According to Table 1, the max. angular acceleration ratio is

$\frac{\alpha_{max}}{w^2}$ = 0.0306 for β = 10°.

$w = \frac{(250)(2\pi)}{60}$ rad/sec. = 26.18 rad/sec.

Hence, α_{max} = (0.0306) $(26.18)^2$ = 21.0 rad/sec². The weight, W, of the disc is given by
$W = \pi r^2 t y$, where y denotes the density of steel and is equal to 0.283 lbs/in^3.

$$W = \pi (3)^2 (0.25) (0.283) = 2 \text{ lbs.}$$

Inertia torque = I α_{max}, where I = polar mass moment of inertia of disc (in-lb-sec²)

$$= \frac{Wr^2}{2g},$$

and g = gravitational constant = 386 in/sec².

Hence, $l = \frac{(2)(3)^2}{(2)(386)}$ = 0.0233 in-lb-sec².

Inertia torque = (21.0) (0.0233) 0A89 in-lbs. This inertia torque is a momentary maximum. The inertia torque fluctuates cyclically at two cycles per shaft revolution oscillating between plus and minus 0.489 in-lbs.

When system vibrations and resonances are Important, it may be required to determine the harmonic content (Fourier series development) of the output shaft displacement as a function of the displacement of the input shaft. The amplitude of the mth harmonic (m> 1) vanishes for odd values of m, while for even values of m it is equal to (2/m) $(\tan 1/2\ \beta)^m$, where β denotes the operating angle.

5.0 JOINT SELECTION (Torque Rating)

The capacity of a universal joint is the torque which the joint can transmit. For a given joint, this is a function of speed, operating angle and service conditions.

Table 2 shows use factors based on speed and operating angle for two service conditions: Intermittent operation (say, operation for less than 15 minutes, usually governed by necessity for heat dissipation) and continuous operation. The torque capacity of a single Cardan joint of standard steel construction is determined as follows:

i. From the required speed in RPM, operating angle in degrees, and service condition (inter. mittent or continuous), find the corresponding use factor from Table 2.

ii. Multiply the required torque, which is to be transmitted by the Input shaft, by the use factor. If the application involves a significant amount of shock loading, multiply by an additional dynamic factor of 2. The result must be less than the static breaking torque of the joint.

iii. Refer to the torque capacity column in the SDP catalogue and select a suitable joint having a torque capacity not less than the figure computed in (ii), above.

If a significant amount of power is to be transmitted and/or the speed Is high, it is desirable to keep the shaft operating angle below 15°. For manual operation operating angles up to 30° may be permissible.

TABLE 2 USE FACTORS FOR THE TORQUE RATING OF UNIVERSAL JOINTS

Intermittent Running Conditions
Suggested Use Factor

SPEED R.P.M.	ANGLE OF OPERATION-DEGREE								
	0	3	5	7	10	15	20	25	30
1800	9	20	34	45	-	-	-	-	-
1500	8	16	28	39	-	-	-	-	-
1200	7	13	22	32	40	-	-	-	-
900	6	11	16	23	34	-	-	-	-
600	5	8	11	15	22	34	40	-	-
300	4	5	7	8	11	16	22	28	34
100	3	4	4	5	6	8	9	11	12

Continuous Running Conditions
Suggested Use Factor

SPEED R.P.M.	ANGLE OF OPERATION-DEGREE								
	0	3	5	7	10	15	20	25	30
1800	18	40	68	90	-	-	-	-	-
1500	16	32	55	78	-	-	-	-	-
1200	14	26	44	64	80	-	-	-	-
900	12	21	32	46	68	-	-	-	-
600	10	15	22	30	44	68	80	-	-
300	8	10	14	16	22	32	44	55	68
100	6	7	8	10	12	15	18	22	24

5.1 Example 2 Universal Joint Selection for Continuous Operation

A single universal joint is to transmit a continuously acting torque of 20 in-lbs., while operating at an angle of 15° and at a speed of 600 RPM. Select a suitable joint.

From Table 2 for continuous operation, the use factor Is given as 68. Note that there are blank spaces in the table, If the combination of operating angle and speed results in a blank entry in the table, this combination should be avoided.
The required torque is (68) (20) = 1360 in-lbs. There is no shock load and the dynamic factor of 2 does not apply in this case.

From the catalogue, it is seen that there are two joints meeting this specification: 508-0500 and 508—D516, both with a torque capacity of 1700 in-lbs. The first has a solid-shaft construction and the second a bored construction. The choice depends on the application.

5.2 Example 3: Universal Joint Selection for Intermittent Operation With Shock Loading

A single universal joint is to transmit 1/4 horsepower at 300 RPM at an operating angle of 15° Select a suitable joint for intermittent operation with shock loading.

Here we make use of the equation:

$$\text{Torque} = \frac{\text{Horsepower} \times 63{,}025}{\text{RPM}} \text{ in-lbs.}$$

Hence, operating torque $= \frac{(0.25)(63{,}025)}{(300)} = 52.5$ n-lbs. From Table 2, for intermittent

loads (300 RPM, 15°), the use factor is 16. Due to shock loading there should be an additional dynamic factor of 2.

Hence, the rated torque = (52.5) (16) (2) = 1680 in-lbs. Thus the same joints found in the previous example are usable in this case.

5.3 Example 4: Determining the Maximum Speed of an Input Shaft

A universal joint is rated at 250 in-lbs., and operates at an angle of 12°, driving a rotating mass, which can be represented (together with the inertia of the driven shaft) by a steel, circular disc, radius r = 6”, thickness t = 1/2",
attached to the driven shaft, How fast can the input shaft turn if the inertia torque is not to exceed 50% of rated torque?