Balancing method of process mandrel rotor -- fan impeller

Balancing machine is a kind of machine which can simulate the working state of the rotor and make the measurement system in an ideal test environment.

The electronic measuring circuit of hp16 hard support balancing machine system fully simulates the operating parameters of balancing machine. Firstly, the input signal transmits the mathematical relationship of rotor unbalance and centrifugal force

$U1=F1\cos(\omega t+\phi 1)=m1r1\omega^2\cos(\omega t+\phi 1)$ $E1=U1k1$

$U2=F2\cos(\omega t+\phi 2)=m2r2\omega^2\cos(\omega t+\phi 2)$ $E2=U2k2$

Among them, the angular frequency $\omega = 2\pi n / 60$, the rotational speed n rpm is a measurable parameter

Therefore, when the factory calibration good support sensitivity K1 K2

The unbalance value m1 m2 can be calculated

$m1=E1/[k1\ r1(\pi n/30)^2\cos(\omega t+\phi 1)]$

$m2=E2/[k2\ r2(\pi n/30)^2\cos(\omega t+\phi 2)]$

The maximum value is

$m1=E1/[k1\ r1(\pi n/30)^2]$ E1，E2 Is the signal power value of the sensor output.

$m2=E2/[k2\ r2(\pi n/30)^2]$

Other abc operations

It should be reliable - that is to say, the measurement result has no moisture, the repeatability of the instrument, the purity of the mechanical signal, the interference degree of the mechanical signal, and the signal-to-noise ratio of the sensor.

The linear working range of the balancing machine, modern hard support balancing machine has a very good linear range - that is, after calibration at one speed, other speeds and rotors of other sizes can be directly calculated and measured without re calibration.

Micro balancing machine From 100g to 0.1mg.

Small balance machine from 10kg to 0.01g.

Large balancing machine from 100kg to 1g.

The super large balance machine can be from 1000kg to 100g.

If the product does not have these functions at all, it will need to be recalibrated for a different rotor, which will bring trouble to the user.

The essence of calibration is E1 / K1 = E2 / K2

The specific performance is that when the left and right sides are symmetrical: adding 100g on the left side should show the same value as adding 100g on the right side.

The normal balance machine should display 85g angle 218 degrees at 300rpm. When the speed is increased to 500rpm, the change is small --- 85 changes 5-10g, the angle changes 2-3 degrees.

Manufacturing requirements of mandrel fixture

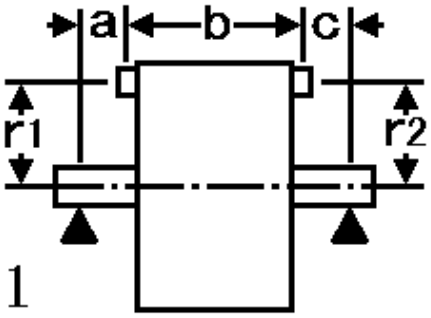
1. The highest accuracy of the rotor through the mandrel is determined by the accuracy of the mandrel. G6.3 is less than 0.02mm.

2. The best mandrel that can be operated is 1:2000 taper mandrel. (drive motor should be controlled by frequency converter)

3. The interface error between mandrel and universal joint can be fixed and balanced at the joint to eliminate the influence of empty shaft.

4. The accuracy of limit effect can be overcome by low interference mode,

5. The influence of couple must be considered for the balancing machine with single side balance. Otherwise, it can not meet the requirements of vibration accuracy.



动平衡支承方式1

When setting the values of R1, R2, a, B, C through the keyboard, press any key of R1, R2, a, B, C, and the corresponding characters will flash. After pressing the number key to enter the value, it will be delayed for several seconds and automatically saved in the memory. Power failure or shutdown will not lose data.

a. The unit of B, C, R1 and R2 is mm.

Re press the letters on the keyboard to re-enter the corresponding data.

Do not consider the order before and after, arbitrary operation.

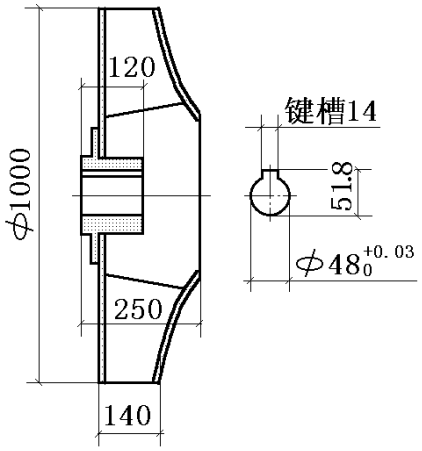
4.1 General fan rotor balancing operation process

This section will take the fan rotor shown in Figure 9 as an example to introduce the operation process of general fan impeller balance calibration. Other types of rotor balance calibration can also refer to this process.

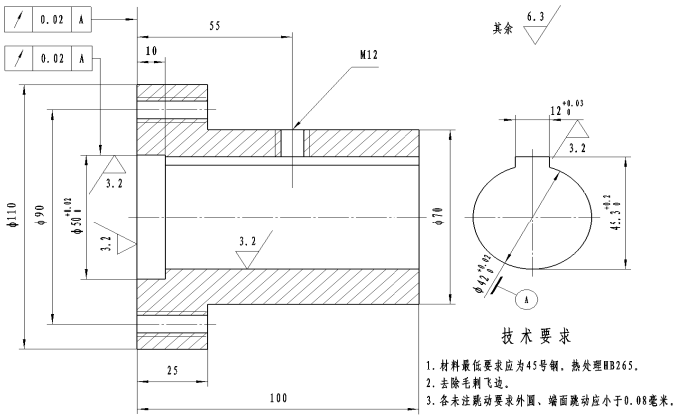
4.1.1 preparation

4.1.1.1 the impeller process shaft and connecting sleeve should be made first. The process shaft and connecting set are shown below

Fig. 10 and 11 (Note: the dimensions shown in the figure correspond to the impeller dimensions shown in Fig. 9).



图九：示例转子简图



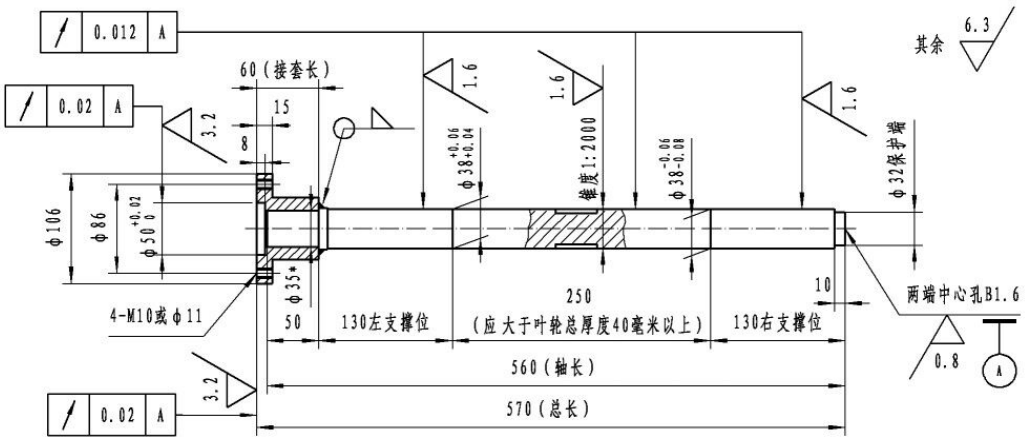
图十：接套图样（例）

4.1.1.2 check whether the anchor bolts are loose. If they are loose, they must be tightened. Check other parts of the machine for abnormalities.

4.1.1.3 set the main power switch on the electrical control box to "0" (off position).

4.1.1.4 check whether the connection is normal. Note that the main power supply must not be energized during the preparatory work.

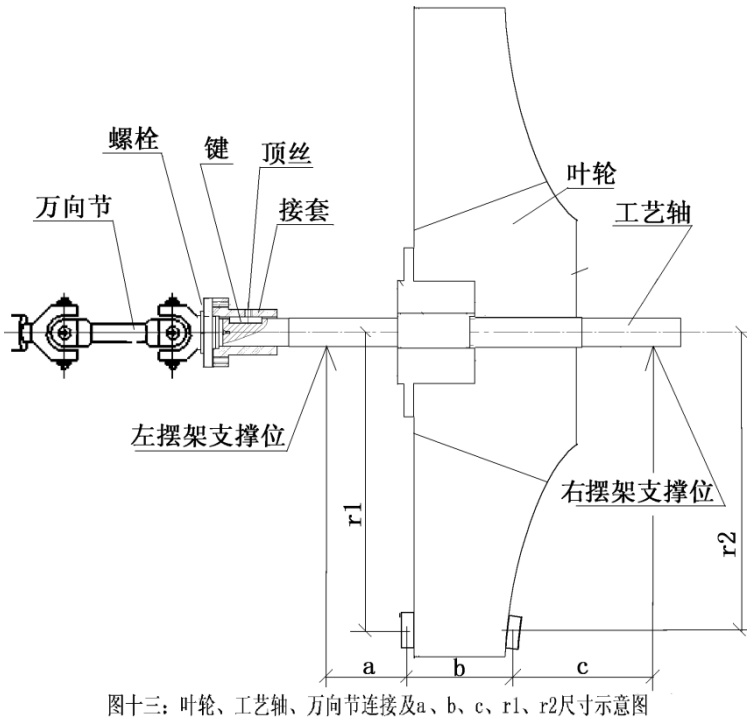
4.1.1.5 adjust the roller scale to "43" position and fasten the roller. Adjust the position of the two swing frames to fit the installation of the rotor and process shaft. Install and connect impeller, process shaft and universal joint as shown in Figure 13. All joints must be firmly connected.



技术要求

1. 材料最低要求应为45号钢。热处理HB265。
2. 去除毛刺飞边。
3. 各轴位跳动要求为初始加工要求。使用过程跳动超过0.05毫米时必须报废。
4. φ35*用于接套联接。较小规格工艺轴推荐：先将工艺轴和接套加工φ35*联结尺寸后焊接，然后参考本图加工。
5. 键槽对称加工，位置按工艺轴和叶轮试装确定。
6. 两个支撑位直径可加工成与转子装配轴位相同的直径和锥度。并一起加工成。
   但支撑位直径不得接近于滚轮外径的整倍数或整分数。例如：当滚轮直径为101时，此直径不得加工成：90-110或45-55。
7. 本图例用于：内孔φ38、总厚度小于200毫米的转子。用户应根据转子实际情况调整长度尺寸，不必完全照搬此图！

φ38锥度工艺轴图样（例）



图十三：叶轮、工艺轴、万向节连接及a、b、c、r1、r2尺寸示意图

4.1.1.8 pay attention to inspection: swing frame, safety frame, roller frame, etc. must be compressed, roller and process shaft support position should be clean, and four roller surfaces should be coated with a little lubricating oil.

4.1.1.9 rotate the impeller by hand for one week to check whether there is any abnormal phenomenon and confirm that all mechanical connections are reliable.

4.1.1.9 set the main power switch to "0" (off position). Check whether the wires are connected

Normal. Set the frequency converter to 20% position, then send power to the whole machine, and the power indicator is on.

4.1.1.10 turn on the power supply of the electric measuring box, and the power indicator on the front panel of the electric measuring box will be on.

4.1.2 unbalance detection process

4.1.2.1 confirm that all mechanical connections are reliable and dimensions a, B, C, R1 and R2 are input correctly,

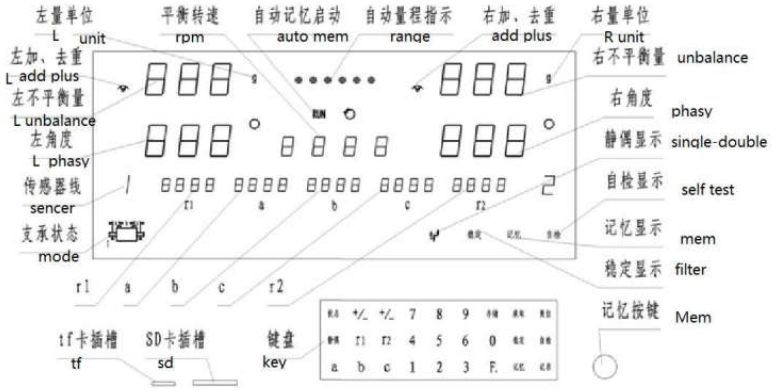
4.1.2.2 inspection: when the balancing machine is working, there must be no one in the rotation diameter direction of the rotor.

4.1.2.3 press the "start" button to start the balancing machine.

4.1.2.4 after a few seconds, the rotor speed is stable. From the electric measuring box, we can see that: a the indication of the tachometer is stable after reaching a certain reading, B the four digital meters are stable (or relatively stable) indication.

Look at the tachometer of the electric measuring box. In the rotating state, you can slowly adjust the speed knob at a speed of 3-5 RPM per second. The small rotor is set at 500-600 rpm, and the large fan impeller is set at 100-300 rpm

4.1.2.6 press the "memory" function button on the electric measuring box



to stop the rotor. Or wait for hp16 electric test box to automatically memorize and then stop automatically.

4.1.2.7 according to the measurement value and angle indicated by the electric measuring box, add the clamp on the corresponding position of the rotor for test weight (see Figure 15 below). The size and position shall be accurate and the clamp shall be firm. (this process is the removal of unbalanced measurement)

4.1.2.8 verify whether the size and position of the clamp test weight are correct according to the change of the indicated value of the electric measuring box.

4.1.2.9 it can be adjusted by moving the clip position (angle) and changing the clip size (weight) to make the remaining unbalance small enough.

4.1.2.10 mark the position and counterweight on the installation clamp.

4.1.2.11 remove the rotor welding counterweight.

Note: a rotor must not be welded on the balancing machine!

B when welding the rotor, the process shaft can not be removed, but attention should be paid to the protection.

C. the weight of counterweight (including the weight of welding rod) shall be accurate.

4.1.2.12 repeat the operation process described in 4.1.2.2-4.1.2.11 until the required balancing accuracy of the rotor is reached.

4.2 rotor balancing operation process of axial and diagonal flow fans

In general, the rotor of axial-flow fan and diagonal flow fan can meet the balance accuracy requirements by static balance verification. The following is the process of static balance test. If necessary, the operator can carry out dynamic balance calibration in combination with the contents of this section and the previous section.

4.2.1 prepare for manufacturing impeller process shaft and connecting sleeve. Refer to figure 10 and 11 for the drawings of process shaft and connecting sleeve (Note: the dimensions shown in the figure correspond to the impeller dimensions shown in Figure 9, and the process shaft and connecting sleeve corresponding to different rotors are different. The size shall be matched with the corresponding rotor).

4.2.2 other preparations are basically the same or similar to those in Section 4.1.

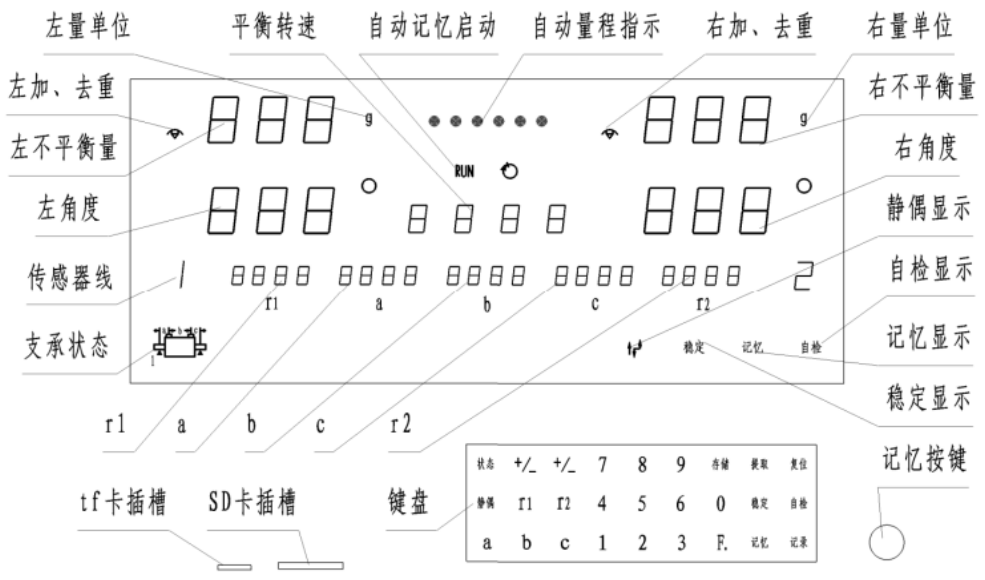
4.2.3 after all preparations and rotor installation are completed, rotate the impeller by hand to check whether there is any abnormal phenomenon, and confirm that all mechanical connections are reliable. Check whether the connections are normal.

4.2.4 refer to section 3.3.1 and figures 16, 17 and 18, input dimensions a, B, C, R1 and R2, press the light and heavy buttons on the left and right sides of the calibration face (indicating light and welding counterweight), press the dynamic / static couple unbalance correction method selection key (static / couple balance mode), and press the rotor support surface, Press the selection key of the relative position of the calibration face (standard support mode, built-in rotor), memory key

4.2.5 start the measurement process according to Section 4.1, after the reading is stable, remember and stop.

4.2.6 the left digital meter shows the magnitude and angle of static unbalance, and the right digital meter shows the magnitude and angle of even unbalance (refer to figure 16). The counterweight operation is carried out according to the size and angle indicated by the digital table on the left. Generally, the counterweight is welded at the appropriate position in the inner cavity of the rotor shell. Trial counterweight operation should also be carried out during counterweight process. Balancing the static unbalance indicated by the digital meter on the left to the required accuracy means that the rotor balance calibration is completed.

4.2.7 in the process of balancing the rotor of axial-flow fan and diagonal flow fan, the counterweight operation can not be carried out according to the value of even unbalance shown by the digital meter on the right side.



If you want to carry out the counterweight operation of couple unbalance, you should refer to Section 4.1 (dynamic balance method) to readjust the dimensions a, B and C after the static unbalance calibration is completed, and the static couple key will change the static couple state (dynamic balance correction method). In strict accordance with the (dynamic balance method) method, until the accuracy requirements.

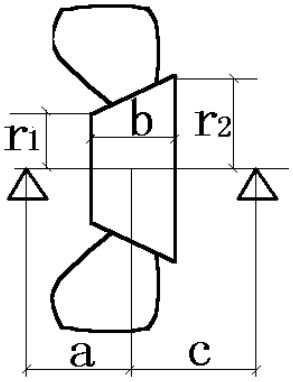
4.4.1 balancing operation of common motor rotors and crankshafts

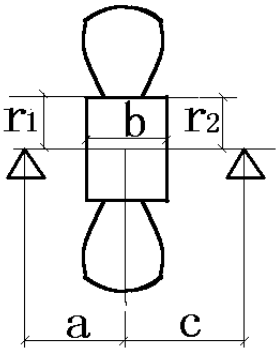
The method and process described in Section 4.1 can be used for unbalance detection of such rotors. The corresponding universal joint sleeve needs to be machined before balance detection. The bearing position of the rotor can be directly used as the support position in the balancing process. Because there is no process shaft error, the actual balancing effect is better than that of the rotor with process shaft.

4.4.2 balancing operation of disk rotors such as flywheel and gear

The method and process described in Section 4.2 can be used for unbalance detection of such rotors. Before balance detection, the corresponding universal joint sleeve and process shaft need to be processed. When the ratio of length to diameter is less than 1:10, only the static unbalance can be calibrated.

5. Operation precautions, operation procedures and brief operation process of balancing machine





图十七：斜流风机转子装载示意图 图十八：轴流风机转子装载示意图

5.1 precautions during operation

5.1.1 when operating the balancing machine, it must be operated by one person from starting to recording data and stopping. The assistant workers other than the operator of the balancing machine must obey the command of the operator and never touch any button of the balancing machine at will.

5.1.2 before hoisting the rotor, adjust the support frame of the balancing machine, including the support position, diameter scale, and the position of the support frame. After the rotor is placed on the support frame, the above mechanism is not allowed to be adjusted.

5.1.3 the larger rotor should be balanced at low speed, and the smaller rotor should be balanced at high speed. The rotor with large initial unbalance should also be balanced at low speed.

5.1.4 the balancing machine is an instrument product. During and after the rotor unbalance detection, attention should be paid to the maintenance of the balancing machine at any time. Barbaric operation is not allowed.

5.1.5 for larger rotors, corresponding supporting lifting equipment (> 20kg) must be provided to facilitate safe operation and avoid unnecessary accidents.

5.1.6 the balance machine must have a solid foundation as shown in the foundation drawing, otherwise its balance result data is unstable and untrue.

5.1.7 there must be a safety guardrail around each balancing machine. The distance between the guardrail and the balancing machine is generally 500mm to 1000mm.

5.2 operating procedures

When the balancing machine is working, there must be no one in the direction of the rotating diameter of the rotor!

5.2.1 when operating the balancing machine, it must be operated by one person from starting to recording data and stopping. When a larger balancing machine is operated, the assistant workers other than the operator must follow the operator's command to install the rotor, and never touch any button of the balancing machine.

5.2.2 the rotor must not be welded on the balancing machine!

5.2.3 before hoisting the rotor, adjust the support frame of the balancing machine, including the support position, diameter scale, and the position of the support frame.

5.2.4 before starting the balancing machine, measure the geometric dimension of the rotor and input it into the electric measuring box.

5.2.5 the larger rotor should be balanced at low speed, and the rotor with large initial unbalance should also be balanced at low speed. Smaller rotors are balanced at high speed.

5.3 after the rotor is installed normally, the brief operation sequence of the

balancing machine is as follows:

5.3.1 push the rotor by hand to see if the installation is proper.

5.3.2 check that no one is allowed to exist in the rotation diameter direction of the rotor.

5.3.3 start the balancing machine.

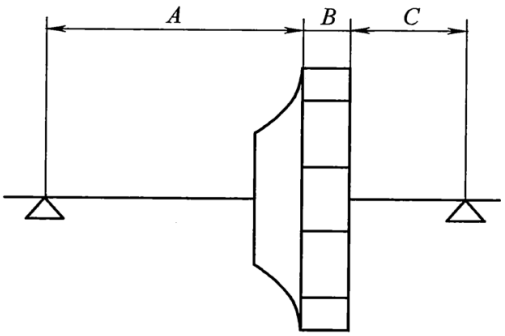
5.3.4 measure and record data.

5.3.5 shutdown.

5.3.6 remove the unbalance.

5.3.7 recheck the measured value.

5.3.8 remove the rotor and weld the balance weight.



After one factory calibration, it meets the following requirements:

All signals of the balancing machine can be calculated: the amplitude frequency characteristics of the electric measuring box meet the following requirements: the change of the displayed value is less than the requirements

The amplitude frequency characteristic of the soft support speed sensor signal is the first power of the angular frequency, $v = K1 * \omega$

The amplitude frequency characteristic of the sensor signal is the second power of the angular frequency, v = K2 * ω 2

The amplitude frequency characteristic of the hard support speed sensor signal is the third power of the angular frequency, v = K3 * ω 3

The phase frequency characteristics of the electric measuring box meet the following requirements: within the working speed range of the machine, the unbalance amplitude change of the electric measuring box is small, and the change of the display angle is less than the requirements

It ensures that the balancer displays the same amount of unbalance (number and angle) at different speeds without calibration.

Dynamic balance technology of motor

The balancing process of motor is similar to that of fan.

There are universal joint balancing machine and belt driven balancing machine.

No matter what kind of balancing machine, the rotor in the balancing process needs to be close to the mass distribution in use. That is to say, when the motor works, the keyway is full, or 75% full (depending on the actual length of the motor key). In order to do dynamic balance, 55% of the mass in the groove of the actual key must be maintained. Another 45% of the mass should belong to the output load of the motor.

Motor balancing speed selection: according to the specific balance machine running stiffness parameter selection.

Generally more than 500 kg, rotate 300-400 rpm

Small rotor selection 600-800rpm

In the belt driven balancing machine, the limiting frame affects the balancing accuracy. Try to adjust the position of the limiting frame to minimize the impact on the balancing accuracy.

The interface error between motor and universal joint can be reversed 180 at the joint to remove the influence value of universal joint.

After balancing the rotor, the connection between the universal joint and the rotor is reversed 180 degrees, and the new unbalance is removed by 50% of the value of the universal joint and the rotor.

Balance precision selection. The big rotor is about 10g, and the small rotor is about 1-2g.

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