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CONTRACTOR REPORT ARLCD-CR-85002

**PRODUCT IMPROVEMENT PROGRAM FOR THE M577
FUZE--VOLUME 1, REDESIGNED TIMER**

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20. ABSTRACT (cont)

change eliminated one part and simplified another. Three of the plates were redesigned as die castings; two of these were combined into one plate.

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INTRODUCTION

The objective of Task #3 was to redesign the timer gear train components to optimize or reduce the number of gear passes and stacked plates. In the current design a ring gear transmits the torque from the mainspring to the timer gear train. The feasibility of using an external gear to drive the timer gear train was investigated. Reducing the number of components and changing the manufacturing process for the plates were pursued. In addition, methods of utilizing the scroll movement as a means of measuring the timer output were investigated.

DISCUSSION

Description of Design Change

The current timer design uses a ring gear and support to transmit the torque from the mainspring to the gear train. In the proposed design, the ring gear is replaced by an external drive gear mounted on the scroll, thus eliminating the ring gear support and epoxy. The complicated ring gear shaft is replaced by a straight pin. Number 1 and 2 gear and pinion assemblies are retained in the proposed design but are redesigned and relocated to accommodate the external drive gear. (See Figure 1.) The current #1 pinion is retained, but the #2 pinion is redesigned to mate with the external drive gear. Since the change from an internal to an external drive gear causes the direction of the torque transmitted to the #2 pinion to be reversed, the torque at the escape wheel is reversed. The present escape wheel and lever are used, but they are both inverted to reverse the direction of the escapement. The direction the balance wheel is detented to start the clock has not been changed for the units tested so far. Since the direction of the escapement is reversed, consideration to reversing the direction of the balance wheel detent should be considered.

The gear train was designed to have nearly the same ratio as the present gear train in order to avoid making large changes in the balance frequency. Tooth counts and ratios of the present and proposed gear train are shown in Table 1. The decrease of the gear ratio in the proposed design necessitates changing the beat rate from 80.74 to 80.18 beats per second.

Table 1. Comparison of gear train ratios

	<u>Present</u>	<u>Proposed</u>
Drive Gear	53	43
#2 Pinion	8	8
#2 Gear	37	39
#1 Pinion	8	8
#1 Gear	31	36
Escape Pinion	8	8
Ratio	118.73	117.91

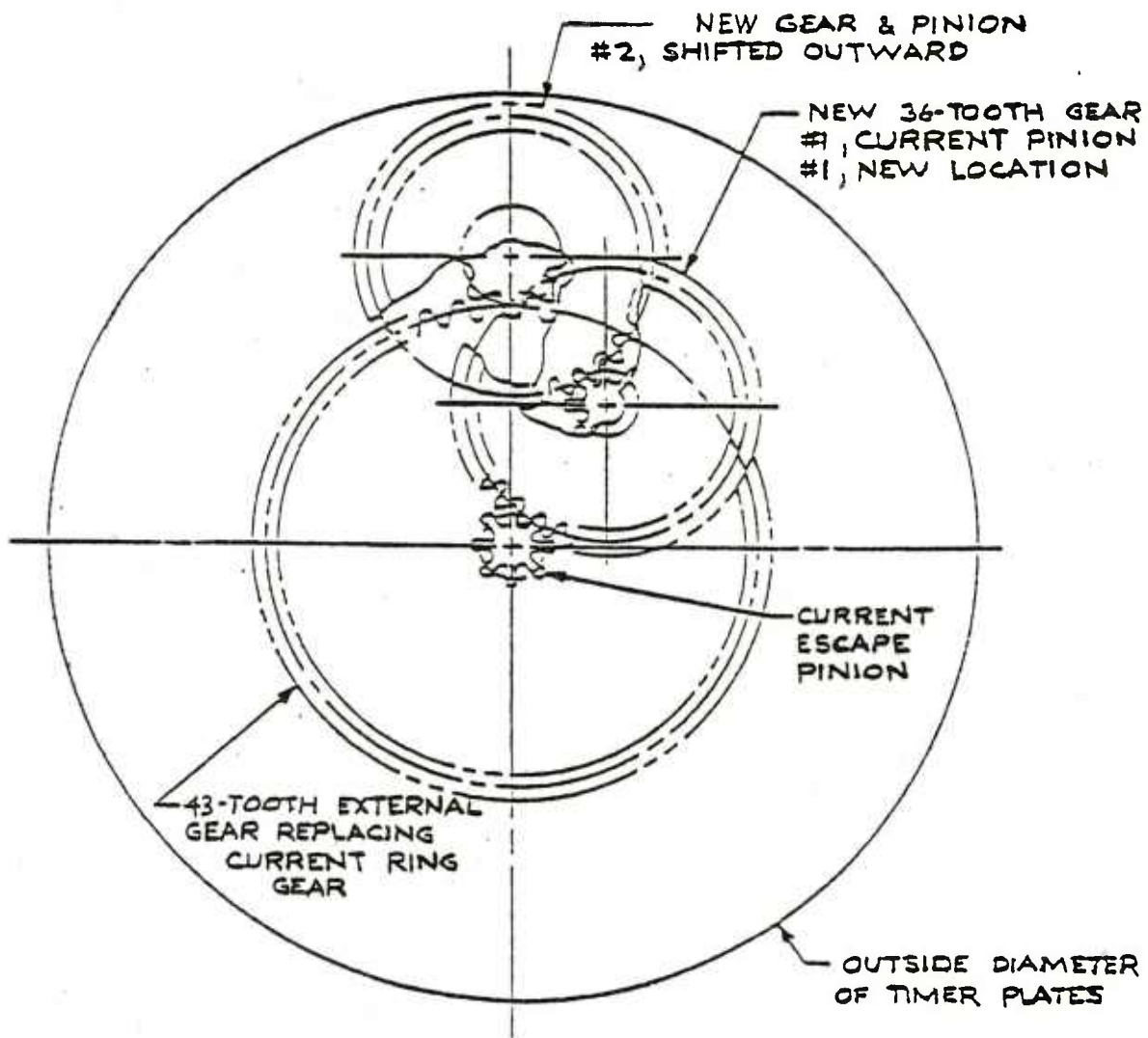


Figure 1. Revised gear train

In the current design, plate no. 6, made from wrought aluminum, houses the lower pivots of the escape wheel and both gear and pinion assemblies; it also houses the upper pivot of the drive gear. Plate no. 5, also wrought aluminum, is used only as a spacer. In the proposed design, plates no. 5 and 6 are combined into one aluminum die cast plate, known as the lower plate. This plate performs the same functions as plates no. 5 and 6 do in the current design; in addition, a hub has been added which aids in retaining the scroll assembly to the gear train. (See Figure 2.)

The current wrought aluminum no. 1 plate is replaced by an aluminum die cast plate of similar design. The method of securing the setting ring gear in the no. 1 plate was modified in order to eliminate the subassembly which consists of the two setting ring gears and dowel pins. Tabs which prevent the setting ring gears from rotating are added to the no. 1 plate. A roll stake is used to hold the setting ring gears in the plate. Since die cast aluminum has less strength than wrought aluminum, changes to the design were made to decrease the load on the no. 1 plate and increase its strength. The list of parts with a description of the change is given in Table 2.

No. 1 Plate Development

A zinc die casting duplicating the present machined no. 1 plate was first tried. Air gun tests indicated that the zinc die cast no. 1 plate could not withstand 30,000g setback. The no. 1 plate showed significant damage from the load applied by the timer housing. Fuzes, incorporating a new timer housing under development at the time, along with the zinc die cast no. 1 plate, were air gun tested. There was no visible damage to the no. 1 plates, but the units did not run properly after the test. The dowel pins and bushing which had been pressed into the no. 1 plate were loose after the air gun test. Dowel pins that had been pressed in timers three months earlier but not air gun tested were also retested for push off. These dowel pins, which had held a 40 pound push off at the time of assembly, pushed off with a load of 8 to 30 pounds on the retest. A short term creep test with a 300% overload performed on the zinc lower plate indicated an unacceptable creep rate. This indicates a problem of creep at an unacceptable rate in the zinc plate. Consequently, using a zinc die cast no. 1 plate and lower plate were dropped from further consideration.

Since die cast aluminum exhibits much less creep than die cast zinc, it was decided to substitute die cast aluminum for zinc in both the no. 1 plate and lower plate. It was determined that the same die could be used to cast the aluminum plates as was used for the zinc plates. Units with die cast aluminum no. 1 plates and lower plates were built and air gun tested. The lower plate withstood the air gun test satisfactorily. Four of the ten no. 1 plates fractured from the load of the timer housing, and loose dowel pins were still present.

Table 2. List of changed parts

Part Description	Current Part No.	Proposed Part No.	Description Of Change
Timer Assembly	9236634	SK5968	Redesigned gear train and changed plates.
Timer Scroll Assy.	9236690	SK5394	Changed configuration and assembly operations
Timing Scroll	9271993	SK5914	Added spline for drive gear
Shaft & Support Assy.	9236709	-	Deleted
Ring Gear Supp. & Shaft Assy.	9236708	-	Deleted
Ring or Drive Gear Shaft	9236695	11786101	Simplified part
Ring Gear Support	9236710	-	Deleted
Ring or Drive Gear	9236694	11786103	Changed to external gear
Pinion #2	9236680	11786102	Increased length and changed tooth form
Gear #2	9236679	SK5417	Changed number of teeth
Gear #1	9236676	SK5416	Changed number of teeth
Escape Wheel & Pinion Assy.	9236672	SK5412	Escape wheel assembled on opposite side
Lever Assy.	9236661	SK5410	Lever assembled on opposite side
Lower Plate	-	11786100	Combined plates no. 5&6 into die casting
Plate No. 6	9236681	-	Deleted
Plate No. 5	9236671	-	Deleted
Plate No. 4	9236669	SK5379	Changed hole locations
Plate No. 3	9236660	SK5378	Changed hole locations
Plate No. 1 Assy.	9236635	SK5971	Changed two assembly operations
Setting Ring Gear Assy.	9236640	-	Deleted
Ring Gear Dowel Pin	9236641	-	Deleted
Setting Ring Gear	9236642	SK5912	Eliminated two slots and hole; changed other two slots
Plate No. 1	9236636	SK5889	Changed to die casting and altered configuration
Dowel Pin	9236637	SK6357	Added knurl
Balance Wheel, Staff & Hairspring Assy.	9236647	SK5967	Changed beat rate
Spacer	9236566	SK6216	Reduced thickness
Sleeve	9236631	SK6276	Changed location of retaining ring groove
Spacer (.025)	-	SK6358	Added shim between spring washer and timing housing
Plate No. 4 & Bearing Ass'y	9236668	SK5439	Changed hole locations in No. 4 Plate
Gear #2 and Pinion Ass'y	9236678	SK5419	Changed gear and pinion
Gear #1 and Pinion Ass'y	9236675	SK5421	Changed gear

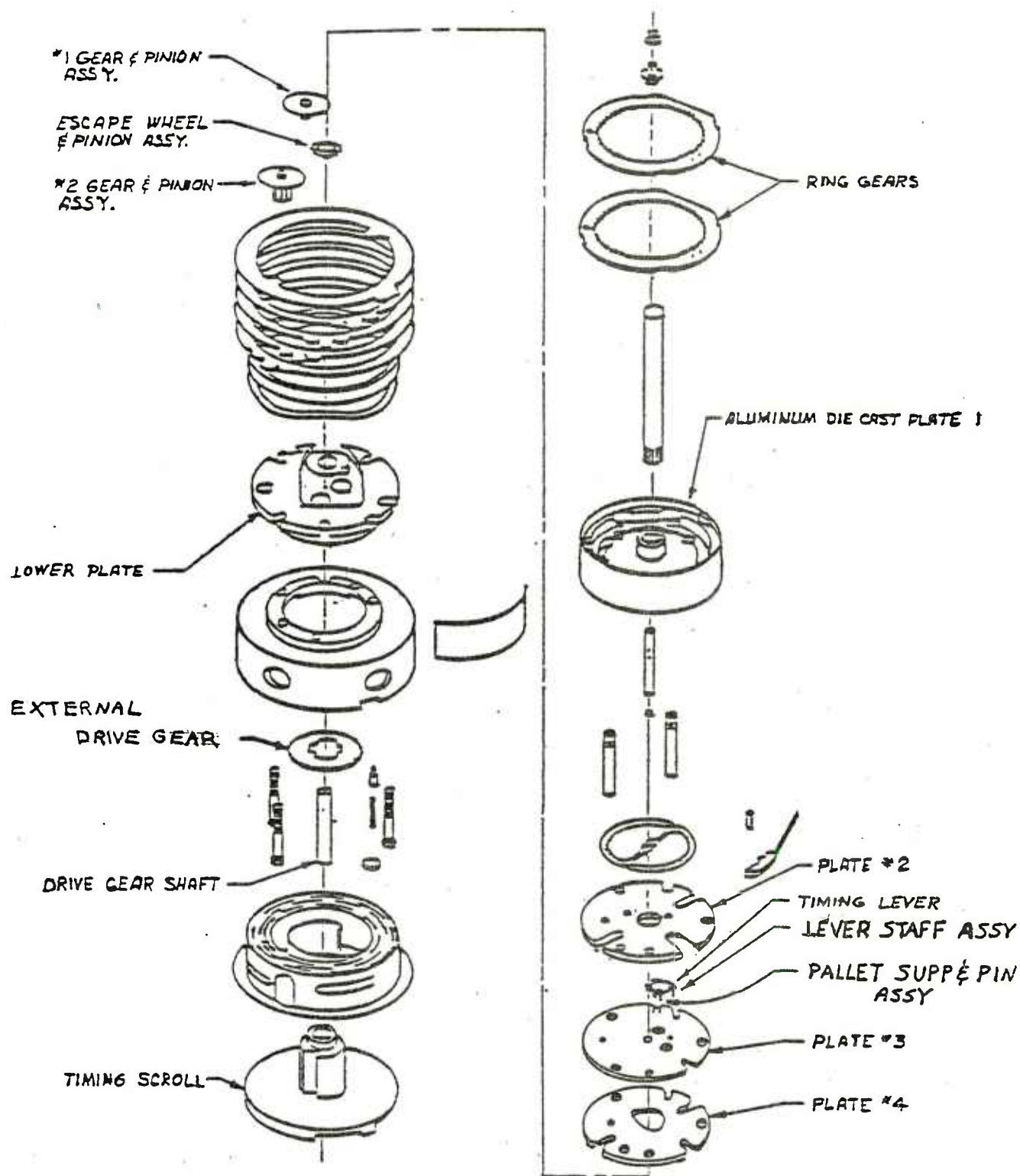


Figure 2. Revised timer redesign

Additional testing and development was performed on the aluminum die cast no. 1 plate. The results of this work showed the following:

1. Normalization improves the strength characteristics of the no. 1 plate and allows the use of a ring stake in the no. 1 plate to retain the ring gear. Static testing showed that the normalized plates can safely withstand 2,000 pounds versus 1,500 pounds without normalizaion.
2. The no. 1 plate thickness was increased .025 inch to increase its strength in the well area.
3. Tolerance studies showed that the clearance between the no. 1 plate and timer housing assembly could be increased from - 0.0125 to 0.0375 inch by removing the counterbone in the no. 1 plate and raising the timer housing by .025 inch.
4. The dowel pins used in the no. 1 plate assembly were embossed with a diamond knurl and the diameter of the dowel pin holes was decreased to increase the interference between the pin and the plate. The engagement length of the dowel pins in the no. 1 plate was increased by .053 inch.

Redesigned no. 1 plates were statically tested and air gun tested with satisfactory results.

Design of Drive Gear and #2 Pinion

A drive gear and #2 pinion were first designed using the clock gear form, but the strength of the pinion teeth was not strong enough to carry the mainspring torque with overwind. The involute tooth form was investigated. While this form is less smooth in its operation than the clock form, it is adequate for this application.

The redesigned timer requires the use of an eight tooth pinion. Because of the low number of teeth required, tooth form modification is necessary to provide sufficient contact ratio and tooth strength. Four standard addendum modification systems were explored to determine which is best suited for this application. Both the enlarged center distance with long addendum pinion and the long and short addendum systems of the AGMA 207.04 and 207.06 were compared.

Both of the above standards use conventional hob withdrawal techniques to achieve a long addendum pinion, differing only in the amount of hob withdrawal recommended. This long addendum pinion is paired with either a short addendum gear on standard centers or a standard addendum gear on enlarged centers. The results of this investigation are tabulated in Table 3.

Table 3. Gear data for systems investigated

	<u>Long/Short Addendum</u>		<u>Enlarged Center Dist.</u>	
	AGMA <u>207.04</u>	<u>207.06</u>	<u>207.04</u>	<u>207.04</u>
<u>Cir. tooth thickness</u> (@ generating pressure))				
pinion	1.9581"	2.09854"	1.9581"	2.09854"
gear	1.1835"	1.04305"	1.5708"	1.5708"
<u>Contact Ratio</u>	1.19	1.16	<u>1.19</u>	1.16
<u>Total Path of Contact</u>	3.5152"	3.4332"	3.5152	3.4277"
<u>Approach Action</u>	2.5602"	2.6642"	2.3464"	2.3840"
<u>Recess Action</u>	.9550"	.7690"	<u>1.1688"</u>	1.0437"
<u>Operating Center Dist.</u>	25.5000"	25.5000"	25.9978"	26.1648"
<u>Max. Allowable Increase</u> <u>in Cent. Dist. (CD)</u>	+.3146"	+.1685"	+.3185"	+.1964"
<u>Operating Pressure)</u>	20.00°	20.00°	22.82°	23.68°
<u>Form Factor (Y)</u>				
pinion	.401	.508	.401	.508
gear	.318	.285	.413	.413

The design selected is the long addendum pinion of AGMA 207.04 used in combination with a standard gear on enlarged centers. This combination was selected because it affords the greatest center distance separation tolerance and gear tooth strength. The actual strength of the pinion using enlarged centers is still greater than the gear strength because of the differing materials and face widths (see Appendix B).

The redesigned drive gear must bear a greater load than its predecessor because the external gear contacts the #2 pinion closer to the center of the timer. Since the radius to the point of loading is decreased, the load must be increased to support the same torque. The redesigned drive gear made of .040 thick beryllium copper supports a 150% overload beyond the mainspring torque (see Appendix B).

A comparison was made between the strength of the present and proposed designs. Using the involute tooth form and increased tooth width, it was determined the proposed design has a greater overload capacity than the present design.

Scroll Movement Measurement

Several methods of metering the scroll movement as a means of measuring timer output were investigated. The intent of this investigation was to reduce inspection costs.

The first method attempted measured the time for the scroll to rotate one revolution using a microswitch to start and stop the time measuring device. This measure was taken simultaneously with a beat rate reading over fifty seconds. The two measurements agreed within .1%. This method provides an accurate measurement of timer output, but it provides no inspection cost reduction.

The second method attempted used an optical device instead of a microswitch to start and stop the time measuring device. A fixture containing a disk with a pin engaging the scroll so the disk rotates along with the scroll was used. Grooves were machined and inked on the disk one degree apart. Every time the disk passed by the optic probe, the time measuring device started and stopped alternately. A digital oscilloscope was used to measure the time. The results were compared with the beat rate reading taken over five seconds. The two measurements agreed within 1%. Measurement of the scroll movement over a small angle would save inspection time and therefore labor costs. However, the information obtained would represent timer performance over a small period of time which is not desirable.

Using the scroll movement as a means of measuring timer output is technically feasible. However, this method reduces inspection costs only by decreasing the monitoring period. Decreasing the monitoring period may not be consistent with good quality timer production.

TESTING

Spin Test

Ten units, consisting of a die cast combined no. 5 and 6 plate and redesigned gear train, were built and centrifuge tested from 13,000 to 30,000 RPM. The beat rate and amplitude were recorded at various RPM intervals until the maximum speed was reached at which the timer would no longer operate. The maximum speed at which the timers would operate varied from 24,000 to 28,000 RPM. Test data showed that the timers held a consistent frequency until 15,650 RPM; then the frequency decreased. The results of the test are shown in Table 4.

A second spin test was performed on ten units with the aluminum die cast no. 1 plate, one piece pallet pin and lever staff assemblies, and the redesigned timer. Three control units were also tested. The timers were centrifuge tested from 13,000 to 30,000 RPM concentrically and eccentrically by .030 inches. The timer redesign units operated in the concentric and eccentric spin tests at spins up to 30,000 RPM. The control units operated at 30,000 RPM in the concentric spin test, but during the eccentric spin test the timers stopped operating between 25,000 and 30,000 RPM. Test results are shown in Tables 5 and 6.

Air Gun Tests

Six air gun tests were performed at various stages of development of the die cast no. 1 plate and redesign of the timer.

Seven units, containing zinc die cast no. 1 and lower plate and redesigned gear train, were built and air gun tested at 30,000 to 32,000g. Three were tested at ambient temperature and four at -50°F. The no. 1 plate had deformation damage in the ambient units and cracks in the cold units. Push off tests on the dowel pins were performed after the air gun tests with unsatisfactory results. The timers did not run after the test, but the timers ran satisfactorily when the no. 1 plate assemblies were replaced. This indicates the die cast lower plate and gear train were not damaged.

Fuzes incorporating a new timer housing along with die cast no. 1 plates, as well as fuzes with a standard timer housing and die cast zinc no. 1 plates, were air gun tested from 27,000 to 36,000g. In the units with the standard timer housing, the no. 1 plates were cracked. In the units with the new timer housing, there was no visible damage to the no. 1 plate, yet these units did not run properly. Upon further examination, it was seen that the dowel pins which had been press fit in the no. 1 plate were loose, which is the likely cause of the failure of the timers to run properly. Further testing indicated a problem of creep in the zinc.

Because of the creep problem with the zinc die castings, the die casting material for both the no. 1 plate and lower plate was changed to aluminum. Ten units with die cast aluminum no. 1 plates and lower plates along with the redesigned gear train were air gun tested from 27,000 to 32,000g at an ambient temperature. Four out of ten timers functioned after the test. Examination of the no. 1 plate assembly revealed cracks in four units and loose dowel pins in five units. Results are given in Table 7.

Twelve units, with the counterbore of the aluminum die cast no. 1 plate removed and increased clearance between the timer housing and the no. 1 plate, were air gun tested from 29,000 to 37,000g. Nine out of twelve timers functioned after the test. The three timers that did not function were tested in excess of 30,000g. Unit by unit results are given in Table 8.

After the design of the aluminum die cast no. 1 plate was finalized, a fifth air gun test from 22,000 to 32,000g at -40°F was performed on twenty units. Ten of these units had a standard timer movement, and ten units had the redesigned timer movement. Three out of ten timers with the standard clock movement ran after the test. Five of the ten timers with the redesigned timer movement ran after the test. Failure of the clocks to run was attributed to loose dowel pins which was caused by normalizing the no. 1 plates after the dowel pins were assembled rather than before as was done in the previous air gun units. Test data are shown in Table 9.

Ten units with an aluminum die cast no. 1 plate and lower plate, knurled dowel pins, timer redesign movement, and Westclox escapement were air gun tested from 24,437 to 31,076 g's at ambient temperature. Four out of ten timers ran after the test. Four timers had one dowel pin loose; three of these timers also had a crack in the no. 1 plate. Although the no. 1 plate assembly still showed damage after the test, these results are an improvement over previous air gun test results. Unit by unit results and observations are shown in Table 10.

Jolt and Jumble Test

Twelve fuzes with the aluminum die cast no. 1 plate, redesigned timer, and one piece pallet pin and lever staff assemblies were built and tested per MIL-STD-331, Tests 102.1 and 101.2. All units were examined after testing and were found to satisfy the criteria of 4.5.16 in MIL-F-50983.

Forty-Foot Drop Test

Five fuzes with the aluminum die cast no. 1 plate, redesigned timer, and one piece pallet pin and lever staff assemblies were built and tested per MIL-STD-331, Test 103. All units were examined after testing and were found to satisfy the forty-foot drop requirements in MIL-F-50983.

Five-Foot Drop Test

Ten fuzes with the aluminum die cast no. 1 plate, redesigned timer, and one piece pallet pin and lever staff assemblies and ten control fuzes were built and tested per MIL-STD-331, Test 111.1. Two test and two control units were dropped in each of the five fuze positions stated in MIL-STD-331, Test 111.1. All test and control fuzes had functioning timers after the test, but in two of the test units and in two of the control units, the setback pin in the timer had gone down.

A second five-foot drop test was performed to examine the setback pin movement at two test positions. A total of ten timer redesign and ten control units were tested. Five units from each group were dropped in a base down position and five units from each group were dropped in a 45° base down position. All previously reported setback pin failures had occurred at either of the two tested positions. All units were X-rayed immediately after they were dropped for setback pin evaluation. The setback pin remained down in three timer redesign units and one control unit. One control and two timer redesign units failed in the base down position and one timer redesign unit failed at the 45° base down position.

Ballistic Tests Using Redesigned Gear Train

One-hundred-five fuzes, containing the aluminum die cast lower plate and redesigned gear train and 105 control fuzes were built, shipped to Yuma Proving Grounds, and ballistically tested in February 1982. Round by round data were reported by U.S. Army Yuma Proving Grounds in Firing Report No. 82-PI-0046-L5. Because of duds and differences in the mean times between the test and control units, it was decided to repeat some of the testing. The results of the testing are shown in Table 11.

Fifty test and fifty control fuzes were ballistically tested in the three phases that had questionable results in the previous test. No duds occurred in either test or control units, and there were no significant differences in the mean times between the test and control units. Round by round data were reported by U.S. Army Yuma Proving Grounds in Firing Report No. 82-PI-0255-L5. Table 11 shows a summary of the results from both ballistic tests.

Ballistic Tests Using Aluminum Die Cast No. 1 Plate

Thirty-five fuzes, containing the aluminum die cast no. 1 plate, and 35 control fuzes were built and shipped to Yuma Proving Grounds for ballistic testing. All test units functioned properly with acceptable times. A summary of the results is shown in Table 12. Round by round data were reported by the U.S. Army Yuma Proving Grounds in Firing Report No. 82-PI-0120-L5.

Combination Ballistic Test

Seventy-five fuzes, containing the redesigned gear train, aluminum die cast no. 1 plate, and one piece lever pallet pins and support, and 75 control fuzes were built and shipped to Yuma Proving Grounds for ballistic testing. Three duds occurred in the test units, one in each of three phases. Three duds were possibly caused by failure of the timer setback pin to go down. Modifications to the lower plate are being made to eliminate this problem. A summary of the test result is shown in Table 13. Round by round data were reported by the U.S. Army Yuma Proving Grounds in Firing Report No. 83-PI-0032-L5. Additional ballistic testing with this fuze configuration will be performed as part of Contract DAAK10-80-C-0063, Task 4.

Table 4. Spin test I

TIMER#	0 RPM BEFORE SPIN TEST			13,000 RPM			15,000 RPM			22,000 RPM			25,000 to 30,000 RPM			0 RPM AFTER SPIN TEST		
	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)		BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)		BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)		BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)		BEAT RATE (Beats/Sec.)	MAX. SPEED CLOCK RAN		BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	
1	80.17	133		80.21	115°		80.23	115°		80.33	(2)		80.18	25,000		80.00	137	
2	80.24	115		80.06	112°		80.21	112°		80.35	100°		79.82	25,000		80.15	119	
3	80.08	130		80.03	118°		80.02	120°		79.86	(2)		79.64	28,000		79.77	132	
4	80.18	139		80.17	115°		80.12	112°		80.30	70°		79.41	24,000		80.02	142	
5	80.23	130		80.32	118°		80.16	115°		80.14	65°		80.13	25,000		80.03	144	
6	80.27	124		80.24	115°		80.26	115°		80.34	85°		80.33	25,000		80.13	124	
7	80.24	133		80.30	100°		80.31	95°		80.13	75°		77.34	24,000		80.09	140	
8	80.17	117		80.17	95°		80.10	92°		79.71	(2)		Stopped	24,000		80.09	132	
9	80.28	127		80.23	112°		80.22	96°		80.11	65°		80.06	25,000		80.11	136	
10	80.16	125		80.14	90°		79.86	90°		70.76	50°		Stopped	24,000		80.01	138	

1. Beat rate range for the timer redesign is 80.08 beats/second to 80.28 beats/second.

2. Test machine did not record data during these tests.

Table 5. Spin test II (concentric)

TIMER#	0 RPM BEFORE SPIN TEST		13,000 RPM		15,000 RPM		22,000 RPM		25,000 to 30,000 RPM		0 RPM AFTER SPIN TEST	
	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)
1	80.20	124	80.08	85	80.16	115	80.16	120	(3)	(3)	80.10	124
2	80.16	126	80.11	125	80.11	123	80.09	120	79.61	120	80.15	126
3	80.11	124	79.93	129	79.91	129	79.91	130	79.76	115	80.08	119
4	80.17	122	80.03	130	80.02	130	80.01	130	79.98	130	80.11	120
5	80.10	122	79.94	130	79.89	135	79.78	135	79.71	125	80.24	113
6	80.16	129	80.04	131	80.06	137	80.08	132	79.91	139	80.04	126
7	80.13	126	79.96	135	79.93	138	79.87	138	79.78	130	79.93	133
8	80.17	120	79.91	129	79.87	130	79.82	130	79.78	130	80.07	119
9	80.23	115	80.02	130	80.01	131	79.93	130	79.85	127	80.21	102
10	80.18	129	80.09	128	80.08	130	80.03	133	80.00	138	80.09	124
11C	80.67	117	80.62	130	80.62	129	80.61	129	80.50	138	80.57	119
12C	80.70	120	80.59	120	80.60	122	80.47	121	80.27	140	80.61	120
13C	80.69	119	80.63	125	80.61	130	80.62	132	80.17	125	80.61	117

1. Beat rate range for the timer redesign is 80.08 beats/second to 80.28 beats/second.
2. Timer numbers 11C, 12C, 13C are control units.
3. Test machine did not record data during these tests.

Table 6. Spin test II (eccentric)

TIMER#	0 RPM BEFORE SPIN TEST		13,000 RPM		15,000 RPM		22,000 RPM		25,000 to 30,000 RPM		0 RPM AFTER SPIN TEST	
	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)	BEAT RATE (Beats/Sec.)	AMPLITUDE (Degrees)
1	80.20	124	80.05	132	80.09	135	80.07	132	79.97	138	80.10	124
2	80.16	126	80.16	125	80.16	125	80.05	122	79.78	128	80.15	126
3	80.11	124	79.96	130	79.96	130	79.89	132	79.96	125	80.08	119
4	80.17	122	80.04	130	80.10	130	80.18	120	79.96	125	80.11	120
5	80.10	122	80.16	120	80.16	125	80.16	122	80.16	130	80.24	113
6	80.16	129	80.16	130	80.16	130	80.08	125	80.07	130	80.04	126
7	80.13	126	80.16	125	80.16	125	80.16	122	80.13	130	79.93	133
8	80.17	120	79.96	130	79.99	130	80.13	120	80.14	130	80.07	119
9	80.23	115	80.09	130	80.09	125	80.02	120	79.51	125	80.21	102
10	80.18	129	80.11	130	80.18	130	80.18	130	79.68	128	80.09	124
11C	80.67	117	(3)	(3)	(3)	(3)	80.66	122	Timer Stopped		80.57	119
12C	80.70	120	80.66	125	80.69	138	80.60	125	Timer Stopped		80.61	120
13C	80.69	119	80.61	125	80.61	130	80.56	122	Timer Stopped		80.61	117

1. Beat rate range for the timer redesign is 80.08 beats/second to 80.28 beats/second.
2. Timer numbers 11C, 12C, 13C are control units.
3. Test machine did not record data during these tests.

Table 7. Air gun test III

Unit #	g Level	Timer Function	Observations
1*	31811	Yes	Sleeve failure, loose dowel pin
2	30910	No	Sleeve failure, no. 1 plate failure, loose dowel pin
4	30552	No	No. 1 plate failure
5	30672	No	No. 1 plate failure, loose dowel pin
6	30298	No	Sleeve failure
7	30342	No	Sleeve failure, no. 1 plate failure, loose dowel pin
9	31434	Yes	Loose dowel pin
10	30488	Yes	
11	30788	No	Sleeve failure, loose dowel pin
12	29738	Yes	Sleeve failure, no. 1 plate failure
1**	30059	No	Hairspring broke, scroll shaft pushed-in
2	30193	No	#2 pinion pivot broke
4	29323	No	Hairspring broke
6	30127	Yes	
7	31333		
8	31254	Yes	
10	29292	Yes	
12	32051	No	#1 pinion damaged
13	27265	Yes	
15	30534	No	Hairspring broke

* Test units consisted of aluminum die cast no. 1 plates.

** Test units consisted of redesigned timer - die cast lower plate, external drive timing scroll movement, and escapement.

Tested: September 1981

Table 8. Air gun test IV

<u>Unit #</u>	<u>g Level</u>	<u>Timer Function</u>	<u>Observations</u>
1*	37240	No	No. 1 plate fracture, two dowel pins loose One screw stripped into no. 1 plate
2	29102	Yes	One dowel pin loose
3	30715	No	Two dowel pins loose, no. 1 plate fractured
4	30329	Yes	One dowel pin loose
5	28967	Yes	Two dowel pins loose
6	28967	Yes	Two dowel pins loose
7	29774	Yes	One dowel pin loose
8	30177	Yes	
9	29101	Yes	Two dowel pins loose
10	30043	Yes	Two dowel pins loose
11	29706	Yes	
12	35334	No	No. 1 plate fracture, two dowel pins worked loose

* Test units consisted of aluminum die cast no. 1 plate with counter bore removed and with .025 increased clearance with timer housing.

Tested: November 1981

Table 9. Air gun test V

Temp.: -40°F

<u>Unit #</u>	<u>g Level</u>	<u>Timer Function</u>	<u>Observations</u>
1*	22409	Yes	
2	23076	No	One dowel pin loose
3	25851	Yes	No. 1 plate fracture, one dowel pin loose
4	24938	No	One dowel pin loose
7	25489	Yes	One dowel pin loose
9	31382	No	One dowel pin loose
10	27165	No	One dowel pin loose
11	30725	No	Two dowel pins loose
12	25197	No	Two dowel pins loose
13	25004	No	One dowel pin loose
14**	22009	Yes	
15	23076	Yes	
16	25004	Yes	One dowel pin loose
17	25230	No	Two dowel pins loose
18	25585	No	One dowel pin loose, hub on lower plate broke
19	32085	No	Two dowel pins loose
20	29325	No	One dowel pin loose
21	29093	No	Two dowel pins loose
22	27294	Yes	Two dowel pins loose
25	27422	Yes	Two dowel pins loose

* Test units consisted of aluminum die cast no. 1 plate

** Test units consisted of aluminum die cast no. 1 plate, lower plate, external drive timing scroll movement, and escapement

Tested: February 1982

Table 10. Air gun test VI

<u>Unit #</u>	<u>g Level</u>	<u>Timer Function</u>	<u>Observations</u>
168	29,981	No	Loose dowel pin and screw, cracked no. 1 plate
166	27,582	No	Loose dowel pin and screw, cracked no. 1 plate
175*	27,630	Yes	Shaft moved in timing scroll
172	27,861	Yes	Loose screw
167	31,076	No	Balance wheel out of beat
169	30,169	No	Loose dowel pin, balance wheel out of beat
77	24,437	Yes	No visible damage
165	30,567	Yes	Balance wheel out of beat
122	30,434	No	Balance wheel out of beat
170	30,290	No	Loose dowel pin and screw; cracked no. 1 plate; balance wheel out of beat

* This unit was tested twice; the first time the g level was 18,646 g.

Tested: February 1984

Table 11. Ballistic test results using redesigned gear train and lower plate

TPR-LCN-T-2594, Supplement 5

24, 25, and 26 February 1982

Test Units - Lot No. HAT81G000E058

# of Units	Gun	Zone	Time Sec.	Environ- ment (°F)	Function	Mean	Std. Dev.
20	105mm, M103	7	50	145	20/20	50.066	.120
20	8 in., M2A2	1	25	-35	17/20	24.973	.055
20	155mm, M185	8	75	70	17/20	75.028	.235
						(outlier excluded)	
15	105mm, M204	8	75	70	15/15	75.272	.183
15	155mm, 198 System	8(M203)	105	70	15/15	105.291	.352
15	8 in., M10A2	9	105	70	15/15	105.253	.200

Control Units - Lot No. HAT82B000E078

20	105mm, M103	7	50	145	20/20	50.043	.068
20	8 in., M2A1	1	25	-35	17/20	24.946	.070
20	155mm, M185	8	75	70	20/20	75.064	.133
15	105mm, M204	8	75	70	13/15	75.193	.168
15	155mm, 198 System	8(M203)	105	70	15/15	104.969	.326
15	8 in., M10A2	9	105	70	15/15	105.091	.216

TPR-LCN-T-2672, Supplement 10

9 and 10 November 1982

Test Units - Lot No. HAT82K000E092

20	155mm, M185	8	75	70	20/20	74.923	.100
15	155mm, 198 System	8	105	70	15/15	104.872	.387
15	8 in., M10A2	9	100	70	15/15	100.008	.086

Control Units - Lot No. HAT82K000E093

20	155mm, M185	8	75	70	20/20	74.961	.172
15	155mm, 198 System	8	105	70	15/15	105.080	.329
15	8 in., M10A2	9	100	70	15/15	100.065	.092

Table 12. Ballistic test results using die cast no. 1 plate

TPR-LCN-T-2594, Supplement 4							3 and 4 May 1982	
Test Units - Lot No. HAT82D000E057								
<u># of Units</u>	<u>Gun</u>	<u>Zone</u>	<u>Time Sec.</u>	<u>Environ-ment (°F)</u>	<u>Function</u>	<u>Mean</u>	<u>Std. Dev.</u>	
15	105mm, M204	8	75	70	15/15	75.153	.116	
20	105mm, M103	7	50	145	20/20	50.115	.068	
Control Units - Lot No. HAT82D000E088								
15	105mm, M204	8	75	70	15/15	75.160	.144	
20	105mm, M103	7	50	145	20/20	50.130	.091	

Table 13. Ballistic test results with combination units

TPR-LCN-T-2672, Supplement 14
Test Units - Lot No. HAT82M000E060

# of Units	Gun	Zone	Time Sec.	Environ- ment (°F)	Function	Mean	Std. Dev.
(1)10	(FFE) 155mm, M198 System	8	75	70	10/10	75.115	.077
10	(SR) 155mm, M198 System	8	75	70	10/10	74.979	.067
(2)15	155mm, M185, M119 CH6	8	75	70	14/15	74.970	.148
(3)15	155mm, M198 System M203 CH6	8	100	70	14/15	100.114	.282
15	105mm, M103	7	50	145	14/15	50.135	.096
(4)10	155mm, M198 System RAP Round	8	95	70	10/10	95.148	.165

Control Units - Lot No. HAT82M000E096

(5)10	(FFE) 155mm, M198 System	8	75	70	10/10	75.042	.074
10	(SR) 155mm, M198 System	8	75	70	10/10	74.964	.135
15	155mm, M185, M119 CH6	8	75	70	15/15	74.999	.094
15	155mm, M198 System, M203 CH6	8	100	70	15/15	100.066	.266
15	105mm, M103	7	50	145	14/15	50.056	.051
(6)10	155mm, M198 System RAP Round	8	95	70	10/10	95.076	.095

- (1) Chronographs failed to record time on 6 of the 10 units tested.
- (2) One fuze time was lost on chronographs.
- (3) One fuze time was lost on chronographs. One fuze was an outlier and one fuze was a dud. The mean and std. deviation were calculated from a sample of 12 units.
- (4) Three rounds were lost on the chronographs; the units were listed by H. Eades as no-tests.
- (5) Chronographs failed to record time on 6 of the 10 units tested.
- (6) Two rounds were lost on the chronographs; the units were listed by H. Eades as no-tests.

COST AND WEIGHT

Cost Comparison

The total projected cost savings is \$1.05 per fuze. This cost savings was calculated using a quantity of 500,000 units and the lowest price obtained from vendors for purchased parts. This cost savings includes material, labor, overhead, and general and administrative costs but do not include tools, gages, and profit. The estimated cost of production tools and gages is \$343,832. This includes multiple sets of tools where needed to maintain a production level of 500,000 units per year. A cost comparison of the present design and new design is shown in Table 4. Parts which are common to the present and new design are not included in the analysis.

A previous cost projection showed a savings of \$1.76 per fuze without general and administrative costs. This savings significantly changed for the following reasons:

1. The cost of the redesigned scroll increased by \$.45.
2. The cost of the present no. 1 plate decreased by \$.37.
3. The cost of the lower plate increased by \$.14.

Weight Comparison

A weight comparison of the changed parts and subassemblies is given in Table 15. The net change to the fuze is .003 pounds decrease, which is insignificant.

Table 14. Cost Comparison per fuze

Part or Assembly Name	Present Design	Proposed Design	Savings	Tools & Gages
Plate #3	0.07	0.07	0.00	32604.00
Plate #4	0.11	0.12	-0.01	29969.00
Pinion #2	0.11	0.11	0.00	9104.00
Drive Gear	0.15	0.18	-0.04	13273.00
Ring Gear Shaft	0.34	0.06	0.28	0.00
Ring Gear Support	0.24	0.00	0.24	0.00
Ring Gear Support Assy.	0.08	0.00	0.08	0.00
Support & Shaft Assy.	0.25	0.00	0.25	0.00
Scroll	0.52	1.07	-0.55	44498.00
Scroll Assy.	0.09	0.11	-0.02	11257.00
Plate #6	0.79	0.00	0.79	0.00
Plate #5	0.07	0.00	0.07	0.00
Lower Plate	0.00	0.65	-0.65	35873.00
Plate #1	0.99	0.54	0.45	39366.00
Setting Ring Gear	0.15	0.22	-0.06	45515.00
Setting Ring Gear Assy.	0.10	0.00	0.10	0.00
Ring Gear Dowel Pin	0.01	0.00	0.01	0.00
Dowel Pin	0.03	0.03	0.00	493.00
Plate #1 Assy.	0.28	0.32	-0.04	3861.00
Timer Assy.	2.51	2.48	0.03	6675.00
Spacer (Ctr. Assy.)	0.02	0.02	0.00	125.00
Sleeve	1.68	1.68	0.00	1623.00
.025 Spacer	0.00	0.04	-0.04	0.00
Lever Assy.				35050.00
Escape Wheel Assy.				2305.00
Gear #1				12444.00
Gear #2				15187.00
Gear #2 Assy.				2305.00
Gear #1 Assy.				2305.00
Total			0.88	343832.00
G&A			0.17	

Table 15. Weight comparison

	<u>Present</u>	<u>Proposed</u>	<u>Net Change</u>
Scroll Assembly	.0855	.0811	(.0044)
No. 1 Plate Assembly	.0306	.0304	(.0002)
Lower Plate			
versus			
No. 5 and No. 6 Plate	.0136	.0145	.0009
Gear Train	.0009	.0015	.0006

CONCLUSIONS AND RECOMMENDATIONS

The timer redesign, including the aluminum die cast no. 1 plate, external drive gear with redesigned gear train, and aluminum die cast lower plate, was subjected to the required laboratory and ballistic tests with acceptable results. Based on test results and a projected cost savings of \$1.05 per fuze, this design has been shown to be a feasible replacement for the present timer. However, because of the large number of parts and subassemblies involved in the timer redesign and the fact that development tests were conducted on units fabricated mainly from development tooling and because the timer is the most important safety and functional component of the fuze, HTI strongly recommends that additional ballistic tests be conducted using production tooling and the inertial PD VECP design prior to releasing the design to production. Using the timer redesign with the M577A1 fuze, the inertial PD design, requires that the sleeve, setting key, and ogive be changed. In consideration of the nature and significance of the change to the timer assembly and since the timer change was not tested with the M577A1 fuze, it would be to the mutual benefit of all to perform additional testing on an increased sample produced from production tooling.

APPENDIX A
CALCULATION OF LOAD ON NO. 1 PLATE



The no. 1 plate is loaded during setback when the timer housing deforms enough to hit the no. 1 plate. The load of the setting mechanism, counter assembly, and timer housing assembly less cylindrical portion is transmitted to the no. 1 plate through the timer housing. The load from the cylindrical portion of the timer housing is transferred to the tumblers, not the no. 1 plate. Table 10 shows the weights necessary to calculate the load on the no. 1 plate.

At 30,000g acceleration, the load on the top of the timer housing is

$$\begin{aligned} F &= wg \\ &= (.1228 \text{ lb.}) (30,000g) \\ &= 3684 \text{ lb.} \end{aligned}$$

The minimum clearance during setback without deformation of the timer housing in the well area of the no. 1 plate and the timer housing assembly is .013 inch. Therefore, the timer housing must deform .013 inch before the timer housing assembly hits the no. 1 plate. Laboratory static tests showed the timer housing deflects .001 inch for every 34.3 lb. of loading. Therefore, the load absorbed by the timer housing is

$$\begin{aligned} \text{Load} &= (.013) (34.3) (1000) \\ &= 446 \text{ lbs.} \end{aligned}$$

Hence the net load on the no. 1 plate at 30,000g is 3238 lb.

Table A-1. Weight of assemblies used in load calculations

<u>Assembly</u>	<u>Part No.</u>	<u>Weight (lbs.)</u>
Setting Mechanism	See Note	0.0315
Counter Assembly	9236573	.0578
Timer Housing Assy.	9236588	.0758
Cylindrical Portion		.0423

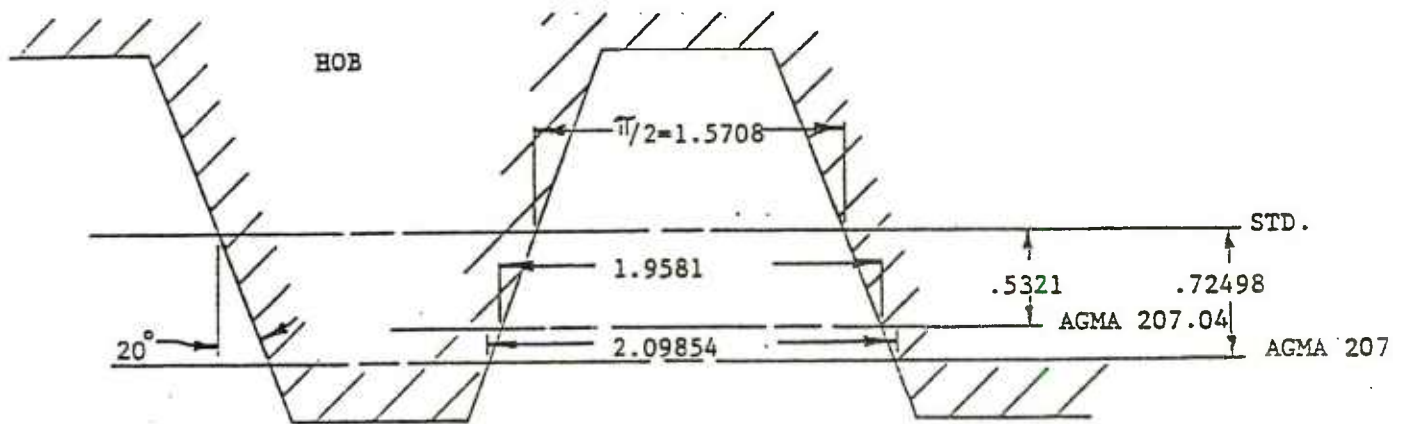
Note: Setting mechanism includes setting key ring (9236515), setting key (9236517), crush tube (9236730), retainer plug (9236731), clutch drive sleeve (9236520), nine clutch grip rings (9236570), three clutch spacers (9236571), set clutch washer (9236551), and spacer (9236566).

APPENDIX B
ANALYSIS OF THE DESIGN USED ON DRIVE GEAR AND NO. 2 PINION



The present timer redesign requires the use of an 8 tooth, 72 DP pinion meshing with a 43 tooth gear using the 20° involute system. Because of the low numbered pinion required, tooth form modification is necessary to provide sufficient contact ratio and tooth strength. The following is a comparison of the strength and operating characteristics obtainable using AGMA recommended modifications. Both the "enlarged center distance" and the "long and short addendum" systems of both AGMA standard 207.04 and 207.06 are compared.

Both of the above standards use conventional hob withdrawal techniques to achieve a "long addendum" pinion which is then paired with either a "short addendum" gear on standard centers or a standard addendum gear on "enlarged centers." They differ only in the amount of hob withdrawal recommended and O.D. modification to prevent pointed teeth.



For 8 tooth pinions, DP = 1	AGMA 207.04	207.06
Basic tooth thickness (t_p)	1.9581	2.09854
Hob shift required (Δ)	.5321	.72498
$\Delta = (t_p - \pi/2)/2 \tan 20^\circ$		
O.D.	10.8738	11.0250

The maximum limits of involute contact for any gear or pinion with respect to its generated pitch point may be calculated from a knowledge of the following four radii.

$$R_p = \text{pitch radius} = N/(2 \text{ DP})$$

$$R_o = \text{outside radius} = \frac{(\frac{N}{2} + 1)}{\text{DP}}$$

$$R_b = \text{base radius} = R_p \cos$$

$$R_t = \text{transition radius (or inside form radius)}$$

this radius represents the point of intersection or tangency of the involute curve and the trochoidal fillet or undercut.

The following analysis for determining R_t is derived from Buckingham's "Analytical Mechanics of Gears" p. 58, 74 and 80.

The relative strengths of the various gear and pinion geometries were compared by calculating the "Y" factor for each design in accordance with the procedure described in AGMA standard 220.02, Appendix A. The bending stress is considered to be inversely proportional to "Y." Thus, tooth strength is directly proportional to "Y."

Tabulation of the parameters relating to the three gears and two pinions studied is shown in Table B-1. The parameters related to the four gear and pinion combinations derived from the gear and pinion components are shown in Table B-2.

Table B-1

Component Data

	<u>Long Add.</u> <u>AGMA 207.04</u>	<u>Short Add</u> <u>AGMA 207.04</u>	<u>Long Add</u> <u>AGMA 207.06</u>	<u>Short Add.</u> <u>AGMA 207.06</u>	<u>Standard</u>
a_o	20°	20°	20°	20°	20°
N	8	43	8	43	43
t_p	1.9581 +.5321	1.1835 -.5321	2.09854 +.72498	1.04305 -.72498	1.5708 0
b	.8119	1.8761	.61902	2.06898	1.3440
R_o	5.4369	21.9679	5.51250	21.77500	22.5000
R_p	4.0000	21.5000	4.00000	21.50000	21.5000
R_t	3.7813	20.2896	3.76404	20.24544	20.4914
R_b	3.7588	20.2034	3.75877	20.20339	20.2034
A	2.5603	1.2728	2.6643	.7690	2.5498
B	.9559	5.4853	1.1691	6.0494	3.9296
"Y"	.401	.318	.508	.285	.413

Table B-2

Gear/Pinion Combination Data

AGMA 207.04

AGMA 207.06

	<u>Long & Short Add System</u>	<u>Enlarged Centers System</u>	<u>Long & Short System</u>	<u>Enlarged Centers System</u>
a	20°	22.824°	20°	23.678°
CD	25.0000	25.9978	25.5000	26.1648
R _p (pinion)	4.0000	4.0782	4.0000	4.1043
R _p (gear)	21.5000	21.9205	21.5000	22.0605
A (pinion)	2.5603	2.3461	2.6643	2.3840
B (gear)	5.4853	5.0813	6.0494	5.4359
A (gear)	1.2728	1.3984	.7690	1.0438
B (pinion)	.9559	1.1701	1.1691	1.4492
L	3.5162	3.5162	3.4333	3.4278
CR	1.191	1.191	1.163	1.161
X	.8810	.7924	.4812	.4757
CD	.3146	.3175	.1686	.1946
a ₀ '	21.838°	24.414°	21.009°	24.625°
Y min of pair	.318	.401	.285	.413

(Data at operating pressure angle)

(All dimensions based on DP = 1)

The design selected for this application was the "long addendum" pinion of AGMA 207.04 used in combination with a standard gear on enlarged centers.

This combination was selected because it affords the greatest center distance separation tolerance ($.3175/72 = .0044$ ") together with a strength factor within 3% of the maximum obtainable.

Stress Analysis of Drive Gear

The tooth strength of the involute drive gear was studied and compared to the present design. Two methods were used to calculate the bending stress on a tooth.

The transmitted tangential load at the pitch diameter is calculated by

$$\begin{aligned} W_t &= \text{torque/pitch radius} \\ &= (34 \text{ in.-oz./16 oz./lb.}) \left(\frac{2}{.5972 \text{ in.}} \right) \\ &= 7.117 \text{ lb.} \end{aligned}$$

According to AGMA 220.02, the tensile bending stress, S_t , at the root of the tooth is calculated by

$$S_t = \left(\frac{W_t K_o}{K_r} \right) \left(\frac{P}{F} \right) \left(\frac{K_s K_m}{J} \right),$$

where

$W_t = 7.117 \text{ lb.}$	transmitted tangential load
$K_o = 1$	overload factor
$K_v = 1$	dynamic factor
$P = 72$	diametral pitch
$F = .040 \text{ in.}$	face width
$K_s = 1$	size factor
$K_m = 1.3$	load distribution factor
$J = .275$	geometry factor

The value of the factors used in the formula are obtained from tables or graphs in AGMA 220.02. Using a tangential load of 7.117 lb., a diametral pitch of 72, and a face width of .040 in., we have

$$\begin{aligned} S_t &= \frac{(7.117)(1)}{1} \frac{72}{.040} \frac{(1)(1.3)}{.275} \\ &= 60,559 \text{ psi.} \end{aligned}$$

Using the Lewis formula, the maximum bending stress, S_t , is calculated by

$$S = \frac{W_t K P}{F Y}$$

where

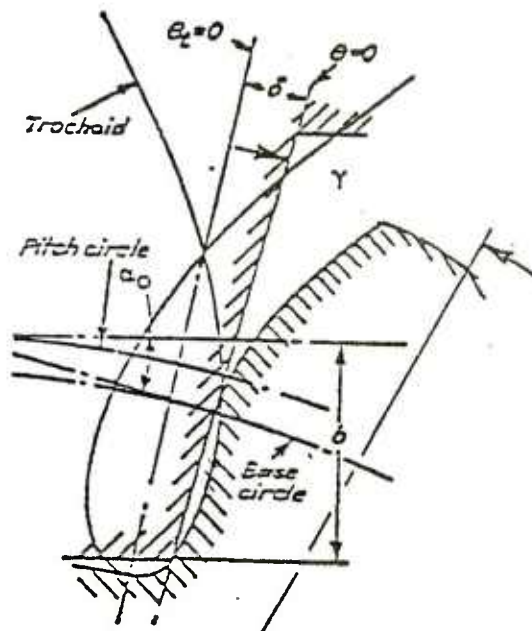
$W_t = 7.117$ lb.	transmitted tangential load
$K = 1.5$	stress concentration factor
$P = 72$	diametral pitch
$F = .04$ in.	face width
$Y = .413$	form factor

The value of K is the common value used for 20-degree pressure angle gears; the form factor, Y , is calculated in the previous section of this appendix. With these values, we obtain

$$S_t = \frac{(7.117)(1.5)(72)}{(.04)(.413)}$$

$$= 46,528 \text{ psi.}$$

Using the larger of the two estimates, we assume a stress of 60,559 psi. To provide protection against overloading caused by overwinding, this figure is doubled. A design value of 121,000 psi. for bending tooth stress is well below the published yield strength of 140,000 psi. for beryllium copper with a hardness of Rc37.



- θ_t = vectorial angle of trochoid
- δ = angle between origins of trochoid and involute
- θ = vectorial angle of involute
- θ_c = vectorial angle from tooth centerline
- b = hob addendum
- α_o = generating pressure angle
- γ = angle between origin of involute and centerline
- R_p = pitch radius
- R_b = base radius
- T_p = tooth thickness at pitch radius

$$\theta_t = \tan^{-1} \frac{\sqrt{R^2 - (R_p - b)^2}}{R_p - b} - \tan^{-1} \frac{\sqrt{R^2 - (R_p - b)^2}}{R_p}$$

$$\delta = \alpha_o - \frac{(R_p - b)}{R_p} \tan \alpha_o \quad (\text{from } \phi \text{ of trochoid to start of inv. at base radius})$$

$$\theta = \sqrt{\frac{R^2 - R_b^2}{R_b}} - \tan^{-1} \sqrt{\frac{R^2 - R_b^2}{R_b}}$$

$$\gamma = \frac{T_p}{2R_p} + \text{inv } \alpha_o \quad (\text{from start of inv. at base radius to } \phi \text{ of tooth})$$

$$\theta_c = \gamma - \theta \quad \text{for involute portion}$$

$$\theta_c = \gamma + \delta - \theta_t \quad \text{for trochoidal portion}$$

$$\theta_c \text{ (involute)} = \gamma - \theta = \gamma + \delta - \theta_t = \theta_c \text{ (trochoid)}$$

$$\text{Transition occurs when } \theta = \theta_t - \delta$$

$$R \text{ at transition} = R_t$$

$$\theta - \theta_t + \delta = 0$$

$$\begin{aligned} \sqrt{\frac{R^2 - R_b^2}{R_b}} - \tan^{-1} \sqrt{\frac{R^2 - R_b^2}{R_b}} - \tan^{-1} \sqrt{\frac{R^2 - (R_p - b)^2}{R_p - b}} + \sqrt{\frac{R^2 - (R_p - b)^2}{R_p}} \\ + \alpha_o - \frac{(R_p - b)}{R_p} \tan \alpha_o = 0 \end{aligned}$$

the value of R satisfying this equation equals R_t

For the following computations a sharp edged hob is assumed with an addendum b equal to $1.200/DP + .002''$ which for the present case of 72 DP scaled to $DP = 1$ gives $b = 1.344$.

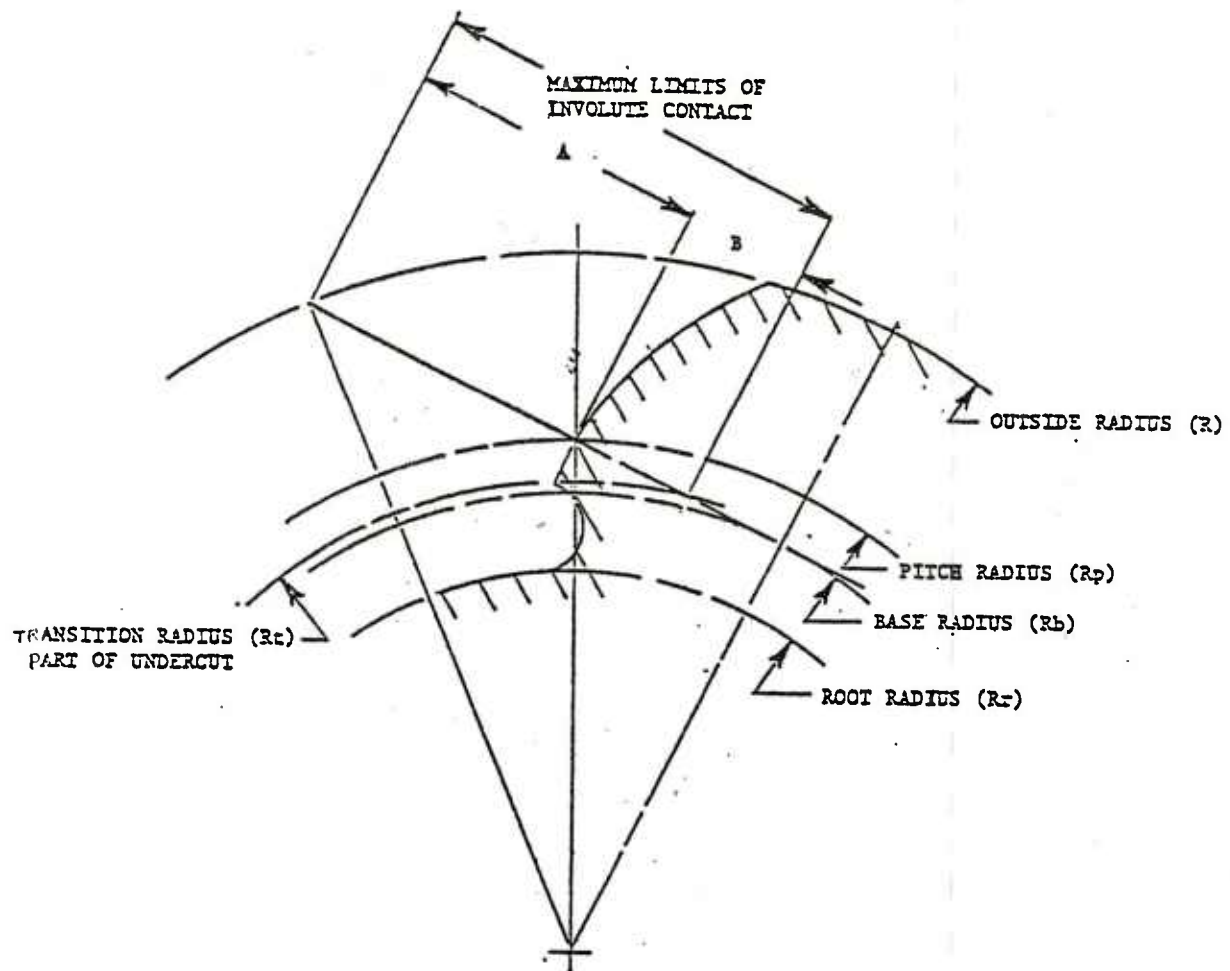
	N = 8 Long Add. 207.04	N = 43 Short Add. 207.04	N = 8 Long Add. 207.06	N = 43 Short Add. 207.06	N = 43 STD
$\alpha_o =$ generating pressure $\angle$	20°	20°	20°	20°	20°
$\Delta =$ hob offset	+.5321	-.5321	+.72498	-.72498	0
$b = 1.344 - \Delta$	.8119	1.8761	.61902	2.06898	1.3440
$R_p = N/2$	4.0000	21.5000	4.0000	21.5000	21.5000
$R_b = (N/2)\cos \alpha$	3.7588	20.2034	3.7588	20.2034	20.2034
$R_o =$	5.4369	21.9679	5.5125	21.7750	22.5000
$R_t =$	3.78132	20.28958	3.76406	20.24544	20.49145

Using the above four radii the involute path lengths A & B shown on the following sketch can be computed from the following considerations.

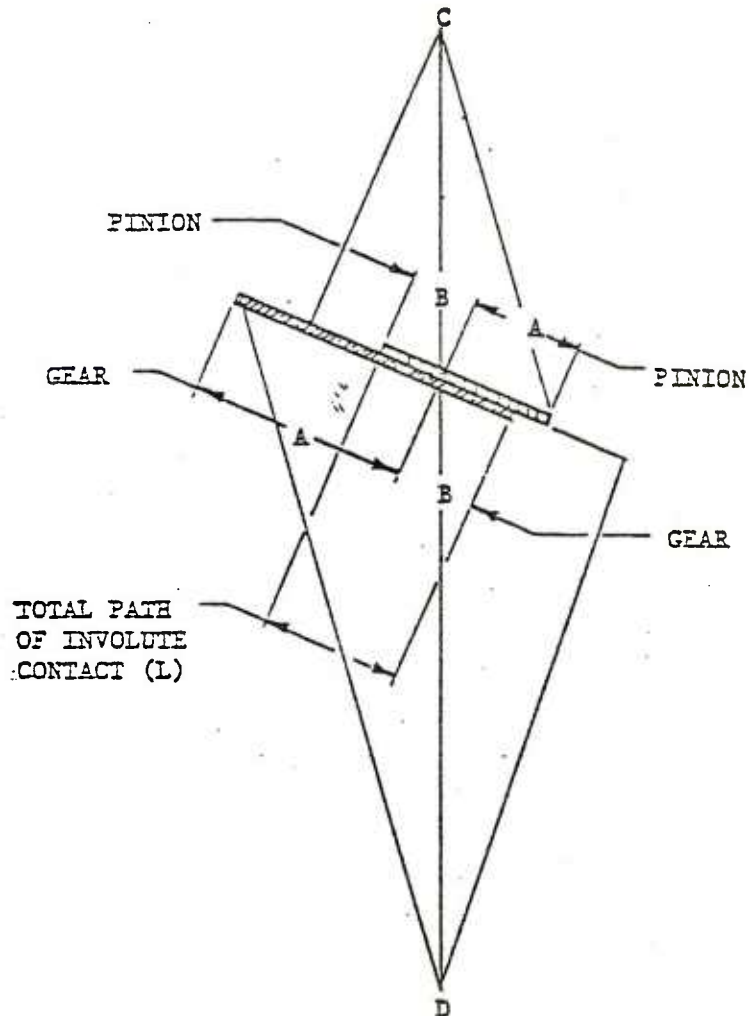
$$A = \sqrt{R_o^2 - R_b^2} - \sqrt{R_p^2 - R_b^2}$$

$$B = \sqrt{R_p^2 - R_b^2} - \sqrt{R_t^2 - R_b^2}$$

A	2.5603	1.2728	2.6643	.7690	2.5498
B	.9559	5.4853	1.1691	6.0494	3.9296
A + B	3.5162	6.7581	3.8333	6.8184	6.4794



When either "long and short addendum" pair is tightly meshed on standard centers the pinion path A overlaps the gear path B and vice versa. The resulting contact path is the sum of the lesser of each overlapping pair as shown.



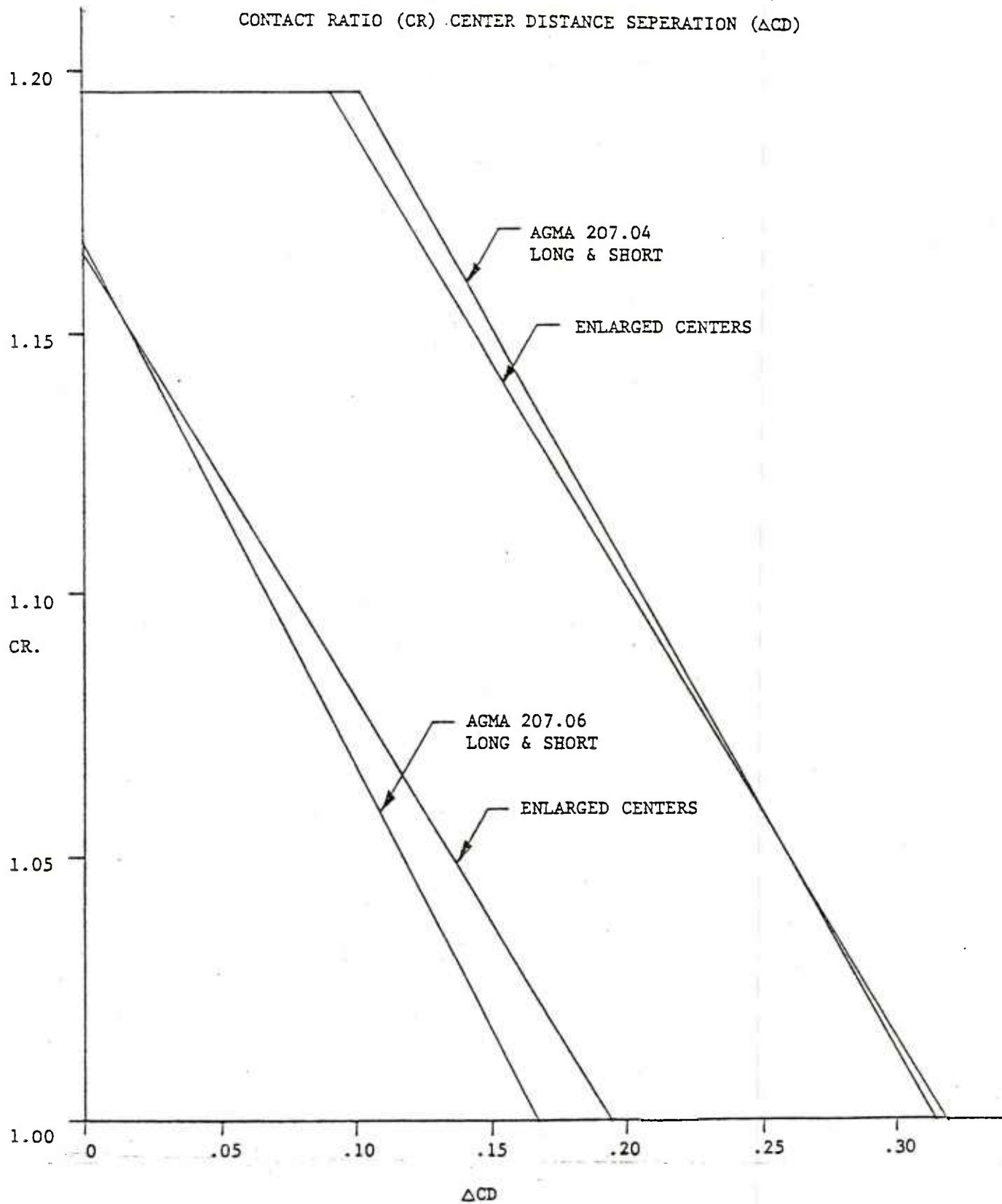
$$\text{For 207.04 } L = \text{Lesser of } \frac{1.2728}{.9559} + \text{lessor of } \frac{2.5603}{5.4853} = 3.5162$$

$$\text{For 207.06 } L = \text{Lesser of } \frac{.7690}{1.1691} + \text{lessor of } \frac{2.6643}{6.0494} = 3.4333$$

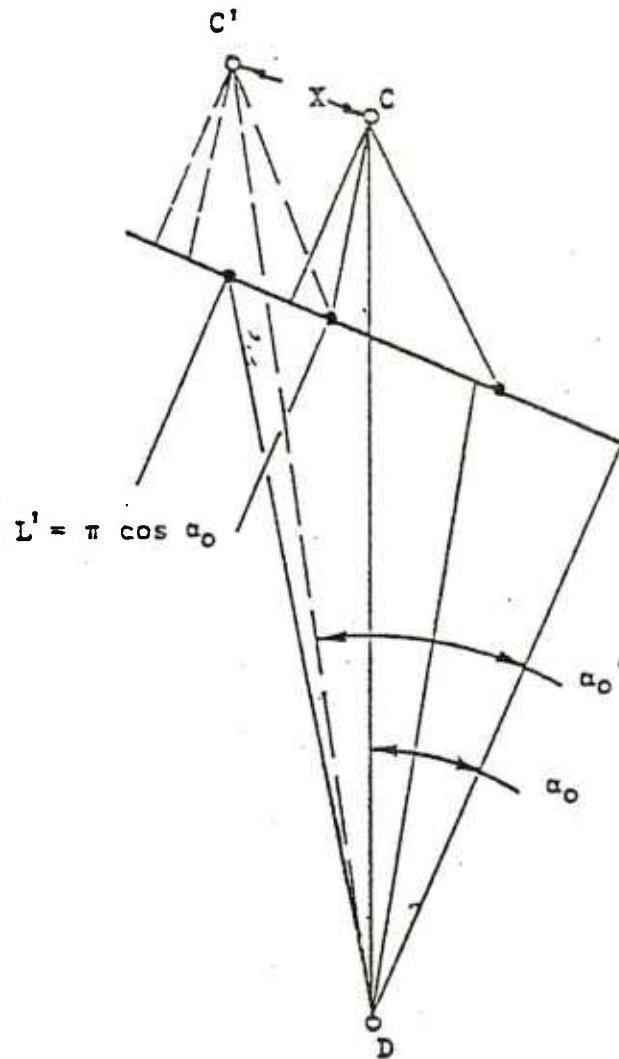
Dividing this length (L) by the base pitch ($\pi \cos \alpha$) gives the contact ratio (CR) for each set.

$$CR = 1.191 \text{ for 207.04}$$

$$= 1.163 \text{ for 207.06}$$



If the pinion center (C) is translated a dist X parallel to L until $L' = \pi \cos \alpha_o$ (CR = 1) the distance C'D equals the maximum center distance for full involute action. The operating pressure angle at this center distance is α'_o



$$X = A_{\text{gear}} + A_{\text{pinion}} - \pi \cos \alpha_o$$

$$\overline{C'D} = \sqrt{(\overline{CD} + X \sin \alpha_o)^2 + X^2 \cos^2 \alpha_o}$$

$$\Delta_{CD} = \overline{C'D} - \overline{CD}$$

$$\alpha'_o = \tan^{-1} \frac{X + \overline{CD} \sin \alpha_o}{\overline{CD} \cos \alpha_o}$$

To evaluate the "enlarged center distance" system the following additional computations are required to determine the operating pressure angle (α_1), the center distance at tightest mesh ($\overline{CD}_1$) and the operating pitch radii (Rp_1).

$$\alpha_1 = \text{inv}^{-1} \left(\text{inv } \alpha_o + \frac{t_G + t_p - \pi}{N_G + N_p} \right)$$

Buckingham
"Analytical Mechanics
of Gears", P. 96

$$\overline{CD}_1 = \frac{N_G + N_p}{2} \frac{\cos \alpha_o}{\cos \alpha_1}$$

$$Rp_1 (\text{gear}) = \frac{N_G}{N_G + N_p} (\overline{CD}_1)$$

$$Rp_1 (\text{pinion}) = \frac{N_p}{N_G + N_p} (\overline{CD}_1)$$

where α_o = generating pressure angle

t_p = arc thickness of pinion at the generating pressure angle α_o

t_G = arc thickness of gear at the generating pressure angle α_o

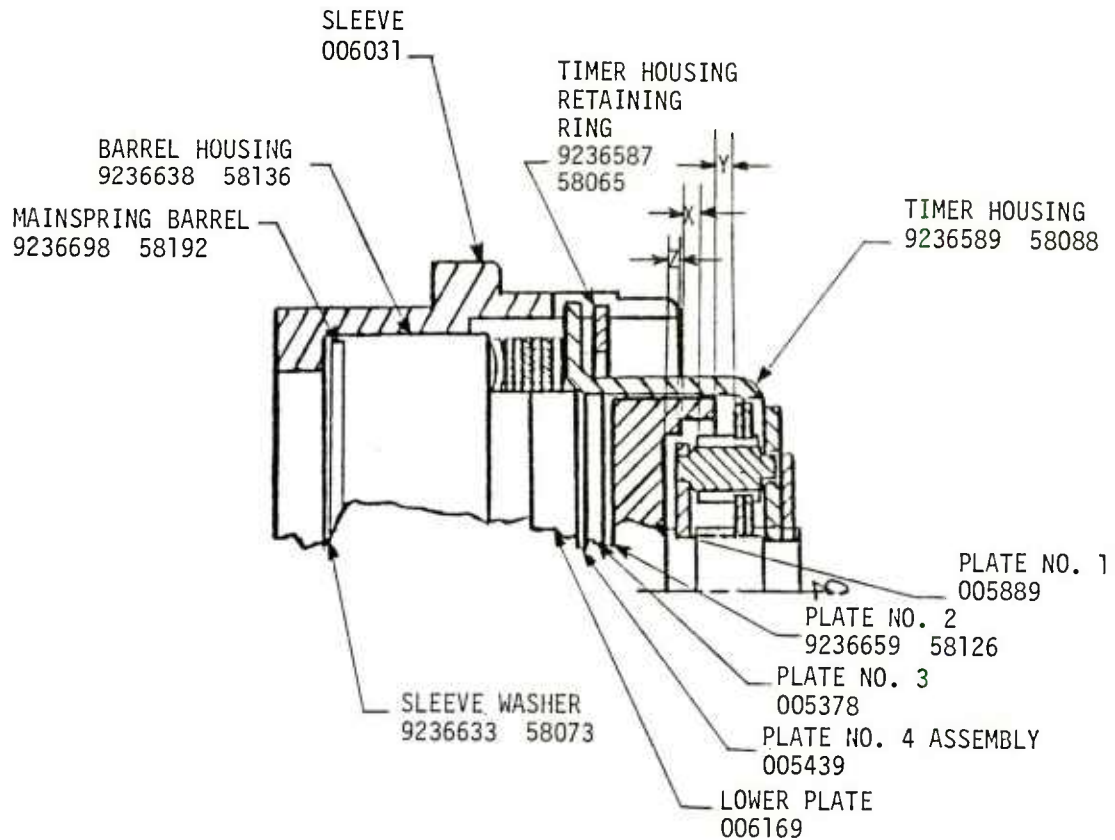
N_G = No. of gear teeth

N_p = No. of pinion teeth

The values of A, B, L, X, Δ_{CD} and α_o' can now be calculated as before.

APPENDIX C
TOLERANCE STUDIES

TOLERANCE STUDIES FOR PIP DESIGNED PLATE
NO. 1



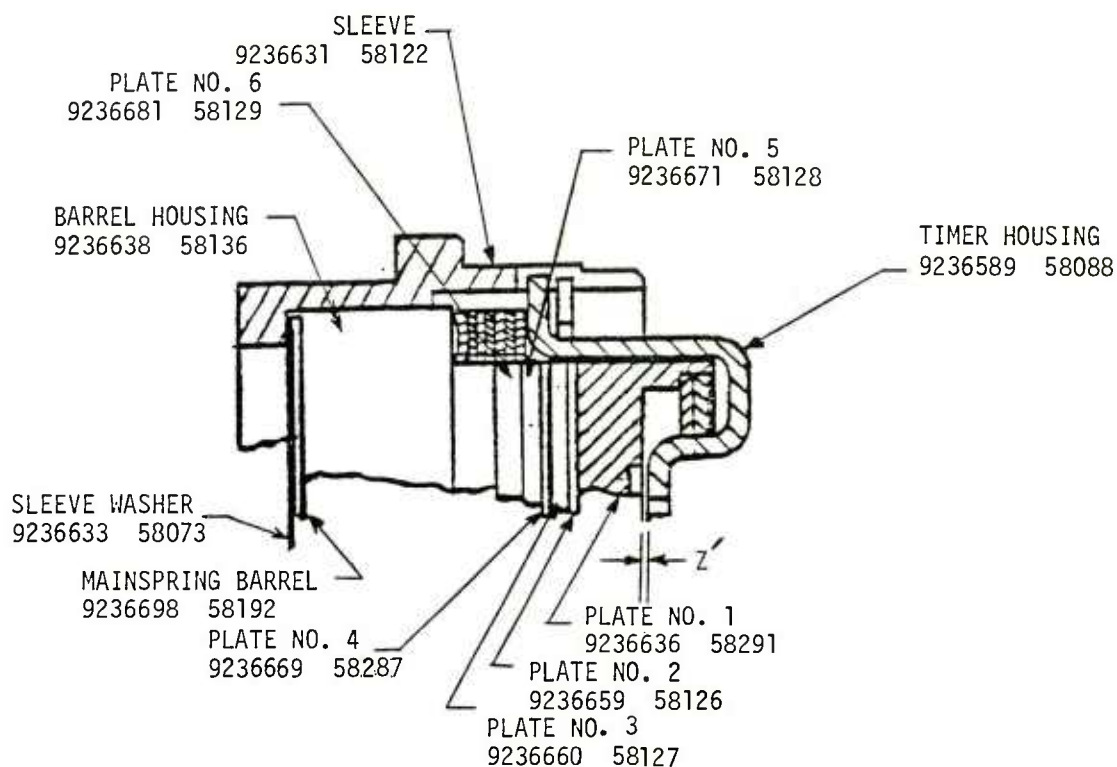
Tolerance study to determine the clearance between the setting pinion and shelf of the PIP designed plate no. 1 when assembled (shown as dimension X).

		+	-
Plate #1	(-) .236	-.005	
Plate #2	(-) .025	-.001	+.001
Plate #3	(-) .052	-.002	
Plate #4	(-) .0225	-.0035	
Lower Plate	(-) .136	-.002	+.002
Barrel Housing	(-) .562	-.003	
Mainspring Barrel	(-) .027	-.004	
Mainspring Barrel	(-) .006	-.002	+.002
Sleeve Washer	(-) .012	-.0015	
Sleeve	.805		-.004
Retainer Ring	(-) .035	-.002	.002
Timer Housing	(-) .056	-.006	
Timer Housing	.622		-.005
Timer Housing	(-) .225		+.005
Setting Pinion	.026	+.003	

$$X = .0585 + .035 - .021$$

$$X = .0375 / .0935$$

TOLERANCE STUDIES FOR THE PRESENT NO. 1 PLATE



Tolerance study that determines the clearance between the counterbore of the present Plate #1 and the Timer Housing. (Shown as Dimension Z'.)

		+	-
Plate #1	(-) .183	-.005	
Plate #2	(-) .025	-.001	+.001
Plate #3	(-) .052	-.002	
Plate #4	(-) .0225	-.0035	
Plate #5	(-) .071	-.001	+.001
Plate #6	(-) .066	-.002	
Barrel Housing	(-) .562	-.003	
Mainspring Barrel	(-) .027	-.004	
Mainspring Barrel	(-) .006	-.002	+.002
Sleeve Washer	(-) .012	-.0015	
Sleeve	.780		-.004
Retainer Ring	(-) .035	-.002	+.002
Timer Housing	(-) .056	-.006	
Timer Housing	.622		-.005
Timer Housing	(-) .225		+.005
Timer Housing	(-) .052	-.010	

$$Z' = .0075 \quad +.043 \quad -.020$$

$$Z' = .0505 / -.0125$$

Tolerance study to determine the clearance between the Timer Housing and the well area of the PIP designed Plate #1. (Shown as Dimension Z.)

		+	-
Plate #1	(-) .158	-.005	
Plate #2	(-) .025	-.001	+.001
Plate #3	(-) .052	-.002	
Plate #4	(-) .0225	-.0035	
Lower Plate	(-) .136	-.002	+.002
Barrel Housing	(-) .562	-.003	
Mainspring Barrel	(-) .027	-.004	
Mainspring Barrel	(-) .006	-.002	+.002
Sleeve Washer	(-) .012	-.0015	
Sleeve	.805		-.004
Retainer Ring	(-) .035	-.002	+.002
Timer Housing	(-) .056	-.006	
Timer Housing	.622		-.005
Timer Housing	(-) .225		+.005
Timer Housing	(-) .052	-.010	

$$Z = .0585 \quad +.042 \quad -.021$$

$$Z = .1005 / .0375$$

Tolerance study to determine the clearance between the top of the PIP designed Plate #1 and the Timer Housing. (Shown as Dimension Y.)

		+	-
Plate #1	(-) .412	-.010	
Plate #2	(-) .025	-.001	+.001
Plate #3	(-) .052	-.002	
Plate #4	(-) .0225	-.0035	
Lower Plate	(-) .136	-.002	+.002
Barrel Housing	(-) .562	-.003	
Mainspring Barrel	(-) .027	-.004	
Mainspring Barrel	(-) .006	-.002	+.002
Sleeve Washer	(-) .012	-.0015	
Sleeve	.805		-.004
Retainer Ring	(-) .035	-.002	.002
Timer Housing	(-) .056	-.006	
Timer Housing	.622		-.005
Timer Housing	(-) .052	-.004	

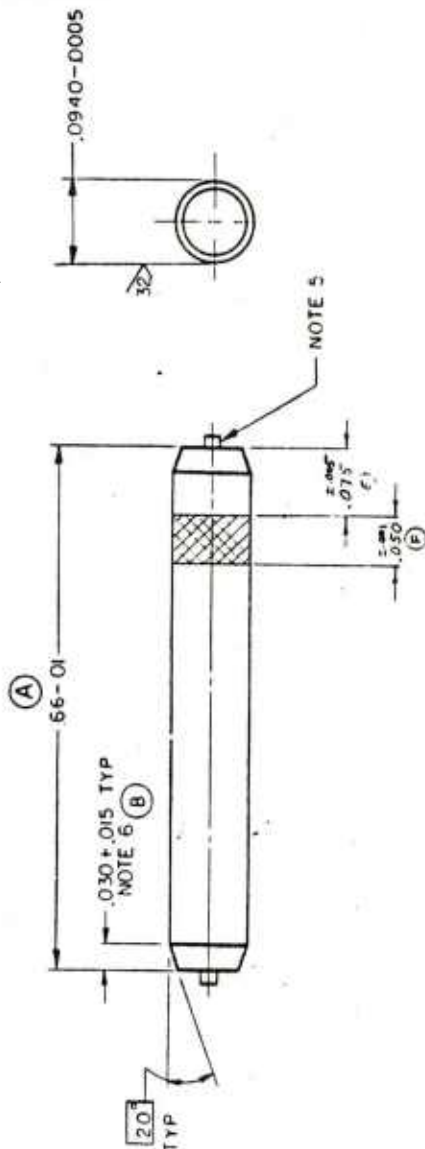
$$Y = .0295 \quad +.041 \quad -.011$$

$$Y = .0705 / .0185$$

APPENDIX D
DRAWINGS



REVISIONS			
SYM	DESCRIPTION	DATE	APPR
—	ERR7200346-1 (REL)	08-28-72	
A	NOR73C1405-1/12-28-73	09-30-74	
B	NOR74C0006-1/02-05-74	06-30-75	
C	NOR75C0163-1/02-25-75	760825	
D	NOTE 7 ADDED	2-1-84	
E	DIMENSIONS TO KUURL ADDED	2-1-84	
F	DATA INFO, BOX ADDED	2-1-84	



- NOTES:-
- 1- SPEC MIL-A-2550 APPLIES.
 - 2 MATERIAL:-FREE MACHINING STAINLESS AND HEAT-RESISTING STEEL WIRE, COLD FINISHED, TYPE 416 OR 416 S, COND A, T OR H, ASTM A581.
 - 3 ALTERNATIVE MATERIAL:-STAINLESS AND HEAT-RESISTING STEEL WIRE, COLD FINISHED, TYPE 410, ASTM A580.
 - 4-12% ALL OVER, EXCEPT AS NOTED.
 - 5-.02 DIA MAX X .02 MAX LONG CUT OFF BURR PERMISSIBLE, BOTH ENDS.
 - 6-KEY AUTOMATIC ASSEMBLY DIMENSION.
 - 7-DIAMOND KUURL FINISH IN SHOWN SPECIFIED AREA.

DIAMOND KUURL DATA
PER ASA B946-1966

* DIAMETRAL PITCH 160
BLANK DIA. .0940-.0945
MAX. KUURL DIA. .0945

* APPROXIMATE "TPI" IS 51.

PART NO. 9236637

U S ARMY ALLEGENT RESEARCH AND DEVELOPMENT CON/DOVER, NEW JERSEY 07801

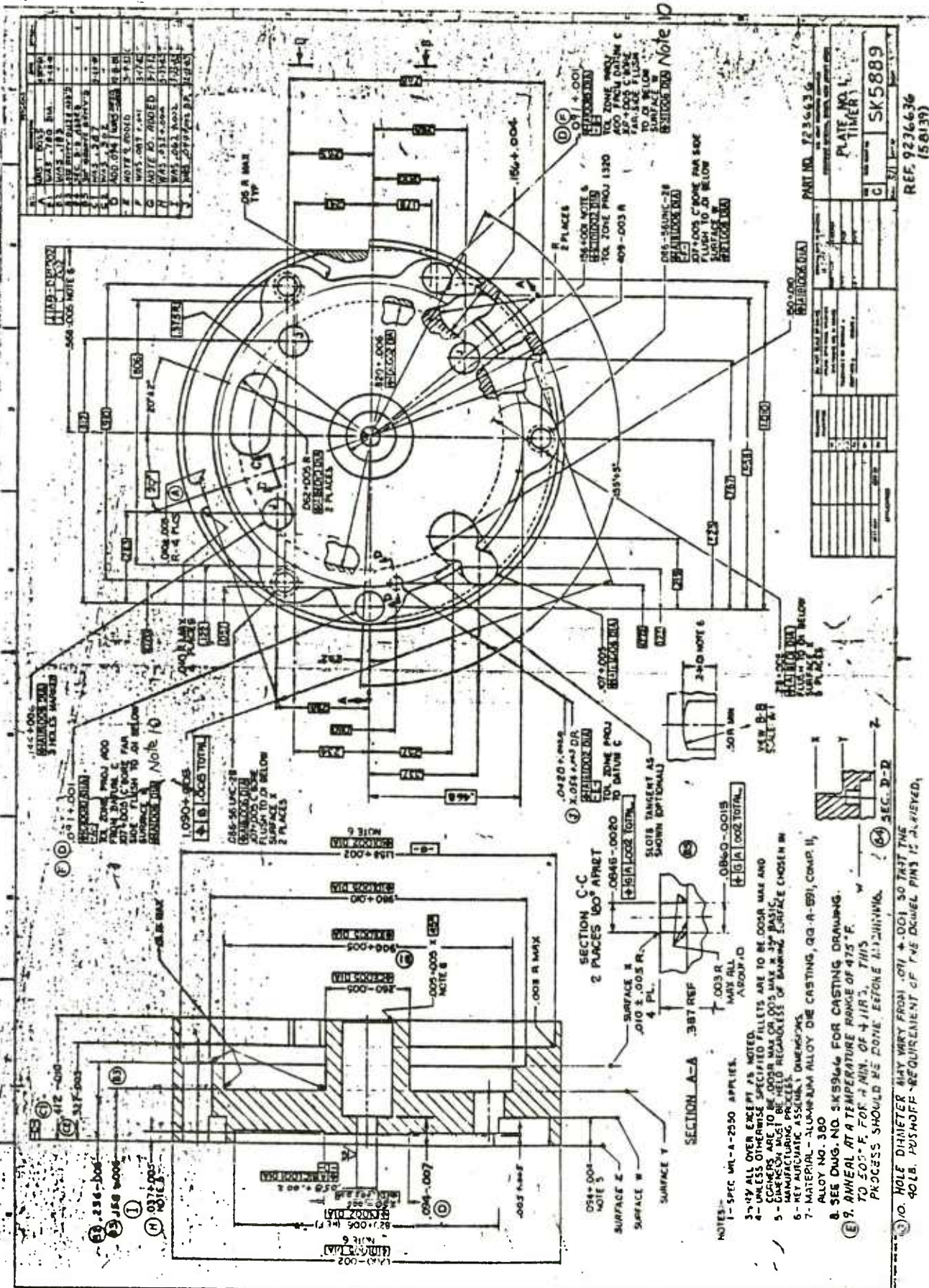
PIN, DOWEL, TIMER

SIZE	CODE CONT NO	9236637
C	19200	
SCALE 10/1	UNIT WT.	SHEET

(A)

MECHANICAL PROPERTIES		DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	
YR	TS	ENGINEER	CHECKER
EL2	RA	ENGINEER	ENGINEER
TOLERANCES ON DECIMALS * FRACTIONS * ANGLES *			
KNOCK-OUT HARDNESS 278-405 (500 GRAM LOAD)			
9236712 FUZE, M522			
9236635 FUZE, M577			
NEXT ASSY USED ON			
APPLICATION			

(C)



GEAR DATA

NUMBER OF TEETH	60
DIA METRIC PITCH	64
PRESSURE ANGLE	20°
PITCH DIAMETER	9.75
TOOTH FORM	INVOLUTE
TOTAL COMPOSITE ERROR (NOTES 8, 11)	.0020
TOOTH 13 TOOTH COMP. ERROR (NOTE 11)	.0010
MANUFACTURER (REF)	979
CIRCULAR TOOTH THICKNESS	.0245
AGMA PRECISION CLASS (REF)	1A

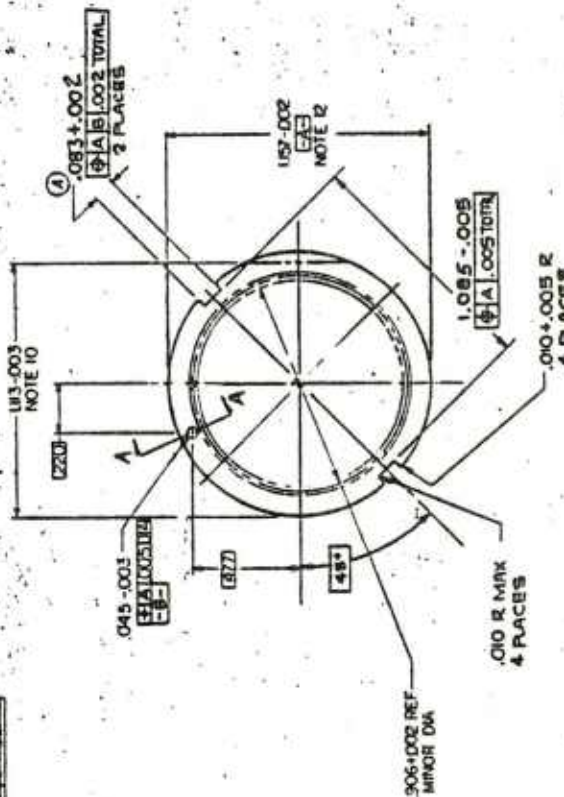
TABLE

ITEM NO.	QTY	QTY	QTY
2-34642-11031-002	102 MIN	2 REQ	REF.
2-34642-11031-002	102 MIN	2 REQ	REF.

NOTES: (CONT.)

- 12 - 1.158 MAX DIA PERMITTED PROVIDED THE REQUIREMENTS OF DWS 9236635 ARE MET.
- 13 - ALTERNATIVE MATERIAL - HIGH STRENGTH STAINLESS AND HEAT-RESISTING CHROMIUM-NICKEL STEEL SHEET AND STRIP TYPE 301, COLD-ROLLED, 1/4 HARD MIN, ASTM A177.
- 14 - 1.113 DIMENSION OPTIONAL, EXCEPT FOR COMPONENTS TO BE ASSEMBLED ON AUTOMATIC TIMER ASSEMBLY EQUIPMENT.

M101

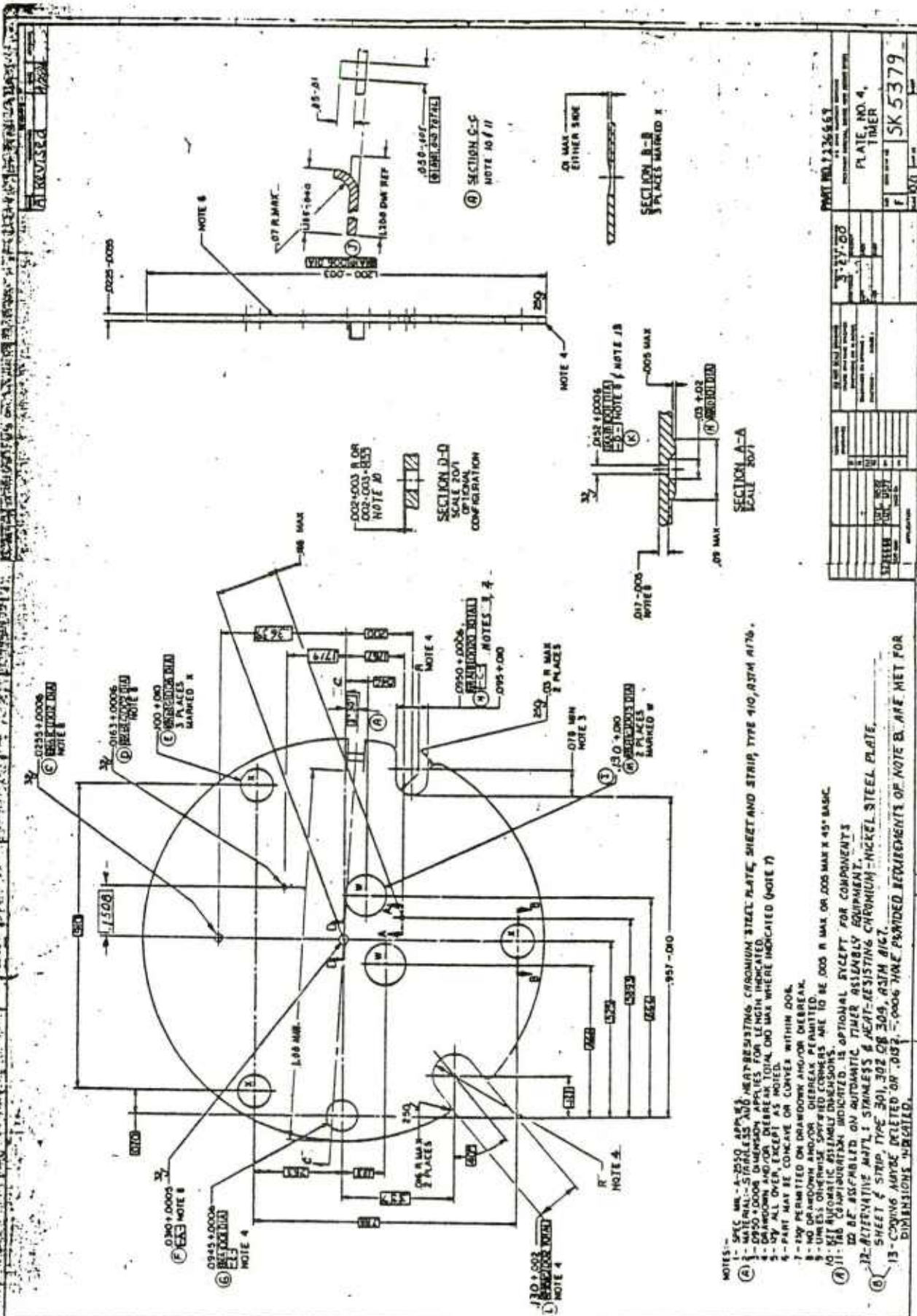


- NOTES:-
- 1 - SPEC MIL-A-2550 APPLIES
 - 2 - MATERIAL - STAINLESS AND HEAT-RESISTING CHROMIUM-NICKEL STEEL PLATE, SHEET AND STRIP, TYPE 301, ASTM A177. (SEE NOTE 13)
 - 3 - 12° ALL OVER EXCEPT ON FACE AND FLANKS OF TEETH UNLESS OTHERWISE SPECIFIED.
 - 4 - PART MAY BE CONVEX OR CONCAVE WITHIN .005.
 - 5 - PERMITTED AROUND ENTIRE INTERNAL AND EXTERNAL PROFILE.
 - 6 - UNLESS OTHERWISE SPECIFIED FILLETS ARE TO BE .005R MAX AND CORNERS ARE TO BE .005R MAX OR .005 MAX X 45° BASIC.
 - 7 - PERMISSIBLE DRAWDOWN AND/OR DIEBREAK ZONE.
 - 8 - TOTAL COMPOSITE ERROR APPLIES WITH RESPECT TO $\square A$.
 - 9 -

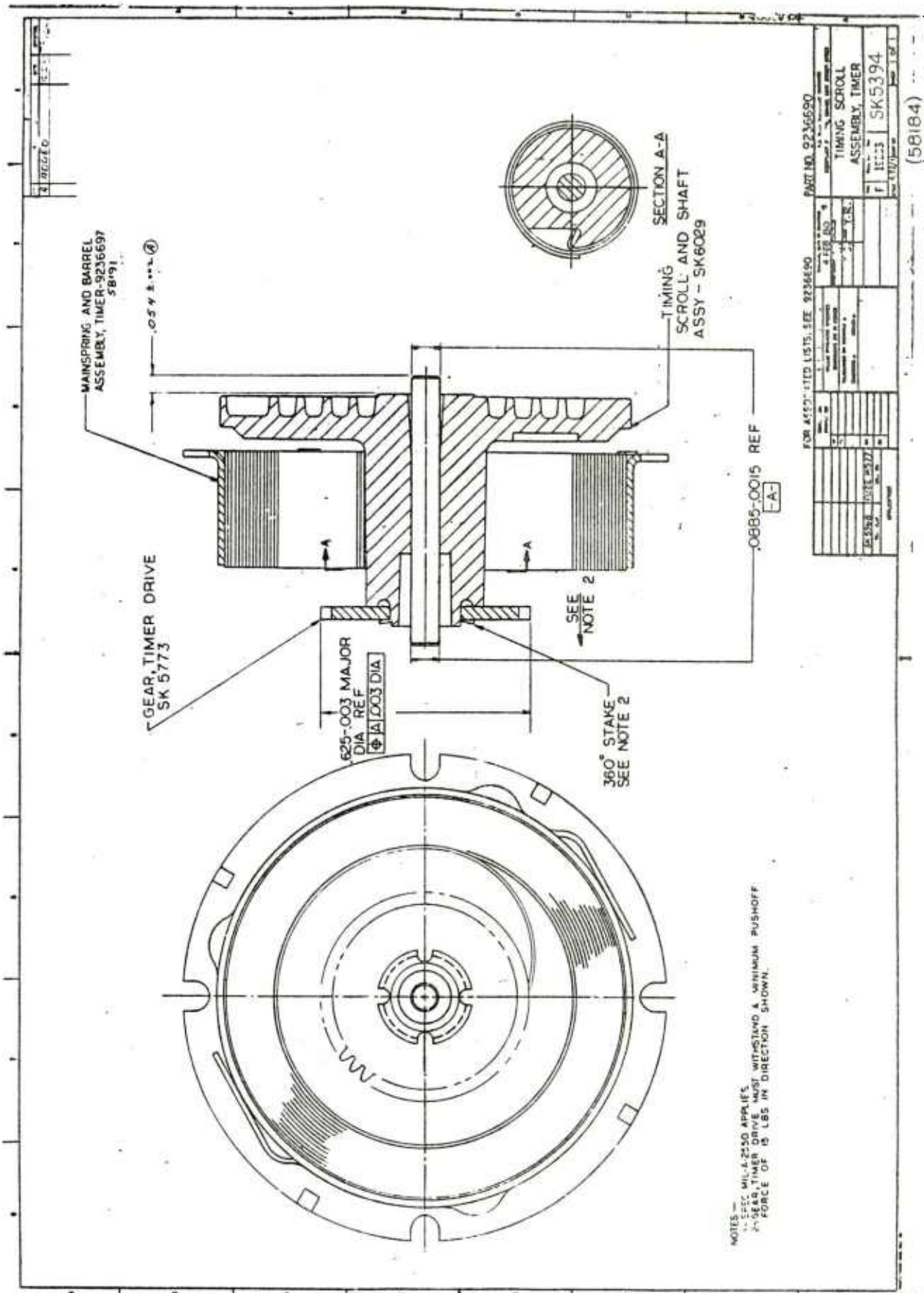
SECTION A-A
SCALE 20/1

PART NO. SEE TABLE		GEAR SETTING		RING, TIMER	
D 19200		SK 5912		D 19200	
DATE 3/1/72		DATE 3/1/72		DATE 3/1/72	
BY 3/1/72		BY 3/1/72		BY 3/1/72	
CHECKED 3/1/72		CHECKED 3/1/72		CHECKED 3/1/72	
APPROVED 3/1/72		APPROVED 3/1/72		APPROVED 3/1/72	

- 10 - KEY AUTOMATIC ASSEMBLY DIMENSION.
- 11 - .003 TOTAL COMPOSITE ERROR AND .002 TOOTH TO TOOTH COMPOSITE ERROR PERMITTED PROVIDED THE REQUIREMENTS OF DRAWINGS 9236569, 9236500 AND 9236700 ARE MET.



- NOTES:
- 1- SPEC. MR. 4-2510 APP. 11
 - 2- MATERIAL: STAINLESS STEEL PLATE, SHEET AND STRIP, TYPE 304, ASTM A166.
 - 3- 0.010 ± 0.005 DIMENSION APPLIES FOR LENGTH INDICATED.
 - 4- DRAWN AND/OR DIEBREAK TOTAL, DIM. MAX. WHERE INDICATED (NOTE 7).
 - 5- 1/4" ALL OVER, EXCEPT AS NOTED.
 - 6- PART MAY BE CONVEX OR CONCAVE WITHIN DIM.
 - 7- 25° PERMITTED ON DRAWN AND/OR DIEBREAK.
 - 8- NO DRAWN AND/OR DIEBREAK PERMITTED.
 - 9- UNLESS OTHERWISE SPECIFIED CORNERS ARE TO BE 0.005 R MAX. OR 0.005 MAX. X 45° BASIC.
 - 10- 1/4" DIMENSION INDICATED IS OPTIONAL EXCEPT FOR COMPONENTS.
 - 11- 1/4" DIMENSION INDICATED IS OPTIONAL EXCEPT FOR COMPONENTS.
 - 12- ALTERNATIVE MAT'L: STAINLESS STEEL-RESISTING CHROMIUM-NICKEL STEEL PLATE.
 - 13- SHEET & STRIP, TYPE 304, 302 OR 309, ASTM A166.
 - 14- DIMENSIONS MAY BE OBTAINED ON 0.002 ± 0.004 TYP. PROVIDED REQUIREMENTS OF NOTE B ARE MET FOR DIMENSIONS INDICATED.



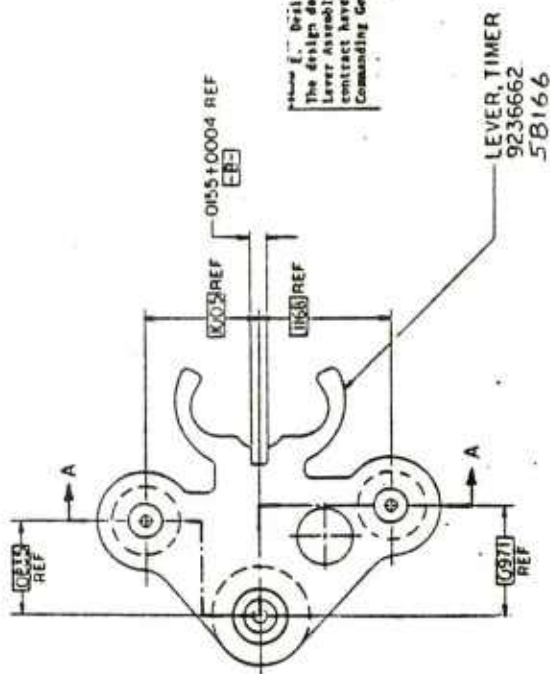
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1. NAME OF THE PARTY 2. ADDRESS 3. CITY 4. STATE 5. ZIP CODE 6. PHONE NUMBER 7. FAX NUMBER 8. E-MAIL ADDRESS 9. WEBSITE 10. OTHER INFORMATION										11. NAME OF THE PARTY 12. ADDRESS 13. CITY 14. STATE 15. ZIP CODE 16. PHONE NUMBER 17. FAX NUMBER 18. E-MAIL ADDRESS 19. WEBSITE 20. OTHER INFORMATION										21. NAME OF THE PARTY 22. ADDRESS 23. CITY 24. STATE 25. ZIP CODE 26. PHONE NUMBER 27. FAX NUMBER 28. E-MAIL ADDRESS 29. WEBSITE 30. OTHER INFORMATION										31. NAME OF THE PARTY 32. ADDRESS 33. CITY 34. STATE 35. ZIP CODE 36. PHONE NUMBER 37. FAX NUMBER 38. E-MAIL ADDRESS 39. WEBSITE 40. OTHER INFORMATION										41. NAME OF THE PARTY 42. ADDRESS 43. CITY 44. STATE 45. ZIP CODE 46. PHONE NUMBER 47. FAX NUMBER 48. E-MAIL ADDRESS 49. WEBSITE 50. OTHER INFORMATION										51. NAME OF THE PARTY 52. ADDRESS 53. CITY 54. STATE 55. ZIP CODE 56. PHONE NUMBER 57. FAX NUMBER 58. E-MAIL ADDRESS 59. WEBSITE 60. OTHER INFORMATION										61. NAME OF THE PARTY 62. ADDRESS 63. CITY 64. STATE 65. ZIP CODE 66. PHONE NUMBER 67. FAX NUMBER 68. E-MAIL ADDRESS 69. WEBSITE 70. OTHER INFORMATION										71. NAME OF THE PARTY 72. ADDRESS 73. CITY 74. STATE 75. ZIP CODE 76. PHONE NUMBER 77. FAX NUMBER 78. E-MAIL ADDRESS 79. WEBSITE 80. OTHER INFORMATION										81. NAME OF THE PARTY 82. ADDRESS 83. CITY 84. STATE 85. ZIP CODE 86. PHONE NUMBER 87. FAX NUMBER 88. E-MAIL ADDRESS 89. WEBSITE 90. OTHER INFORMATION										91. NAME OF THE PARTY 92. ADDRESS 93. CITY 94. STATE 95. ZIP CODE 96. PHONE NUMBER 97. FAX NUMBER 98. E-MAIL ADDRESS 99. WEBSITE 100. OTHER INFORMATION									

[illegible]



Section I. Design Information
The design data presented on Neg. No. 9236461
Lever Assembly, Tiner and all aspects of this
contract have been declassified by Authority,
Commanding General, ARSCON, dated 14 July 1976

NOTES —
1- SPEC MIL-A-2550 APPLIES.
2- STAKING MUST WITHSTAND A PUSH-OFF FORCE
OF 2 LB MIN IN DIRECTION SHOWN.

FOR ASSOCIATED LISTS SEE 9236661

PART NO. 9235661

LEVER ASSEMBLY,
TIMER

SK 5410

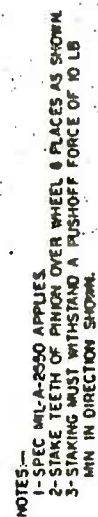
9203

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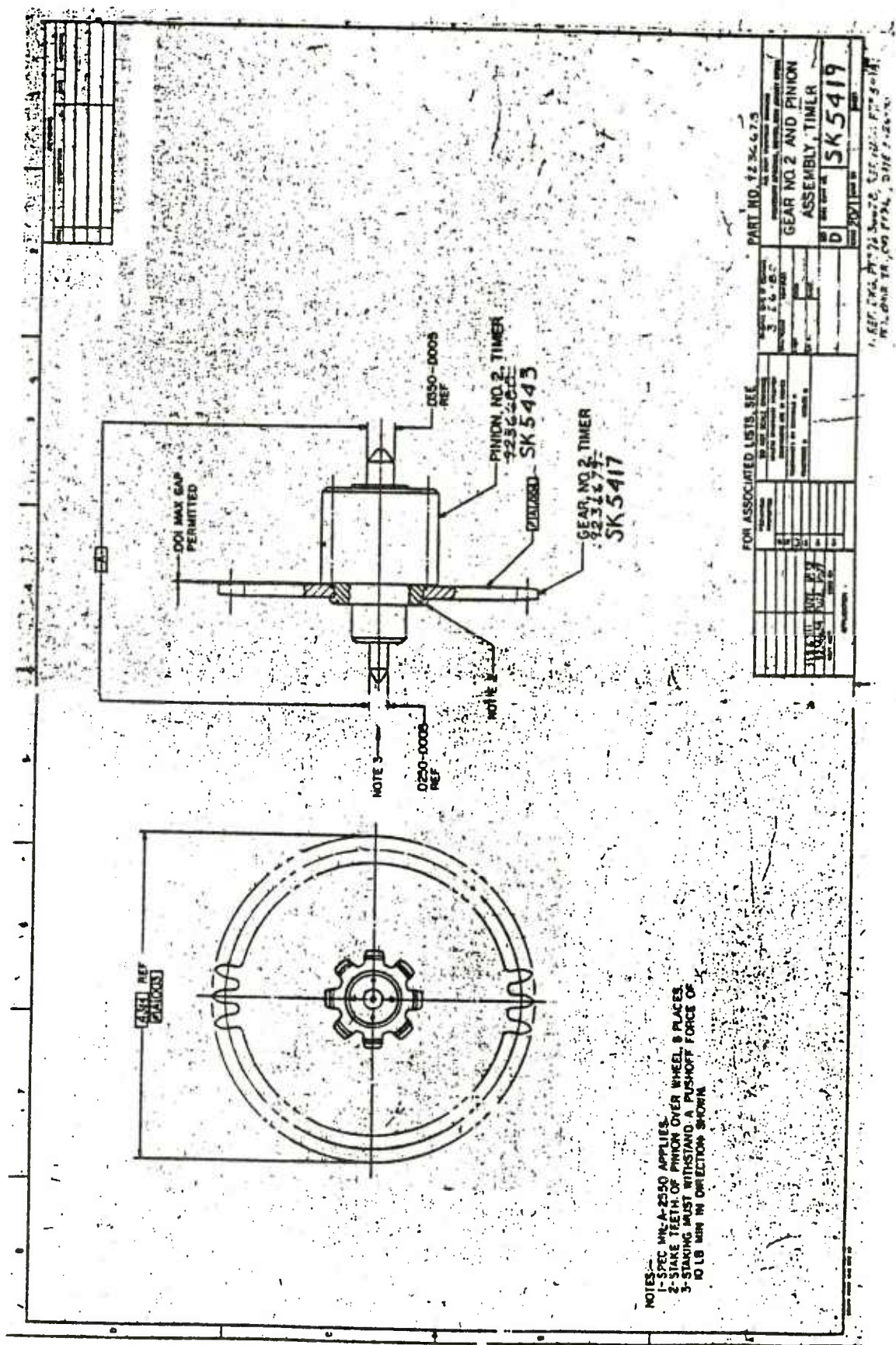
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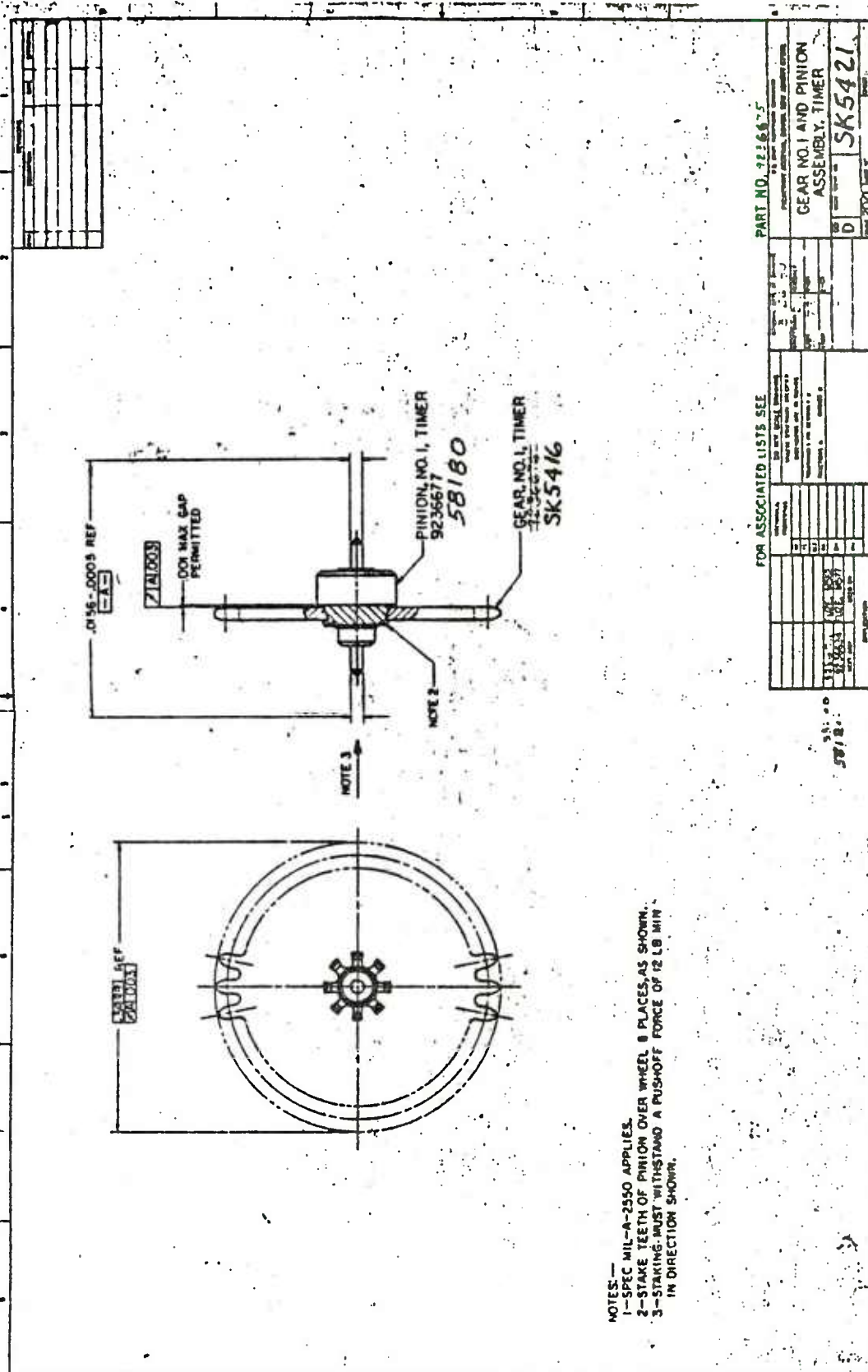
FOR ASSOCIATED LISTS		20 MAY 1957		UNITED STATES DEPARTMENT OF COMMERCE		BUREAU OF ECONOMIC ANALYSIS	
NAME OF ASSOCIATION		ADDRESS		CITY		STATE	
AMERICAN ASSOCIATION OF UNIVERSITY PROFESSORS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
AMERICAN ASSOCIATION OF COLLEGE PROFESSORS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
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AMERICAN ASSOCIATION OF MUSICIANS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
AMERICAN ASSOCIATION OF PLAYERS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
AMERICAN ASSOCIATION OF WRITERS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
AMERICAN ASSOCIATION OF ACTORS		1201 16TH STREET, N.W.		WASHINGTON, D.C.		D.C.	
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NOTES:
 1- SPEC MTL-A-2550 APPLIES.
 2- STAKE TEETH OF PINION OVER WHEEL 8 PLACES.
 3- STAKING MUST WITHSTAND A PUSHOFF FORCE OF 10 LB MIN IN DIRECTION SHOWN.

- 1- SPEC MIL-A-2550 APPLIES.
- 2-MATERIAL; FREE MACHINING STAINLESS AND HEAT RESISTING STEEL WIRE TYPE 416 OR 416S₄ CONDITION A, T, OR H. ~~ASTM A581~~ ASTM A581.
- 3-LONG ADDENDUM INVOLUTE TOOTH FORM . GENERATE USING STANDARD HOB POSITIONED AT .0079 GREATER THAN STANDARD CENTER DISTANCE.(REF)
- 4- DRIVE POINT INDENTATIONS ARE PERMISSIBLE ON EITHER FACE. THERE SHALL BE NO RAISED METAL RESULTING FROM THE DRIVE POINT INDENTATIONS.
- 5- 32(ENTIRE TOOTH PROFILE).
- 6- 12½ ALL OVER, EXCEPT AS NOTED.
- 7- UNLESS OTHERWISE SPECIFIED FILLETS ARE TO BE .005R. MAX. AND CORNERS ARE TO BE .005R MAX OR .005 MAX. X[45°].



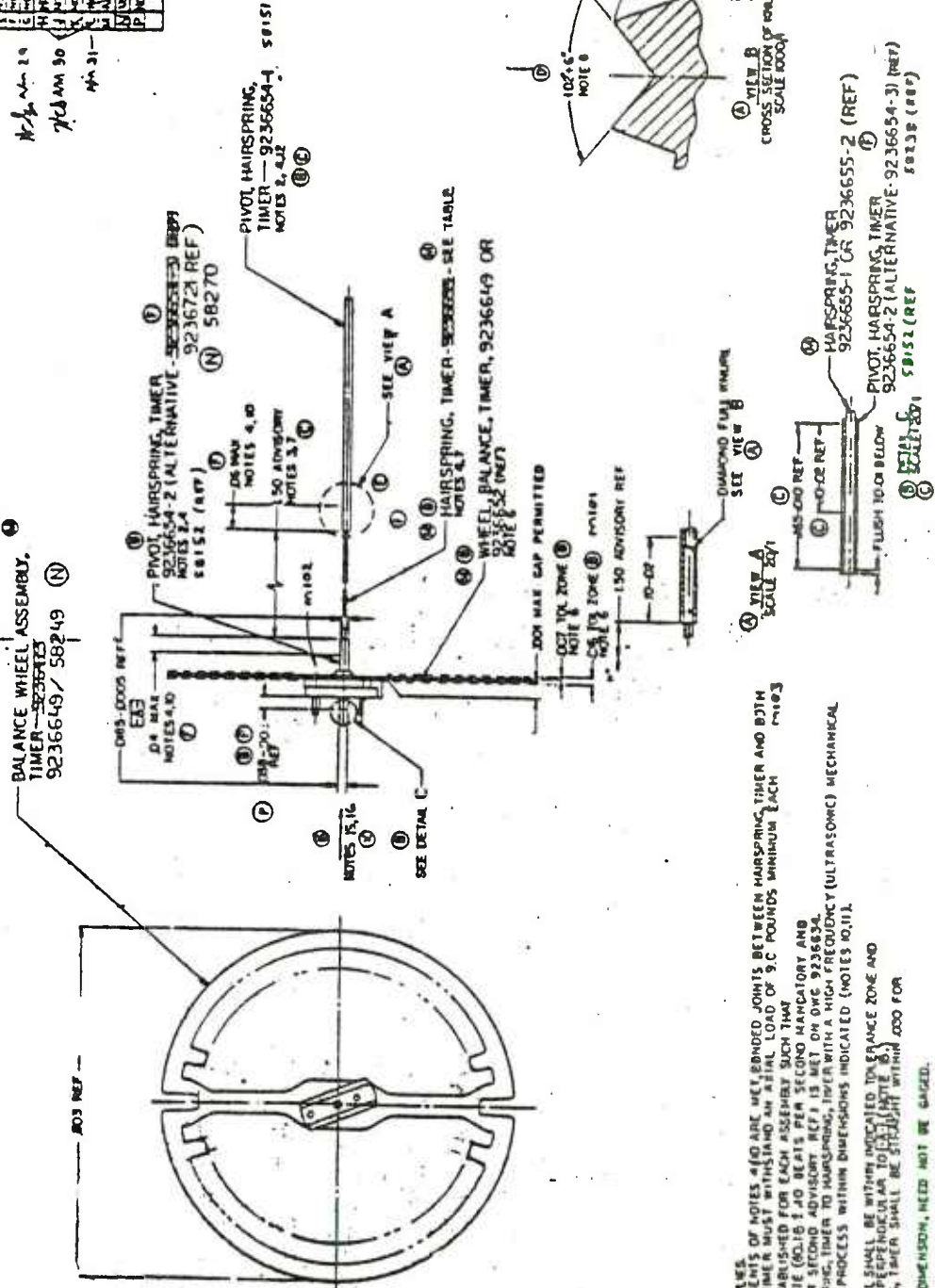


NOTES:—
 1—SPEC MIL-A-2550 APPLIES.
 2—STAKE TEETH OF PINION OVER WHEEL 8 PLACES, AS SHOWN.
 3—STARTING MUST WITHSTAND A PUSH-OFF FORCE OF 12 LB MIN IN DIRECTION SHOWN.



411-21-06
06 WSPK
01 WSPK

2025



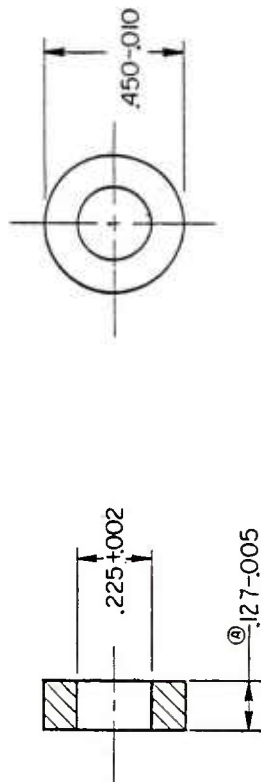
NOTES—

- NOTES:-
- 1- SPEC WH- A- 2550 APPLIES
 - 2- AFTER THE REQUIREMENTS OF NOTES 4, 6 ARE MET, BOND JOINTS BETWEEN HAIRSPRING, TIMER AND BDM PIVOTS, HAIRSPRING, TIMER MUST WITHSTAND AN AXIAL LOAD OF 9 C POUNDS MINIMUM EACH
 - 3- DIMENSION TO BE ESTABLISHED FOR EACH ASSEMBLY SUCH THAT A SPECIFIED BEAT RATE (20.16) JO BEATS PER SECOND MANDATORY
 - 4- BEAT RATE (20.16) JO BEATS PER SECOND ADVISORY RC F1 IS MET ON Dwg 9236634.
 - 5- BOND PIVOT, HAIRSPRING, TIMER TO HAIRSPRING, TIMER WITH A HIGH FREQUENCY (ULTRASONIC) MECHANICAL VIBRATION BONDING PROCESS WITHIN DIMENSIONS INDICATED (NOTES 10, 11).
 - 6- TIMER BALANCE WEIGHT SHALL BE WITHIN INDICATED TOLERANCE ZONE AND THIS ZONE SHALL BE REPEATED FOR BOTH PIVOTS (B1, B2)
 - 7- ADVISORY: HAIRSPRING, TIMER SHALL BE STRUTTED WITHIN .000 FOR INDICATED LENGTH.
 - 8- TOOLING REFERENCE DIMENSION, NEED NOT BE GAGED.
 - 9- THE REMOVAL OF EXCESS MATERIAL, PRODUCED BY BONDING PROCESS PERMITTED WITHIN DIMENSIONS INDICATED.
 - 10- ADVISORY: RECOMMENDED ASSEMBLY EQUIPMENT, Dwg 9236706, MAY BE USED TO PERFORM BONDING PROCESS.
 - 11- ALTERNATE: PIVOT, HAIRSPRING TIMER- 9236634-4 MAY BE USED.
 - 12- THE REQUIREMENTS OF NOTES 6 ARE OPTIONAL, PROVIDED THE REQUIREMENTS OF NOTE 13 ON Dwg 9236635 (641910) ARE MET.
 - 13- ADVISORY MATERIAL MAY BE REMOVED FROM TIMERS TO A .360" RADIUS MAXIMUM TO ASSIST IN FORGING THE WHEEL ASST. 9236707 (542193).
 - 14- PIVOT, HAIRSPRING, TIMER MUST WITHSTAND A PUSH/PULL FORCE OF 6 LBS MIN IN DIRECTION SHOWN (NOTES 10, 11).
 - 15- THE REQUIREMENTS OF NOTE 15 ARE OPTIONAL PROVIDED THE REQUIREMENTS OF Dwg 9236707 (542193) ARE MET.
 - 16- ADVISORY: .002 MAX DIA HOLES MAY BE PLACED ON A .753 DIA ON TAB 100° ADJNET TO ADJUST THE BEAT RATE OF THE TIMER ASSEMBLY- 90236634.

FOR ASSOCIATED LISTS, SEE 9236647		PART NO. 9236647	
1. DESCRIPTION 2. QUANTITY 3. UNIT 4. PRICE 5. TOTAL 6. DATE 7. BY 8. REMARKS		9. DATE 10. TIME 11. LOCATION 12. STATUS 13. REMARKS 14. DATE 15. TIME 16. LOCATION 17. STATUS 18. REMARKS 19. DATE 20. TIME 21. LOCATION 22. STATUS 23. REMARKS 24. DATE 25. TIME 26. LOCATION 27. STATUS 28. REMARKS 29. DATE 30. TIME 31. LOCATION 32. STATUS 33. REMARKS 34. DATE 35. TIME 36. LOCATION 37. STATUS 38. REMARKS 39. DATE 40. TIME 41. LOCATION 42. STATUS 43. REMARKS 44. DATE 45. TIME 46. LOCATION 47. STATUS 48. REMARKS 49. DATE 50. TIME 51. LOCATION 52. STATUS 53. REMARKS 54. DATE 55. TIME 56. LOCATION 57. STATUS 58. REMARKS 59. DATE 60. TIME 61. LOCATION 62. STATUS 63. REMARKS 64. DATE 65. TIME 66. LOCATION 67. STATUS 68. REMARKS 69. DATE 70. TIME 71. LOCATION 72. STATUS 73. REMARKS 74. DATE 75. TIME 76. LOCATION 77. STATUS 78. REMARKS 79. DATE 80. TIME 81. LOCATION 82. STATUS 83. REMARKS 84. DATE 85. TIME 86. LOCATION 87. STATUS 88. REMARKS 89. DATE 90. TIME 91. LOCATION 92. STATUS 93. REMARKS 94. DATE 95. TIME 96. LOCATION 97. STATUS 98. REMARKS 99. DATE 100. TIME 101. LOCATION 102. STATUS 103. REMARKS 104. DATE 105. TIME 106. LOCATION 107. STATUS 108. REMARKS 109. DATE 110. TIME 111. LOCATION 112. STATUS 113. REMARKS 114. DATE 115. TIME 116. LOCATION 117. STATUS 118. REMARKS 119. DATE 120. TIME 121. LOCATION 122. STATUS 123. REMARKS 124. DATE 125. TIME 126. LOCATION 127. STATUS 128. REMARKS 129. DATE 130. TIME 131. LOCATION 132. STATUS 133. REMARKS 134. DATE 135. TIME 136. LOCATION 137. STATUS 138. REMARKS 139. DATE 140. TIME 141. LOCATION 142. STATUS 143. REMARKS 144. DATE 145. TIME 146. LOCATION 147. STATUS 148. REMARKS 149. DATE 150. TIME 151. LOCATION 152. STATUS 153. REMARKS 154. DATE 155. TIME 156. LOCATION 157. STATUS 158. REMARKS 159. DATE 160. TIME 161. LOCATION 162. STATUS 163. REMARKS 164. DATE 165. TIME 166. LOCATION 167. STATUS 168. REMARKS 169. DATE 170. TIME 171. LOCATION 172. STATUS 173. REMARKS 174. DATE 175. TIME 176. LOCATION 177. STATUS 178. REMARKS 179. DATE 180. TIME 181. LOCATION 182. STATUS 183. REMARKS 184. DATE 185. TIME 186. LOCATION 187. STATUS 188. REMARKS 189. DATE 190. TIME 191. LOCATION 192. STATUS 193. REMARKS 194. DATE 195. TIME 196. LOCATION 197. STATUS 198. REMARKS 199. DATE 200. TIME 201. LOCATION 202. STATUS 203. REMARKS 204. DATE 205. TIME 206. LOCATION 207. STATUS 208. REMARKS 209. DATE 210. TIME 211. LOCATION 212. STATUS 213. REMARKS 214. DATE 215. TIME 216. LOCATION 217. STATUS 218. REMARKS 219. DATE 220. TIME 221. LOCATION 222. STATUS 223. REMARKS 224. DATE 225. TIME 226. LOCATION 227. STATUS 228. REMARKS 229. DATE 230. TIME 231. LOCATION 232. STATUS 233. REMARKS 234. DATE 235. TIME 236. LOCATION 237. STATUS 238. REMARKS 239. DATE 240. TIME 241. LOCATION 242. STATUS 243. REMARKS 244. DATE 245. TIME 246. LOCATION 247. STATUS 248. REMARKS 249. DATE 250. TIME 251. LOCATION 252. STATUS	

② WAS-PT-5815-012F,
WIS-PT-58292-

SYM	DESCRIPTION	DATE	APPROVAL
AM-23	[A 0A 0811] 763	10 JULY 1979	
P	WAS 152-005	12-7-83	



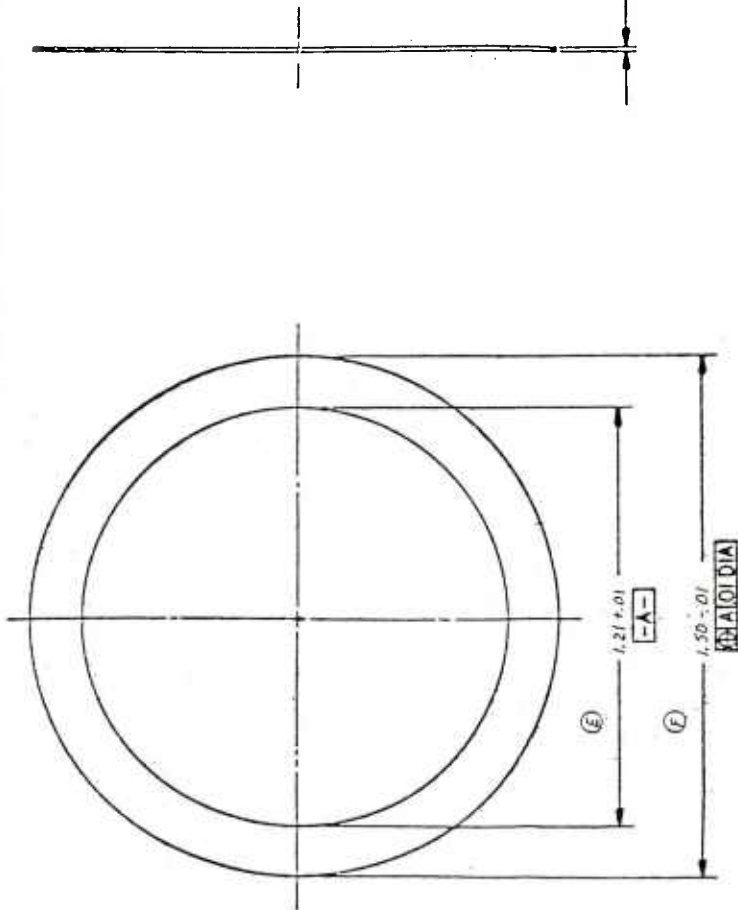
- NOTES:-
 1-SPEC MIL-A-2550 APPLIES.
 2-MATERIAL:-ALUMINUM-ALLOY, SHEET AND PLATE, ASTM B209.
 3 ALTERNATIVE MATERIAL ALUMINUM-ALLOY BARS, ROD AND WIRES, ASTM B211.

58-24-90

PART NO. 9236566		U S ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND DOVER, NEW JERSEY 07801	
ORIGINAL DATE OF DRAWING 22 DEC 78		SPACER	
DO NOT SCALE DRAWING UNITS: OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		SIZE C 19200	
TOLERANCES ON DECIMALS ± FRACTIONS ± ANGLES ±		CODE IDENT NO 9236566	
MECHANICAL PROPERTIES Y.P. T.S. E.L. R.A. B.H. R.H.		SCALE 4/1	
APPLICATION FUZE M582 FUZE M577 NEXT ASSY USED ON		SHEET	

SK 6216

SYM	DESCRIPTION	DATE	APPROVAL
—	ERR7200346-1 (REL)	08-28-72	
A	NORABA3046 780912	780706	
B	DIMENSION ADDED	2-2-84	
C	PART NO. DIM A REMOVED	2-2-84	
D	WAS SK 2380	2-24-84	
E	WAS -0.01211 ± .008	6-13-84	
F	WAS -0.017499 ± .018	6-13-84	



PART NO.	DIM A
9236596-1	.0050 ± .0015
9236596-2	.0100 ± .0015
9236596-3	.003 ± .001
9236596-4	.0020 ± .0005
9236596-5	.008 ± .001

DIM A - (.025 ± .001)

(B)

(A)

NOTES:—

- 1-SPEC MIL-A-2550 APPLIES.
- 2-MATERIAL—STAINLESS AND HEAT-RESISTING CHROMIUM NICKEL STEEL PLATE SHEET AND STRIP, TYPE 301, ASTM A167.
- 3-125/ALL OVER.

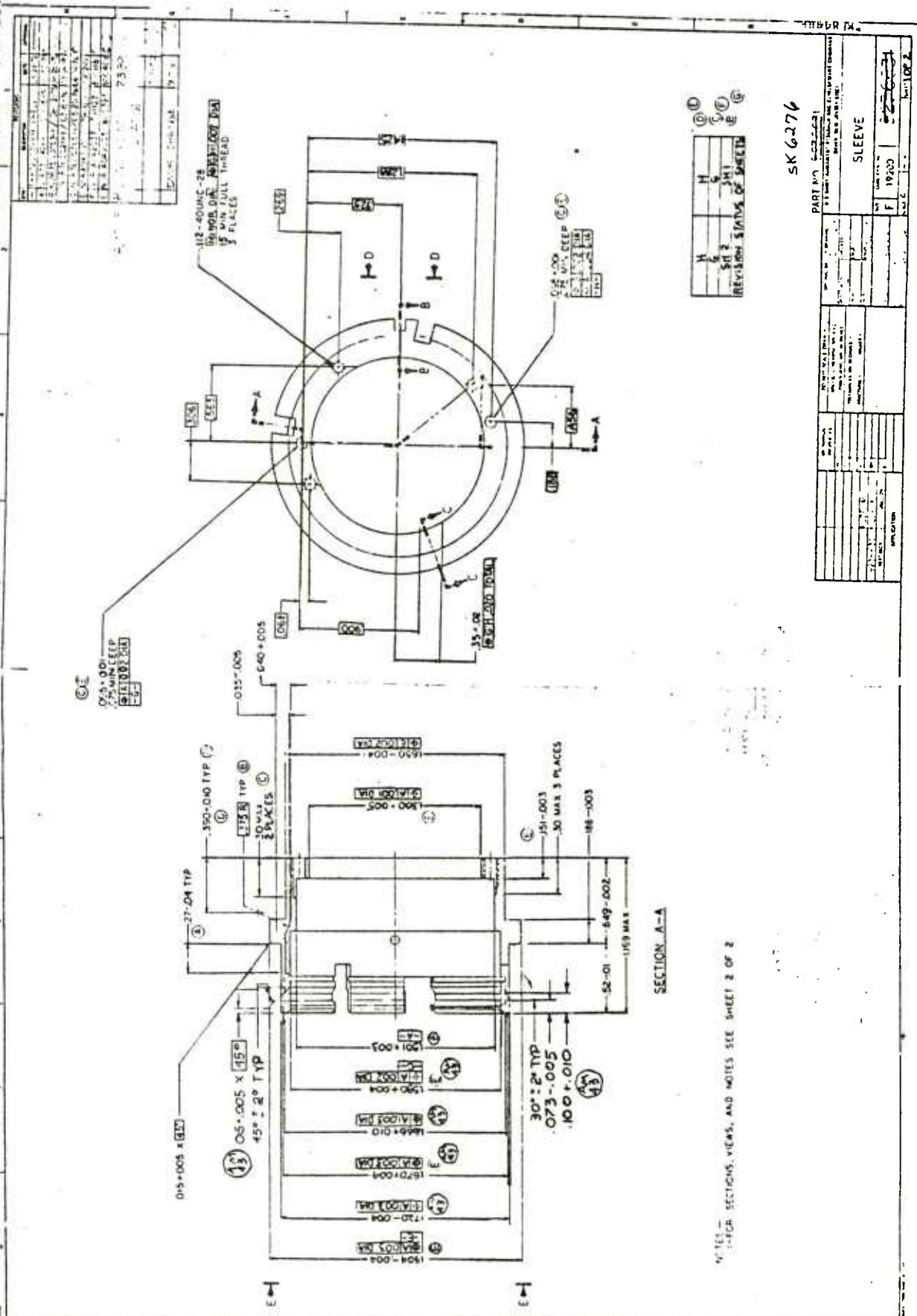
ENG.

JUN 13 1984

580660

PART NO. SEE TABLE

DO NOT SCALE DRAWING UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS * FRACTIONS * ANGLES *		ORIGINAL DATE OF DRAWING 28 AUG 1972		U.S. ARMY BARTONS COMMAND PICATINNY ARSENAL, DOWRY, NEW JERSEY 07801	
MECHANICAL PROPERTIES		DRAWN BY ENGR		CHECKED BY ENGR	
Y.P.		ENGR		ENGR.	
T.S.		ENGR		ENGR.	
E.L.		ENGR		ENGR.	
R.A.		ENGR		ENGR.	
M.I.		ENGR		ENGR.	
P.H.		ENGR		ENGR.	
FUZE M582		FUZE M577		FUZE M577	
9236569		NEXT ASSY		USED ON	
APPLICATION		SIZE C 19203		CODE IDENT NO. 9236596	
		SCALE 4/1		UNIT WT.	
		SHEET		① SK 4358	



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