DYNAMIC ROTOR STABILITY IN DUEL MODE TURBOGEARS - FCCU Drive Applications

SCOPE:

This statement deals with dynamic rotor stability in gears which transmit torque in both directions without changing the sense of rotation, and with the torque varying between no load and maximum load.

GENERAL:

Gearbox rotors normally show the highest vibration amplitudes when operating in a no load condition. Therefore if a gear unit can adequately operate within specified vibration limits under no load full speed conditions it will typically demonstrate improved results when loaded. This is especially important to recognize when gearbox manufacturers accept vibration criteria set forth for a typical installation by demonstrating acceptance within a no load full speed test.

LOAD VARIATION & POWER REVERSALS:

In the case where rotors are subject to varying load or torque over a speed range or at a given speed there exists a point of operating where the tooth reaction is exactly equal to the rotor weight. At this point the rotor is dynamically "floating" in the bearings. This condition has a tendency to increase vibration levels above the limits which are normally specified. However, the condition is in no way harmful to the gear. It does present a problem for the normal setting of the trip switches.

This is a result of vector analysis and is therefore a fact that cannot be eliminated. The sense of rotation or direction of mesh also does not eliminate the phenomena (see diagrams 1 thru 4). However, attention to the combination of the sense of rotation and meshing direction could help avoid the problem.

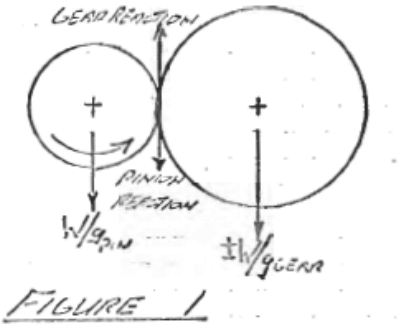

FIGURE 1

Gear reducing
pinion driving

Pinion reaction down
Bullgear reaction up

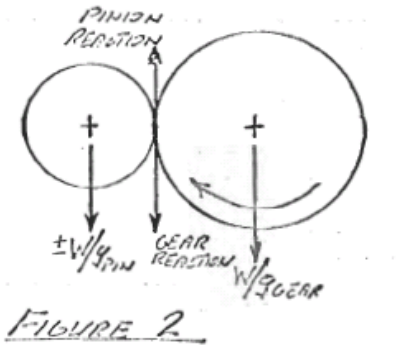

FIGURE 2

Gear increasing
Bullgear driving

Pinion reaction up
Bullgear reaction down

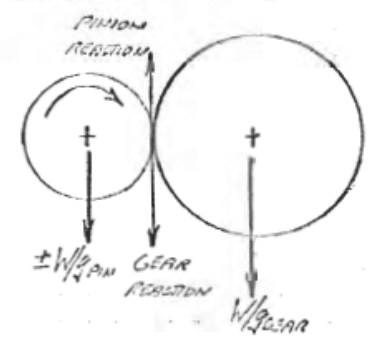

FIGURE 3

Gear reducing
Pinion driving

Pinion reaction up
Bullgear reaction down

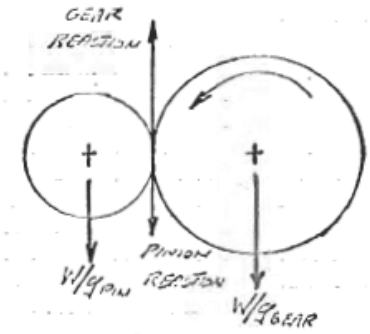

FIGURE 4

Gear increasing
Bullgear driving

Pinion reaction down
Bullgear reaction up

Since the pinion is considerably lighter than the bull gear, the damping effects of the bearing and gear mesh will substantially reduce pinion vibration in a “floating” mode whereas the damping influence on a bull gear in a similar mode is not as effective. So attention should be given to the combination of rotation as well as mesh direction to avoid bull gear “floatation” for those conditions where the load could vary.

Thus gear installations built for reversing power modes are best approached in such a manner that allows the bull gear to remain in a downward loaded condition in the most frequent operating mode. If this is not possible, it should be attempted to avoid the narrow power range where the bull gear (or pinion) is “floating” for long periods of time, although the bearings are designed to withstand the higher vibration levels due to this operating mode.

In these cases, particularly where the shaft speeds are high, multi-lobe or multi-land journal bearings are provided. Such bearings demonstrate excellent stability with vibration levels normally at reduced and controlled levels.

It is worthy to identify the specific shaft vibrations levels applicable to the above described mode of operation. This condition must be separated from the normal operating mode vibration limits.