FIERO A/C ELECTROMAGNETIC CLUTCH

WHO AM I, HISTORY, TOOLS, REMOVAL, DESCRIPTION, DESIGN, INSTALATION, TROUBLE SHOOTING

Jim Pardee

Glen Ellyn, IL and Janesville, WI

Warner Electric Brake & Clutch 28 YRS

Senior Designer – Mobil Power Group

Specialize in patentable new products

Some of my other interests:


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CITY HALL
EXHIBITION

WARNER ELECTRIC HISTORY

- A. P. Warner (1870-1954) studied electrical engineering in 1897 and began experimenting and building dynamos and electric motors in Beloit, WI.
- Warner Instrument Co. founded in 1904 in South Beloit, IL. to manufacture Auto-meter.
- First aviator in Wisconsin: owned and flew Curtis pusher in 1909.
- Trailers, camping trailers (first one?), electric wheel brakes where some of the early products.
- WWII: full line of electric wheel brakes for field howitzers & trailers of all types.
- Industrial electromagnetic clutches & brakes developed around 1950.

Auto A/C Clutch History

- The Packard Motor car Company was the first automobile manufacturer to build air conditioners into its cars, beginning in 1939. These air conditioners were originally optional, and could be installed for an extra $274 (about $4,050 in 2007 dollars).

- In 1954, the Nash Ambassador was the first American automobile to boast front-end, fully-integrated heating, ventilating, and air-conditioning system.

- General Motors made a front mounted air conditioning system optional in 1954 on Pontiacs with a straight-eight engine that added separate controls and air distribution. How ever, the alternative layout pioneered by Nash became established practice.

- 1955 Buicks available w/ fully-integrated A/C for $440.

- Warner developed automotive compressor clutches in the late 60's for Chrysler Corp.

A/C Clutch Service Kit from O'Riley Auto Parts

$130 Buy/Rent – Decide in 48 Hours


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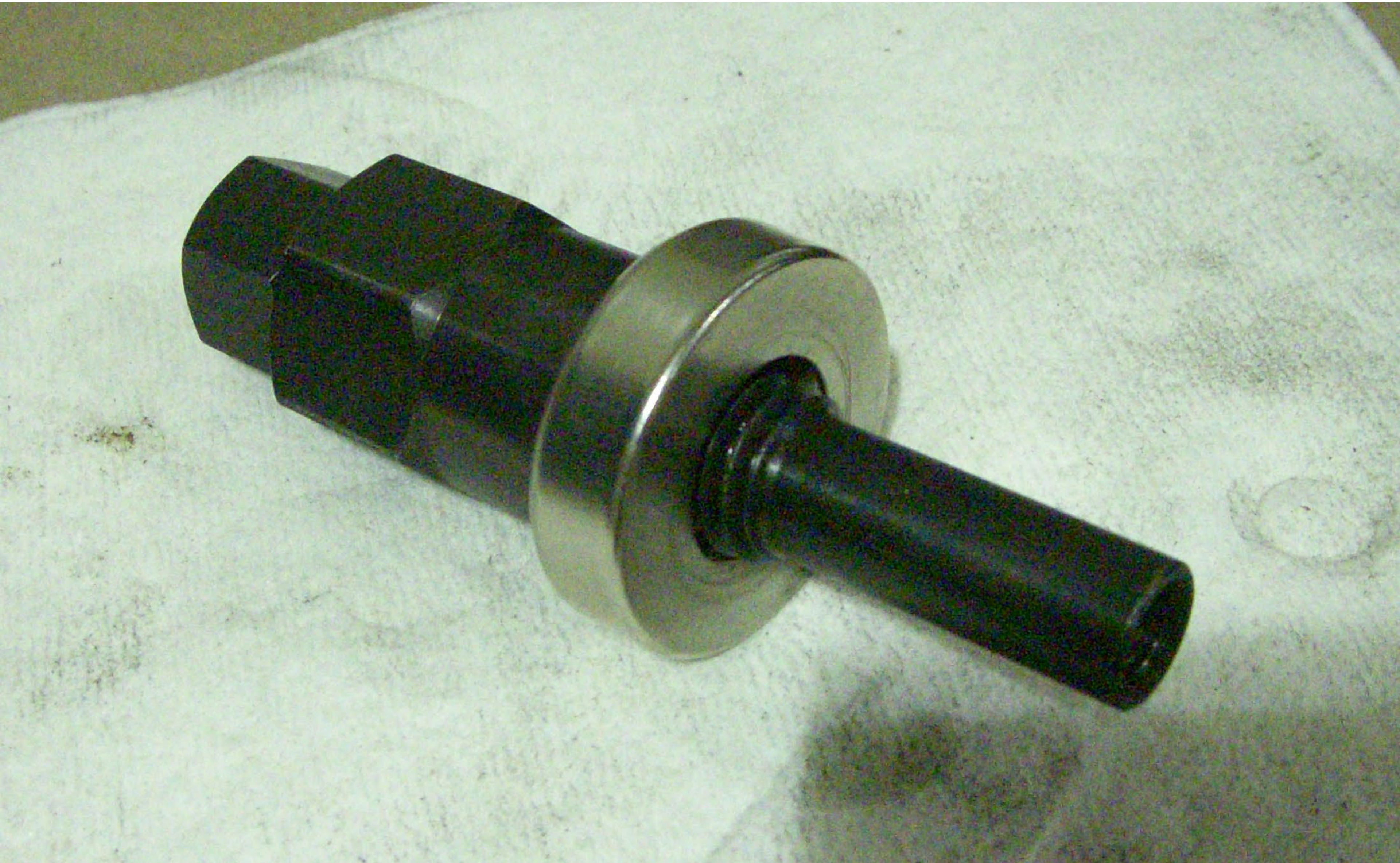
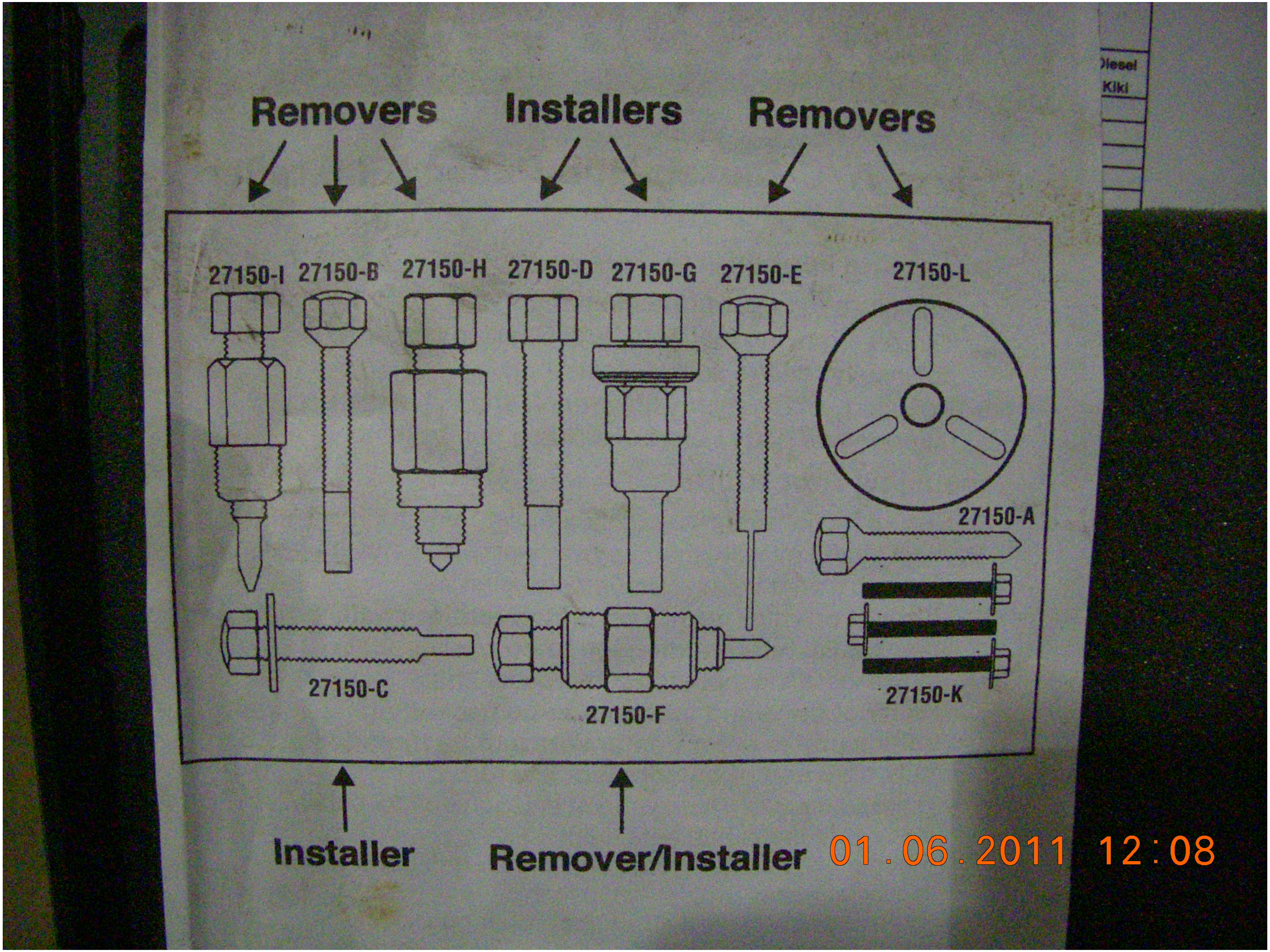
ARMATURE PULLER

ARMATURE INSTALLER

ARMATURE INSTALLER W/ BEARING IN PLACE




Removers
Installers
Removers
27150-I
27150-B
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Installer
Remover/Installer
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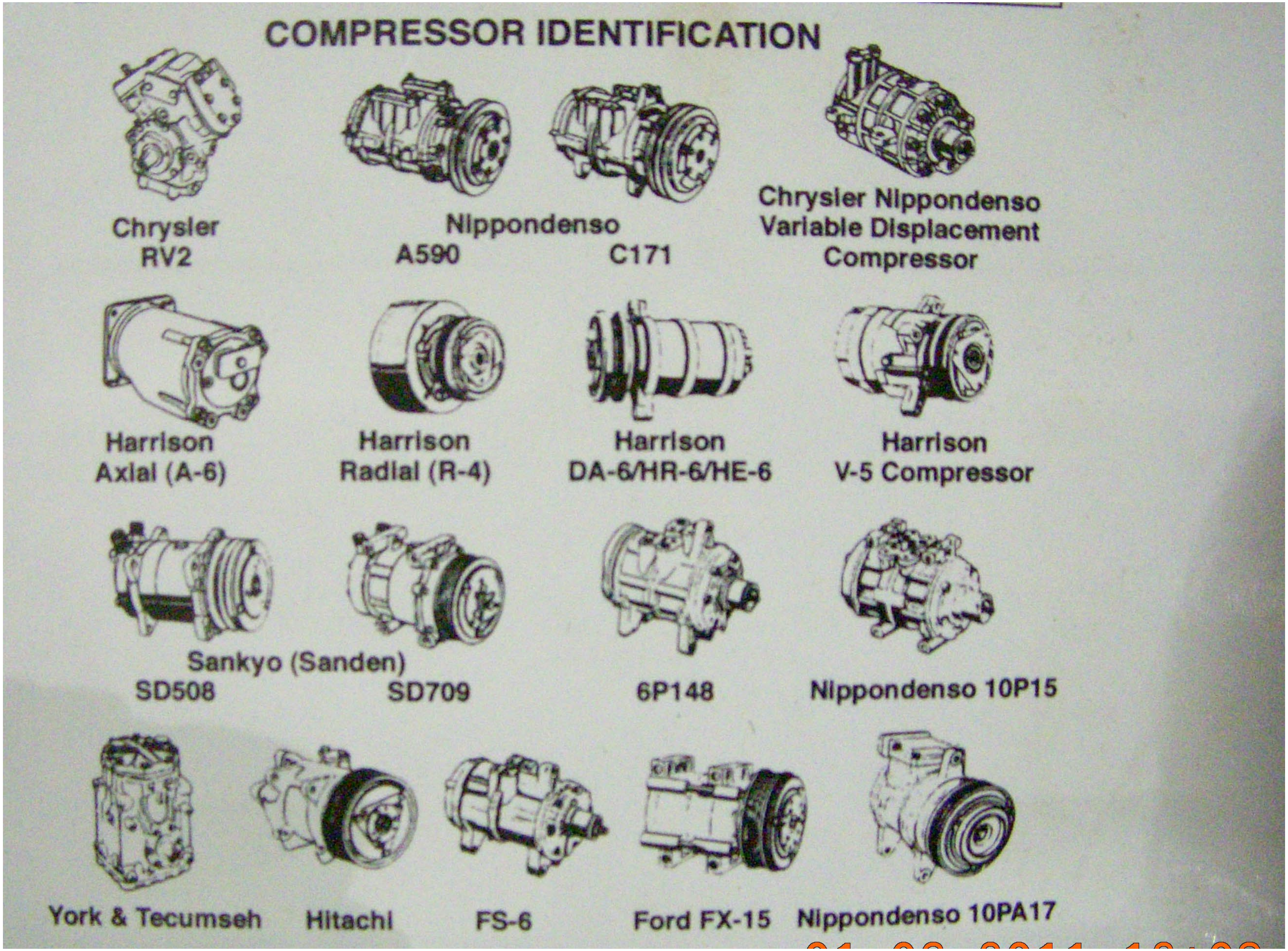
DA-6 USED ON '84 FIERO, V-5 ON '85 – '88



Make	Remover	Installer
Harrison GM DA-6, HR-6 & V5	27150-H Nut & Arbor	27150-G Nut, Bearing & 27150-D Arbor
A-6 & Earlier R4	27150-I Nut & Arbor	27150-G Nut, Bearing & Arbor
R4	27150-I Nut & Arbor	27150-G Nut, Bearing & 27150-D Arbor
Nippondenso **Ford / Chrysler** A590, C171 & FS-6	27150-F Nut & 27150-H Arbor	27150-G Nut & 27150-C Arbor & Washer
For FS-6 W / Special 24mm x 2.0	27150-F Nut & Arbor	27150-G Nut & 27150-C Arbor & Washer
New Style	27150-I Nut & Arbor	27150-G Nut & 27150-C Arbor & Washer
Sanden	27150-L Puller Plate & Arbor	
York / Tecumseh HR980	27150-F Nut & 27150-H Arbor	27150-G Nut & 27150-C Arbor & Washer
Zexel / Mitsubishi CH Series	27150-E Arbor & 27150-L Puller Plate	

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Compressor Type Used
(Vechicles from 1989-present)

Make	Nippon	Sanden	York Tecumseh	Harrison	Zexel Hitachi	Seiko Seiki	Diesel Kiki
Acura	X						
American Motors		X					
Audi	X		X				
BMW		X	X				
Buick				X			
Cadillac				X			
Chevrolet				X			
Chevrolet Truck				X			
Chrysler	X						
Dodge	X						
Dodge Truck	X	X					
Eagle	X	X					
Fiat		X					
Ford	X	X					
Ford Truck	X	X					
GMC Truck				X			
Honda	X						
Hyundai		X					
Infinity					X		
Isuzu				X			
Jaguar		X	X	X			
Jeep		X	X				
Lexus	X						
Lincoln	X						
Mazda	X						
Mercedes Benz			X	X			
Mercury	X						
Mitsubishi	X						
Nissan					X		
Oldsmobile				X			
Peugeot		X					
Plymouth	X						
Plymouth Truck	X						
Pontiac				X			
Porsche		X	X				
Renault		X					
Saab						X	
Saturn					X		
Subaru		X	X				
Suzuki	X						
Toyota	X						
Volkswagon	X	X	X				
Volvo							X

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CLUTCH REMOVAL – ARMATURE PULLER
CHECK ARMATURE TRAVEL WITH DIAL INDICATOR ON OUTSIDE FACE BEFORE DIS-ASSEMBLY. ANYTHING OVER .120 TRAVEL INDICATES SUBSTANTIAL WEAR. REGAPPING TO .030 MAY BRING IT BACK FOR A FEW MORE YEARS OF SERVICE UNLESS THERE ARE OTHER PROBLEMS.

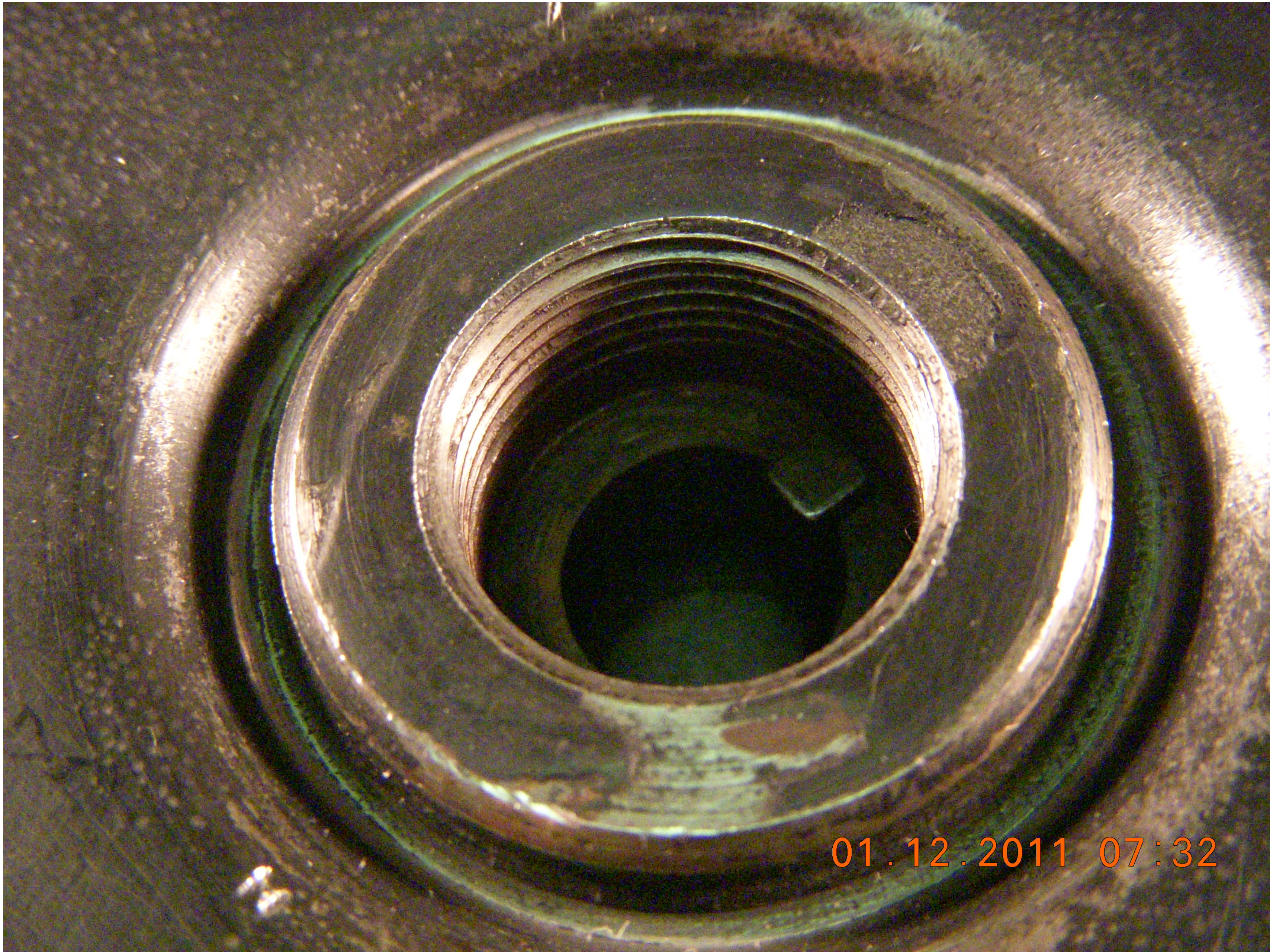
CLUTCH REMOVAL – ROTOR/PULLEY PULLER. RESISTANCE SHOULD BE MINIMAL. BE CAREFUL NOT TO BEND OR DISTORT FACE OF CLUTCH

CLUTCH REMOVAL – EXSPOSED FIELD

CLUTCH REMOVAL – FIELD REMOVAL.
PULLEY PULLER WOULD HAVE WORKED BETTER.

ARMATURE/BUMPER PLATE/HUB ASSEMBLY

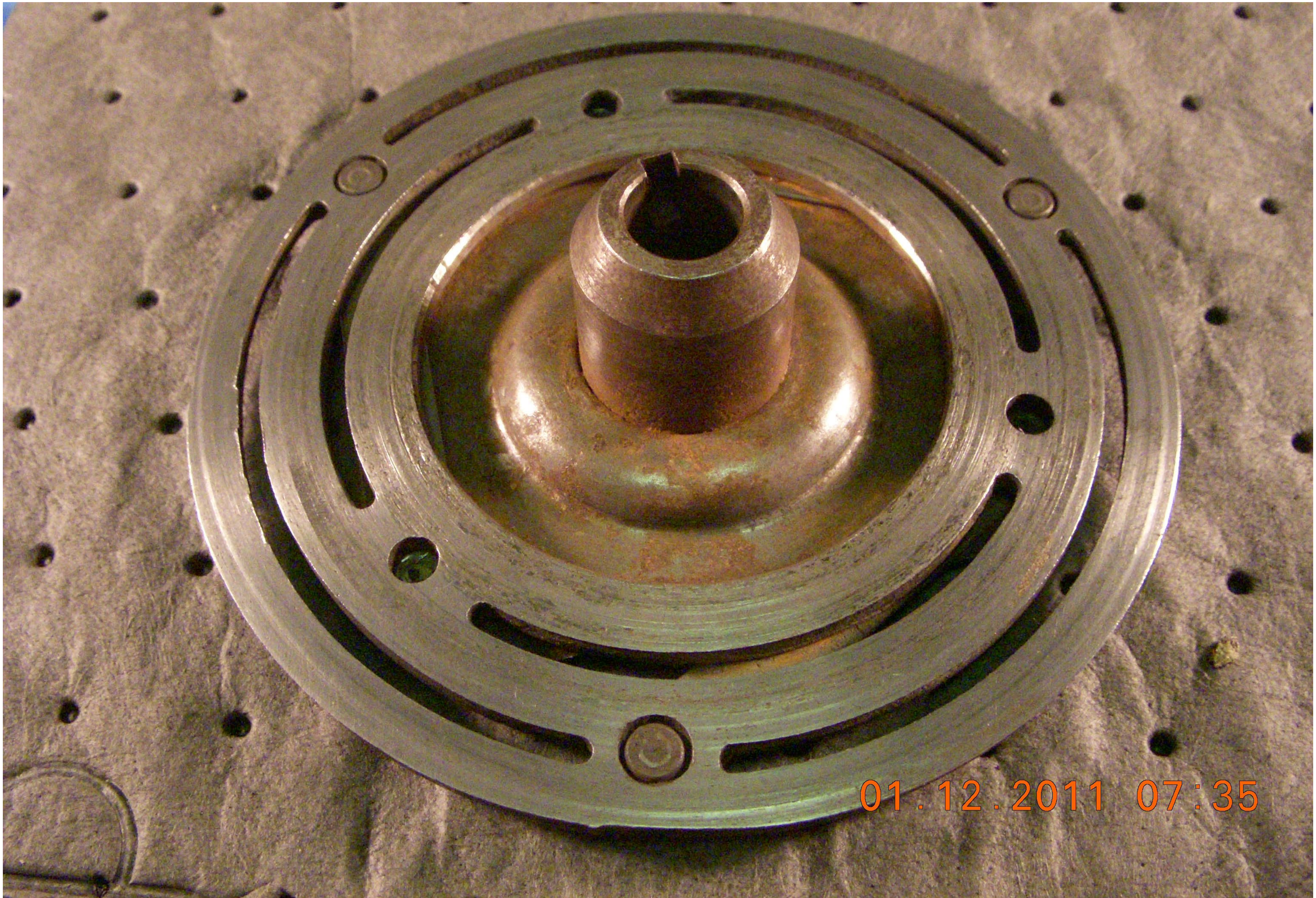
HUB & KEY CLOSE UP (NOTE EXTRACTION THREAD)
HUB IS RESISTANCE WELDED TO BUMPER PLATE.



RIVIT, LEAF SPRING, BUMPER PLATE, & ARMATURE “BANANA” SLOT

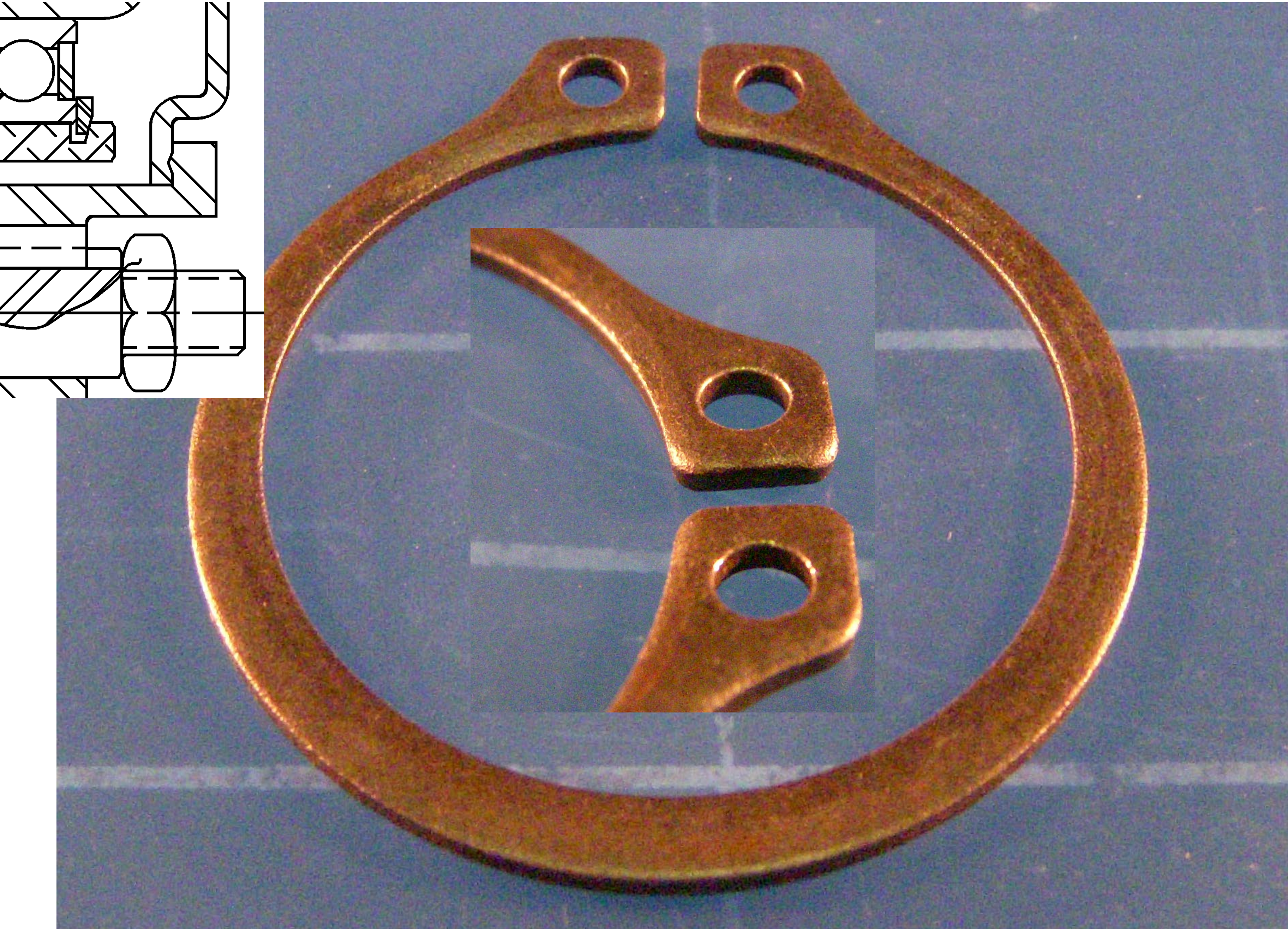
EDGE VIEW OF BUMPER PLATE, LEAF SPRING, HEADED RIVIT, AND ARMATURE

CLUTCH FRICTION FACE SHOWING HEADED RIVITS, BANANA SLOT PATTERN, & DEBRI RELEIF HOLES OVER BUMPER PLATE RIVITS.

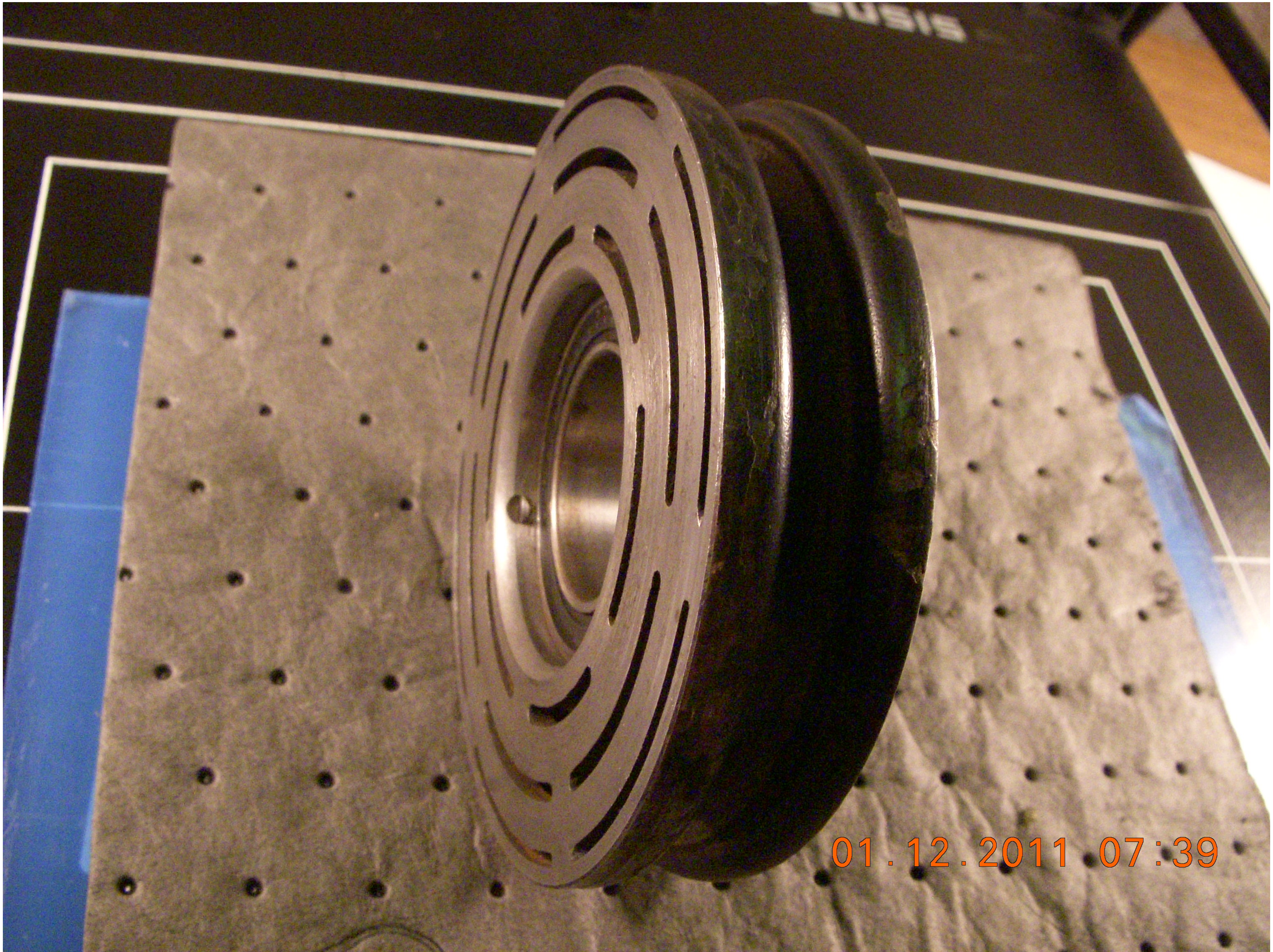


CLOSE UP OF COUNTER SUNK HEADED RIVIT ON “BRIDGE”

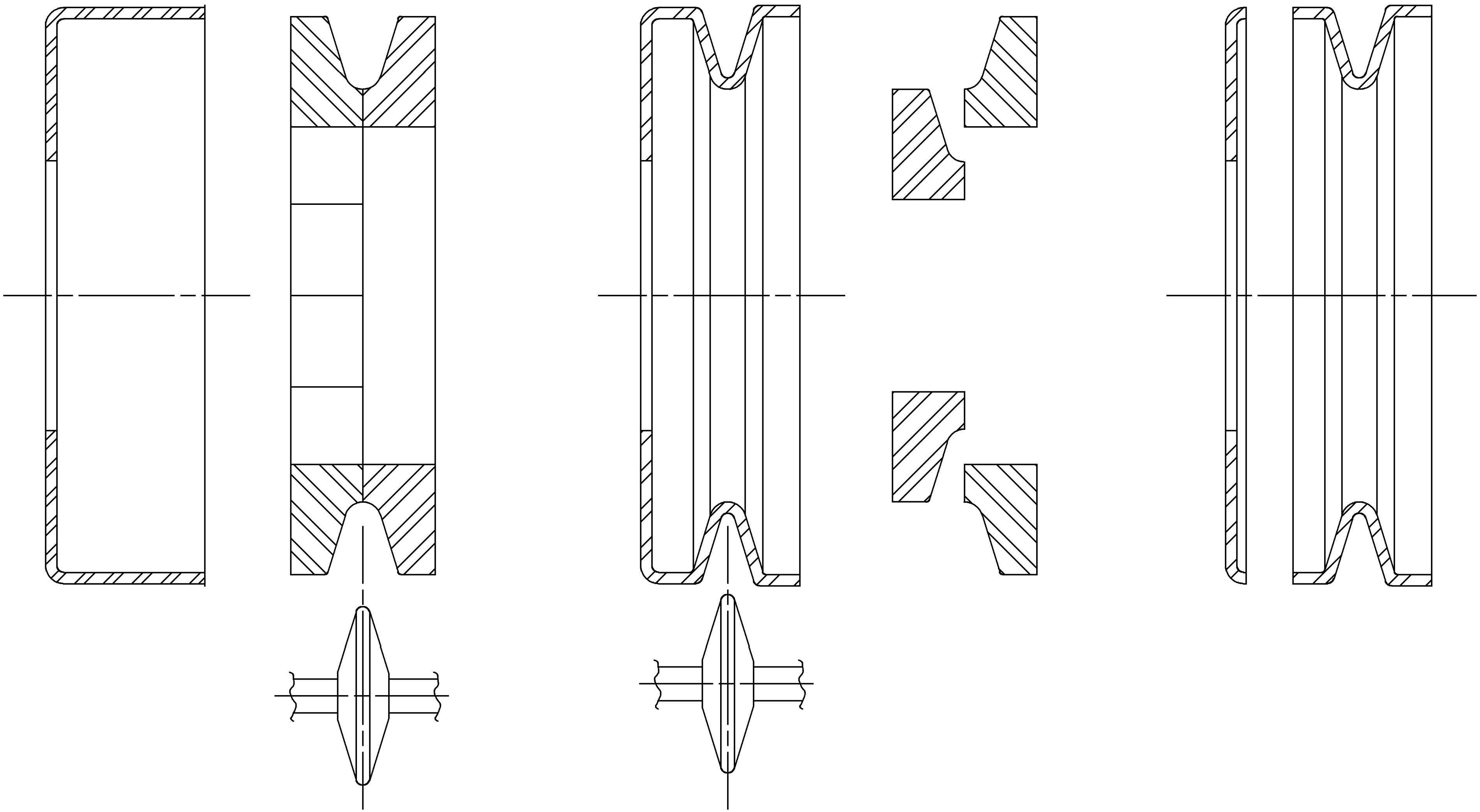
BEVELED SNAP RING ASSEMBLED AGAINST BEVEL IN SNAP RING GROVE



CLUTCH ROTOR W/ DOUBLE ROW BEARING & SPUN PULLEY

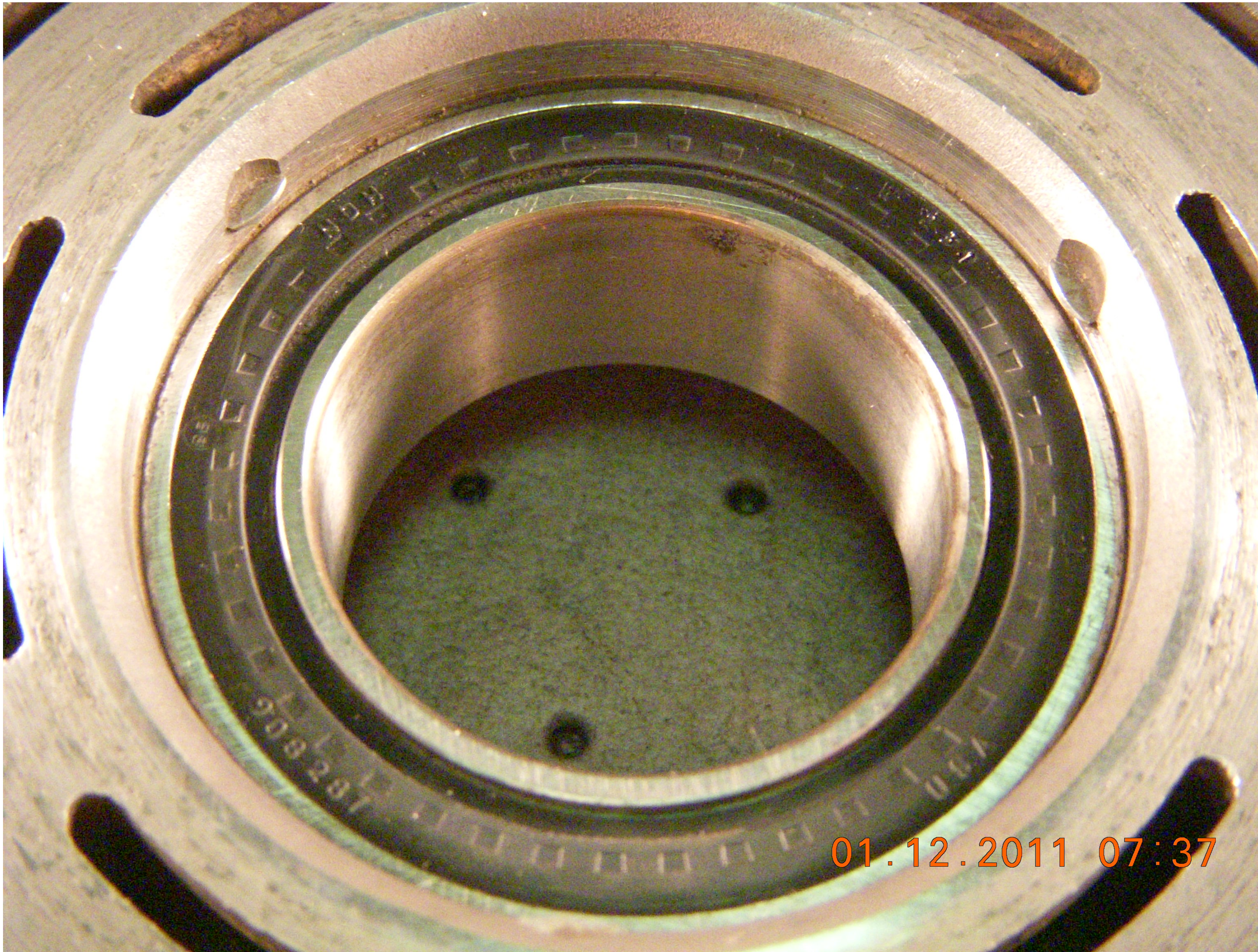


SPUN PULLEY IS FORMED OVER A RETRACTABLE MANDREL & THE BOTTOM OF THE “CAN” IS SHEARED OFF (OR SHEAR BOTTOM OF CAN FIRST AND USE SOLID MANDRELS)



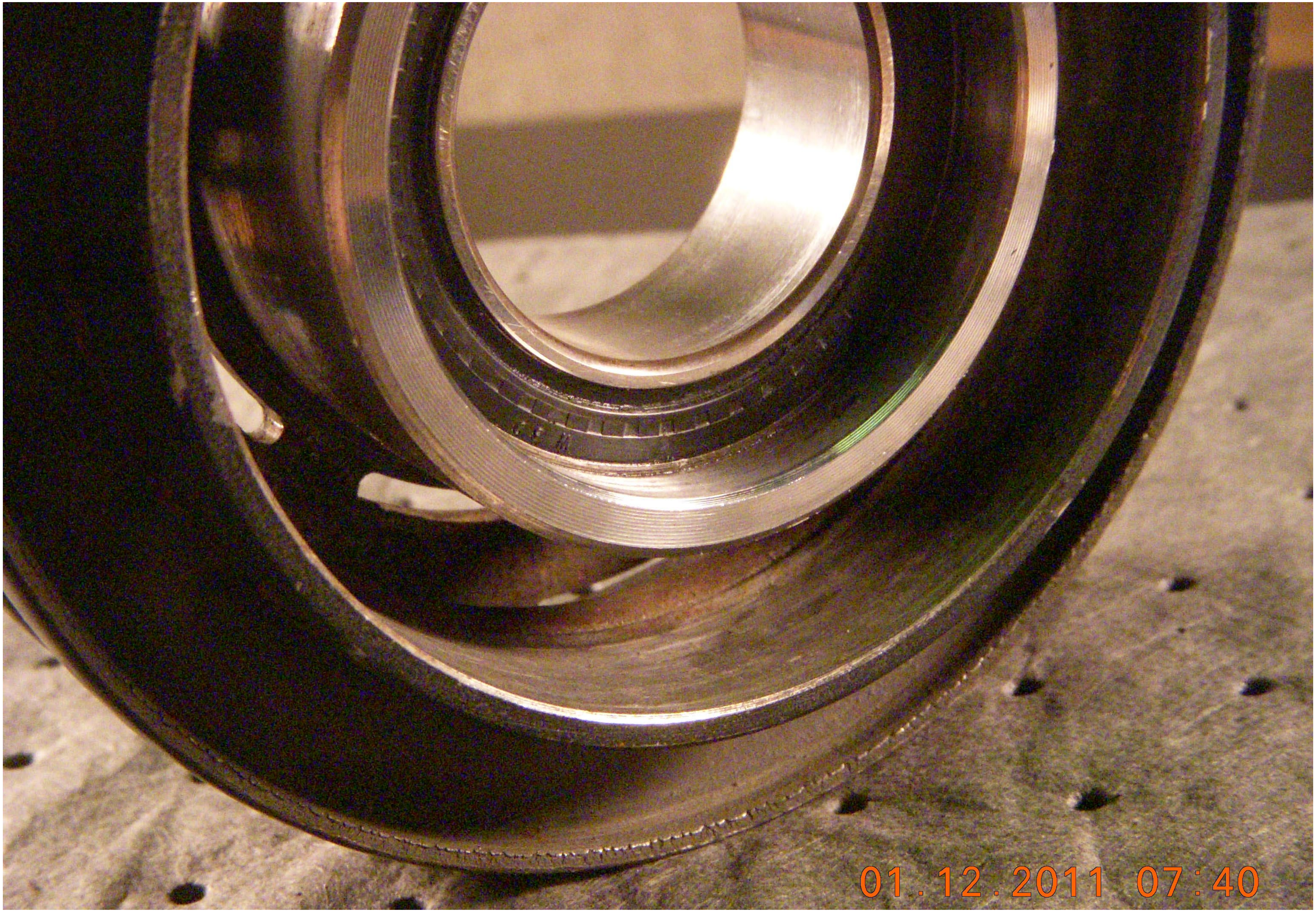
ROTOR FRICTION FACE SHOWING BANANA SLOTS
CHECK BEARING FOR “FEEL” AND GREASE LEAKAGE PAST SEALS

STAKED BEARING IN PRECISE BORE (NEW DEPARTURE HYAT BEARING MADE IN USA). IT IS POSSIBLE TO GRIND AWAY STAKES AND REMOVE OLD BEARING AND REPLACE WITH NEW BEARING.

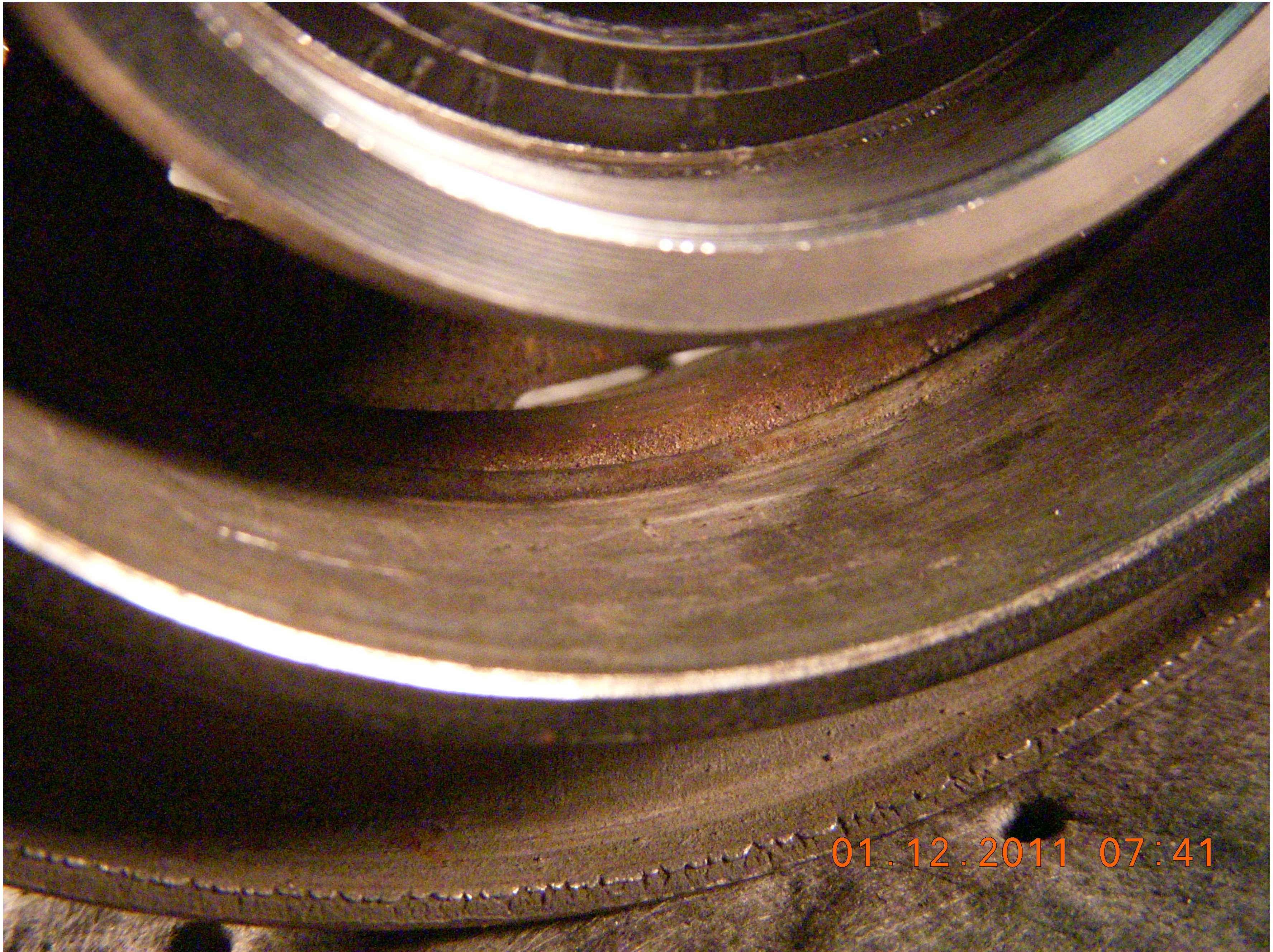


ROTOR BACK SIDE SHOWING INNER & OUTER POLES

ROTOR BEARING, INNER & OUTER ROTOR POLES



ROTOR OUTER POLE/SPUN PULLEY JOINT – PROBABLY ENERTIA WELDED

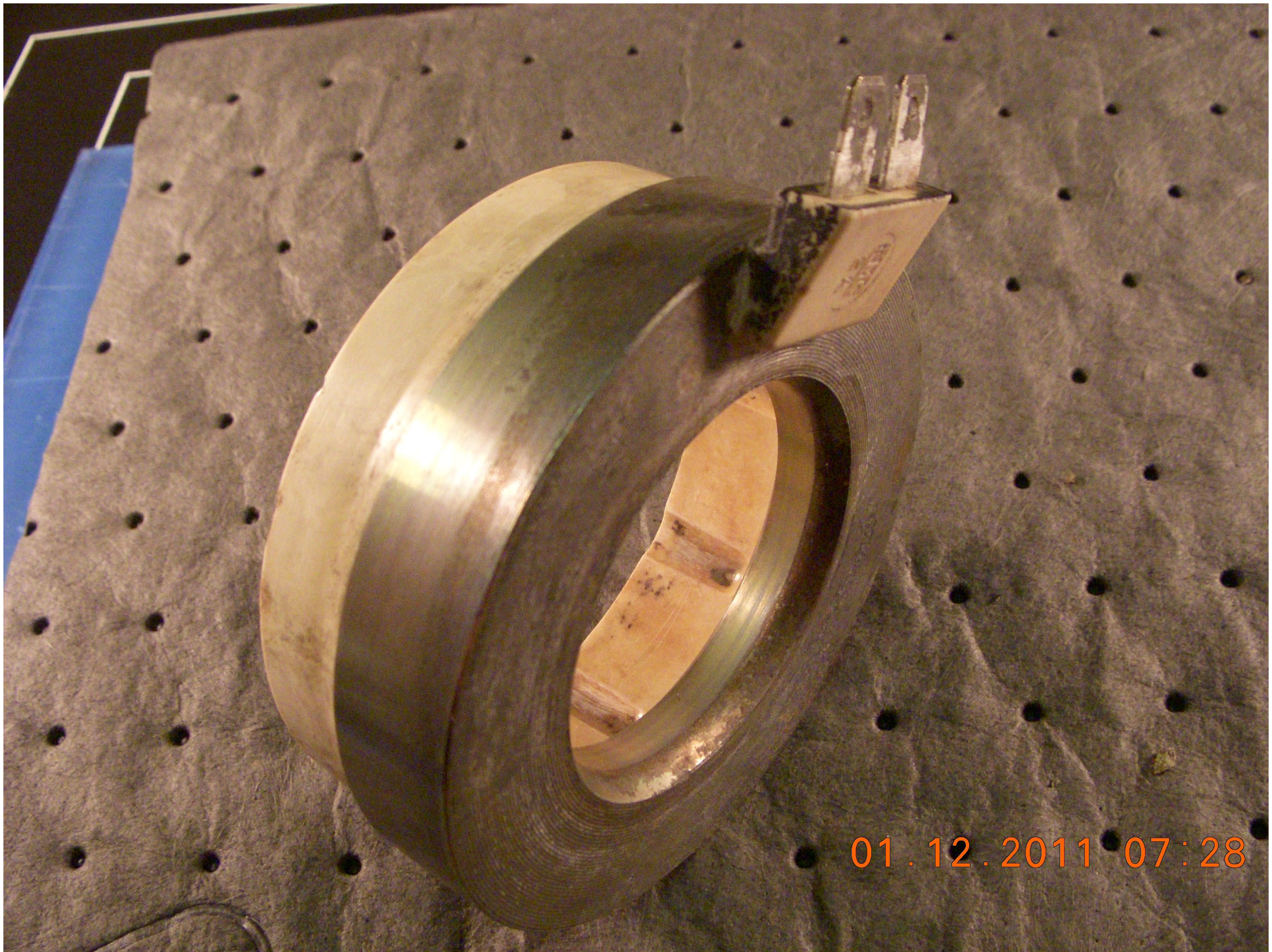


ROTOR OUTER POLE/SPUN PULLEY JOINT – PROBABLY ENERTIA WELDED

ROTOR OUTER POLE/SPUN PULLEY JOINT – PROBABLY ENERTIA WELDED

FIELD ASSEMBLY SHOWING FIELD SHELL, MOLDED COIL, CONNECTORS, LOCATION PIN MARKS

RESISTANCE SHOULD BE ABOUT 4 OHMS. HI POT TEST IS REQUIRED TO BE SURE COIL DOES NOT HAVE AN INTERNAL SHORT OR SHORT TO FIELD SHELL



HI-POT TESTOR
ADJUSTABLE VOLTAGE (TO 5,000 V) AND DURATION
CHECKS FOR SHORT FROM COIL TO GROUND

ALIGATOR CLIP GOES ON THE CONNECTOR AND PROBE ON THE BACK OF FIELD SHELL. NOTE RECESSED PROBE, SAFETY TRIGGER, AND PALM BUTTON TO AVOID “S.U.E.” (SOILED UNDERWEAR EVENT)

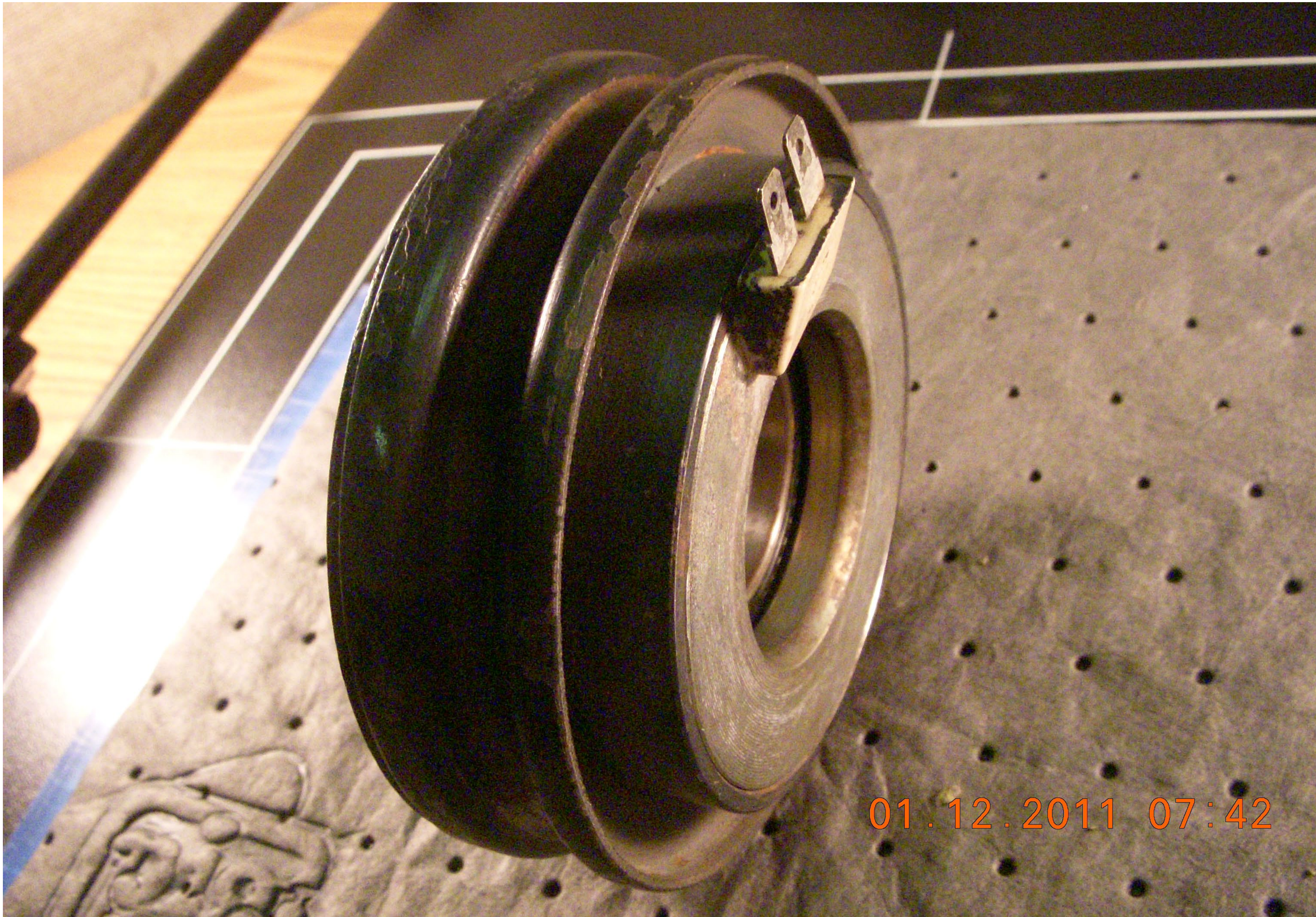
FIELD ASSEMBLY SHOWING FIELD SHELL, MOLDED COIL, CONNECTORS, LOCATION PIN MARKS

FIELD ASSY. CUT AWAY SHOWING STAMPED SHELL, COIL WIRES, RETENTION GROVE, LOCATOR BOBBIN (LATER DEVELOPMENT)

COATED MAGNET WIRE IS HEAT SET AFTER WINDING, COOLED, AND REMOVED FROM BOBBIN (NOTICE HEX SHAPE FROM PRESSURE)

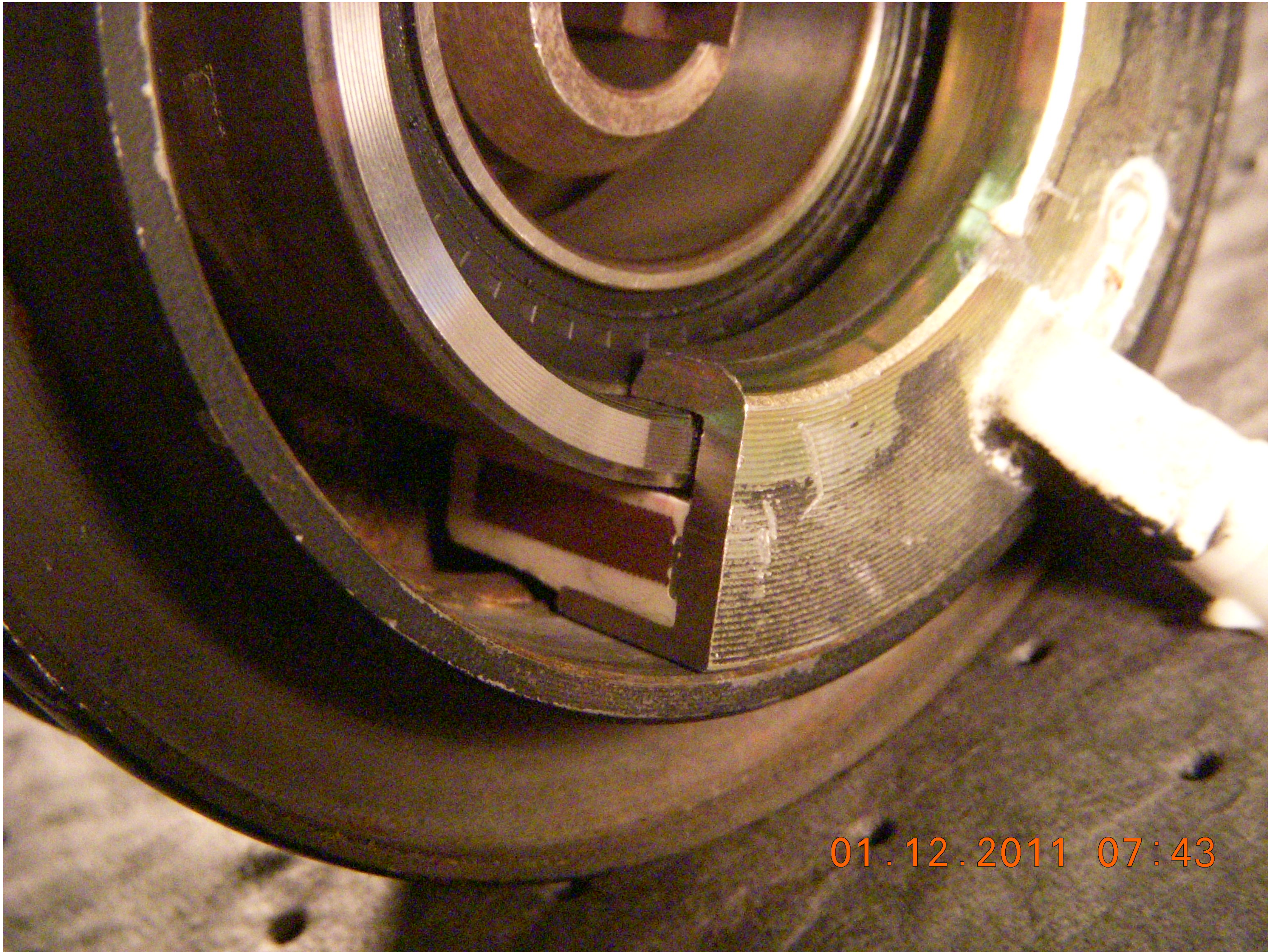
“ASSEMBLED” CLUTCH

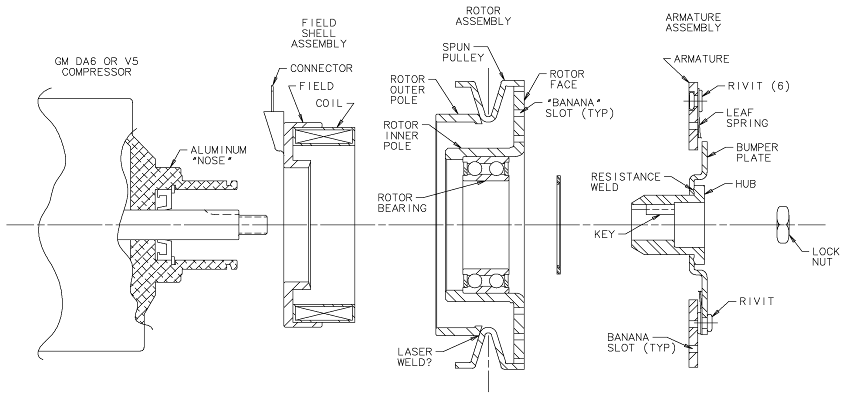
“ASSEMBLED” CLUTCH - BACKSIDE

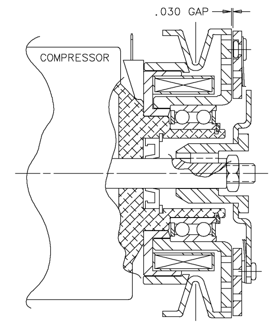


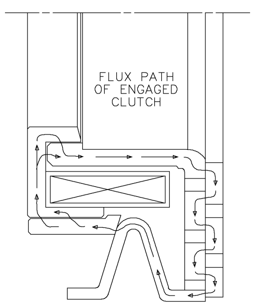
"ASSEMBLED" CLUTCH - BACKSIDE

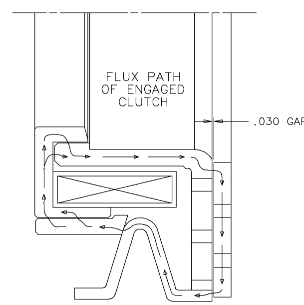
“ASSEMBLED” CLUTCH – BACKSIDE W/ CUT AWAY FIELD











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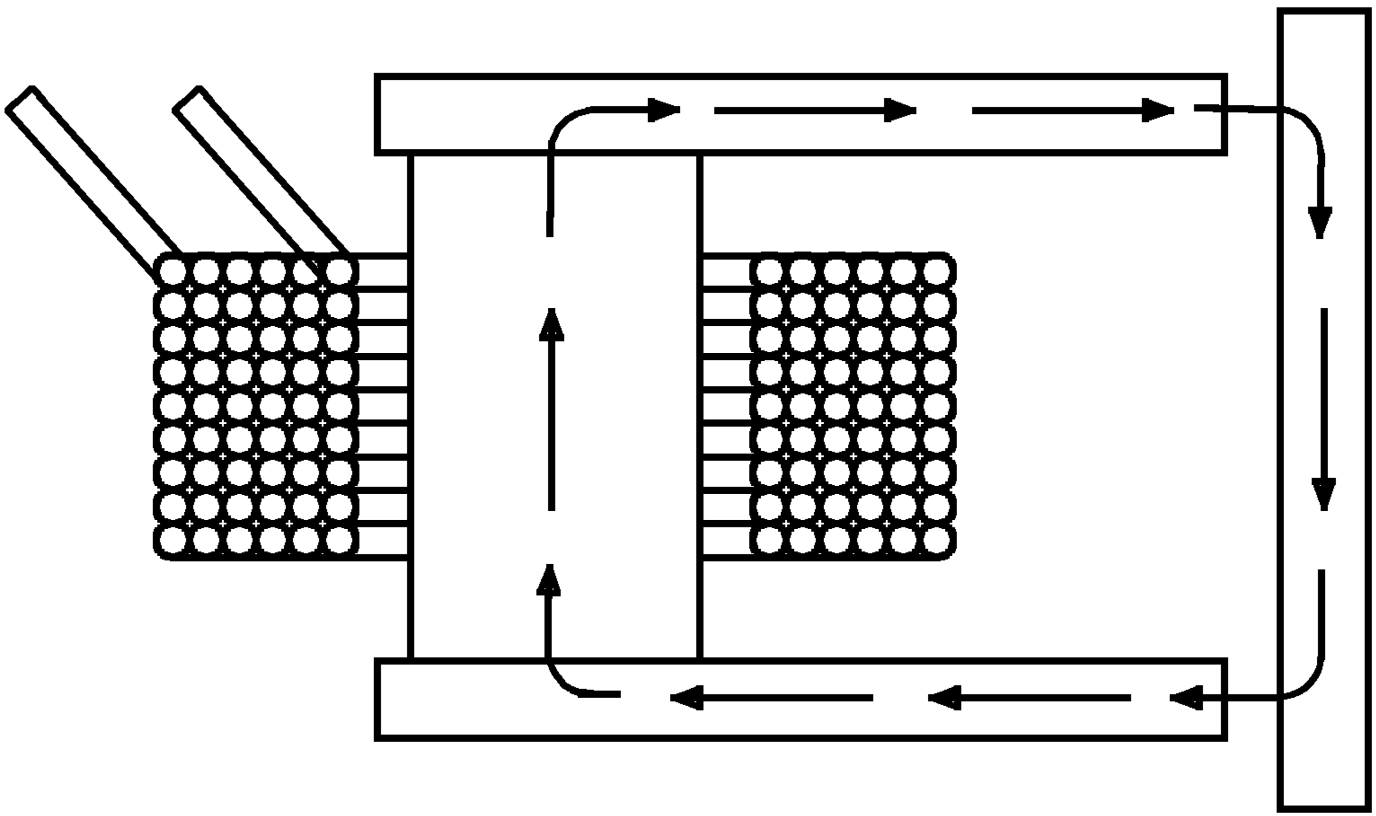
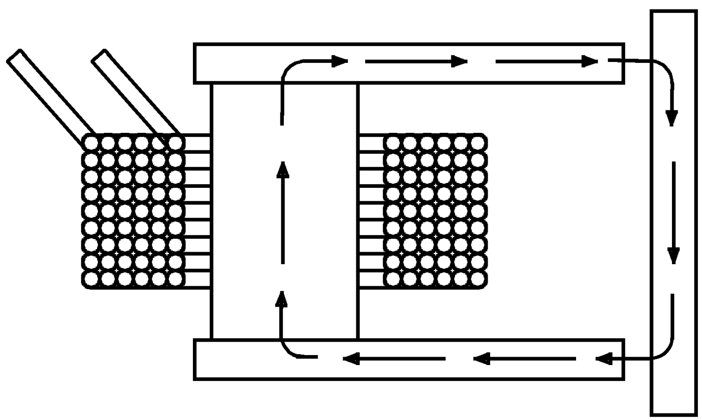
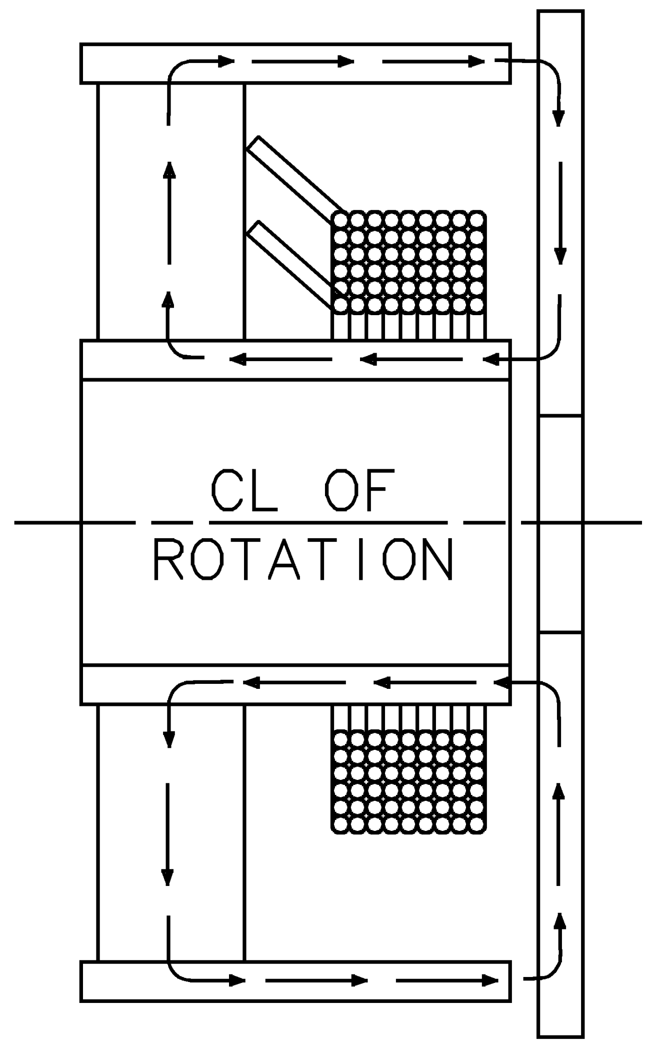
VERSION 1
CLUTCH
FULL
CLUTCH

ELECTRIC CLUTCH DEVELOPMENT
SIMPLE ELECTROMAGNETIC CIRCUIT W/ ROD GOING THROUGH COIL AND TWO BARS



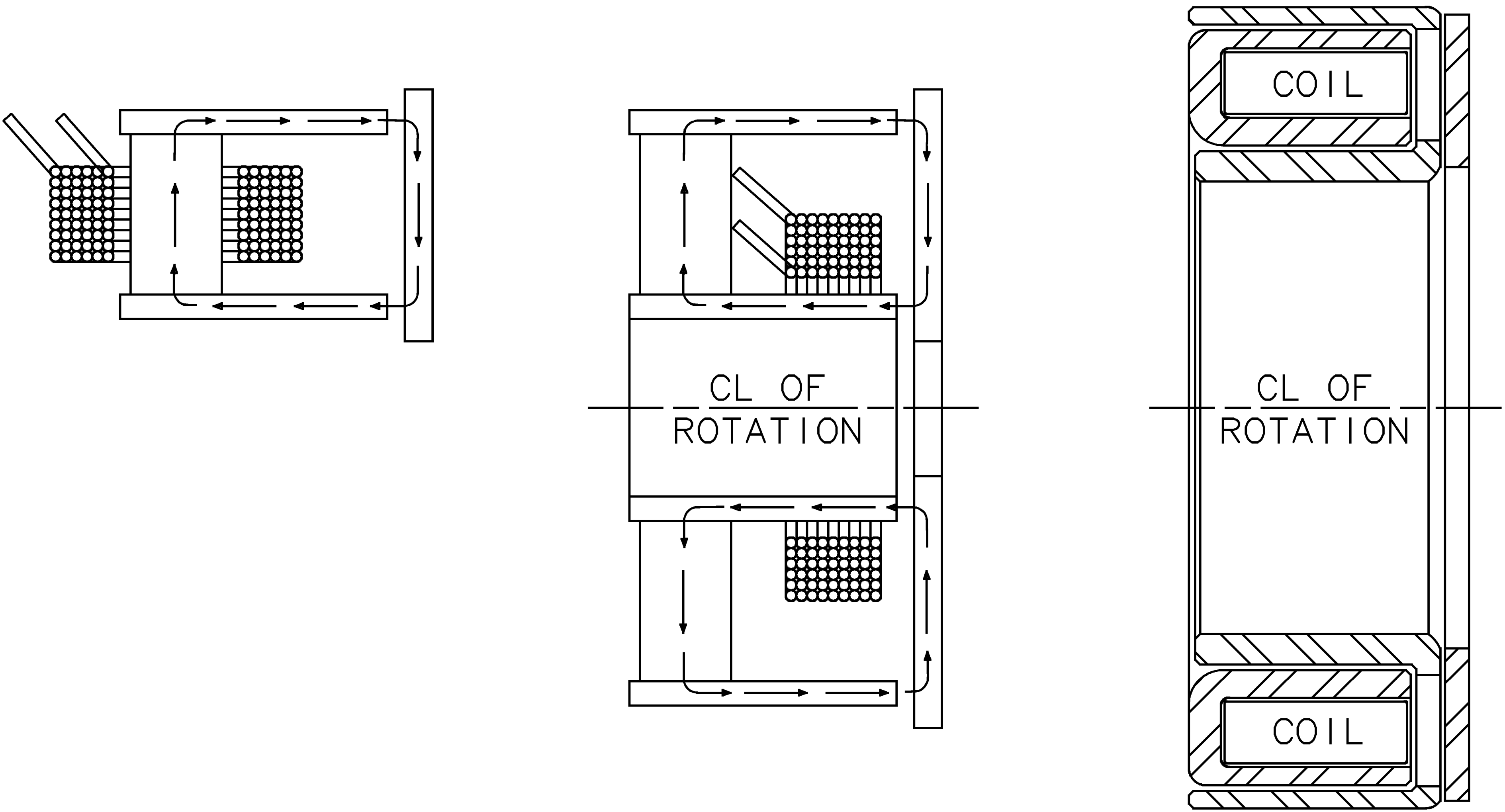
ELECTRIC CLUTCH DEVELOPMENT
“WASHER” W/ TUBE INSIDE & OUTSIDE OF COIL



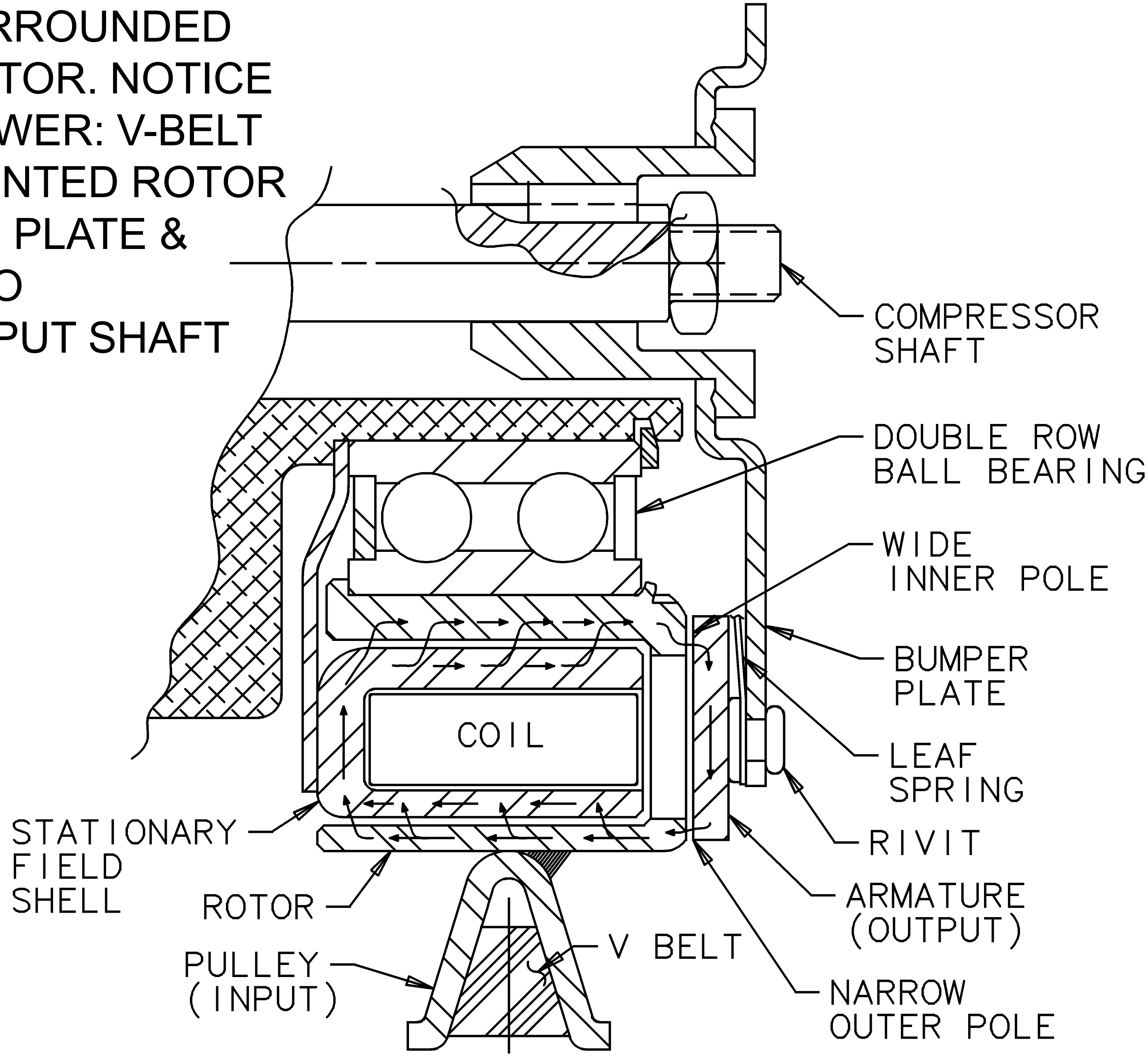


ELECTRIC CLUTCH DEVELOPMENT

STATIONARY FIELD SHELL & COIL SURROUNDED BY 2 POLE ROTOR

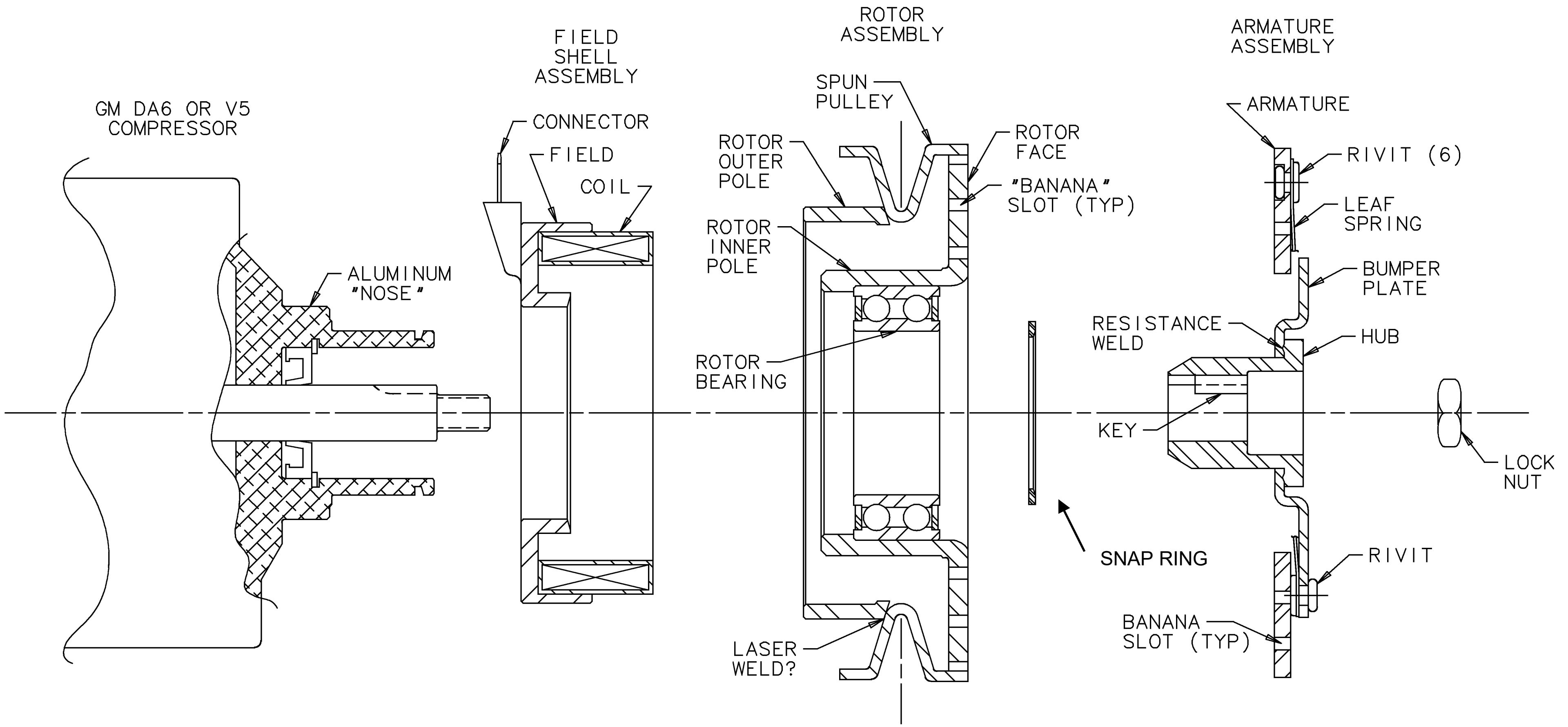


SIMPLIFIED STATIONARY FIELD SHELL & COIL SURROUNDED BY TWO POLE ROTOR. NOTICE THE FLOW OF POWER: V-BELT TO BEARING MOUNTED ROTOR TO ARMATURE TO PLATE & HUB ASSEMBLY TO COMPRESSOR INPUT SHAFT

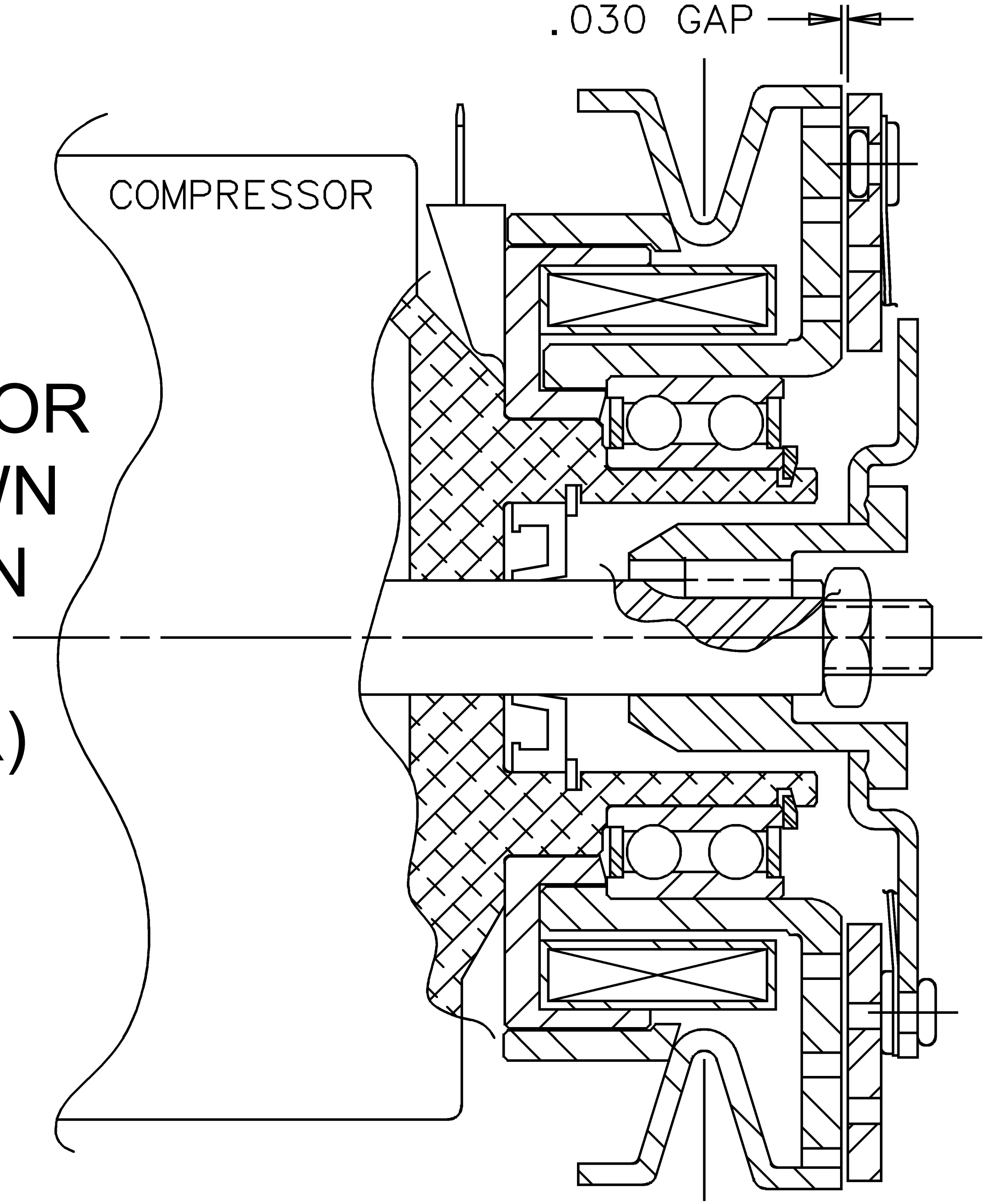


GM COMPRESSOR CLUTCH COMPONENTS

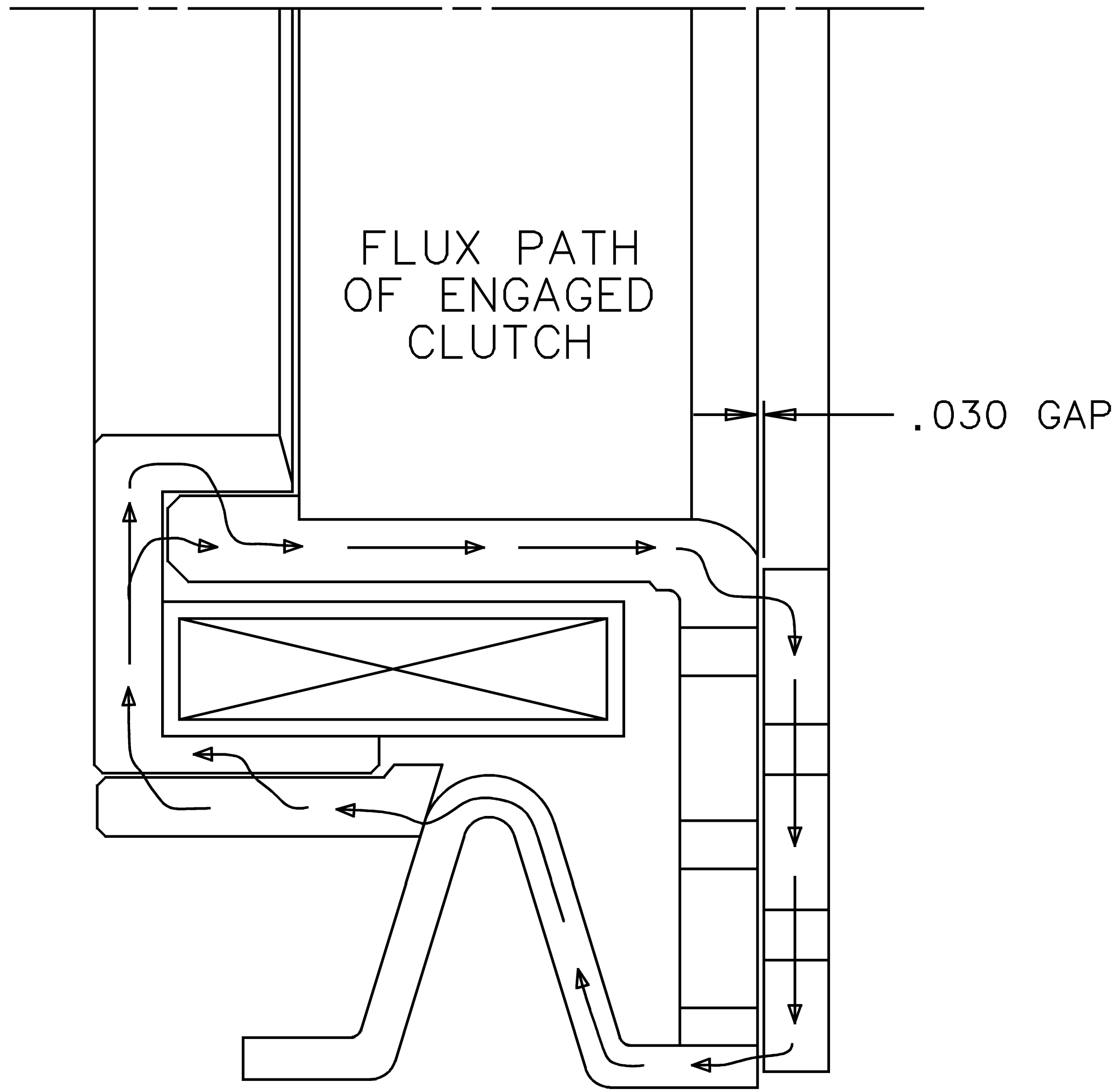
(Exploded view)



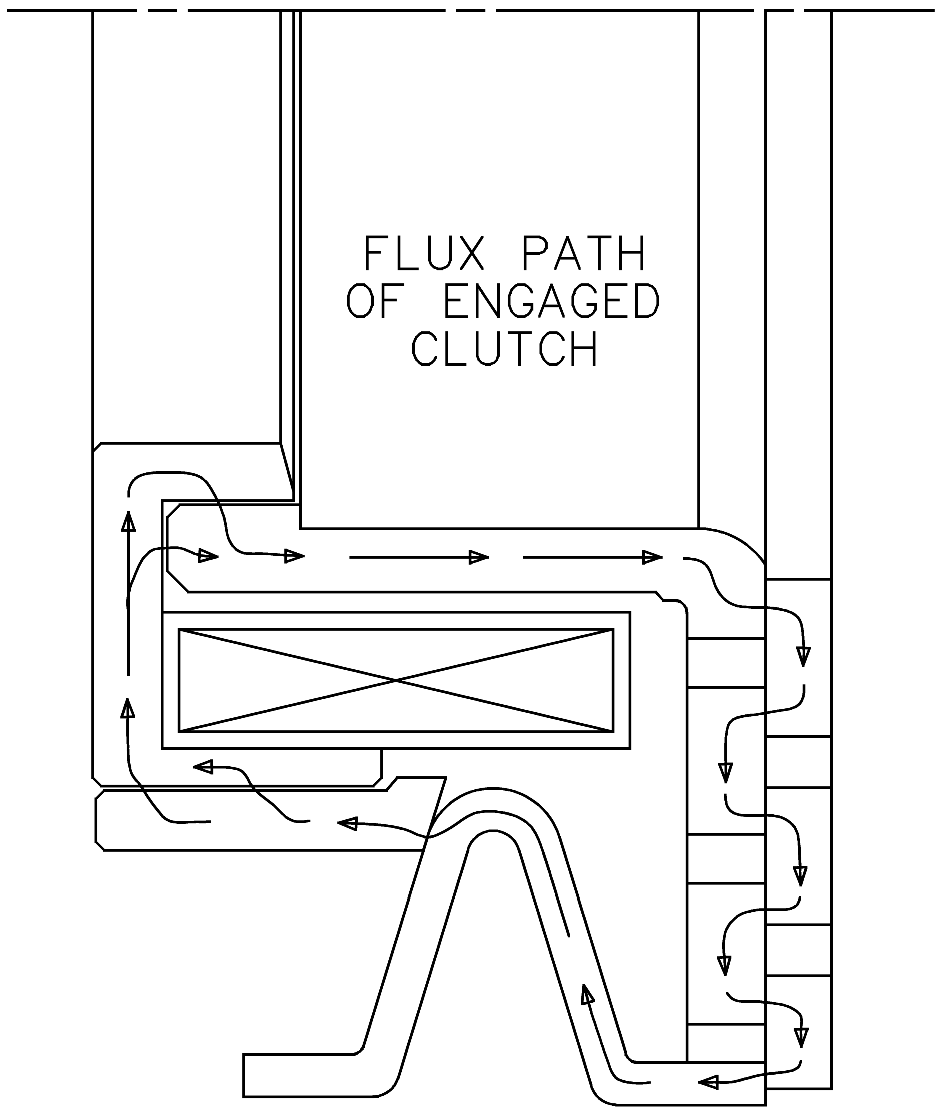
ASSEMBLED GM COMPRESSOR CLUTCH (SHOWN SECTIONED ON "NOSE" OF COMPRESSOR)



CLUTCH ENGAGES IN 2 POLE MODE
(MAGNETIC FLUX REQUIRES 2,000+ TIMES THE NI BEHIND IT TO JUMP AIR VS. LOW CARBON STEEL)



ARMATURE AND ROTOR COME TOGETHER AND THE 6 POLE FLUX PATH IS FORMED. MOST OF THESE CLUTCHES GENERATE 100 – 120 FT. LB. OF STATIC TORQUE



BASIC MAGNETIC THEORY

- COIL GENERATES “NI” OR AMP TURNS AND GIVES THE CLUTCH ELECTROMAGNETIC CIRCUIT THE REQUIRED MAGNETOMOTIVE FORCE.
- NI EQUATES TO ELECTRICAL VOLTAGE
- THIS COIL HAS 34 WRAPS AND 8 LAYERS = 272 TURNS, & DRAWS 3 AMPS GIVING 816 NI

BASIC MAGNETIC THEORY

A CLUTCH MAY HAVE 4 OR 5 SQ. IN. OF FACE SURFACE AREA GIVING A CLAMP FORCE OF 670 TO 850+ LBS. AND A STATIC TORQUE VALUE OF 100 – 110 FT. LBS.
FLUX LINES EQAUTE TO ELECTRICAL CURRENT.

The magnetic attraction is calculated with the following formula:

$$\text{Magnetic Attraction} = \frac{B^2}{72 \times 10^6}$$

Magnetic Attraction is in Lbs. /In.^{2}

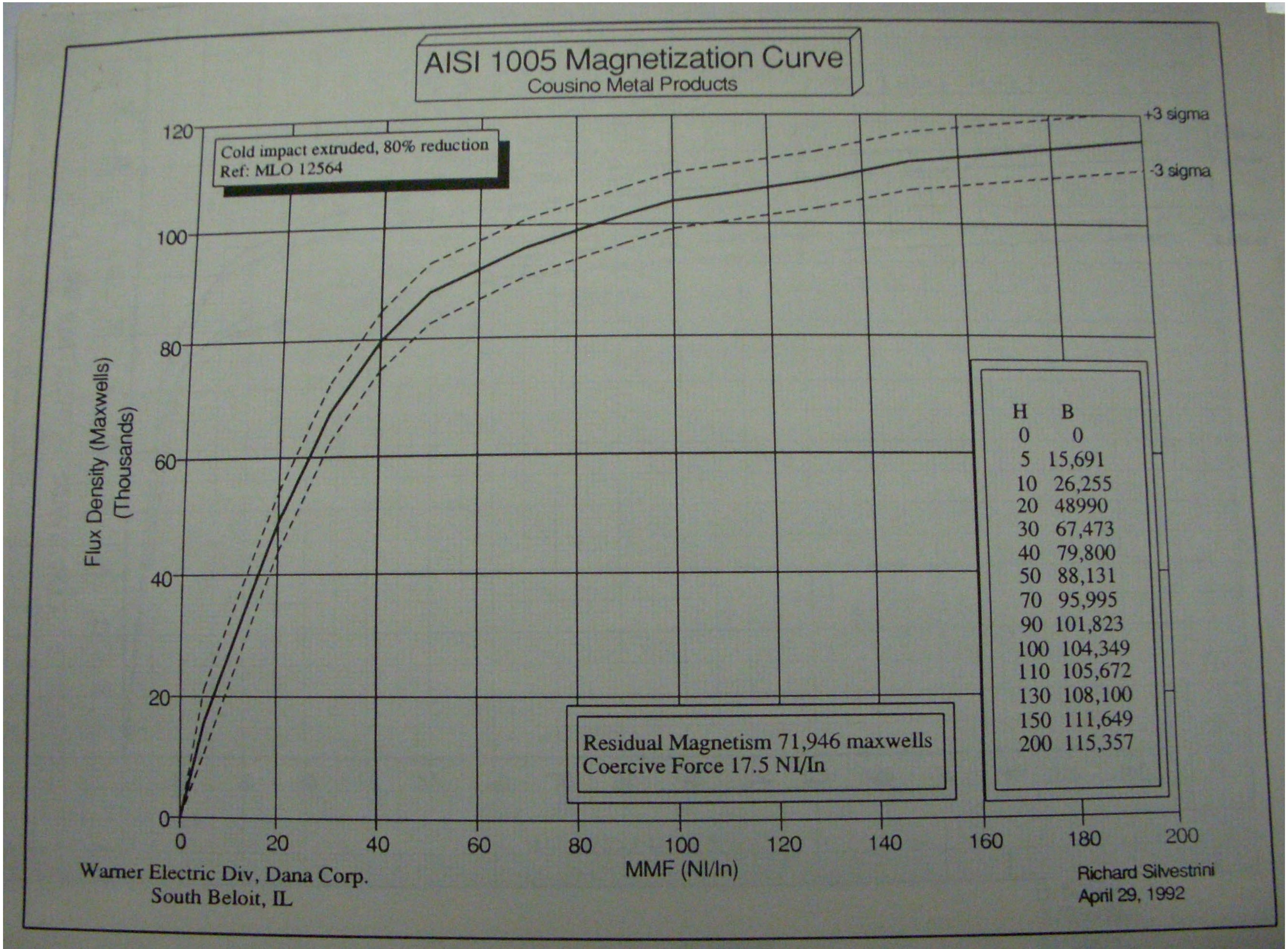
B = Flux Density at the Pole in Thousands of Lines/In.^{2}

Assuming a flux density at the pole of 110,000 Lines/In.^{2}, then the Magnetic Attraction

$$= \frac{110{,}000^2}{72 \times 10^6} = 168 \text{ Lbs. /In.}^2$$

Multiply Attractive Force, Lbs. /In.^{2} x Pole Area, In.^{2}, to obtain the total Attractive Force at the Pole.

- AS FLUX DENSITY INCREASES PAST 90,000 LINES/SQ. IN., THE NI REQUIRED TO "PUSH" IT INCREASES DRAMATICALLY, THE SAME AS INCREASED AMPS THROUGH A GIVEN SIZE WIRE REQUIRES MORE VOLTAGE TO "PUSH" IT.



FAILURE MODES

- COMPRESSOR LOCKS UP AND LOCKED ARMATURE ENGAGES AGAINST ROTOR AND COOKS BEARING &/OR COIL. EASY TO SPOT
- ROTOR BEARING FAILURE. ROTOR LOCKS UP AND BELT COOKS OR JUMPS OFF PULLEY.
- ROTOR BEARING SEAL FAILS. GREASE PURGES BETWEEN ROTOR/ARMATURE AND CLUTCH SLIPS, CREATING HEAT AND COOKS FIELD &/OR BELT. FIELD COULD MELT INTO ROTOR AND LOCK IT UP, RUINING BELT.
- FIELD COIL FAILS OPEN. NO CONTINUITY.
- FIELD COIL FAILS, SHORTING THROUGH FIELD SHELL TO COMPRESSOR. BLOWN FUSE.
- FIELD COIL FAILS, WIND TO WIND SHORT, RESISTANCE VALUE IS LOW, COIL RUNS HOT, NI VALUE IS LOW, CLUTCH PARTIALLY ENGAGES, SLIPS AND BURNS, BEARING COOKS.