

DYNAMIC BALANCE MANUAL
SETTING OPERATIONS FOR
CLOCKWISE ROTATING ROTOR
(SA 330 BLADES)

GIR. 3544

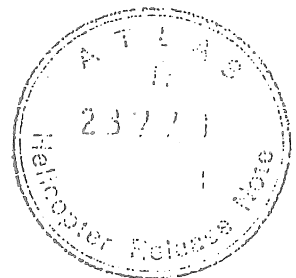
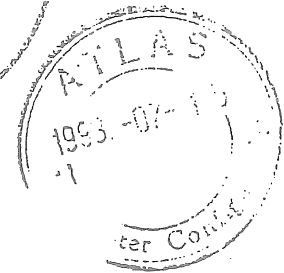
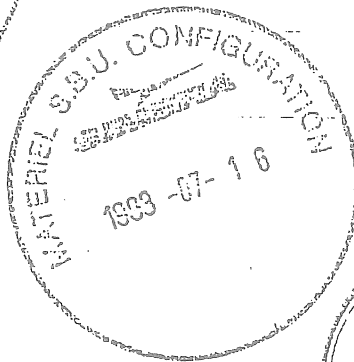


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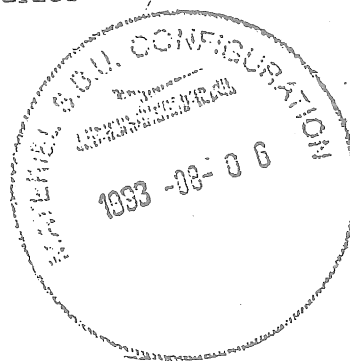
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The blades adjusting on dynamic stand gives the possibility to meet the flight qualities requirements while ensuring the interchangeability, blade by blade, on aircraft.

In order to ensure a satisfactory adjustment, a properly balanced rotor head should be used (lowest possible interactions on measures).

The rotor head balancing, without blades, will be dealt with in part I. of this document. However, as any balancing cannot be perfect, and as the master blades themselves show proper values, it should be necessary to determine their influences on the results. This will be dealt with in part II.

Part III will deal with the secondary blades calibration and with how to determine the corrections which will have to be applied during the series balancing.

Pitch angle (θ) :

Sleeve rotation angle, around its axis.

The adjustment is made through the main pitch chain (written M.P. further on) which gives to the three sleeves, in any position, the same incidence.

Characteristic angle : $\theta = 0^\circ$ \rightarrow chord of the blade to be balanced, at the level of the reference section, parallel to the ground.

Moment versus pitch axis (M_θ)

Moment measured through the dynamometric rod.

M_θ positive \rightarrow rod in tension (increasing pitching moment)

Moments departure ($M_\theta 0^\circ$) : Moment M_θ for $\theta = 0^\circ$ M.P.

Moments slope (ΔM_θ) : difference between $M_\theta 10^\circ$ and $M_\theta 0^\circ$

$$\begin{cases} M_\theta 10^\circ = M_\theta \text{ for } \theta = 10^\circ \text{ M.P.} \\ M_\theta 0^\circ = M_\theta \text{ for } \theta = 0^\circ \text{ M.P.} \end{cases}$$

It is always referred to a pitch variation $\Delta \theta = 10^\circ$

Direct Measures :

Measurement of the magnitude in absolute value.

Differential measures :

Difference between direct measures on the given sleeve (red or blue) and the yellow sleeve, taken as reference.

SECTION ONE
BALANCING OF ROTOR HEAD

IMPORTANT NOTE

All checks relating to the horizontality of the levers and all angle measurements taken at rest must be effected in the following configuration; dynamometric rod of the spindle-sleeve assembly on which the measurement is taken should be vertical to the LH cyclic pitch actuator.

SYMBOLS USED AND DEFINITIONS

Coning angle :

Angle of the sleeve axis measured in a vertical plane (it corresponds to the up and down motion of the sleeve).

Coning = 0° → sleeve axis parallel to the ground.

Drag angle :

Angle of the sleeve axis measured in a plane perpendicular to the above (it is bound to the retraction of the damper).

Drag angle = 0° → sleeve axis in a vertical plane incorporating the rotor axis.

Pitch angle (θ) :

Angle of rotation of the sleeve about its axis. It is adjusted through the collective pitch channel (abbreviated in the text to "coll") which gives the same angle of incidence to the three sleeves in any position.

Typical angle :

$\theta = 0^{\circ}$ → chord of the blade to be balanced parallel to the ground at the reference section.

Moment with respect to pitch axis (M_{θ}) :

Moment measured by means of the dynamometric rod

M_{θ} positive \rightarrow pitch change link under tension (nose-up moment)

Start of moments ($M_{\theta 0}$) : moment M_{θ} when $\theta = 0^{\circ}$ coll

Slope of moments (ΔM_{θ}) : difference between $M_{\theta 10^{\circ}}$ and $M_{\theta 0^{\circ}}$

$$\begin{cases} M_{\theta 10^{\circ}} & = M_{\theta} \text{ for } \theta = 10^{\circ} \text{ Coll} \\ M_{\theta 0^{\circ}} & = M_{\theta} \text{ for } \theta = 0^{\circ} \text{ Coll} \end{cases}$$

It is always plotted for a pitch variation of $\Delta \theta = 10^{\circ}$

Direct measurement :

Measurement taken as an absolute value.

Differential measurements :

Difference between the direct measurements on the sleeve in question (red or blue) and the yellow sleeve taken as a reference.

NOTES :

Marking of sleeves :

The three sleeves and measurement linkages are coloured :

Yellow : for the reference sleeve

Red and blue : for the other two sleeves

Units used for measuring the moments M_{θ} :

All tolerances are given in "units of moments"

1 unit = 1 inch-pound = 0.113 meter-Newton

REMARKS

Identification of the sleeves :

The three sleeves, as well as their measures chains, are identified by means of colours :

- . Yellow : for the reference sleeve
- . Red and blue : for the other two sleeves

Units used for the moments M 0 measures :

All tolerances are given in " Moments - Units "

- . 1 unit : 1 inch-pound = 0.113 meter-N.

BALANCES FREQUENCY

A/ - Complete balance - (Phases I - II - III and IV, described here under)

- . For a new head
- . For a recently overhauled head

B/ - Combined checks - (Phase IV)

- . Every month
- . Or after a part has been changed
- . Or if discrepancies appear in the measures

METHOD OF OPERATION

The equipped rotor head must be installed on the test bench.

At this stage, only the following items are not yet mounted :

- . All the counterweights (Torque, coning and centrifugal)
- . The linear actuators
- . The equipped dynamometric rods
- . The adapters (possibly)

The rotor head balancing is divided in four phases, which are :

PHASE I - CHECKS OF THE CYCLIC AND MAIN PITCH CHAINS -

CELLS MOUNTING AND CALIBRATION -

I. 1. - CYCLIC PITCH MAIN CHECK -

Aim :

Checking the coherence between the indicated cyclic pitch (dial) and the real cyclic pitch (measured on sleeve).

Operations to be performed :

- . Put the dynamometric rods to length : center - to - center distance : 612,8 mm (24.1/8 in) (use the assembly planned for this purpose), and position the counterweights at the dimension indicated on plans n° 87.05.330.11.0000.00, drawing 87 or 103 (BALDWIN Cells) or drawing n° 108 (SEDEME Cells).

Note : The mounting of the cell will have to enable a change of its orientation of ± 1 revolution (see adjustment page 14)

- . Put the linear actuator electrically to length : center - to - center distance : 254 mm (10 in) (use the planned assembly).
- . Mount the dynamometric rods and the actuators on the bench.
- . Set the main pitch to about 0° (more accurate adjustment performed in parag. 1.2).

- . Perform the cyclic pitch adjustment to " 0 " lengthwise and sidewise , as indicated hereunder :

With a protractor, take the yellow flange and yellow sleeve incidences (see diagramm) in the four following positions :
yellow dynamometric rod in front of :

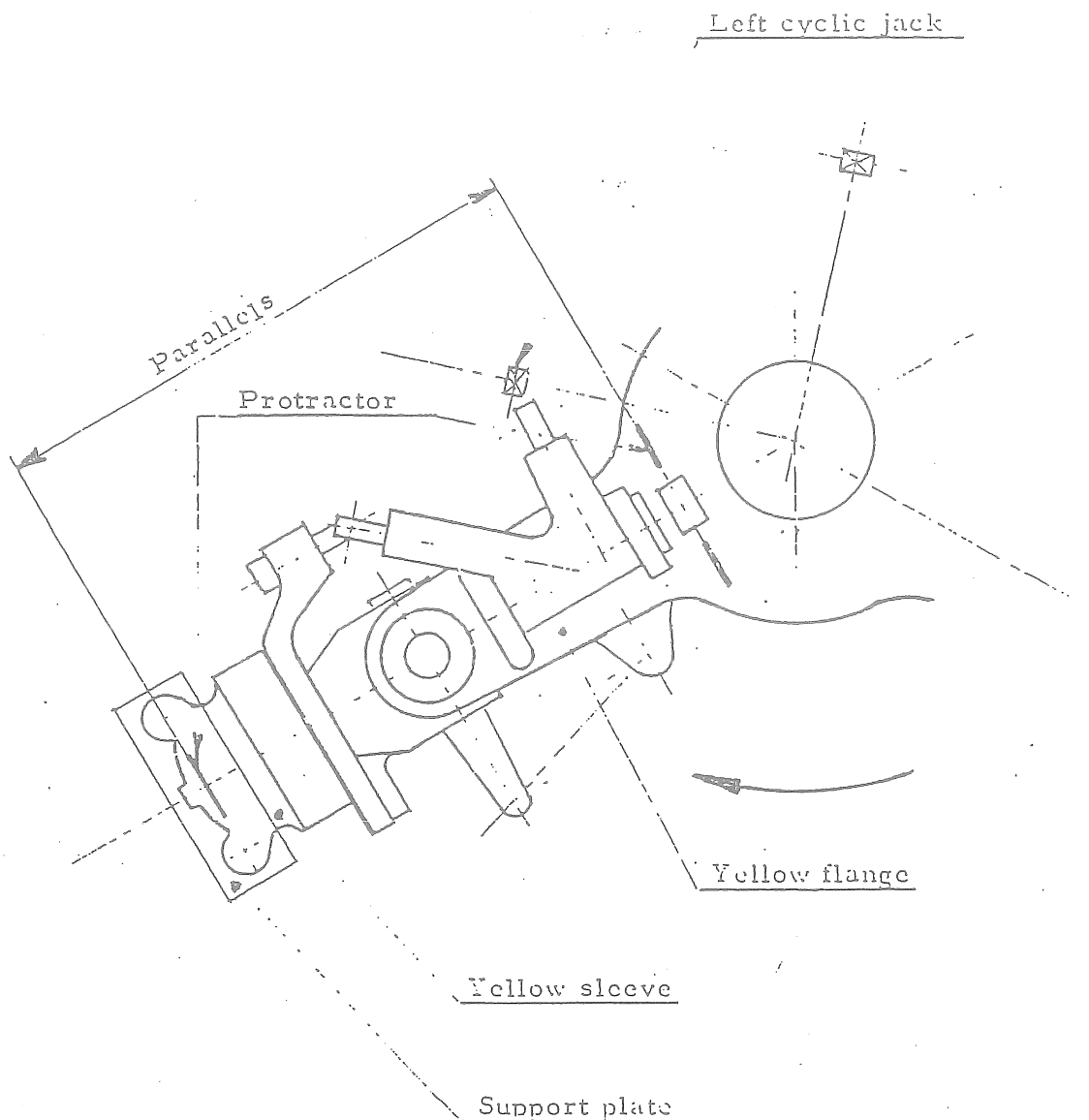
- 1°/ - the left cyclic jack
- 2°/ - the front cyclic jack

3° - the right cyclic jack

4° - the stationary scissors (rear)

For each position, calculate the difference between the yellow sleeve incidence and the yellow flange incidence, and actuate the cyclic pitch controls until the four values, thus obtained, are equal among themselves within 10'.

Then set the two cyclic dials on "0".



Measures of the sleeve and flange incidences

REMARK -

Operations to perform in case of replacement of a cyclic pitch chain component :

After having set the cyclic pitch to 0° lengthwise and sidewise, check the coherence between the indicated cyclic pitch (dials) and the real cyclic pitch (on yellow sleeve).

For that, put successively the yellow rod in front of :

1°/ - the left cyclic jack, and display $\pm 1^\circ 30'$ (sidewise only).

Take the corresponding sleeve incidence variations (maximum tolerated gap between dial and measure : $\pm 15'$).

2°/ - the front cyclic jack, and display $\pm 1^\circ 30'$ (lengthwise only). Take the corresponding sleeve incidence variation

(Maximum tolerated gap between dial and measure : $\pm 15'$).

I.2. - MAIN PITCH CHAIN CHECK -

Aim

Checking the coherence between the indicated main pitch (dial) and the real main pitch (measured on sleeves with protractor) and the linearity of the corresponding law.

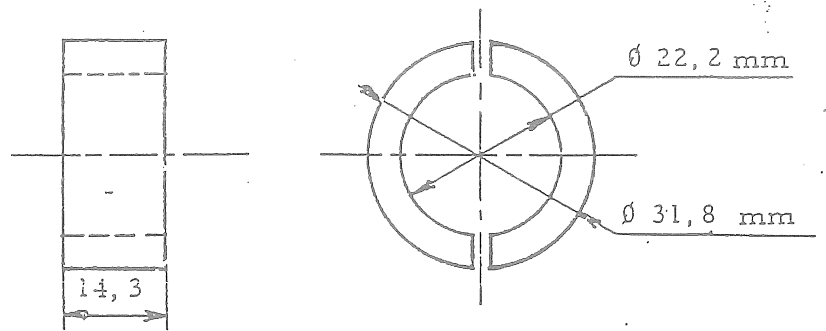
Operations to perform

- . Use the same configuration as before (dynamometric rod and actuators adjusted and placed).
- . If necessary, put the cyclic pitch back to " 0 " , with a protractor.
- . Mount the small damper stops (drag 1°), taking good care to bring back the damper into contact with these stops.

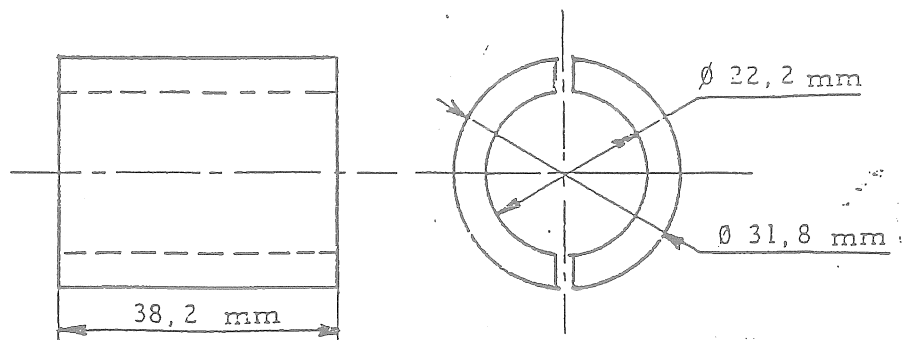
- Check successively on each sleeve (the rod being in front of the left cyclic jack) the coning angles without spacers, with the small spacers (coning angle 0°) and with the big spacers (coning angle 5°).
- The small and big spacers are adjustable.
- Adjust them so as to obtain the following at the same time :
- 1°/ - the nominal value (0° and 5°) to $\pm 5'$
 - 2°/ - a maximum gap, between the three sleeves, not exceeding $5'$ in each configuration.

(without spacers, $15'$ will be tolerated).

- These adjustments being done, mount the small spacers (coning angle = 0°).
- Set the yellow sleeve incidence on $4^\circ 12'$ (with protractor) - and set the main pitch dial on 0° .
- Display the main pitch (dial) degree by degree from 0° to 10° and, with a protractor, take the values of the corresponding sleeve angles (on red and blue sleeves, check only for 0° and 10° M. P.).



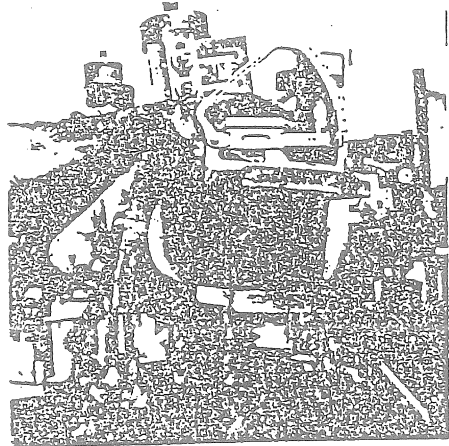
Small damper stop



Big damper stop



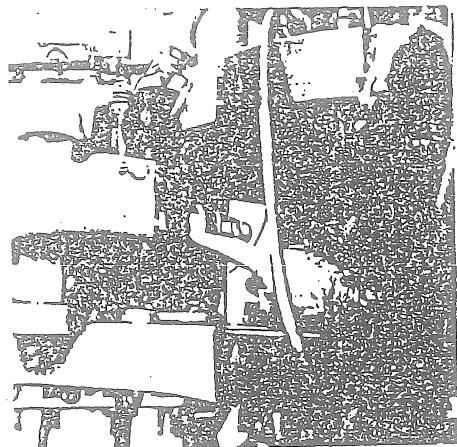
330 - Coning angle



330 - Pitch angle



Spacers



Damper stops

Conditions to be carried out :

- . The sleeve measures are made at the adapters level.
- . Tolérances on the origin angle : the three sleeve incidences must be equal to $4^{\circ} 12'$ to $\pm 10'$ for 0° displayed on the main pitch dial.
- . Tolérances over the operating pitch range. For $\Delta \theta = 10^{\circ}$ (dial), there must be $\Delta \theta = 10^{\circ}$ (sleeve) to $\pm 10'$.
- . Tolérances on the linearity : maximum deviation versus theoretical sleeve value : $\pm 10'$ at all pitches.
(theoretical sleeve value = $4^{\circ} 12' - 5^{\circ} 12' - 6^{\circ} 12' \dots \dots \dots 14^{\circ} 12'$ for θ dial = $0^{\circ}, 1^{\circ}, 2^{\circ} \dots \dots \dots 10^{\circ}$).

If these conditions are not met :

Exchange the rods to see if the defect comes from a faulty putting to length of the dynamometric rods ; if not proceed to more thorough checks about the putting to length of the actuators and the setting of the torque tube (hinges correctly mounted and correctly centered).

I. 3. - CELLS ADJUSTMENT AND CALIBRATION -

Aim :

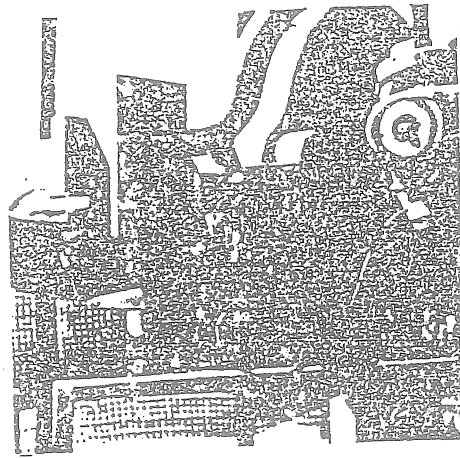
- 1°/ - Having the three $\Delta M \theta$ rating (between $N = 280$ r.p.m and $N = 5$ r.p.m) equal to ± 5 units.
- 2°/ - Having, for each cell, equal $M \theta$ to ± 5 units, for $N = 280$ r.p.m and $N = 5$ r.p.m.

Measures :

Perform the adjustments directly. Check, finally, (tolerances directly and differentially.

Joint operations to both adjustments :

Remove the actuators and safety the sleeves in rotation.

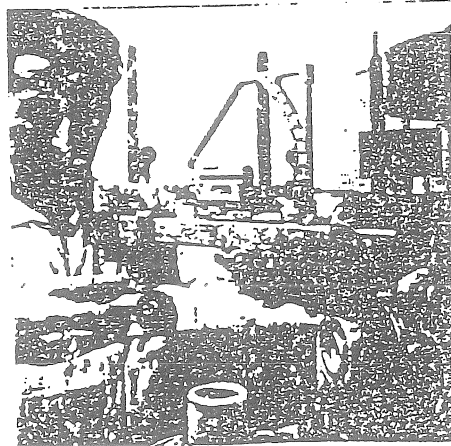


Sleeve safetying

- . Connect the cells with their recorders.
- . Disconnect the dynamometric rods at the level of their lower clevis.
- . Adjust the " 0 " directly and differentially on the three recorders.
- . Calibrate the cells and the recorders according to document GIR. 3675 on balancing.
- . Re-connect the rods.
- . Display $1/2^\circ$ of " front " cyclic pitch (dial).
- . Adjust the torque tubes parallel to the ground (with a protractor, - adjust the yellow one and check the red and blue ones - tolerances : $\pm 5'$).

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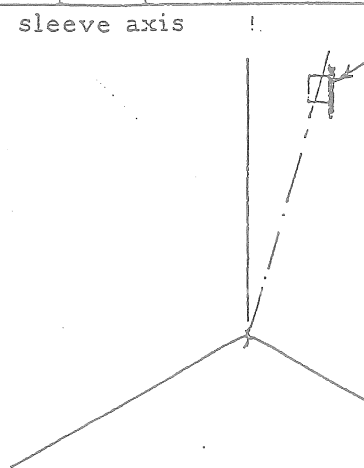
Torque tube parallel to the ground

First adjustment : ΔM^0 rating adjustment

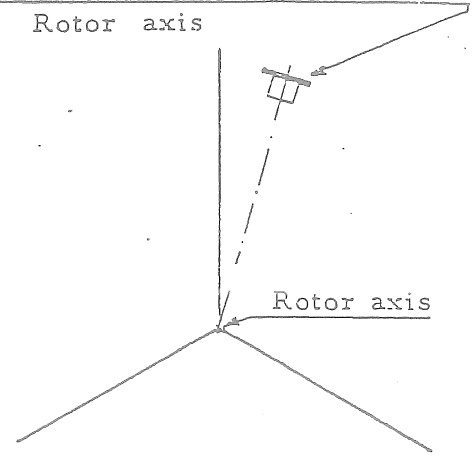
Between 230 r.p.m and N = 5 r.p.m.

. Position, a priori, the cells identification plates, as indicated in the following diagrams :

Name plate parallel to sleeve axis



Name plate to cell radius Rotor axis



Stand equipped with BALDWIN cells

Stand equipped with SEDEME cells

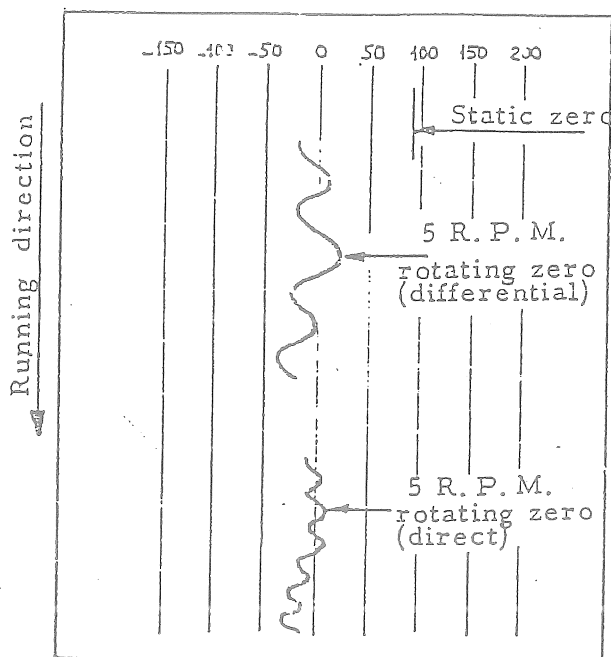
. At N = 5 r.p.m., establish the rotating " 0 " by adjusting the pens to " 0 ", directly and differentially. (The signal which is obtained is a sinusoid). We thus obtain the origin for the measures of M^0 .

. At N = 0, disconnect the dynamometric rods at their lower clevis and leave a sign on the diagram. It is the static " 0 " which enable to follow the cells - drifts.
Reconnect the push-rods.

. At N = 280 r.p.m., record the M^0 .

NOTE :

For the BALDWIN-CELLS push-rods, it is necessary to come back to the right length (see parag. I. 1.) after each modification of position.



Model of Rotating "0" (N = 5 R. P. M.) and static "0" recording

. Conditions to be carried out :

The three $\Delta M \theta$ rate between $N = 280$ r.p.m. and $N = 5$ r.p.m. must be equal, to ± 5 units.

. Adjustment procedure :

Modify the position of one or two cells from 45° to 45° so that the $\Delta M \theta$ rate concentrates on a joint value, to ± 5 units (do the measures again, each time, for $M \theta$ at $N = 5$ r.p.m. and at $N = 280$ r.p.m.).

Second adjustment : $M \theta$ adjustments in absolute value :

When the $\Delta M \theta$ are satisfactory, use the corresponding results as an adjustment basis for the next operation.

. Conditions to be carried out :

For each sleeve, the $M \theta$ at $N = 280$ r.p.m. and $N = 5$ r.p.m., must be equal, to ± 5 units.

. Adjustment procedure :

Actuate the main pitch control until the above-mentioned condition is met.

Note the corresponding pitch value.

PHASE II - TORQUE COUNTERWEIGHTS POSITIONNING AND ADJUSTING

Aim :

Annulling any influence from the equipped torque tubes on the measures, i. d. :

1°/ - Having $\Delta M \theta = 0$, to ± 5 units, for $\Delta \theta = 10^\circ$ M.P (dial).

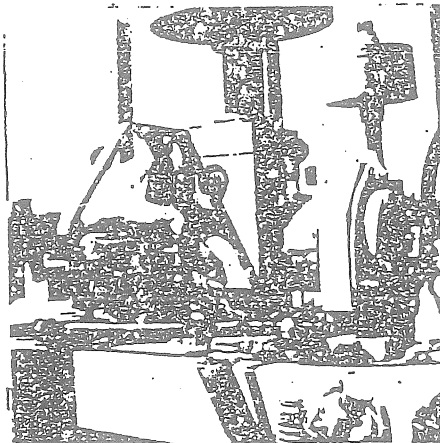
2°/ - Having $M \theta_0 = 0$, to ± 5 units, for $\theta = 0^\circ$ M.P (dial).

Measures :

Perform the adjustments directly. Check, finally, (tolerances) directly and differentially.

Joint operations to both adjustments :

- Keep the above-noted main pitch value.
- Display $1/2^\circ$ of " front " cyclic pitch.
- Mount the counterweights supports on the three torque tubes, and before fastenning the jumpers, set them to the vertical with a protractor.
- Mount the torque counterweights. Set them, a priori, at 85 mm (3.35 in) from the support basis, and lock them by means of a locknut.



Setting of the counterweight support

First adjustment : ΔM_{θ} slope adjustment for $\Delta \theta = 10^{\circ}$ M.P. (dial).

- Do the rotating "0" at $N = 5$ r.p.m., set them to "0" directly and differentially, and do the static "0" (do not rectify them).

Be careful : First, adjust completely the yellow sleeve (slope and departure), then adjust simultaneously the red and blue sleeves, taking the yellow as a reference. At $N = 230$ r.p.m., record the M_{θ} on the yellow one, for $\theta = 0^{\circ}$ M.P. and $\theta = 10^{\circ}$ M.P. (dial).

Calculate : $\Delta M_{\theta} = M_{\theta} 10^{\circ} - M_{\theta} 0^{\circ}$

Conditions to be carried out :

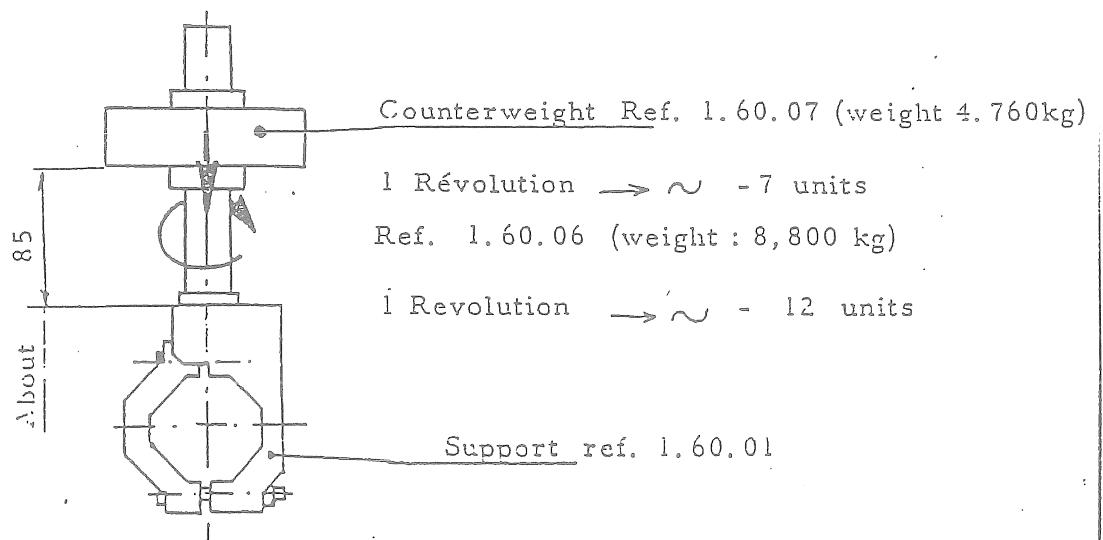
$\Delta M_{\theta} = 0$, to ± 5 units

Adjustment procedure :

If ΔM_{θ} is positive, shift the torque counterweight downwards.

Average efficiency :

- With a 4.760 kg counterweight (stand equipped with SEDEME cells) : 1 revolution \rightarrow about 7 units.
- With a 8.800 kg counterweight (stand equipped with BALDWIN cells) : 1 revolution \rightarrow about 12 units.



ΔM_{θ} slope adjustment (for $\Delta \theta = 10^{\circ}$ M.P.)

Second adjustment : $M \theta 0^\circ$ departure adjustment for $\theta = 0^\circ$ M.P. (dial) - .

For this operation, use the latest value obtained before, as a basis.

Conditions to be carried out :

$M \theta 0^\circ = 0$ to ± 5 units (for $\theta = 0^\circ$ M.P)

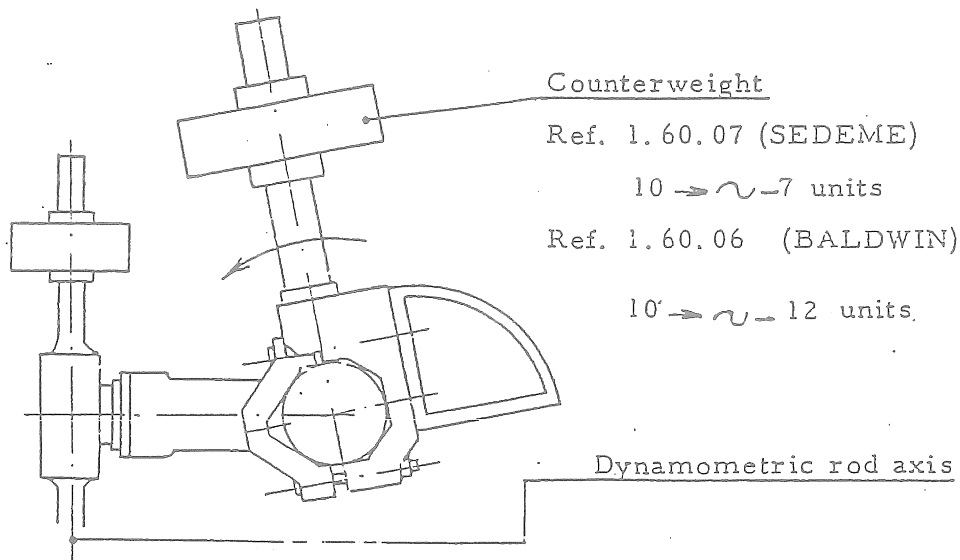
Adjustment procedure :

If $M \theta 0^\circ$ is positive, incline the support towards the dynamometric rod :

Efficiency :

- With the 4.760 kg counterweight (SEDEME cells) :
 $10'$ \rightarrow about 7 units.

- With the 8.800 kg counterweight (BALDWIN cells) :
 $10'$ \rightarrow about 12 units.



$M \theta 0^\circ$ Moments departure adjustment (for $\theta = 0^\circ$ M.P.)

The yellow sleeve being properly adjusted, use the same method to adjust the red and blue sleeves (adjust them simultaneously with regard to the yellow one, and apply the same tolerances on the measures, differentially and directly).

PHASE III - ACTUATORS AND ADAPTORS MOUNTING -

CENTRIFUGAL AND CONING COUNTERWEIGHTS POSITIONNING AND ADJUSTING -

- . Remove the lockwires and mount the actuators, which have been put to length. (Center-to-center distance : 254 mm (10 in
- . Mount the adaptors that correspond to the type of blade to be balanced.

III. 1. - CONING COUNTERWEIGHTS POSITIONNING AND ADJUSTING

Aim :

Having $M\theta = 0$, to ± 5 units and without coning angle.

Measures :

Perform the adjustment directly. Check, finally, (tolerances) directly and differentially.

Operations to be performed :

- . Display $1/2^\circ$ " front " cyclic pitch, and $\theta = 0^\circ$ M.P.
- . Mount the small damper stops (drag 1°).
- . Mount the small spacers (coning angle 0°).
- . Perform the rotating " 0 " at $N = 5$ r.p.m.
Adjust them directly and differentially. Perform the static " 0 " (do not rectify them).
- . Mount the coning weights in the center of their supports.
(See to it that they are mounted symmetrically with respect to the support horizontal axis).

- Adjust the yellow coning weight supporting arm parallel to the ground (with a protractor) by actuating the main pitch control.

At $N = 255$ r.p.m., record the M_0 on the three sleeves.



Leveling of the coning weight support

- Replace the small spacers (coning angle = 0°) by the big ones (coning angle = 5°) and put the yellow supporting arm back to a parallel position with respect to the ground.

At $N = 255$ r.p.m.; record the M_0 on the three sleeves.

- Calculate : ΔM_0 coning angle = M_0 (c. a = 5°) - M_0 (c. a = 0°)

- Conditions to be carried out :

For each sleeve. ΔM_0 coning angle = 0, to ± 5 units (directly and differentially).

- Adjustment procedure :

If ΔM_0 coning angle is positive, bring the coning weight closer to the pitch axis, following the support horizontal axis.

Average efficiency : a displacement of 1 mm \rightarrow about 0.7 units

REMARK :

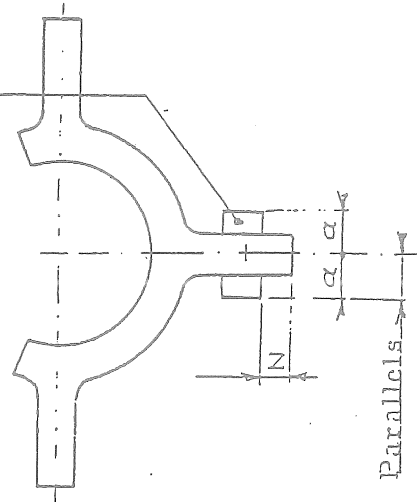
Do the tests again until the above - mentionned condition is met, taking good case to put back the yellow coning weight supporting arm parallel to the ground (with a protractor) after each change of coning angle.

Counterweight SLGNB 1071-2A

Ref. (1.61.03)

Weight = 1,100 kg

$\Delta Z = 1 \text{ mm} \rightarrow \sim -0,7 \text{ unit}$



Coning angle influence adjustment

III.2. - CENTRIFUGAL COUNTERWEIGHTS POSITIONNING AND ADJUSTING -

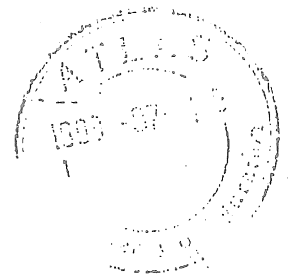
Aim :

Annulling on the measures, any influence from the equipped sleeves.

That is to say :

1°/ - Achieving $M \theta = 0$, to \pm units, for both the departure $M \theta$ and the rate influence (at $\theta = 0^\circ$ M.P. and $N = 205, 255$ and 280 r.p.m.).

2°/ - Achieving $\Delta M \theta = 0$, to ± 5 units, for $\Delta \theta = 10^\circ$ M.P (dial).

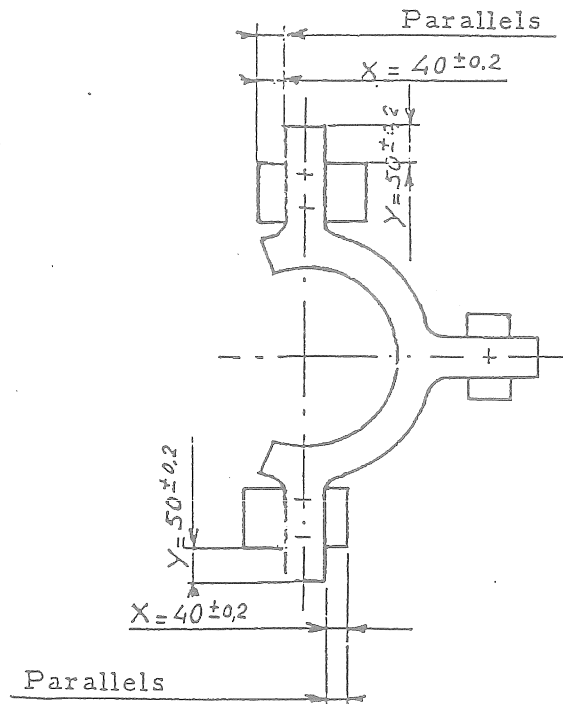


Measures :

Perform the adjustments directly. Check, finally (tolerances), directly and differentially.

Joint operations to both adjustments :

- . Display $1/2^\circ$ " front " cyclic pitch.
- . Mount the small spacers (coning angle = 0°).
- . Keep the small damper stops (drag = 1°).
- . Mount the upper and lower centrifugal counterweights on the three sleeves at the points : $X = 40$ mm and $Y = 50$ mm (see diagram).
- . Adjust the rotating " 0 " ($N = 5$ r.p.m., $\theta = 0^\circ$) and note the static " 0 ".



Centrifugal counterweights mounting.

First adjustment : $\Delta M\theta$ slopes adjustment , for $\Delta \theta = 10^\circ$
M.P. (dial) -

Be careful :

First, adjust completely the yellow sleeve in X and Y.
 Then adjust simultaneously the blue and red sleeves,
 taking the yellow one as a reference.

At $N = 255$ r.p.m., record, on the yellow sleeve,
 $M\theta$ for $\theta = 0^\circ$ M.P. and $\theta = 10^\circ$ M.P. (dial).

Calculate $\Delta M\theta = M\theta_{10^\circ} - M\theta_{0^\circ}$

Conditions to be carried out :

$\Delta M\theta = 0$, to ± 5 units.

Adjustment procedure :

If $\Delta M\theta$ is positive, bring the centrifugal counterweights
 closer to the sleeve axis, following Y.

REMARK :

Check that upper Y = lower Y to ± 0.2 mm, and
 maintain the parallelism between the counterweight edge
 and the support side.

Average efficiency : a shift along Y = 1 mm \rightarrow about
 3,3 units on $\Delta M\theta$

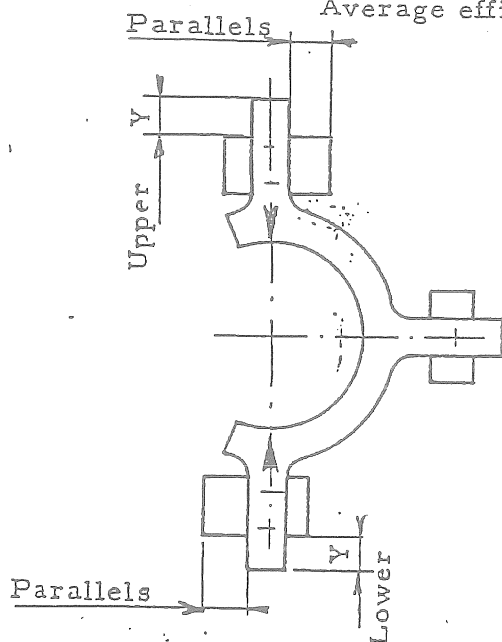
Counterweight SLGNB 1071-3A

Ref. (1:61.02) Weight = 2,945 kg

$\Delta Y = 1\text{mm} \rightarrow \sim - 3,3$ units on $\Delta M\theta$

Upper Y = Lower Y ± 0.2

$\Delta M\theta$ Moments slope adjustment



Second adjustment : Moment departures and rate influence adjustment -

- . At $N = 205$ r.p.m., and $\theta = 0^\circ$ M.P. (dial)
record M_θ (205 r.p.m.)
- . At $N = 255$ r.p.m. and $\theta = 0^\circ$ M.P. (dial),
record M_θ (255 r.p.m.)
- . At $N = 280$ r.p.m. and $\theta = 0^\circ$ M.P. (dial),
record M_θ (280 r.p.m.)

Conditions to be carried out :

1°/ - M_θ (255 r.p.m.) = 0, to \pm 5 units

2°/ - ΔM_θ rate = M_θ (280 r.p.m.) - M_θ (205 r.p.m.)
= 0, to \pm 5 units

Adjustment procedure :

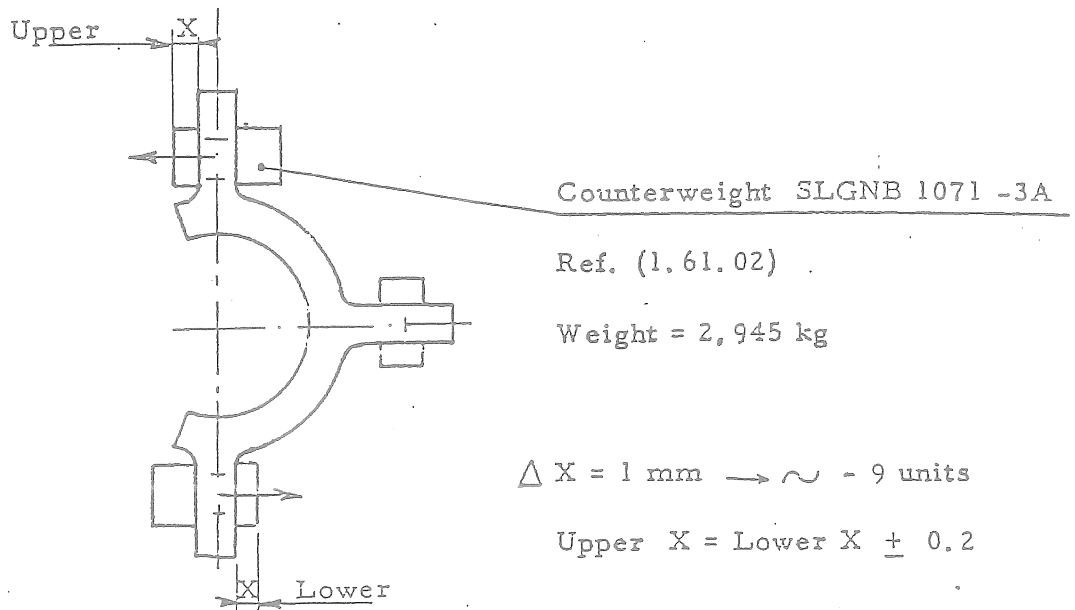
M_θ (255 r.p.m.) and ΔM_θ rate are linked and are adjusted simultaneously by actuating the centrifugal counterweights (shift in X direction, clockwise or counter clockwise).

If M_θ (255 r.p.m.) is positive, shift the counterweights in X direction, counter clockwise.

REMARK : Check that upper X = lower X to \pm 0.2 mm, and maintain the value of Y corresponding to the previous adjustment, as well as the parallelism between the counterweight edge and its support edge.

Average efficiency :

A shift along X = 1 mm → about 9 units



M 0 0° Moments departure adjustment

The yellow sleeve being carefully adjusted, act in the same way to adjust the blue and red ones (adjust them simultaneously with respect to the yellow one, and apply the same tolerances on the direct and differential measures)

PHASE IV - COMBINED CHECKS -

Aim :

To check the rotor head balancing without blades.

Measures :

Meet the direct and differential tolerances for all the following operations.

Operations to be performed for the low-pitch combined test :

- . Display $1/2^\circ$ " Front " cyclic pitch (dial).
- . Mount the small spacers (coning angle = 0°) and the small stops (drag = 1°).
- . Display $\theta = 0^\circ$ M.P. (dial).
- . Do the rotating " 0 " and note the static " 0 ". At $N = 255$ r. p. m. record the $M\theta$ for the three sleeves. Note again the static " 0 " then put them back to the previous values (directly and differentially).
- . Correct the $M\theta$ of the value corresponding to static " 0 " half value before and after rotation test.
- . Perform these operations three times and average the results for each sleeve.

Operations to be performed for the high pitch combined test :

- . Display $1/2^\circ$ " Front " cyclic pitch (dial).
- . Mount the big spacers (coning angle = 5°) and the big stops (drag : 6°).
- . Display $\theta = 10^\circ$ M.P. (dial).

Note the static "0".

At $N = 255$ r.p.m., record the $M\theta$ for the three sleeves.

Note again the static "0", then put them back to the previous values, directly and differentially.

Bring the $M\theta$ to the half value between static "0" before and after rotation test.

Perform these operations three times, and average the results for each sleeve.

Checks :

Calculate the average slopes for each sleeve :

$$\Delta M\theta = M\theta_{10^\circ} - M\theta_{0^\circ}$$

Check directly and differentially that :

1°/ - The three sleeves average slopes are equal, within 10 units

2°/ - The departures $M\theta_{0^\circ}$ (average value) are null, to ± 5 units

Adjustment procedure :

Check successively the coning, drag, and pitch influences, until the combined tests are satisfactory.

REMARK :

If the combined tests entail no rectification in situ, perform directly the pitch influence check (page 29)

. Coning angle influence check :

- Display $1/2^\circ$ " front " cyclic pitch (dial).
- Mount the small spacers (coning angle = 0°), and the small stops (drag = 1°). Put the yellow coning weight supporting arm parallel to the ground (with a protractor).

At $N = 255$ r.p.m. , record the M_θ (coning angle 0°) for the three sleeves.

- Replace the small spacers (coning angle = 0°) by the big ones (coning angle = 5°) and put the yellow coning weight supporting arm parallel again to the ground.

At $N = 255$ r.p.m. , record the M_θ (coning angle = 5°) for the three sleeves.

. Conditions to be carried out :

For each sleeve :

$$\begin{aligned} \Delta M_\theta \text{ (coning angle)} &= M_\theta \text{ (c. a = } 5^\circ) - M_\theta \text{ (c. a = } 0^\circ) \\ &= 0, \text{ to } \pm 5 \text{ units.} \end{aligned}$$

. Adjustment procedure :

Actuate the coning counterweights (see parag. III. 1. page 19)

Check of the drag angle influence -

After having checked and, if necessary, rectified, the coning counterweights, if the combined tests are not satisfactory, proceed to the checking of the drag angle influence, as follows :

. Put $1/2^\circ$ " Front " cyclic pitch (dial).

- . Mount the small spacers (coning angle = 0°) and the small stops (drag = 1°).
 - . Put the yellow coning weight supporting arm parallel to the ground (with a protractor).
- At N = 255 r.p.m., record the M_θ for the three sleeves.
- . Replace the small stops (drag = 1°) by the big ones (drag = 6°) and put again the yellow supporting arm parallel to the ground.
- At N = 255 r.p.m., record the M_θ for the three sleeves.

. Conditions to be carried out :

For each sleeve :

$$\Delta M_{\theta}(\text{drag}) = M_{\theta}(\text{drag } 6^{\circ}) - M_{\theta}(\text{drag } 1^{\circ}) = 0, \text{ to } \pm 5 \text{ units}$$

. Adjustment procedure :

Check the symmetry of the lower and upper counterweights along X and Y.

Correct them and do the combined tests again.

Check of the pitch influence :

All previous checks being performed, proceed to the pitch influence adjustment.

For this :

1°/ - Display 1/2° " Front " cyclic pitch (dial).

- Mount the small spacers (coning angle = 0°) and the small stops (drag = 1°).
- At N = 255 r.p.m., record the M_θ, for each sleeve, for θ varying from - 2° to 10° M.P. (dial), degree by degree.

. Conditions to be carried out :

1°/ - For the three sleeves :

$$\Delta M \theta = M \theta_{10^\circ} - M \theta_{0^\circ} = 0, \text{ to } \pm 5 \text{ units}$$

2°/ - The $M \theta$ moments curves must show a reasonable break (maximum break : 20 units with respect to the straight line joining the $M \theta$ values for $\theta = 0^\circ$ and $\theta = 10^\circ$ M. P.

. Adjustment procedure :

1°/ - To correct the $\Delta M \theta$ slopes, actuate the lower and upper centrifugal counterweights along Y (see parag. III. 2 page 21) and do the combined tests again.

2°/ - If the linearity gap is out of tolerance, check the pitch control chain hinges and bearings.

PART 2

DETERMINATION OF THE SLEEVES AND PRIMARY

MASTER BLADES PROPER VALUES

-o-o-o-o-

WARNING

Set the cyclic pitch as a function of the wind (see Notice GIR. 3675 before performing any measure with primary, secondary or series blades.

I. - DEFINITIONS -

Tracking of a blade

Passage height of this blade, measured differentially with respect to the reference blade (blade mounted on the yellow sleeve).

Positive tracking → blade considered as being situated above the reference blade.

Tracking slope of a blade

Difference between tracking value for $\theta = 7^\circ$ and tracking value for $\theta = 1^\circ$.

Pre-tracking number of a blade

Value of the incidence correction to apply to a blade by a modification of the length of its pitch rod (actuator on stand). The object of the correction is to ensure an equal lift to all blades.

Positive pre-tracking number \rightarrow increase of the nominal incidence in the nose up direction.

Pre-tracking zero of a rotor head

Operation which consists in ensuring an accurate correspondence between the pre-tracking number of the blades and the zero tracking at a given pitch, and this, irrespective of the chosen sleeve-blade pairing.

Primary master blades

Blades selected according to criteria determined by the Engineering and design department.

They must be used only :

- . to perform the " pre-tracking zero " of the rotor head.
- . to determine the sleeves proper values (it is during this operation, in fact, that their proper values are determined).
- . to adjust the secondary master blades.

Secondary master blades

Blades selected according to criteria determined by the Engineering and design department. They are used as a reference to perform the series blades balance.

Units used

The M 0 moments measures results are expressed in " Moment units ".

1 " moment unit " = 1 in.-lb \simeq 0.113 meter - Newton.

The measures results of tracking T are expressed in " Tracking units ".

1 " Tracking unit " = $\frac{1}{16}$ in \simeq 1.6 mm

II. - TESTS CONDITIONS - CHECKS AND ADJUSTMENTS FREQUENC

See Notice GIR. 3675.

Static zeroes.

Now, the rotor head is balanced and it is necessary to do the rotating zero at 255 r. p. m.

III. - PROCESS -

The unequipped rotor head being set (see Part I), it is then proceeded to the accomplishment of the head pre-tracking " zero and to the determination of the sleeves values with primary master blades as follows :

III. 1. - Execution of the rotor head " pre-tracking zero " -

Aim :

To cancel any interference of the sleeves on the blades pre-tracking results, by permutating three primary master blades

Measures (tracking only)

Performed differentially with respect to the reference sleeve (yellow).

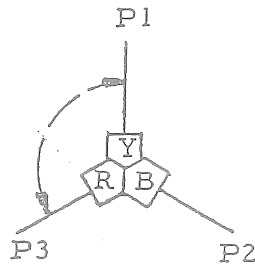
Operations to be performed

(see drawing hereafter)

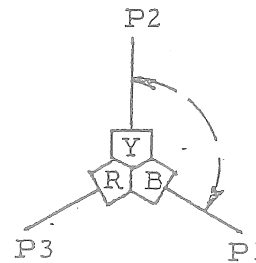
- Mount the three primary blades P1, P2 and P3 on the three sleeves : Y, B and R.
- Display electrically the pre-tracking number of each blade on the corresponding actuator.
- At $N = 255$ r.p.m and $\theta = 1^\circ$, measure the tracking of the blades which are mounted on the blue and red sleeves.
- Reset electrically these trackings to " 0 " by operating the actuators B and R. (Exceptionally the Y one if the indications corresponding to the tracking of sleeves B and R are absolutely identical).
- At $N = 0$, record the indications of the actuators meters, disengage them and re-display manually the pre-tracking number of the corresponding blade, without modifying the length of the actuator, reengage it.
(Refer to notice GIR. 3675 as regards the use of the ARTUS actuator).
- Do again all these operations while permutating the blades according to the drawing given after, and at the end, check that the tracking deviation does not exceed 0 ± 2 units when everything is back to the original configuration.

Example of permutations :

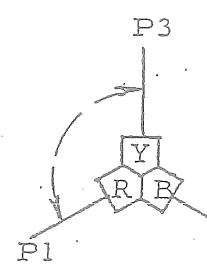
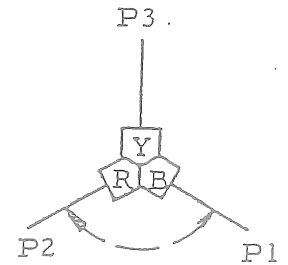
1st test



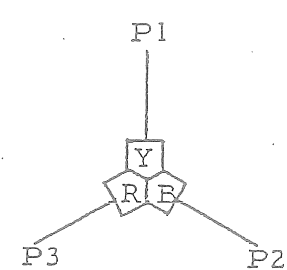
2nd test



3rd test



4th test



5th test

Tolerance : (5th test)

Maximum tracking deviation : 2 units.

If the tolerances are not carried out :

- . First of all do again all these operations and carefully display the exact pre-tracking numbers.
- . If the results are still not satisfactory, check the rotor head (excessive hinges play, brinell hardness in the bearings.....), as well as the blades (refer to notice GIR. 3675 as regards the check of the blades pre-tracking numbers).

III. 2. - Determination of sleeves and primary masters proper values

Aim :

Knowledge about the proper values of the sleeves and the master blades enables to follow up the evolution of these components with time, and to reveal possible degradations. Knowledge about the proper values of the primary masters is necessary to determine the corrections to apply in series.

Measures :

The moments measures should be performed :

- . directly : for the assembly : Y sleeve + the blade mounted on this sleeve.
- . differentially only : for the assemblies : R or B sleeves + blades mounted on these sleeves.

The tracking measures should be performed only differentially with respect to the assembly : Y sleeve + blade mounted on this sleeve.

III. 2. 1. - Operations to be performed -

- . Mount the three primary masters P1, P2 and P3 on sleeves Y, B, R.
- . Display electrically the pre-tracking index of each blade by means of the corresponding actuator.
- . Perform the static " 0 " before the tests and record them (directly on Y, and differentially only on B and R).
- . At $N = 255$ r.p.m and $\theta = 1^\circ, 3^\circ, 5^\circ, 7^\circ$, record : the moments : M_0 and the tracking = T
- . Perform successively three series of measures, and then calculate the mean value for each θ value.

REMARK

If among the three measures performed on B and R, one of them deviated of more than 10 units in moments at $\theta = 1^\circ$ and of more than 15 units on the moment slopes, do again an additional test and consider as not valid the test the results of which deviate most from the three others.

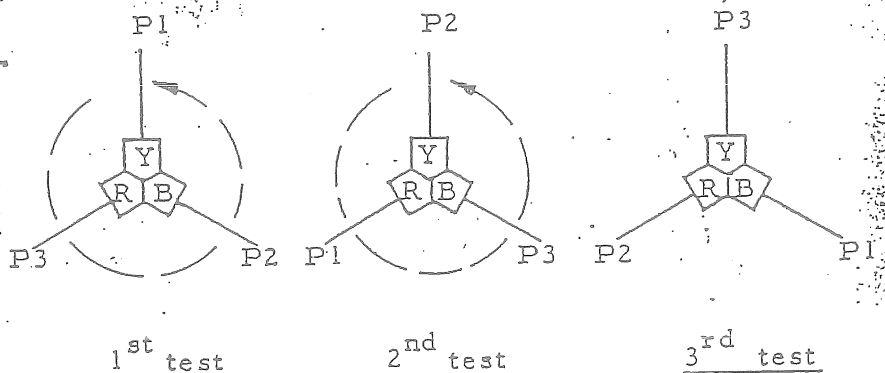
At $N = 0$ perform the static "0" after test and record them.

Correct each average value found previously by the half drift of the static "0". This correction applies only to the values of M_θ measures for $\theta = 1^\circ, 3^\circ, 5^\circ, 7^\circ$, and in no case to the moments slopes calculated at each test.

Permutate the blades as indicated in the drawings hereafter and do again all these operations for each configuration. The following coefficients B_1, B_2, B_3 and R_1, R_2, R_3 , defined in the table page 38, will be thus obtained;

B_1 corresponding to blade P1 on sleeve B

R_2 corresponding to blade P2 on sleeve R, etc.....



III. 2. 2. - Calculations of the proper values -

The results of the three series of tests can be summed up as follows :

	On sleeve B	On sleeve R
1 st test	$B2 = (B - Y) + (P2 - P1)$	$R3 = (R - Y) + (P3 - P1)$
2 nd test	$B3 = (B - Y) + (P3 - P2)$	$R1 = (R - Y) + (P1 - P2)$
3 rd test	$B1 = (B - Y) + (P1 - P3)$	$R2 = (R - Y) + (P2 - P3)$

B, Y, R and P1, P2, P3 represent here the part, in moment or in tracking, due to respectively, the sleeves alone and the blades alone.

1/ - Calculation of the sleeves proper values : (differentially)
(B - Y) and (R - Y) -

For each θ value and for each sleeve, calculate the average value of the results from the stay of the three blades on this sleeve. We shall thus obtain :

$$(B - Y) = \frac{B1 + B2 + B3}{3}$$

$$(R - Y) = \frac{R1 + R2 + R3}{3}$$

Use the tables n° 1 and 2, pages 57 and 58.

2/ - Calculation of the A1 - A2 - A3 primary blades proper values -

What is called the proper value of a primary blade is moment or tracking deviation which this blade shows with respect to the average value of the three blades ; that is :

$$A1 = P1 - \frac{P1 + P2 + P3}{3}$$

$$A2 = P2 - \frac{P1 + P2 + P3}{3}$$

$$A3 = P3 - \frac{P1 + P2 + P3}{3}$$

For each θ value, calculate :

- the sum of the average values of the results from the considered blade stays on sleeves B and R ; that is :

- . For blade P1 , calculate B1 + R1
- . For blade P2, calculate B2 + R2
- . For blade P3 , calculate B3 + R3

- the sum of the sleeves values , that is :

$$K = (B - Y) + (R - Y)$$

- the difference between these two operations, and divide it by three ; that is :

$$\text{. Blade P1 : } A1 = \frac{B1 + R1 - K}{3} = P1 - \frac{P1 + P2 + P3}{3}$$

$$\text{. Blade P2 : } A2 = \frac{B2 + R2 - K}{3} = P2 - \frac{P1 + P2 + P3}{3}$$

$$\text{. Blade P3 : } A3 = \frac{B3 + R3 - K}{3} = P3 - \frac{P1 + P2 + P3}{3}$$

Remark concerning the tracking

Shift the results obtained for (B - Y) and (R - Y) and for A1, A2, A3, of a constant , so as to attain 0 at $\theta = 1^\circ$.

IV. -- DATA ANALYSIS -

- Sleeves proper values. Note on a graph the values of each red and blue sleeve for :

M 0 moment at 1°

M 0 slope

T tracking slope

Only the tracking slope is dependent upon a limitation :
warning level : 4,5 units ; use limit : 7,5 units (refer to " repair sheet " in notice : GIR. 3675).

- Blades proper values . Note on a graph the A1, A2, A3 values for the same parameters as above, in order to monitor the masters constancy. It is normal to observe a certain oscillation of the values ; an important drift of only one blade is a sign of a probable deterioration.

In such a case, get in touch with the engineer in charge of the balance, and as for the licenced or approved workshops, get in touch with Aerospatiale.

- Definition of the average primary master blade .

It is necessary to know this blade for the calibration of the secondary one (next paragraph). The selected criterion is the tracking slope. Consequently, the master blade having the tracking slope the nearest to 0 is defined as average primary master blade. The parameter which comes in second position is the moment slope.

PART 3

CALIBRATION OF THE SECONDARY MASTER BLADES

DETERMINATION OF THE SLEEVES CORRECTIONS

Same cyclic conditions as in Part II

-0-0-0-0-

I. - DEFINITIONS -

Series correction :

Value to be added algebraically to the results obtained on a given sleeve in order to eliminate the influence of this latter sleeve as well as the influence of the secondary master blade taken as reference.

Value to be attained :

Value corresponding to the series correction, with changed sign and to which one can refer during the balance to evaluate the result.

II. - TEST CONDITIONS - ADJUSTMENTS AND CHECKS FREQUENCY -

See document GIR. 3675

III. - PROCESS -

When the sleeves and primary blades proper values have been determined it is then proceeded to the secondary master blade calibration, as well as to the calculation of the corrections that must be applied in series.

III. 1. - Check of the secondary master blade balance -

Aim :

To decrease the variations between the secondary master blade and the mean value of the 3 primary blades.

Warning :

As the average primary blade was defined in IV, it is replaced by the secondary blade, which is mounted on the yellow sleeve. To do this, refer to tablesⁿ 3 and 4 pages 59 and 60.

Measures :

Same conditions as in paragraph III. 2.

III. 1. 1. - Operations to be performed -

- . Mount the secondary blade on the yellow sleeve.
- . Mount the two selected primary blades on R and B by referring to table 3.
- . Display electrically the pre-tracking number of each blade with the corresponding actuator.
- . Perform the static " 0 " before test and note them.
- . At N = 255 r.p.m. and $\theta = 1^\circ$
- . Measure the trackings.
- . Bring these values back to the ones corresponding to the test performed previously in paragraph III. 2; by operating the yellow actuator.
- . Once these values are found again, cancel them by operating actuators R and B.
- . The tracks being reset to 0, record the M 0 . Note T and M 0 .

. Still at $N = 255$ r.p.m, display the θ pitches = $3^\circ, 5^\circ, 7^\circ$

Record and note M_θ and T.

. Perform thus three series of successive readings (Same remarks as in paragraph III. 2 as regards the measures stability), calculate the mean value for each θ value.

. At $N = 0$ r.p.m, perform the static " θ " and note them, then bring them back to the original value.

Correct each previously found value by a half drift of the static " θ ", these values applying only to M_θ value for $\theta = 1, 3, 5, 7$, and in no way to the M_θ slopes.

III. 1. 2. - Data analysis - (Follow on tables 3 and 4 pages 59 and 60)

We have on line (1) the primary blades values respectively in blue and red with respect to the secondary blade mounted on yellow.

. Put in line " B or R coefficient ", the coefficients corresponding to the values of the same primary blades mounted on B and R during the circular permutations. (paragraph III. 2.)

The variation between line (1) and line " B or R coefficient " gives the variation between the secondary blade and the average primary blade seen on R sleeve and B sleeve.

In order to judge of the necessity of readjustments, it is necessary to perform the mean value of the variations seen on R and B and to check that it does not exceed 25 units for the M_θ and 4 units for the tracking. Otherwise, make slight rectifications on the secondary blade .

(refer to GIR. 3675, paragraph IV. 1 and IV. 2)

Nota :

Avoid repeated rectifications on the tab.

- . If the secondary blade has had readjustments do again the whole cycle of the three readings.
- . If not, proceed to the next stage.

IV. - DETERMINATION OF THE CORRECTIONS THAT MUST BE APPLIED IN SERIES -

Measures :

Same conditions as in paragraph III. 2.

IV. 1. - Operations to be performed -

- . Permutate two by two the primary blades on R and B.
- . Re-display electrically the pre-tracking index of each blade with the corresponding actuator.
- . Do again entirely the cycle described in paragraph III. 1. 1., i. e : static " 0 ".
- . Tracking cancellation - 3 series of measures - static " 0 " check.

IV. 2. - Data analysis -

Let us call the average primary blade P_m and the other two primary ones of the set P_i and P_j (m, i, j corresponding to one of the indexes 1, 2, 3).

We then have the mean values of blades P_i and P_j on B and R sleeves, facing the secondary one, mounted on yellow.

At the first test :

$$P_i \text{ on blue} \quad b_i = P_i + B - S - Y$$

$$P_j \text{ on red} \quad r_j = P_j + R - S - Y$$

Second test, after permutation of P_i and P_j :

$$P_j \text{ on blue} \quad b_j = P_j + B - S - Y$$

$$P_i \text{ on red} \quad r_i = P_i + R - S - Y$$

Taking the average primary blade proper value into account,
i.e. $A_m = - (A_i + A_j)$.

We obtain the correction for a given sleeve and a given secondary blade :

$$\text{Correction} = \frac{A_i - b_i + A_j - b_j}{2}$$

$$\text{Correction} = - \frac{(A_m + b_i + b_j)}{2}$$

On the table , it is advisable to put in line (3) the proper value of the average primary blade A_m (replaced by the secondary one), to add (1) + (2) + (3), to change the sign, and then to divide this result by 2.

V. - RESULTS LAYOUT -

- . The $M \theta$ values are calculated within one unit.
- . As for the tracking, all the calculations are performed within a tenth of unit, then the final result should be rounded within half a unit so as to be homogeneous with the measuring instruments.

Two results appear :

- Corrections to be applied in series :

This value should be applied algebraically to the final readings made on series blades for a given sleeve and a given secondary blade. It gives the real value of the balanced blade with respect to the mean value of the three primary ones.

- Value which should be attained :

This value is an artifice which enables to check rapidly, during the adjustments, the position of the blade to be balanced.

DATE: _____

OPERATOR: _____

STAND: _____

direction 330 321

ROTOR HEAD BALANCE WITHOUT BLADES

REMARKS

(Aim of the balance, modifications and repairs performed, discrepancies noted before and during balance, etc....)



PHASE I

I.1. - CHECK OF CYCLIC PITCH " 0 " (see calibration in doc. GIR. 3543 or 3544)

1. Mount rods (L = 612, 8 mm) and actuators (L = 254 mm) - PG ≈ 0°
2. On Y flange and Y sleeve, measure the incidences for Y rod facing left, front, right cyclic jacks and scissors (rear)
3. Obtain a maximum variation between " Δ " < 10'.

	1 st		2 nd		3 rd		4 th		Test	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Sleeve										
Flange										
Δ										

1.2. - MAIN PITCH CHECK -

a) - Check of the coning angles and corresponding sleeve settings (θ) :

. 0° M.P, 0° C.P, small stops - Reds facing left cyclic jack

Coning angle to be attained :

without spacers

with small spacers

with big spacers

maxi variation $\Delta < 15'$

coning angle $0^\circ \pm 5'$
maxi variation $\Delta < 5'$

coning angle $5^\circ \pm 5'$
maxi variation $\Delta < 5'$

	without spacers	small spacers	big spacers
Y	$0 =$	$0 =$	$0 =$
B	$0 =$	$0 =$	$0 =$
R	$0 =$	$0 =$	$0 =$
Δ maxi			

b) - Main pitch check :

- CP = 0° , small spacers , small stops

θ dial	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	$\Delta \theta$
Y												
B												
R												

Obtain :

departures : $\theta_0 = 4^\circ 12' + 10'$
slopes : $\Delta \theta = 10^\circ + 10'$
linearity : variation = $\pm 10'$ (on Y)

1.3. - CELLS ADJUSTMENT AND CALIBRATION -

- Remove the actuators and put the lockwire
- Calibrate the recorders (doc. GIR. 3675)
- Calibrate the cells

1/2: front CP, torque tube Y // ground $\rightarrow \theta =$ Ground / parallelism variation (tolerances : $\pm 5'$) $\left. \begin{matrix} B= \\ R= \end{matrix} \right\}$

rotating " 0 " (5 r.p.m , 0')

static " 0 " (to be noted)

	Y direct	B direct	R differ	B differ	R differ

a) - N = 5 r.p.m. and N = R.P.M. - Adjustment of the slopes by cells orientation

Attain $\Delta M \theta$ equal to ± 5 units

	1st Test		2nd Test		3rd Test		4th Test		5th Test		last Test	
	Y dir	B dir	R dir	Y dir	B dir	R dir	Y dir	B dir	R dir	Y dir	B dir	R diff
M0 5r.p.m	0	0	0	0	0	0	0	0	0	0	0	0
M0 r.p.m												
$\Delta M \theta$												

b) - N = 5 r.p.m and N = r.p.m. - Cancel slopes by M.P.

Attain $\Delta M \theta = 0 \pm 5$ units with maxi variation 5 units

	Y dir	B dir	R dir	B diff	R diff
M0 5 r.p.m	0	0	0	0	0
M0 r.p.m					
$\Delta M \theta$					

$\theta'' =$

PHASE II

- SET UP AND ADJUSTMENT OF THE TORQUE COUNTERWEIGHTS -

1/2° Front C. P., M. P. at the value of 0" which is enframed on page 49.

Supports to the verticale and counterweights at h = 85 mm

Rotating " 0 " (5 r.p.m., 0")

Static " 0 " (to be noted)

Y dir	B dir	R dir	B diff	R diff

a) - Y sleeve slope adjustment (N = r.p.m.) -

Attain $\Delta M \theta = 0 \pm 5$ units

Y dir	1 st test	2 nd test	3 rd test	4 th test	5 th test	6 th test	Efficiencies (+ : upwards)
Mθ₀:							(+ 1 revolution → + 4 units (SEDEME)
Mθ₁₀:							(+ 1 revolution → + 5, 2 units (BALDWIN)
Δ Mθ							(+ 1 revolution → + 7 units (SEDEME)
Correction							(+ 1 revolution → + 12 units (BALDWIN)

b) - Y sleeve departure adjustment (N = r.p.m.) -

Attain M θ₀ = 0 ± 5 units and check that Δ M θ = 0 ± 5 units

Y dir	1 st test	2 nd test	3 rd test	4 th test	5 th test	6 th test	Efficiencies (+ : towards the rod)
Mθ₀:							(+ 10' → - 4 units (SEDEME)
Mθ₁₀:							(+ 10' → - 5, 2 units (BALDWIN)
Δ Mθ							(+ 10' → - 7 units (SEDEME)
Correction							

III.2. - CENTRIFUGAL COUNTERWEIGHTS ADJUSTMENT -

1/2° front C.P. - Mount the small spacers, the small stops and the centrifugal counterweights ($X = 40\text{mm}$, $Y = 50\text{mm}$)

Rotating "0" (5 r.p.m. $\theta = 0^\circ$)

Static "0" (to be noted)

Y dir	B dir	R dir	B diff	R diff

a) - Y sleeve slope adjustment (N = r.p.m)

Have $\Delta M \theta = 0 \pm 5$ units

dir	1st test	2nd test	3rd test	4th test	5th test	6th test
$M\theta_0$						
$M\theta_{10}$						
$\Delta M\theta$						
Correction						

Efficiencies (+ : bring the counterweights closer to reach other)

321 : $\Delta Y = +1\text{ mm} \rightarrow -2, 4$ units

330 : $\Delta Y = +1\text{ mm} \rightarrow -3, 3$ units

b) - Adjustments of departure and influence of Y sleeve rate

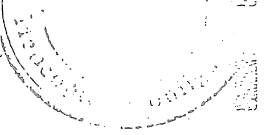
Have $M\theta_0$ (N = r.p.m) and $\Delta M \theta$ rate = 0 ± 5 units and check that $\Delta M \theta = 0 \pm 5$ units

dir	1st test	2nd test	3rd test	4th test	5th test	6th test
$M\theta_0$ (r.p.m)						
$M\theta_5$ (r.p.m)						
$M\theta_{10}$ (r.p.m)						
$M\theta_{15}$ (r.p.m)						
$\Delta M\theta$						
$\Delta M\theta$ rate						
Correction						

Efficiencies :

321 : $\Delta X = +1\text{ mm}$ (clockwise) $\rightarrow -5$ units

330 : $\Delta X = +1\text{ mm}$ (counter clockwise) $\rightarrow -9$ units



c) - B and R sleeves slopes adjustment (N = r.p.m)

Have $\Delta M_0 = 0 \pm 5$ units with maxi variation < 5 units

	1st test		2nd test		3rd test		4th test		5th test		last test	
	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir
M θ_0 :												
M θ_0 :												
$\Delta M\theta$												
Correction												

d) - Adjustment of departures and influence of B and R sleeves rate -

Have $M_{0^0} = (N = r.p.m)$ and ΔM_0 rate = 0 ± 5 units with maxi variation < 5 units -

Check that $\Delta M_0 = 0 \pm 5$ units with maxi variation < 5 units

	1st test		2nd test		3rd test		4th test		5th test		last test	
	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir	Y dir	R dir
ΔM_{0^0} (r.p.m)												
M θ_0 (r.p.m)												
M θ_0 (r.p.m)												
M θ_0 (r.p.m)												
$\Delta M\theta$												
$\Delta M\theta$ rate												
Correction												

PHASE IV - COMBINED CHECKS -

- 1/2° front C.P. - Mount the small spacers and the small stops
- Make the rotating "0" (5 r.p.m. $\theta = 0^\circ$)
- Note the static "0" of departure (first line on the table) and the static "0" between tests (set them back to the values of departure)
- Correct the results of the half difference between the static "0" before and after the test

	M 0				static "0"								
	Y dir	B dir	R dir	B diff	R diff	Y dir	B dir	R dir	B diff	R diff			
1st test	M θ_0 :												
	M θ_0 : corrected												
	M θ_{10} :												
	M θ_{10} : corrected												
	$\Delta M\theta$												
2nd test	M θ_0 :												
	M θ_0 : corrected												
	M θ_{10} :												
	M θ_{10} : corrected												
	$\Delta M\theta$												
3rd test	M θ_0 :												
	M θ_0 : corrected												
	M θ_{10} :												
	M θ_{10} : corrected												
	$\Delta M\theta$												
	M θ_0 : average												
	$\Delta M\theta$ average												

Low pitch test : M θ_0 :
 $\theta = 0^\circ, \frac{1}{2}^\circ$ front C.P.

Little spacers - small stops

High pitch test: M θ_{10} :
 $\theta = 10^\circ, \frac{1}{2}^\circ$ front C.P.

Big spacers - big stops

Check that $M\theta_0$: average = 0 ± 5 units with maxi variation < 5 units
 $\Delta M\theta$ average = 0 ± 10 units with maxi variation < 10 units

TABLE I

PRIMARYS MASTERS TESTS

BLADE TYPE

STAND

Date: _____

Blade P1 n°

Operator: _____

Blade P2 n°

SLEEVES and PRIMARYS PROPER VALUES - M 0 MOMENTS

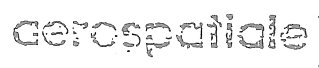
Blade P3 n°

REMARK : Calculate within an unit

Blade	Y SLEEVE					B SLEEVE					R SLEEVE					Static 0						
	1°	3°	5°	7°	*9°	Blade	1°	3°	5°	7°	*9°	slope	Blade	1°	3°	5°	7°	*9°	slope	dir	R diff	
P1						P2							P3									
X						B2							R3									
1st test						P3							P1									
						B3							R1									
2nd test						P1							P2									
						B1							R2									
3rd test						(B-Y)							(R-Y)									

* 0 = 9° : for 321 only

(1)	(2)	(3)	(4)	(5)	Blade P1 (n°)					Blade P2 (n°)					Blade P3 (n°)							
					1°	3°	5°	7°	*9°	slope	1°	3°	5°	7°	*9°	slope	1°	3°	5°	7°	*9°	slope



Conditions

TABLE 2

STAND : PRIMARIES MASTERS TESTS

BLADE TYPE : SLEEVES and PRIMARIES PROPER VALUES - TRACKING

Date :

Operator

	B SLEEVE					R SLEEVE									
	Blade	1°	3°	5°	7°	9°*	slope	Blade	1°	3°		5°	7°	9°	slope
P2								P3							
(B2)								(R3)						<Average	
P3								P1							
(B3)								(R1)						<Average	
P1								P2							
(B1)								(R2)						<Average	
(B-Y)								(R-Y)						<AVERAGE	
(B-Y)	0							(R-Y)	0					<=0 for 0=1°	
	Blade P1 (n°)					Blade P2 (n°)					Blade P3 (n°)				
(1)	X	1°	3°	5°	7°	9°	slope	X	1°	3°	5°	7°	9°	slope	
(2)	K							-K						<(B-Y)/(R-Y)	
(3)	-K							B3+R3						<=-(1)	
(4)	B+R1							A'3						<=(2)+(3)	
(5)	A'1							3 = 0						<=(4)+3	
(6)	A'1 = 0													(0 for 0=1°)	

* 0 = 9° : for 321 only

REMARKS :

1° - Calculate within a tenth of unit

2° - For results (B-Y), (R-Y), A1, A2, A3 round within half a unit.

27-01-72

