

# 航空齿轮传动系统的‘风阻’问题

南京航空航天大学 陈士煊\*\*

【摘要】 本文旨在综合与分析国内外有关机种的结构方案,为设计时如何提出抑制和利用“风阻”的技术措施,开拓思路,明确方向。

关键词: 齿轮传动 风阻

## 1 关于“风阻”的分析

随着航空技术不断发展,齿轮传动系统结构愈来愈趋于轻型化、高速化。由此带来的“风阻”问题已成为当前世界各国密切关注的重要课题。“风阻”的主要表现,在于使箱体发热加剧、油雾生成严重、抽回油能力困难等。形成的原因在于箱内自由空间相对缩小,齿轮等高速旋转体与周围空气的接触面相对增大,致使它们的相对运动与摩擦加剧,并将滑油搅动激化。随着旋转速度不断提高,发热、搅动等现象渐趋严重。当轮齿速度超过  $50\text{m/s}$  时,“风阻”与搅动已近恶化。由于“风阻”帘幕阻滞作用,滑油与油珠在接近轮齿表面和轴承前,就已被吹散,“风阻”的空气运动将成为对其做功的主要搅动源,所以它是传动系统中动力损耗的重要因素。综述之,“风阻”和搅动耗损受到速度、滑油流量以及结构因素的影响,但是却与传动功率量值没有直接关系。在箱体内,“风阻”影响区仅发生在局部空间里,它的特征主要表现在,该区域内存在一股强烈的强迫涡流,高速度场与离心力场是该区域的两个重要特点。根据它们的作用,可以看出,既是危害根源,又是收益源泉。

## 2 典型结构方案

对不同航空高速传动系统,由于使用场合和结构各异,“风阻”与搅动现象的表现是五花八门的,起因和后果也不尽相同,有时只要技术措施合适,可以获得绝然相反的结果。目前,常用的办法是抑制“风阻”的不利影响。它们有:

(1) 在齿轮、轴承等高速旋转件周围提供一个较大空间,以减少滑油在风阻流一侧集聚;并有助于避免滑油搅拌、风阻耗损与滑油被夹带的作用,从而使箱体发热减轻。

(2) 在高速轮齿外缘周围设置挡板护罩或精细的网眼隔板(图1),既可以消除来自轮齿的油喷动能,又可驱散风阻流,透默III C 涡轴发动机采用了该方案。

(3) 对箱体下方的高速齿轮,设置挡(导)风板(罩),可

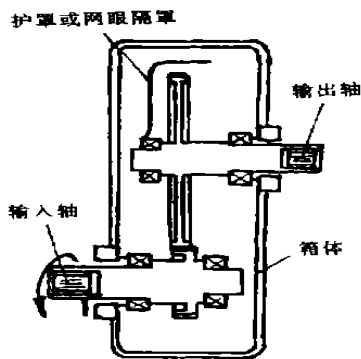


图1 加护罩方案

限制风阻引起的帘幕影响区, 提供一个畅通的排油通道(图 2), 阿赫耶涡轴发动机采用该技术。

(4) 齿轮箱内壁表面应尽量平滑, 不使流动气体和液体产生新的扰动源与死角。

从辩证观点看,“风阻”的流场特点也可为我所用。其方案为:

(1) 在齿轮进入啮合的外缘处, 设置导风罩(图 3 所示), 利用轮齿旋转功能, 引导滑油喷向啮合处作冷动润滑用, 或喷向箱体油槽作清洗油污用。

(2) 在齿轮侧面设置环形槽, 经搅动导流的滑油油珠集聚在该槽内, 并形成一层厚度一定的环形压力油膜, 经导管引出, 即构成皮托泵(Pitot Type)。引出的是一股净洁的不含油气的压力油, 因此腔内收油池将被用于代替滑油箱(图 4)。同时, 在“风阻”涡流中心附近或带径向通孔的高速轴心处, 设置通气管, 经双向排气阀将箱腔与大气沟通。从而简化了滑油系统。

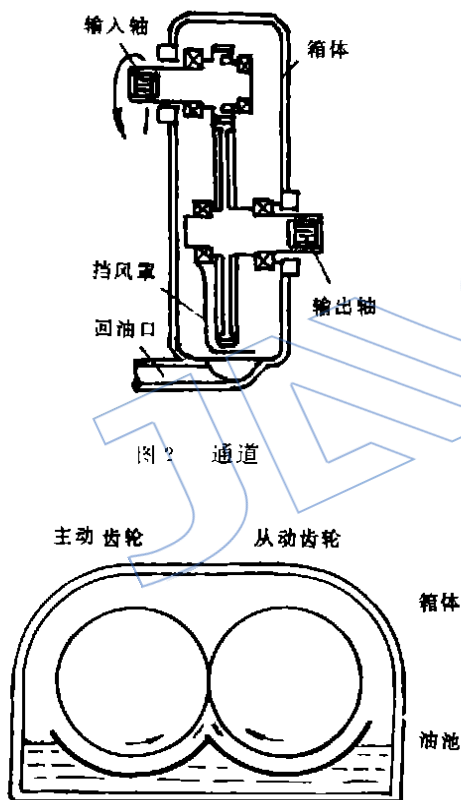


图 3 设导风罩方案

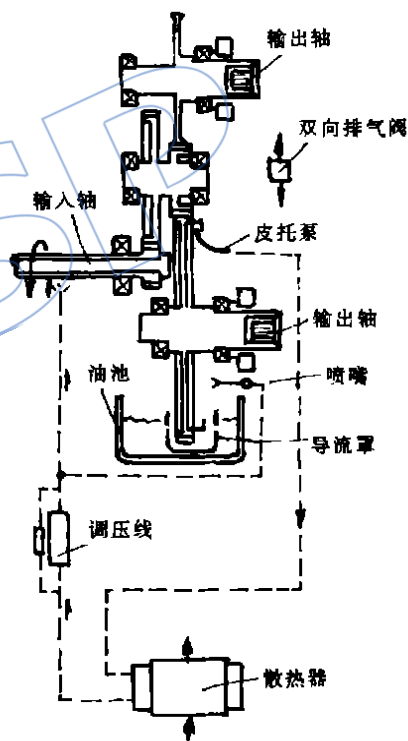


图 4 用皮托泵收油方案

总之,“风阻”不是不可逾越的障碍。根据使用要求,设计出性能良好的紧凑结构。

## 参 考 文 献

- 1 Rolls-Royce Advanced Mechanical Engineering Demonstrator L 2649/1
- 2 Allied-Signal Aerospace Company. Aviation Products Seminar 87-30660, Rev. 1

(责任编辑 王震华)

## NUMERICAL PREDICTION OF STEADY FORCE NOISE ON A COMPRESSOR ROTOR BLADE

Chen Jìng and Ren Rugan (Gas Turbine Establishment)

Sun Xiaofeng and Hu Zongan (Beijing university of Aeronautics and Astronautics)

**ABSTRACT** Sources of compressor noise are usually considered as multiple pure tone noise, interaction noise and broadband noise. In the paper, the noise propagation equation of steady force on the compressor rotor blade is derived. The numerical results are compared with the WP-11 compressor rotor acoustical experiment. The theoretical and experimental investigations indicate that the steady force noise on the compressor rotor blade is an important source of the compressor noise.

## A NEW TYPE OF FUEL CONTROL MODEL

Qin Xuguang

(Xi'an Yuandong Company)

**ABSTRACT** A new type of fuel control model is developed without the conventional fuel cock and pressure drop valve. It consists of a high-precision electronic block, a micro-computer and an actuator. The actual fuel flow calculated by the micro-computer or checked from the data chart against the parametric signals fed out from the digital-type transducer in relation to the fuel supply is compared with the required fuel flow and the actuator then balances the actual flow with the required by adjusting the pumping flow or return flow according to the amount of deviation and its characteristics if there is any deviation. The fuel control unit built with the new model features high precision, low weight, compact size and good adaptability, and is especially suitable to the application of digital control project of aircraft and engine. The new type of fuel control model has been testified for about 100 hours on the digital control research test bed for a type of aeroengine.

## FAULT-TOLERANT CONTROL OF RECONFIGURING RULE

Wang Yingen

(Northwestern Polytechnical University)

**ABSTRACT** A new method of fault-tolerant control for multiloop SOSI system is suggested. A reconfiguration control rule is applied to the neighbouring loop of any fault sensor for compensating its effect. The suggested method is able not only to maintain the stability of the system but also to keep the controlling quality to be the same as that before the fault happens. This method is suitable for both minimal and non-minimal phase systems. The results of the numerical simulation show that the method is of good compensating function.

## "WINDAGE" FOR HIGH GEAR SYSTEMS IN AVIATION

Chen Shixuan

(Nanjing Aeronautical Institute)

**ABSTRACT** The problems about "windage" and churning for high-speed gear systems in aviation are considered. The domestic and foreign technical projects are introduced. The structural measures for depressing and using "windage" in high-speed gear systems in aviation are presented.