

## Turning Gear and Component Selection Guidelines

### Turning Gear Selection

The main purpose of a turning gear is to alleviate the ill effects due to thermal stratification when a hot gas fan is shut down. During a hot shutdown of the fan, there will be a temperature gradient across the fan rotor because of the migration of warmer gas to the top portion of the fan housing and cooler gas to the bottom portion of the fan housing. This causes a temporary set in the fan shaft and on a re-start the fan will experience higher vibration levels. The following fans are typically good candidates to have a turning gear:

- Induced Draft fans over 120" in diameter and with large shafts and are subject to frequent start/ stops and or hot shut downs.
- All Gas Recirculation fans
- Hot Gas fans with high system sensitivity or fans operating close to the installed resonant speed
- All high temperature process fans in Cement, Sintering and Pelletizing etc.

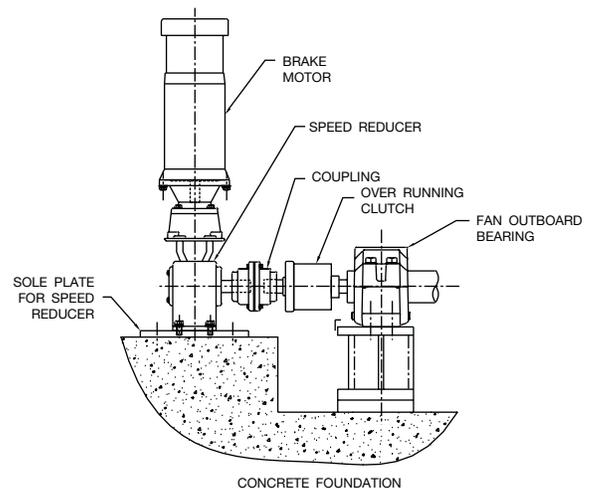
There are basically three types of turning gears. The first has the capability of being able to start the fan from a dead rest. The second type engages only on coast down and the size of the turning gear unit is much smaller as compared to the one that can start from a dead rest. The third type of turning gear is employed for fans with hydrodynamic bearings, which are fitted with hydrostatic lift.

For starting from a dead rest, typically the turning gear size ranges from 5 HP to 150 HP for fan applications. A smaller turning gear is possible for smaller fans. High starting torque motors, typically NEMA C, are used with units that start from a dead rest. Sometimes with a marginal main drive motor, turning gear with the starting capability from a dead rest would be helpful to take away some burden from the main motor. Instead of starting from a dead rest, the main motor will accelerate from the turning gear speed.

For units engaging on coast down, the motor may range up to 100 HP and could utilize a standard NEMA B as opposed to a NEMA C motor.

Turning gear systems employed with fans that have bearings fitted with hydrostatic lift provide more compact units. This is because these units can run at a very low speed due to the fact that there is no minimum speed required for the bearings to develop the oil film since the oil film is provided by the hydrostatic lift. The size of the unit with hydrostatic lift may range up to 25 HP.

A typical arrangement of a turning gear in a fan application is given below:



### Components

#### Motor

To make the turning gear unit compact for units starting from a dead rest, usually NEMA C motors are used. This is done to utilize the high starting torque characteristics of a NEMA C motor to help overcome the high breakaway torque of the fan and drive motor. For units engaging during coast down and for units with hydrostatic lift, standard NEMA B motors are adequate since high breakaway torque is not involved. Most applications use 1800 rpm motors, but 1200 rpm motors are used in certain situations. With a certain speed reducer combination, a brake motor or a separate brake may be required.

#### Speed Reducer

Usually right-angled speed reducers or in line speed reducers are used to rotate the fan at the required turning gear speed. A brake might be necessary depending on the type of speed reducer used and if the back drive resistance of the reducer is not adequate to overcome the drag torque of the clutch. The brake is wired to disengage while the turning gear motor is energized and engage while the turning gear motor is de-energized.

The speed reducer must have adequate torque carrying capability to handle the maximum torque and peak torque of the turning gear system. Thermal rating of the speed reducer is important to handle the normal operating torque without overheating the reducer for reliable operation. Output speed of the turning gear system is to be determined based on the minimum speed required to develop oil film when used with hydrodynamic bearings. This is usually dependent on the Sommerfeld number, which again depends on the oil viscosity, radial load, size of the bearing, bearing clearance etc. Fans with anti-friction bearings do not typically have a minimum speed requirement.

### **Clutch**

For turning gear applications, overrunning clutches are required and are either shaft-mounted type or foot mounted type with input and output shafts. It must be noted that the clutches are assembled either for clockwise rotation or counter-clockwise rotation. Clutch rotation must match the normal fan rotation. Shaft mounted type clutches are available with inner race over-running or outer race over-running. Clutches with inner race over-running are mounted on the fan shaft and clutches with the outer race over-running are mounted on the output shaft of the reducer. Often times special output shafts for the speed reducer are required and this increases the cost and lead-time of the speed reducer.

### **Couplings**

There are usually three couplings in a turning gear assembly. One between the fan and the clutch, the second between the clutch and the speed reducer and the third between the speed reducer and the turning gear motor. Typically all the couplings are gear couplings and the one between the fan and the clutch has to accommodate thermal expansion of the shaft. For smaller units and with different arrangements, the number of couplings can be reduced to one or two.

### **Selection and Sizing of Components**

The first step is to calculate the breakaway torque of the fan rotor as a dead load and the breakaway torque of the drive motor. The next step is to determine the turning gear speed, which is a function of the type of bearing and whether or not the bearings are equipped with hydrostatic lift. All components have to be adequately sized for the duty requirements and the peak load requirements of the turning gear system.

### **Controls**

When the fan motor is de-energized, the turning gear motor is energized and when both speeds match, the clutch automatically engages. If there is a brake in the turning gear system, it should disengage on energizing the turning gear motor. Bearings equipped with hydrostatic lift and/or circulating oil must continue to operate while the turning gear is operating and rotating the fan rotor and motor rotor.

### **Turning Gear Motor Inertia Verification**

For turning gear units starting from a dead rest, it is necessary to make sure that the turning gear motor has adequate inertia capability to accelerate the load without overheating. Inertia seen by the turning gear motor must be lower than the inertia capability of the turning gear motor.



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