ROTARY SOLENOIDS

1. Design and Features

The rotary solenoid's design starts from a standard flat face push-pull solenoid. The rotary solenoid then incorporates the mechanical design principle of an inclined plane to convert linear motion to rotary motion. There are three uniform inclined planes (spiral grooves) that are stamped into both the case and the armature, called "ball races". The "ball races" provide both a means of converting linear motion to rotary motion and a secondary bearing system to support this rotary motion. (Fig. 1)

- The ball races are specially designed and provide a constant torque output over the complete angle of rotation at 25% duty cycle.
- The rotary solenoid uses an enclosed coil and therefore provides maximum magnetic efficiency.
- The magnetic circuit is very short, so high efficiencies in terms of torque output can be obtained, and energization/response times are very quick.

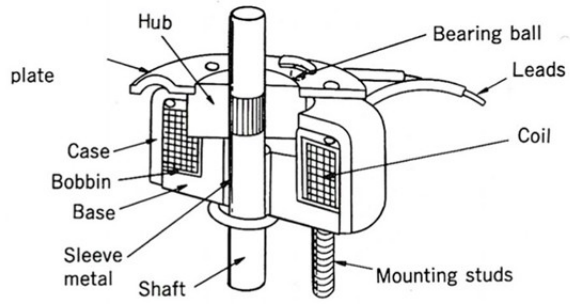


Fig. I

2. Starting Torque

The starting torque shown in the catalog is the gross value output at 20 deg.C. With the addition of the return spring, the solenoid's net output is the gross starting torque minus the return spring torque.

3. Rotation Angle Direction of Rotation

A) Use of an External Stopper (Fig. 2)

The angle and direction of rotation are predetermined (and fixed) by the manufacturing process of the three ball races that are in the case and armature. The degree of rotation can be reduced(example : a 35 deg RH rotation solenoid reduced to 30 deg RH rotation), by the use of an external stopper. However, to assure that the solenoid operates properly, it is imperative that the solenoid armature always be allowed to return to 0 deg. or unenergized position.

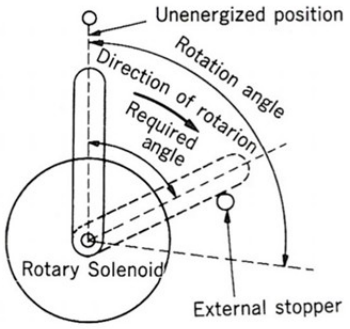


Fig. 2

B) Direction of Rotation (Fig. 3)

The normally accepted convention to describe the rotation of the rotary solenoid is that the direction of rotation is viewed from the armature plate (top) of the solenoid. Clockwise rotation is right hand (RH) rotation, and counter clockwise rotation is left-hand (LH) rotation.

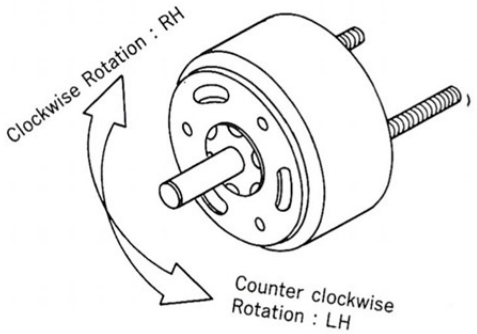


Fig. 3

C) Rotation Angle Available

The rotation angles are available as follows.

Table 1

SIZE301	25°, 35°, 45°	RH and LH
SIZE341	25°, 35°, 45°, 67.5°	RH and LH
SIZE401	25°, 35°, 45°, 67.5°, 95°	RH and LH
SIZE490, 491		
SIZE590, 591		
SIZE700		
SIZE870		

4. Axial Travel

In this design of the rotary solenoid the rotary motion is created by converting linear motion into rotary motion. The use of the inclined plane (ball races) also generate a small axial stroke(about 0.7 to 2.6 mm depending upon the amount of rotation and the size of the solenoid).

Table 2

SIZE	301	341	401	490, 491	590, 591	700	870, 874
Axial travel (mm), approx.	0.7	0.9	1.2	1.5	1.6	2.3	2.6

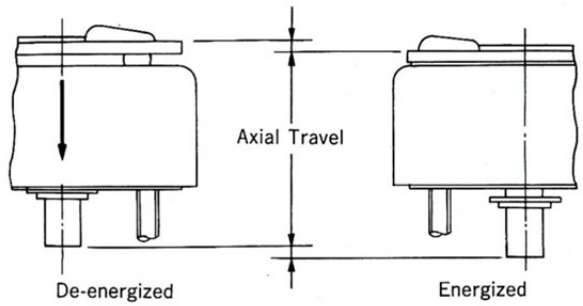
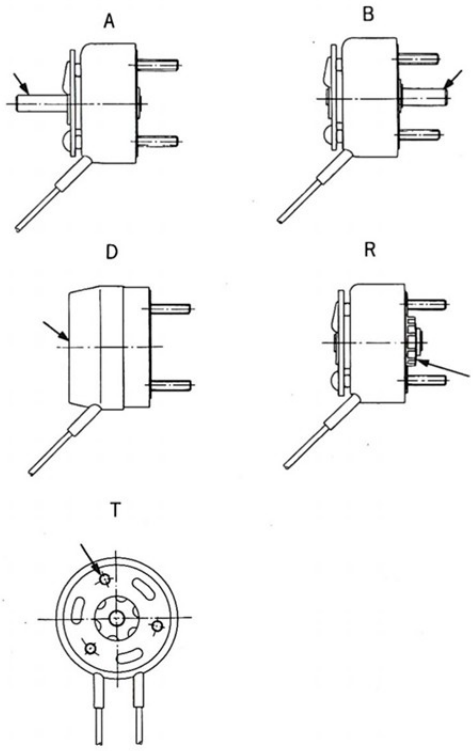


Fig. 4

5. Standard Available Accessories

The standard rotary solenoid is available with different accessories to meet your application requirements.



A : Shaft extension on the armature plate
B : Shaft extension on the base side
D : Dust cover over armature plate
R : Return spring provided
T : Tapped holes in armature plate

6. Operational Considerations

A) Temperature

The coil data of rotary solenoids shows the values at ambient temperature 20℃ and with a standard heat sink. When a solenoid is used at the ratings mentioned in the coil data, it is designed so that the coil temperature rises and reaches equilibrium at approximately 85℃. In applications where the ambient temperature is higher than 20℃ or the heat sink is smaller than indicated in the catalog, possible thermal damage can occur. Temperature rise tests should be performed by the customer to assure that the coil does not reach 120℃. Coils can be constructed to operate at temperatures higher than 120℃ without thermal damage. Please consult the factory for details.

B) Shaft Modifications
It is not recommended that the customer modify the shaft, as the shafts are fabricated before assembly. Any special configurations can be supplied. Please consult the factory for details.
C) How To Use The "T" (tapped armature plate) Feature
As noted above, the rotary solenoid does have axial movement in the armature plate position during energization and de-energization. When directly attaching a mechanism to the armature plate, the load must allow for free movement in the axial direction. Also, the attaching screws can not be longer than the thickness of the armature plate or interference in the rotary motion will occur.

7. General Characteristics

Insulation class	Class E (120℃) Lead wire class A (105℃)
Dielectric strength	AC 1000V 50/60 Hz 1 min. (at normal temperature and normal humidity)
Insulation resistance	More than 100 Mohm at DC 500V megger (at normal temperature and normal humidity)
Expected life	Standard life : 2 million cycles Extended life : 10 million cycles Long life : 50 million cycles

(Solenoid cycle life is very dependent upon side load, frequency of use, and environmental conditions. Cycle life tests should be performed by the customer.)

8. How to Select a Rotary Solenoid

Before selecting a rotary solenoid, the following information must be determined :

A) Torque
The actual torque required in the application should be increased using a safety factor multiplier of 1.5 to arrive at the torque value that should be used in your specification.

B) Duty Cycle
Use the aforementioned formula to calculate duty cycle. Also note the maximum on time. (See page 2)

C) Rotation Angle
Rotation angle is determined by application requirements.

D) Rotation Direction
Rotation direction is determined by application requirements (note direction of armature plate).

E) Operating Voltage
Operating DC voltage is determined by the application and voltage available.

After determining these specifications, one can find the correct size solenoid for the application, using the torque characteristics tables. The coil data is also shown for different sizes of magnet wire. If the exact operating voltage is not in the coil data table, use the nearest voltage shown in the table.
NOTE : When the operating voltage falls between 2 coil sizes, always use the higher AWG numbered coil so as to prevent potential thermal damage. To determine the torque output of the solenoid after temperature rise, please use the amp-turn gross torque tables (pages 22) after calculating the amp-turns.

9. Ordering Information

●When ordering a rotary solenoid, the correct part number needs to be determined, from the following combination of characteristics (1-5) :

(1) M-Metric Thread
F-SAE Thread
(2) Solenoid Size (example-490)
(3) Coil Wire Size (AWG no.)
(4) Angle of rotation, direction of rotation and accessories (table 3)
(5) R-Standard Life Bearing
RE-Extended Life Bearing
RL-Long Life Bearing

●Example of a complete part number :

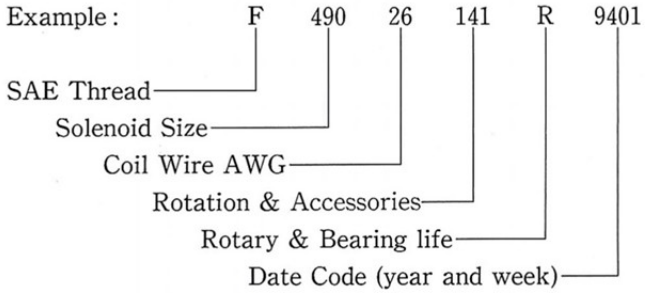
(1)	(2)	(3)	(4)	(5)
F	490	26	141	R

This part number is for a solenoid with ① SAE threads, ② size 490, ③ 26 AWG coil wire, ④ 35 deg. right-hand rotation, with accessories of armature side shaft extension and return spring provided, ⑤ and standard life bearings.

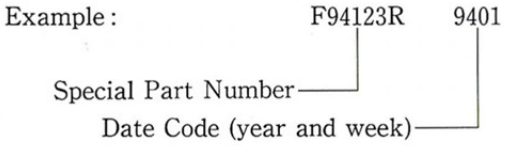
10. Labeling

For rotary solenoids the part number labeling is as follows :

A) Standard Solenoid (no modifications).
The solenoid label will have the part number and the date code (which identifies the year and week of manufacture).



B) Special Configuration (required for any modification to a standard design)
Any change from the standard catalog design requires that a custom part number be assigned, which will also include the date code of manufacture.



11. Accessories Definition Table

When ordering a rotary solenoid, the correct number for the angle of rotation, direction of rotation and accessories needs to be determined from the following table.

Table 3

Accessories	Clockwise Rotation(RH)					Counter Clockwise Rotation(LH)				
	25°	35°	45°	67.5°	95°	25°	35°	45°	67.5°	95°
A	070	071	072	073	074	075	076	077	078	079
A T	100	101	102	103	104	105	106	107	108	109
A T R	110	111	112	113	114	115	116	117	118	119
A D	120	121	122	123	124	125	126	127	128	129
A D R	130	131	132	133	134	135	136	137	138	139
A R	140	141	142	143	144	145	146	147	148	149
T	170	171	172	173	174	175	176	177	178	179
T R	180	181	182	183	184	185	186	187	188	189
B	220	221	222	223	224	225	226	227	228	229
A B	230	231	232	233	234	235	236	237	238	239
A B T	260	261	262	263	264	265	266	267	268	269
A B T R	280	281	282	283	284	285	286	287	288	289
A B D	290	291	292	293	294	295	296	297	298	299
A B D R	300	301	302	303	304	305	306	307	308	309
A B R	310	311	312	313	314	315	316	317	318	319
B T	340	341	342	343	344	345	346	347	348	349
B T R	360	361	362	363	364	365	366	367	368	369
B D	370	371	372	373	374	375	376	377	378	379
B D R	380	381	382	383	384	385	386	387	388	389
B R	390	391	392	393	394	395	396	397	398	399