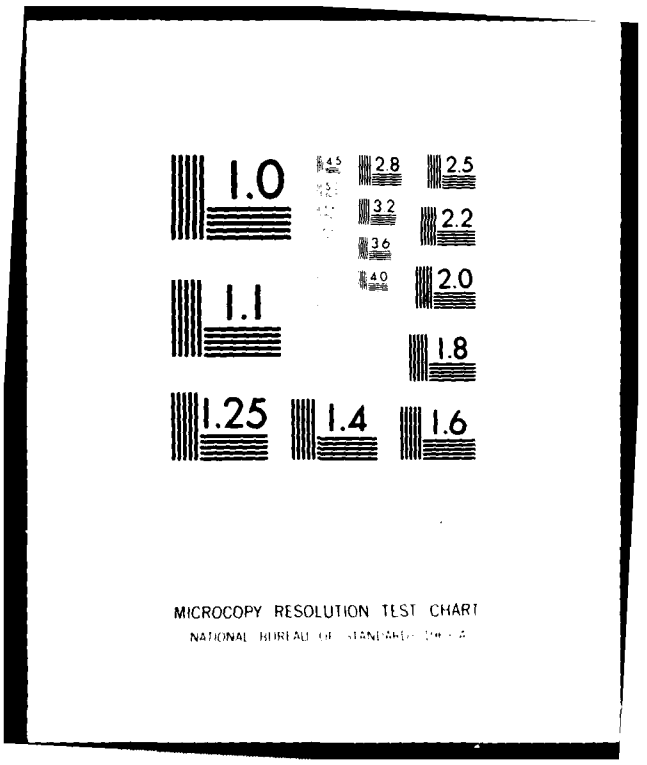
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(6) LEVEL II

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DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

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8-80

MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY EVALUATION

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24 MARCH 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

FAILURE OF THE TEMPERED SPRING STOP PIN IN THE HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY OF THE MK 12 SSDS HAS REQUIRED FURTHER EVALUATION OF EXISTING AND PROPOSED EXHAUST VALVE CONFIGURATIONS. TEST RESULTS INDICATE THE ADOPTION OF RECOMMENDED RETROFIT AND DESIGN CHANGE PROPOSALS.

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BACKGROUND

The stop pins on the helmet adjustable exhaust valve handles (P/N MS16562-211) of the MK 12 SSDS have failed on several occasions both during training and operational dives.

Although this failure will allow the handle to be removed from the valve body, it should be noted that, with the handle removed, the exhaust valve will operate in the ambient mode and no direct hazard to the diver exists.

Three stop pin failures were investigated by NSWC, Dahlgren. It was reported that the failures were a result of intergranular fractures due to the brittle characteristics of the stop pin material, which fractured from the force of the stop pin impacting against the stop.

The results of these investigations are found in Appendix A, NCSC Memorandum dated 14 March 1980. Retrofit and design change recommendations presented in this report (NEDU Test Report 80-11) supersede the recommendations presented in the above memorandum.

A summary of the findings outlined in the memorandum indicated that many of the existing stop pins had been plastically deformed during valve handle assembly. This condition is the result of inserting the tempered stop pin into a .004" to .006" undersized hole in the valve handle barrel. (See Figures 1 and 2).

STATEMENT OF PROBLEM

1. To develop appropriate retrofit procedures for existing MK 12 SSDS helmet adjustable exhaust valve assemblies to decrease the probability of stop pin failure to an acceptable level.

2. To investigate alternate helmet adjustable exhaust valve assembly configurations and submit design changes to be incorporated into new procurements.

TEST REQUIREMENTS

To conduct both static and dynamic test procedures on different valve assembly configurations and to obtain comparable empirical data to be used in determining appropriate retrofit and design change.

(Tables 1 and 2, Static Test Results and Dynamic Test Results, describe configurations utilized and results for each configuration). Configurations that include a new stop design are illustrated as Enclosures (1) and (2) of Appendix A.

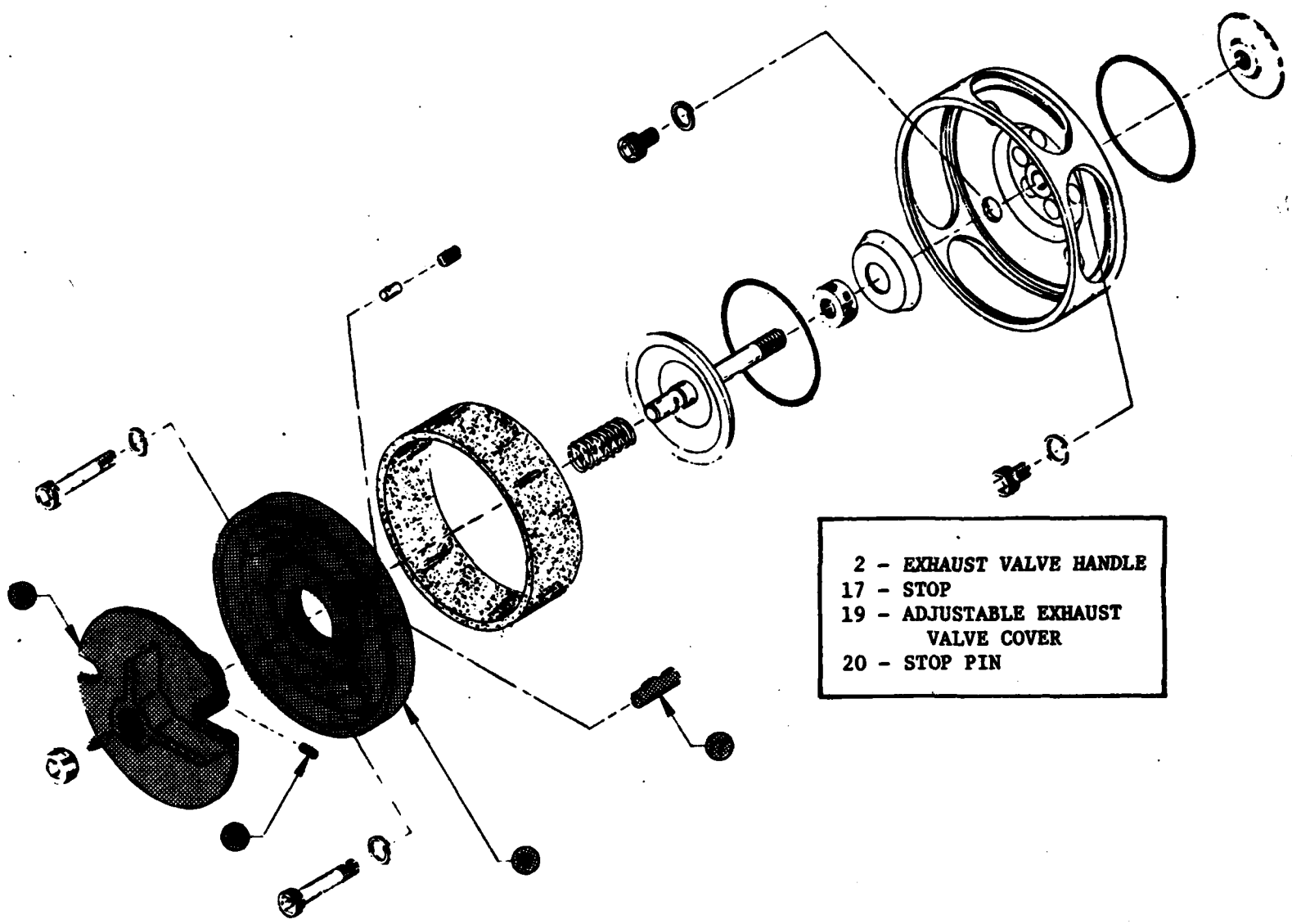


FIGURE 1. MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY RETROFIT AND DESIGN CHANGE PARTS LOCATION

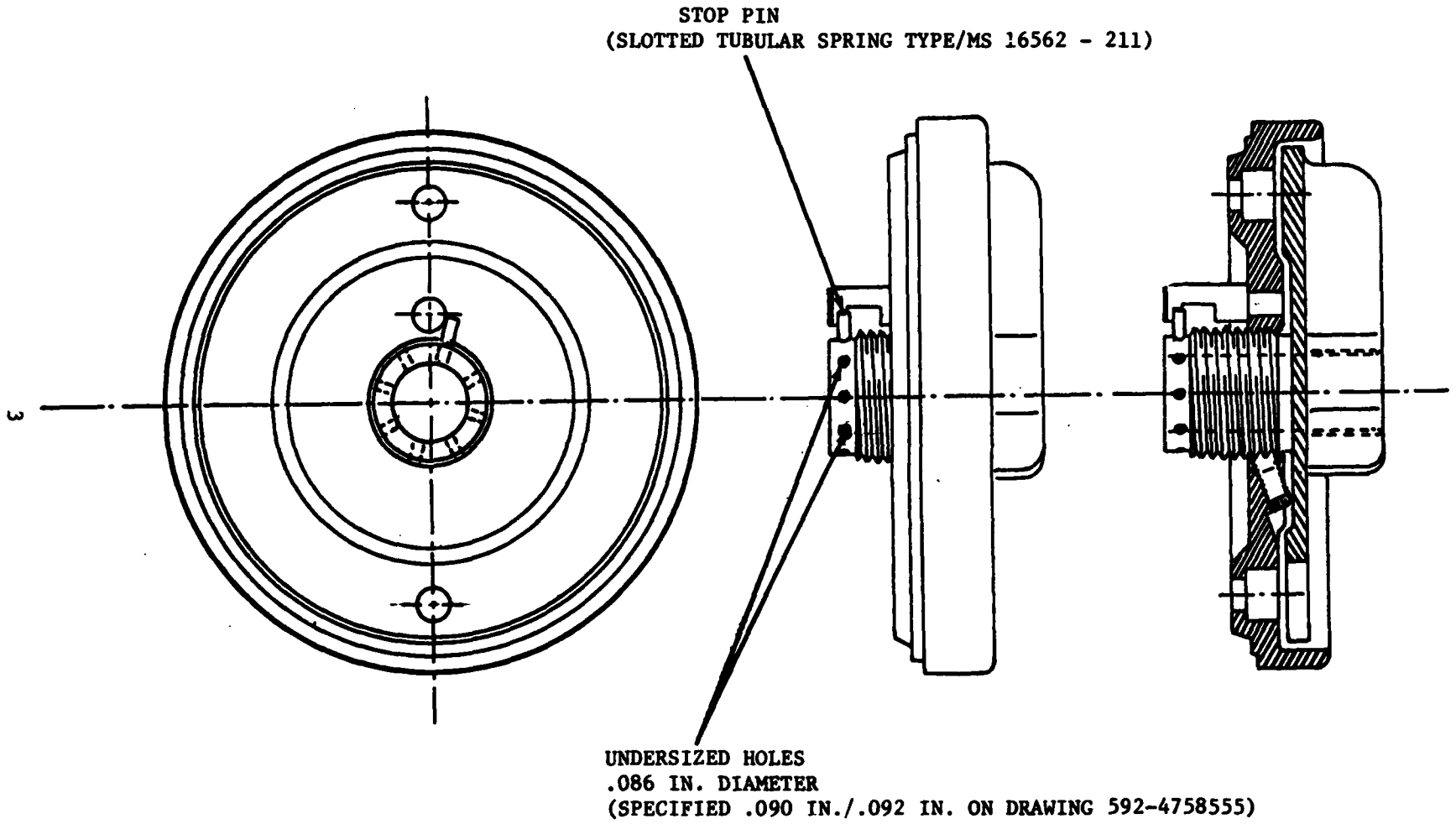


FIGURE 2. PRIMARY FAILURE SITES ON MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY

STATIC TEST PROCEDURES

The helmet adjustable exhaust valve cover was secured in a six jaw lathe with the exhaust valve handle fully inserted. A bolt was screwed into the valve handle with washers preventing the bolt from contacting the bottom of the hole in the handle body. A torque wrench was fitted with a standard socket, and torque was applied to the bolt until failure of the stop pin.

TABLE 1 - STATIC TEST RESULTS

STATIC TEST NUMBER	CONFIGURATION OF TEST HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY	FAILURE DESCRIPTION	POINT OF FAILURE*
ST 1	Retrofit ring installed on existing exhaust valve handle and secured with three 3/32 in. solid stainless steel grooved pins. Valve adjusted to full in position.	Pin bent and slipped by the stop.	175 in. lbs.
ST 2	Retrofit ring installed on existing exhaust valve handle and secured with two 3/32 in. solid stainless steel groove pins.	Pin bent and slipped by the stop.	220 in. lbs.
ST 3	Retrofit ring installed on existing exhaust valve handle and secured with three 3/32 in. solid stainless steel groove pins.	Pin cocked in hole and bent. Stop was loosened in hole in valve cover.	240 in. lbs.
ST 4	Standard valve with new design stop and 3/32 in. solid stainless steel groove pin.	Groove pin was rolled over and threads damaged.	180 in. lbs.
ST 5	Standard valve with groove pin hole opened to .093 in. (3/32 in.). Groove pin silver soldered in place.	Groove pin was bent and slipped by the stop.	100 in. lbs.
ST 6	New valve design with full length 1" diameter threaded exhaust valve handle. New design stop and 3/32 in. solid stainless steel groove pin.	Groove pin was rolled over and threads damaged.	300 in. lbs.
ST 7	Standard valve with 3/8" long, 3/32" diameter stainless steel rod soldered in place. Standard stop.	Rod bent.	80 in. lbs.
ST 8	Standard valve with 3/8" long, 3/32" diameter stainless steel rod soldered in place. New design stop.	Rod bent.	150 in. lbs.

*NOTE: THE RANGE OF THESE STATIC TEST RESULTS IS CONSIDERED ACCEPTABLE DUE TO THE VARIATION IN GEOMETRY BETWEEN EXHAUST VALVE ASSEMBLIES. THE PIN HOLE LOCATION WILL VARY WITH RESPECT TO THREAD LOCATION.

TABLE 1 - STATIC TEST RESULTS CONTD.

STATIC TEST NUMBER	CONFIGURATION OF TEST HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY	FAILURE DESCRIPTION	POINT OF FAILURE*
ST 9	New valve design with full length 1" diameter threaded exhaust valve handle. Standard stop moved .015 in. toward center. Solid stainless steel grooved stop pin (3/8 in. long and 3/32 in. diameter) pressed into place. THIS IS THE RECOMMENDED NEW DESIGN CONFIGURATION.	Pin yielded at 140 in. lbs. and sheared at failure.	230 in. lbs.

*NOTE: THE RANGE OF THESE STATIC TEST RESULTS IS CONSIDERED ACCEPTABLE DUE TO THE VARIATION IN GEOMETRY BETWEEN EXHAUST VALVE ASSEMBLIES. THE PIN HOLE LOCATION WILL VARY WITH RESPECT TO THREAD LOCATION.

DYNAMIC TEST PROCEDURES

The helmet adjustable exhaust valve cover was handheld, and the exhaust valve handle rapidly spun causing the pin to contact the stop with a sharp impact. This procedure was utilized to simulate observed in-service misuse of the assembly caused by lack of application of the proper drag on the friction drag insert.

TABLE 2 - DYNAMIC TEST RESULTS

DYNAMIC TEST NUMBER	CONFIGURATION OF TEST HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY	RESULTS*
DT 1	Same configuration used in Static Test #1 and #3. Retrofit ring loose fit.	Pin came out following 205 contacts with stop.
	Same configuration used in Static Test #7.	Pin came out following 50 contacts with stop.
DT 2	Same configuration used in Static Test #9 (RECOMMENDED NEW DESIGN CONFIGURATION).	Pin tightly held in exhaust valve handle after 500 contacts with stop.
DT 3	Same configuration used in Static Test #7.	Pin came out following 50 contacts with stop.
DT 4	Same configuration used in Static Test #8.	Pin tightly held in exhaust valve handle following 300 contacts with stop.
DT 5	Same configuration used in Static Test #5.	Pin came out following 34 contacts with stop.
DT 6	Same configuration used in Static Test #6.	Pin tightly held in exhaust valve handle following 300 contacts with stop.

*NOTE: THE RANGE OF THESE DYNAMIC TEST RESULTS IS CONSIDERED ACCEPTABLE DUE TO THE VARIATION IN GEOMETRY BETWEEN EXHAUST VALVE ASSEMBLIES. THE PIN HOLE LOCATION WILL VARY WITH RESPECT TO THREAD LOCATION.

RETROFIT RECOMMENDATION

Based on the preceding test results and other available data, the following Retrofit is recommended for existing MK 12 SSDS helmet adjustable exhaust valve assemblies: (See Figure 3).

1. Machine unthreaded section of the valve handle barrel to .750 in.

2. Produce a ring of naval brass approximately 3/16 in. thick, ID .751 in. and OD 1.040 in., radially drilled with one 3/32 in. center hole.

3. Open the selected hole in the valve handle barrel to 3/32 in.

4. Position ring on barrel and secure with a solid stainless steel groove pin, 3/8 in. long and 3/32 in. diameter, pressed in place.

5. Radially drill two additional center holes through the ring and barrel 1/16 in. in diameter, and press solid stainless steel groove pins, 1/4 in. long and 1/16 in. diameter in place. Position of new holes in ring and barrel will be determined by available stock between existing holes.

DESIGN CHANGE RECOMMENDATION

The following design changes are recommended for new procurement: (See Figure 4).

1. Modify the valve handle barrel to be extended 1/16 in. in length and accept a full length 1-12 UNC-2A thread. (Length extension allows more material between the holes and the edge of the part).

2. Install the same 3/8 in. grooved pin described in the retrofit.

3. Move the stop .015 in. closer to the center of the exhaust valve handle.

4. Rethread adjustable exhaust valve cover to accept the 1-12 UNC-2B thread and relocate the stop hole .015 in. closer to the center of the cover.

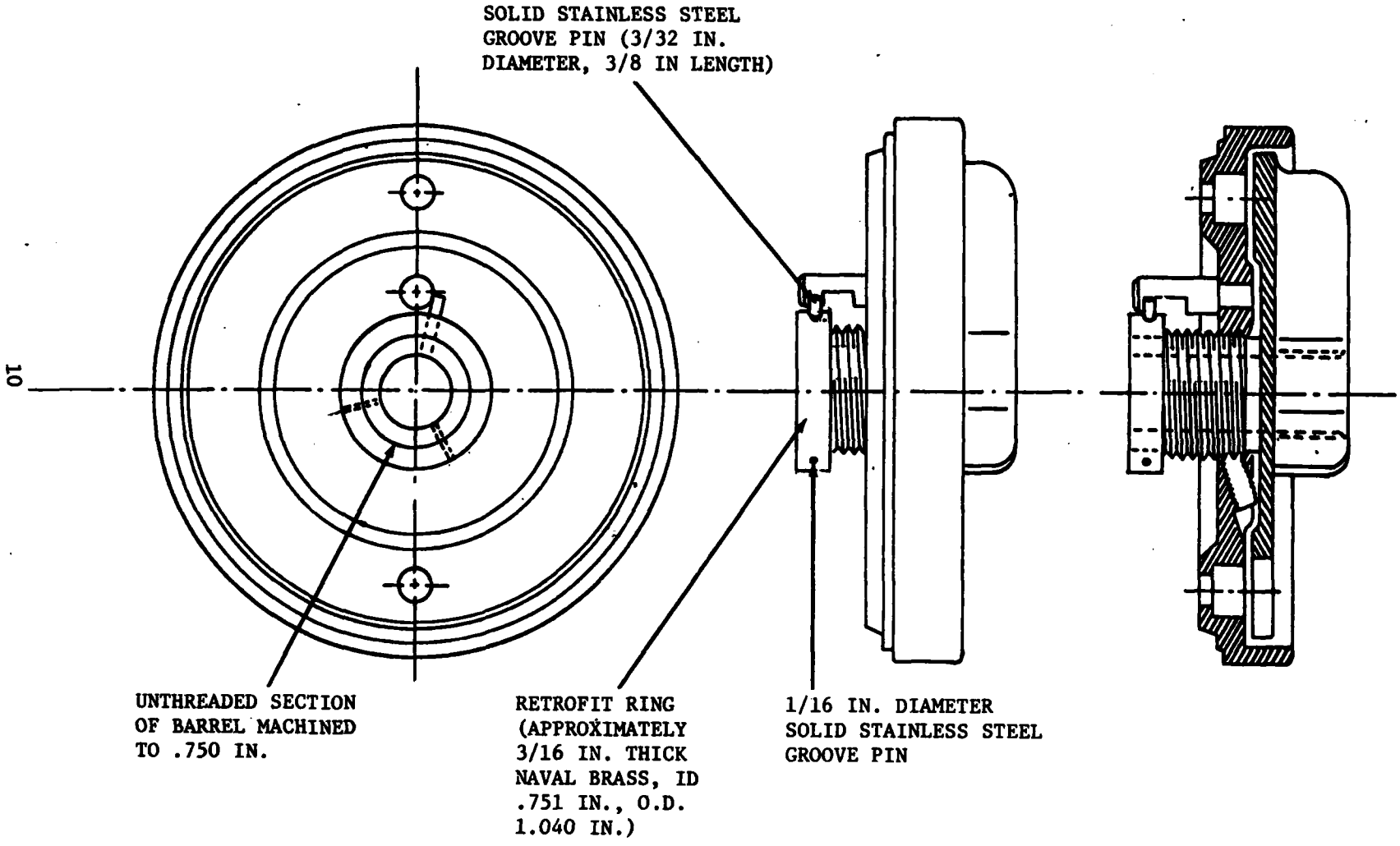


FIGURE 3. PROPOSED RETROFIT - MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY

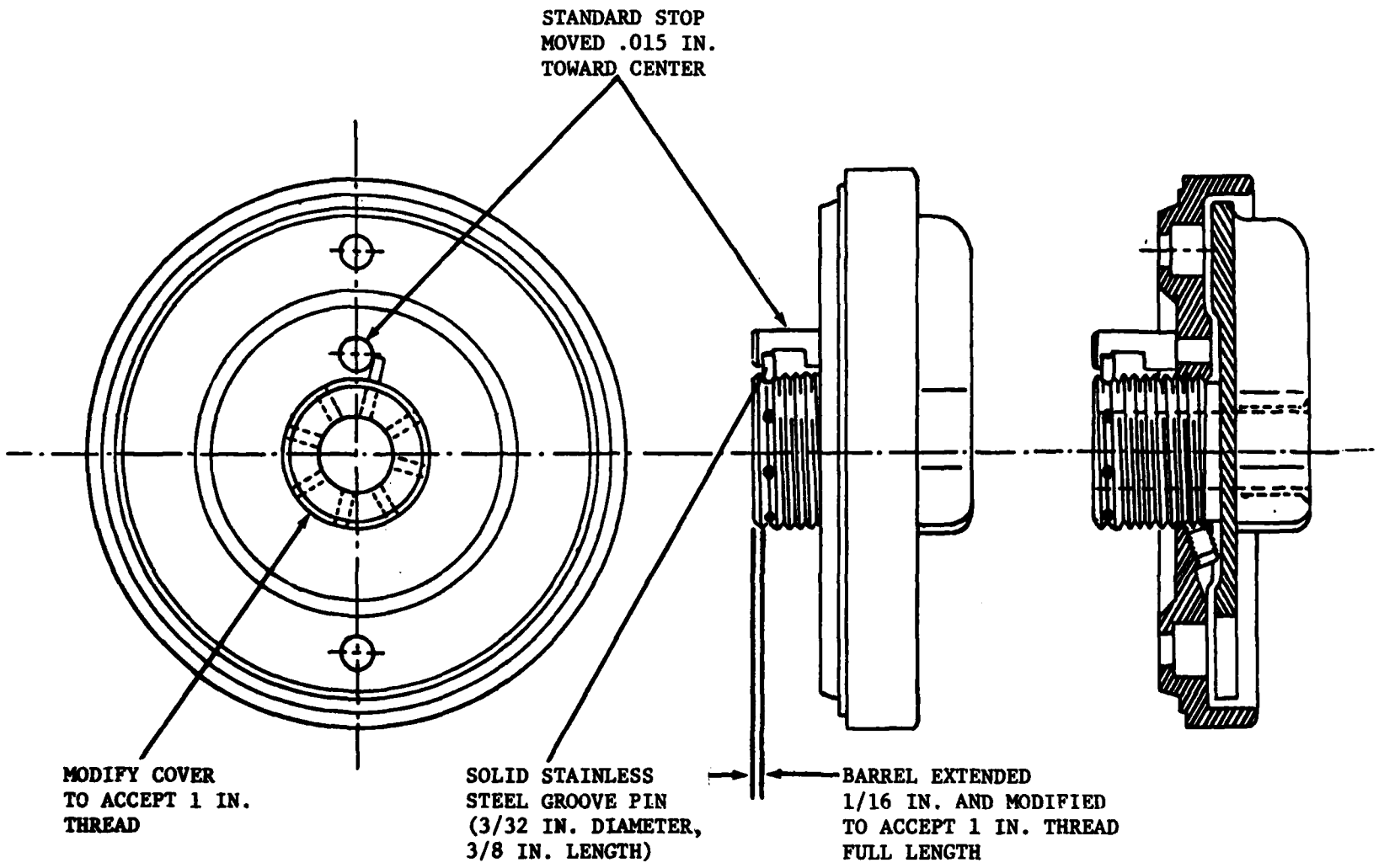


FIGURE 4. PROPOSED DESIGN CHANGE - MK 12 SSDS HELMET ADJUSTABLE EXHAUST VALVE ASSEMBLY

UNITED STATES GOVERNMENT

Memorandum

NAVAL COASTAL SYSTEMS CENTER
PANAMA CITY, FLORIDA 32407

14 March 1980

From: A. F. Moeller, Code 753.1
To: Lt M. Coulombe, Mark 12 SSDS, Project Manager, NEDU

Subj: Stop Pin Failure in MK 12 SSDS Exhaust Valves

1. Three reported failures of stop pins were investigated by NSWC (Dahlgren) personnel. They report that the failures were a result of intergranular fractures due to the brittle characteristic of the stop pin material which fractured from the force of the stop pin impacting the stop.

In reviewing the design and apparent mode of operation of this part, we submit the following:

a. The specified pin is a slotted tubular spring type (MS 16562-211) made of Corrosion Resisting Steel 410/420 with a hardness of Rockwell C42-52.

b. This pin is installed in a selected hole in the exhaust valve handle (P/N 555) as detailed on Dwg 475 8552, Notes 2-C and 2-D.

c. The diameter of the hole in which the pin is inserted is specified on Dwg 555 as .090" $^{+.002}_{-.000}$". We feel this diameter should have been .094" - .097" as recommended on MS Dwg 16562.

d. The valves that failed were manufactured by Morse Diving Company. Inspection of these parts shows that the diameter of the pin holes was .086" as opposed to the specified .090"/.092" on the drawing. This undersized hole puts an excessive stress concentration on a pin of this temper. It has been noted that several of the valves, as received from the manufacturer, had these pins split at assembly. It is apparent that if the pin is split at assembly, the ability of the pin to remain in its hole as well as resist bending or breaking is considerably reduced.

e. It has also been noted upon inspection of seven exhaust valve assemblies, as received from the manufacturer, that five of these did not have the pins installed in the proper hole as specified on Dwg. 475 8552, Note 2-C.

This improper assembly results in an interference between the stop and pin that forces the pin to flex or the brass pin hole to be stressed beyond its elastic limits. This undue stress not only could contribute to the part failure but it also conditions the operator to expect high resistance in normal operations. This could cause him to erroneously apply excessive force on the pin when it was at the end of normal travel.

f. Examination of some of the failed valves indicated the possibility of excessively impacting the pin by freely spinning the valve handle into the pin stop. The design of the valve incorporates a friction drag to prevent this. Apparently the manufacturer did not properly assemble the units, as set forth on Dwg. 475 8552, Note 3-C. The user also did not excercise the predive procedures as set forth in the MK-12 O&M manual, Table 2-1A, step 1.2.1.k.

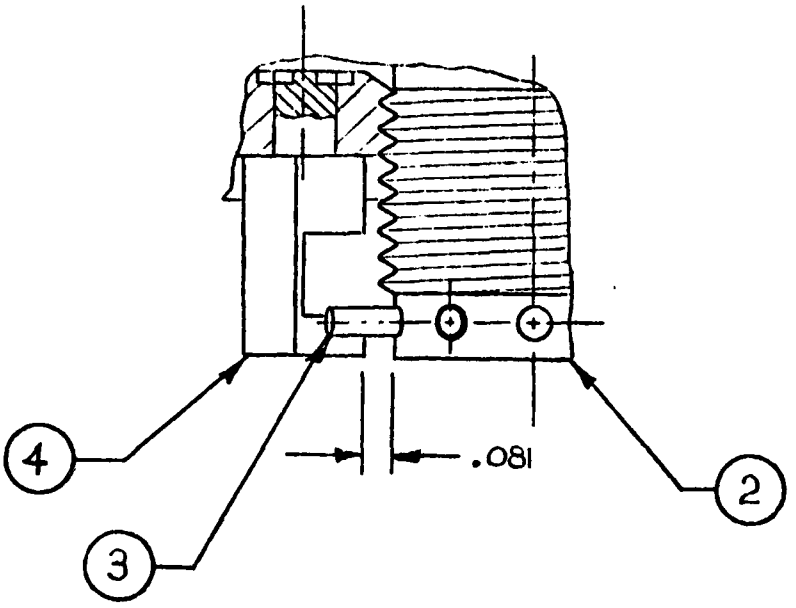
2. Although it is indicated that correct manufacture (as per drawing package) and correct set up and predive procedures, as per the O&M manual, may have prevented most or all of the above noted failures, we consider that the possibilities of some of these recurring real enough to recommend the following:

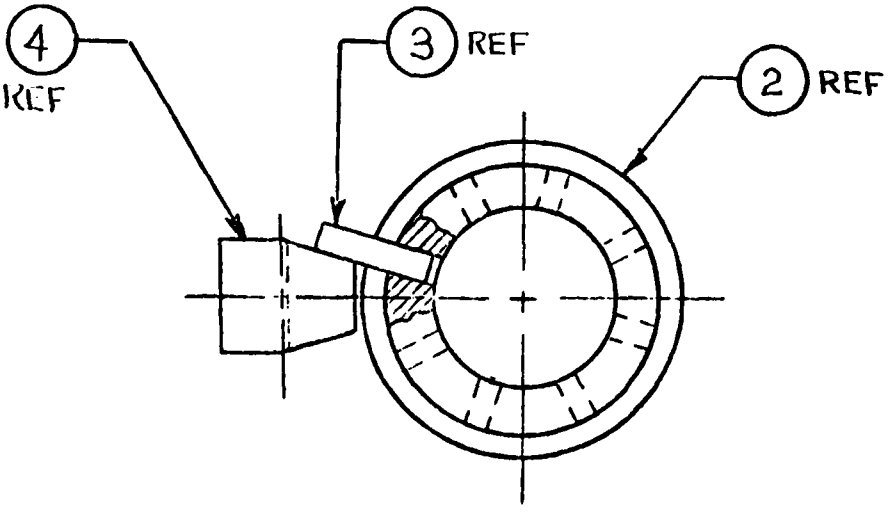
a. A retrofit to existing valves in the nature of a redesign of the pin stop (see Encl. 1). The present pin and stop configuration sees a moment arm on the pin of .242" and requires a force on the valve handle of approximately 60" lbs. to fail. The proposed retrofit would reduce the moment arm to .081" and require a force of approximately 180" lbs. to fail. This retrofit would require a minimum effort, as it only requires that the existing pin stop be pressed out of the exhaust valve cover, the exisiting hole be reamed slightly larger; and the new pin stop pressed in. We feel that this change, with proper manufacturing and user technique, should be an acceptable solution to the problem in the existing valves.

b. We would recommend a revision for future buys which would also be simple to implement but would offer a considerable increase in strength over the retrofit. (See Encl. 2) This change would increase the .875" thread diameter to 1.000" diameter on the valve cover and handle. This would increase the available material thickness from .125" to approximately .250" in the area of the pin engagement. With this added material, a solid pin may be used to replace the spring pin now used. This design change also allows a reduction of pin moment arm to .015". This configuration would require a force in excess of 600" lbs. to cause failure.

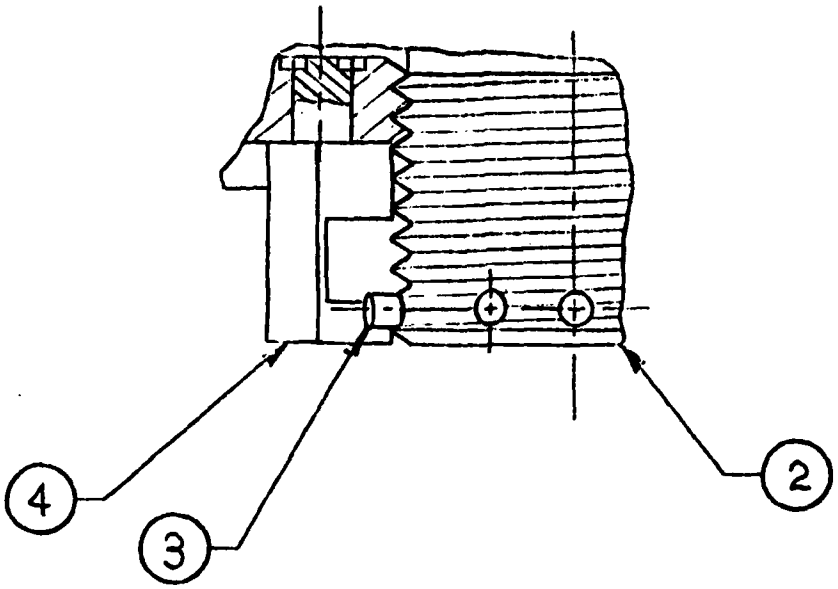
The above change would require no change to the exisitng cover pattern, but a minor change to the pattern for the handle.

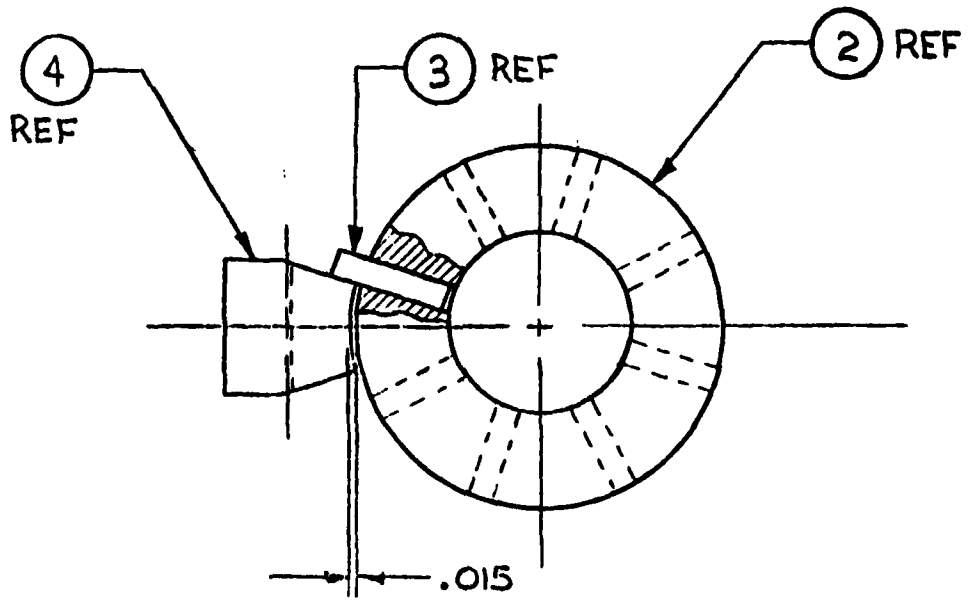
A. F. MOELLER





ENCLOSURE 1





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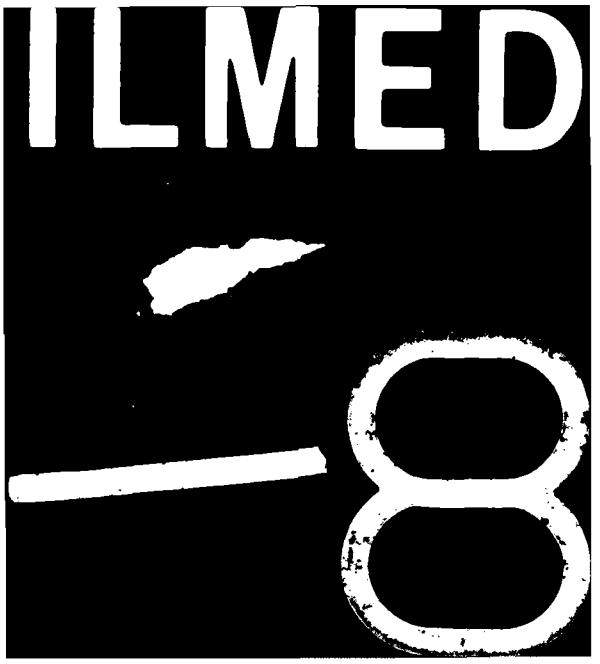
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