Graupner / heim

UNI-Mechanics

2000

Order No. 4448.LN Mechanics, kit-form, excluding motor

Warning!

The RC helicopter which can be built based on this mechanical system is by no means a toy! It is a complex flying machine which is capable of causing serious personal injury and damage to property if handled and operated incompetently.
You alone are responsible for completing the model correctly and operating it with due regard for safety. Please be sure to read and observe the enclosed sheets SHW3 and SHW7 which include full safety information. They should be considered as an integral part of these instructions.

GRAUPNER GmbH & Co. KG D-73230 KIRCHHEIM/TECK GERMANY
We reserve the right to introduce modifications. E.&O.E. ID# 52054 5/04

Foreword

The Graupner/Heim UNI-mechanics 2000 set is a self-supporting helicopter mechanical aggregate for two-stroke motors of 10 … 15 cc capacity.
In conjunction with a fuselage kit (available separately) the system produces a model helicopter which is equally suitable for training, aerobatics and competition work.
Good accessibility to all components makes maintenance and repair work easy and trouble-free, both at the flying site and in the workshop.
The UNI-Mechanics 2000 can be completed with either a simple cabin and tubular tail boom to form a trainer for beginners and more advanced practice flying, or installed in any of a wide range of beautiful GRP fuselages. In every case the result is a model helicopter whose all-up weight is very low, and therefore possesses considerable reserves of performance. This is the result of the extensive exploitation of high-strength, vibration-absorbing glass fibre reinforced nylon. The excess performance can be utilised by the experienced pilot for power-sapping aerobatics, but it also provides ample reserves for the beginner who finds it difficult to set up his model exactly perfectly. The extra performance also copes effortlessly with additional features such as a training landing gear.

The Graupner/Heim UNI-Mechanics 2000 set offers the following outstanding design features:

- Mechanical construction based primarily on vibration-absorbing, fatigue-free, high-strength glass fibre reinforced nylon.
- Highly efficient two-stage main gearbox with durable, machined Delrin gears.
- Replaceable gears enable the user to adjust the gearbox reduction ratio to suit different sizes of model and main rotor diameter.
- Excellent access to all vital components, making the system easy to repair and maintain.
- Servo installation immediately below the swashplate for rigid, direct, backlash-free control linkages. All mixing is carried out by the transmitter electronics, which results in accurate overall control response.
- High-efficiency cooling fan for the motor.
- „In-line" silencer arrangement in the bottom section of the mechanics keeps the fuselage slim, and is ideal for rear-exhaust motors; the system can also accommodate side-exhaust motors.

Warnings

- The contents of this kit can be assembled to produce a working model, but the helicopter is by no means a harmless plaything. If assembled incorrectly or handled incompetently or carelessly it can cause serious injury to persons and damage to property.

- When the model helicopter's engine is running, the two rotors are spinning at high speed and contain an enormous quantity of rotational energy. Anything and everything that gets into the rotational plane of the rotors is either damaged or destroyed - and that includes parts of your body. Please take extreme care at all times with this machine.

- If any object obstructs the rotational plane of the revolving rotors the rotor blades will probably be severely damaged as well as the object. Broken parts may fly off and result in enormous imbalance; the whole helicopter then falls into sympathetic vibration, you lose control and have no way of predicting what the model will do next.

- You may also lose control if a problem arises in the radio control system, perhaps as a result of outside interference, component failure or flat or faulty batteries, but in any case the result is the same: the model helicopter's response is entirely unpredictable. Without prior warning it may move off in any direction.

- Helicopters have many parts which are naturally subject to wear, including gearbox components, motor, ball-links etc., and as a result it is absolutely essential to check and maintain the model regularly. It is standard practice with full-size aircraft to give the machine a thorough „pre-flight check" before every flight, and this is equally important with your model helicopter. Constant checking gives you the opportunity to detect and correct any faults which may develop before they are serious enough to cause a crash.

- The kit also includes two additional information sheets - SHW3 and SHW7- which include safety notes and warnings. Please be sure to read them and keep to our recommendations. They are an essential part of these instructions.

- This helicopter is designed to be constructed and operated by adults, although young people of 16 years or more may do so under the instruction and supervision of competent adults.

- The model features sharp points and edges which may cause injury.

- Flying model aircraft is subject to certain legal restrictions, and these must be observed at all times. For example, you must take out third part insurance, you must obtain permission to use the flying site, and you may have to obtain a licence to use your radio control system (varies from country to country).

- It is important to transport your model helicopter (e.g. to the flying site) in such a way that there is no danger of damaging the machine. Particularly vulnerable areas are the rotor head linkages and the tail rotor generally.

- Controlling a model helicopter successfully is not easy; you will need persistence and determination to learn the skills, and good hand-eye co-ordination is a pre-condition.

- Before you attempt to fly the model you should study the subject of helicopters in depth, so that you have a basic understanding of how the machines work. Read everything you can on the theory of helicopters, and spend as much time as you can watching other model helicopter pilots flying. Talk to chopper pilots, ask their advice, and enrol at a specialist model flying school if you need to. Many model shops will also be prepared to help you.

- **Please be sure to read right through these instructions before you start work on the model. It is important that you clearly understand each individual stage of assembly and the correct sequence of events before you begin construction.**

- **Don't make modifications to the model's construction by using parts other than those specifically recommended, unless you are certain of the quality and suitability of these other parts for the task.**

- **We have made every effort to point out to you the dangers inherent in operating this model helicopter. Since neither we, the manufacturer, nor the model shop that sold you the kit have any influence on the way you build and operate your model, we are obliged to disclaim any liability in connection with it.**

Liability exclusion / Compensation

As manufacturers, we at GRAUPNER are not in a position to influence the way you assemble your model, nor how you install, operate and maintain the radio control system components. For this reason we are obliged to deny all liability for loss, damage or costs which are incurred due to the incompetent or incorrect use and operation of our products, or which are connected with such operation in any way.
Unless otherwise prescribed by binding law, the obligation of the GRAUPNER company to pay compensation, regardless of the legal argument employed, is limited to the invoice value of that quantity of GRAUPNER products which was immediately and directly involved in the event which caused the damage. This does not apply if GRAUPNER is found to be subject to unlimited liability according to binding legal regulation due to deliberate or gross negligence.

Contents

The instructions

We have invested considerable effort in producing these instructions to ensure that you build and fly your new model helicopter safely and without problems. Whether you are a beginner or an expert, please be sure to follow these instructions, step by step, exactly as described in the text.

- Even if you bought a factory-assembled version of the mechanics set it is not set up or adjusted ready to fly. It is entirely the modeller's responsibility to check that all screws and other joints are tight and secure, and to carry out the essential adjustments thoroughly and conscientiously.

- The process of completing the mechanics is carried out by referring to the illustrations and the explanatory texts which accompany them.

- The joints marked with this symbol must be secured with thread-lock fluid, e.g. Order No. 952 resp. Order No. 951; be sure to remove all traces of grease before applying the fluid.

- All bearings, whether plain, ballrace or needle roller, must be lubricated thoroughly. The same applies to all ball-links and gears, even if the instructions do not state this specifically.

- Parts list, replacement parts list and exploded drawings are included at the end of the instructions.

Additional items required: (parts not included in basic mechanics kit)

Recommended motors and accessories for UNI-Mechanics 2000

Motor	Capacity cc	Order No.	Exhaust manifold	Silencer	Tuned pipe silencer
OS MAX 61 RX-HGL »C«	9,95	1892	2239A -	- 2253	2240 or 2250 -
OS MAX 61 SX- HGL »C«	9,97	1890	2238A	2258	2240 or 2250
OS MAX 91 FX / SX- HGL	14,95	1922, 1935	2238A	2258	2240 or 2250

Clutch / ring gear combinations, according to motor and rotor diameter

Motor (examples)	Rotor-Ø approx.	Ratio	Clutch bell	Clutch shoe	Taper collet	Ring gear
OS MAX 61 RX/SX-HGL »C« Order No. **1890, 1892** ...	150 cm	**9:1**	4448.124	4448.79	4448.77	4448.107A
OS MAX 91 FX / SX- HGL Order No. **1922, 1935**	150 cm	**7,7:1**	4448.126A	4448.79A	4448.77	4448.107C
OS MAX 91 FX / SX- HGL Order No. **1922, 1935**	180 cm	**10:1**	4448.122	4448.79A	4448.77	4448.107A
OS MAX 91 FX (modified) Order No. **1816**	150cm	**7,7:1**	4448.126	4448.79A	4448.77A	4448.107C

Main rotor blades, (suitability varies according to fuselage kit used)

Order No. 1246B	GFRP, reflex	688 mm long	Rotor Ø 1551 mm
Order No. 1266	CFRP, symmetrical	686 mm long	Rotor Ø 1547 mm
Order No. 1272	CFRP, reflex	825 mm	Rotor Ø 1825 mm

Glowplug battery, e.g.
2 V glowplug battery, Order No.3694 or 771 (use only with dropping resistor, No.1685 or 1694.)

Fuel: AeroSynth COMPETITION SX-10, Order No. 2811

Starter: Electric starter, Order No. 1628 or 1626 (12 V starter battery, Order No. 2593).

Radio control equipment (see main Graupner catalogue)
We recommend that you use a radio control system equipped with specialist helicopter options or a micro-computer RC system such as the mc-12, mc-14, mc-15, mc-19, mc-22 or mc-24.
The minimum requirement for the RC system is that it has a 3-point swashplate mixer and five servos for the functions pitch-axis, roll, collective pitch, tail rotor and throttle.

RC functions

Swashplate, lateral:	Roll function, right/left
Swashplate, longitudinal:	Pitch-axis function, forward/back
Tail rotor:	Rotation around the vertical (yaw) axis
Throttle and collective pitch:	Climb and descent
Also recommended:	Gyro stabilisation of the tail rotor function
	Electronic regulation of main rotor speed

Servos (we recommend high-performance servos only) such as: C 4421, Order No. 3892

Gyro:
Gyro-System PIEZO 5000, Order No. 5146 with Super-Servo NES-8700G, Order No. 5156 or Gyro-System PIEZO 550, Order No. 5147 or Gyro-System G490T, Order No. 5137

Electronic rotor speed governor: mc-HELI-CONTROL, Order No. 3286

Receiver battery: for safety reasons we recommend that you use a battery of at least 1800 mAh capacity: **POWER switch harness**, Order No. 3050, with 4RC-3000 MH battery, Order No. 2568. We also advise the use of the **NC-AKKU-CONTROLER**, Order No. 3155, so that you can monitor the condition of the receiver battery at all times.

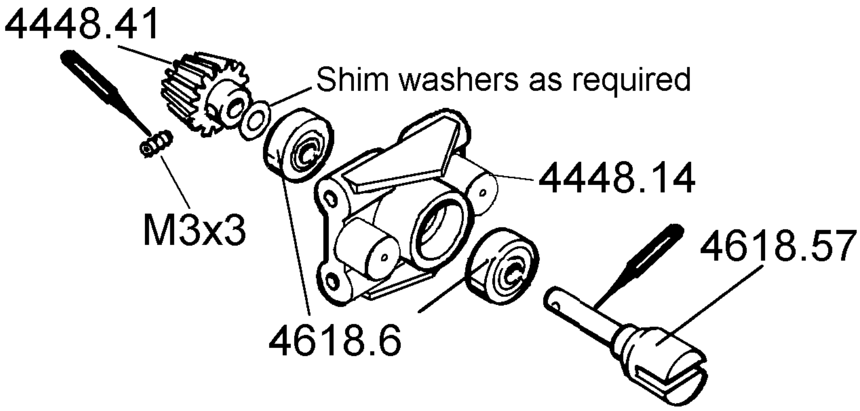
1. Assembling the main mechanics

Most of the components of the UNI-Mechanics 2000 system are moulded in glass fibre reinforced nylon, a composite which offers important advantages over other materials such as aluminium, which are used to build model helicopters. These advantages are low weight combined with high mass constancy, freedom from fatigue effects, low noise, and the ability to absorb motor vibration. Careful design of these mechanical systems gives them the robustness and rigidity required; when a helicopter suffers a „hard landing" it is most helpful to the pilot if the parts either survive undamaged (in which case they can be used again without restriction), or alternatively simply break, so that there is no doubt that they have to be replaced. This construction eliminates the problem of bending or distortion of the chassis, which certainly affects metal mechanics; such damage may even go unnoticed by the owner, but it can easily cause other components to fail prematurely, and has a negative effect on the entire system's efficiency and safety.
Compared with its many advantages, the only drawbacks to nylon construction are the greater (and more cost-intensive) complexity in manufacture, together with the requirement for the owner to assemble the parts carefully and conscientiously, and to adjust and trim parts slightly where necessary. The system then repays you for your care with a long-lasting model and low rates of wear.

Shafts, bearings, fits

Virtually all the rotating parts of the mechanical system are ballraced. Where ballraces are used it is very important that the shaft is a tight fit in the inner ring of the bearing, otherwise there is a danger that it will rotate within the ring. This causes the inner ring to heat up (a blue or yellow discoloration betrays this), and the bearing is damaged and has to be replaced. In an extreme case the bearing may become so hot that it melts the nylon bearing seat, and the shaft then loses its correct position relative to other components. If this should occur, it is tempting to claim that the bearing seat material is at fault, but the actual problem is the incorrect shaft/bearing fit.
If a bearing fit is too loose, another possible consequence is that the inner ring causes wear on the shaft, and the resultant local reduction in shaft diameter causes a change in meshing clearance in any gears mounted on the shaft, i.e. the gears wear rapidly and eventually fail altogether.
In order to avoid the problems described above, the fits between shafts and ballraces are maintained on the close side of normal in the Graupner/Heim system. If the manufacturing tolerances in the bearing and shaft should be unfavourable, you may occasionally find that the fit is too close, i.e. the bearing cannot be pushed onto the shaft. In this case the shaft must be reduced in diameter by rubbing with fine abrasive paper (600 - 1200 grit) until the bearing can be pushed into position using no more than moderate force.
At the other extreme, if the combined manufacturing tolerances produce too loose a fit - as may also occur occasionally - the solution is to glue the bearing to the shaft using LOCTITE bearing retainer fluid 603, which fixes the parts together reliably. When you use this material, please note that the cure time of the fluid varies with the closeness of the fit: the closer the fit, the faster the cure. Under certain circumstances you may only have a few seconds to locate the bearing correctly on the shaft before it is fixed immovably.
If a shaft is supported in multiple bearings, it is important to prevent axial stress due to incorrect positioning relative to each other. One way to avoid this is to position both bearings on the shaft really accurately; an alternative is to use a combination of fixed and sliding fits: one bearing is a press-fit on the shaft (or is glued in place), and the other bearing is a sliding fit, i.e. it can be shifted axially on the shaft using moderate force. In the latter case the second bearing takes up the optimum position automatically once installed.
The problem of shafts wearing inside bearings is affected by two factors: the smaller the shaft diameter and the higher the rotational speed, the greater the danger. The problem of stress between bearings is affected by the difference in internal and external diameter of the bearings: the smaller the difference, the greater the danger. Bearing fits are important, and if you wish to produce a helicopter which is as safe and reliable as possible, all these factors have to be taken into account in every individual case. For this reason the building instructions state in every case when the bearings must be secured using thread-lock fluid or bearing retainer fluid.

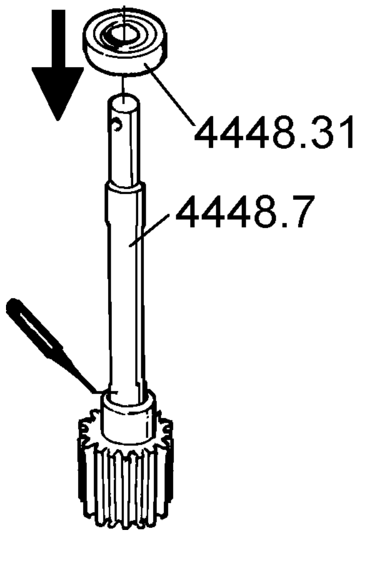
1.1 Assembling the tail rotor drive unit *(bag U2-1A)*

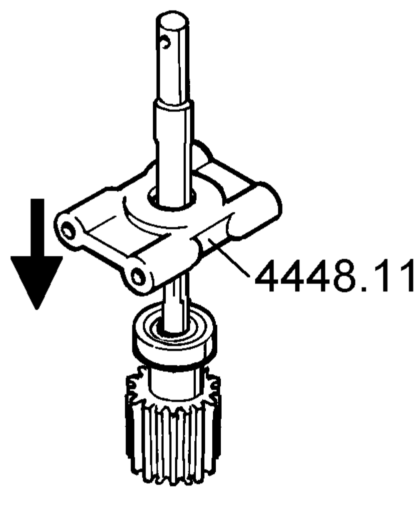


There must be absolutely zero axial play in the shaft of the quick-release coupling 4618.57 within the bearings 4618.6. If the shaft is not a sufficiently tight fit in the bearings, glue it to the inner rings using bearing retainer fluid 603, Order No. 951. This is the procedure: apply bearing retainer fluid 603 to the inside face of the rear bearing, and press it onto the shaft until it rests against the coupling yoke. Wait until the adhesive has hardened - this may take anything from 20 seconds to 30 minutes depending on the closeness of the fit. Push this assembly fully into the bearing holder 4448.14 (until it stops), then apply bearing retainer fluid 603 to the front bearing, push it onto the shaft in one movement, and press it into the bearing holder as far as it will go. Now check immediately (before the adhesive sets) that the shaft still rotates freely; you may find that axial stress has caused the bearings to become stiff. If so, tap lightly (e.g. using a screwdriver handle) on the end of the shaft in the axial direction or (more strongly) on the bearing holder until the bearings revolve freely, then leave the bearing retainer fluid to cure.
Fit a shim washer and the pinion 4448.41 on the front end of the shaft, press it against the front bearing and secure it in this position with the grubscrew: apply a drop of thread-lock fluid (Order No. 952) in the threaded hole and tighten the grubscrew, checking that it engages fully on the ground flat section of the shaft. Rotate the pinion to and fro on the shaft until you find the optimum position for the grubscrew, then tighten it fully.

1.2 Assembling the layshaft *(bag U2-1B)*

Fix the bottom layshaft bearing 4448.31 on the shaft 4448.7 using bearing retainer 603, Order No. 951. Position it resting against the pinion, then allow the adhesive to cure. Press the shaft and bearings into the bottom bearing holder 4448.11.

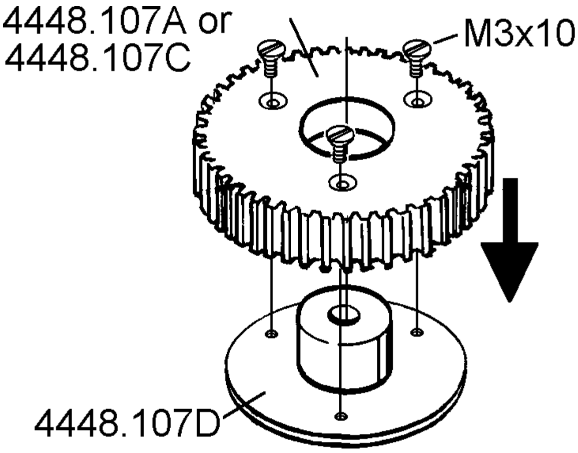




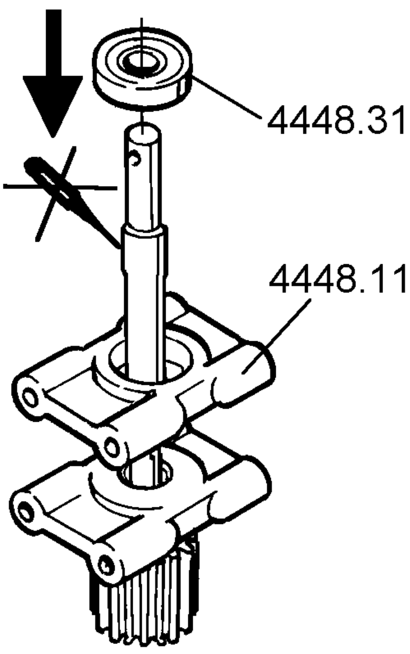
The UNI-Mechanics 2000 system is designed to accept a wide range of motors, and to make this possible different gears can be fitted in the first stage (see also the table on page 6):

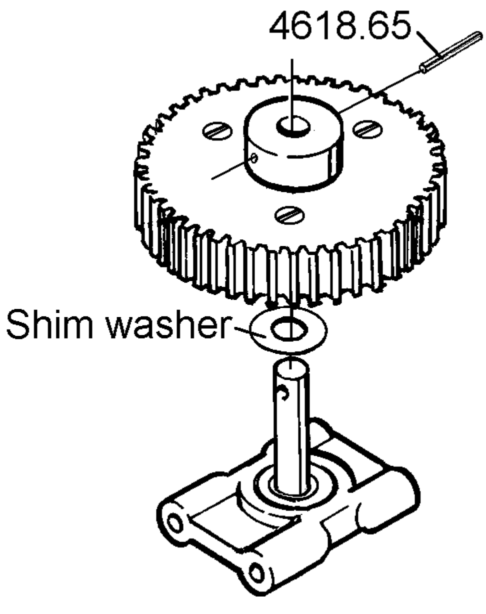
- For normal-sized models with a rotor diameter around 150 cm and a powerful 10 cc two-stroke motor, a ratio of 9:1 is used. This is achieved by fitting a 24-tooth pinion on the clutch bell, and a spur gear with 54 teeth.
- For 15 cc two-strokes with rotor diameters of 180 cm or more, we recommend a reduction ratio of 10:1. This is achieved with a 22-tooth clutch pinion and a spur gear with 54 teeth.
- For 15 cc two-stroke motors and rotor diameters of around 150 cm we suggest the ratio of 7.7:1 in the interests of optimum noise reduction. This is obtained by fitting a 26-tooth clutch pinion and a 50-tooth spur gear.

Once you have selected the appropriate reduction ratio, you will need to fit either the ring gear 4448.107A (54 teeth) or 4448.107C (50 teeth) on the gear flange 4448.107D. In either case the gear is secured using three M3 x 10 countersunk screws. Tighten the screws fully, but not so hard that they distort the ring gear, as it may then wobble when rotating.

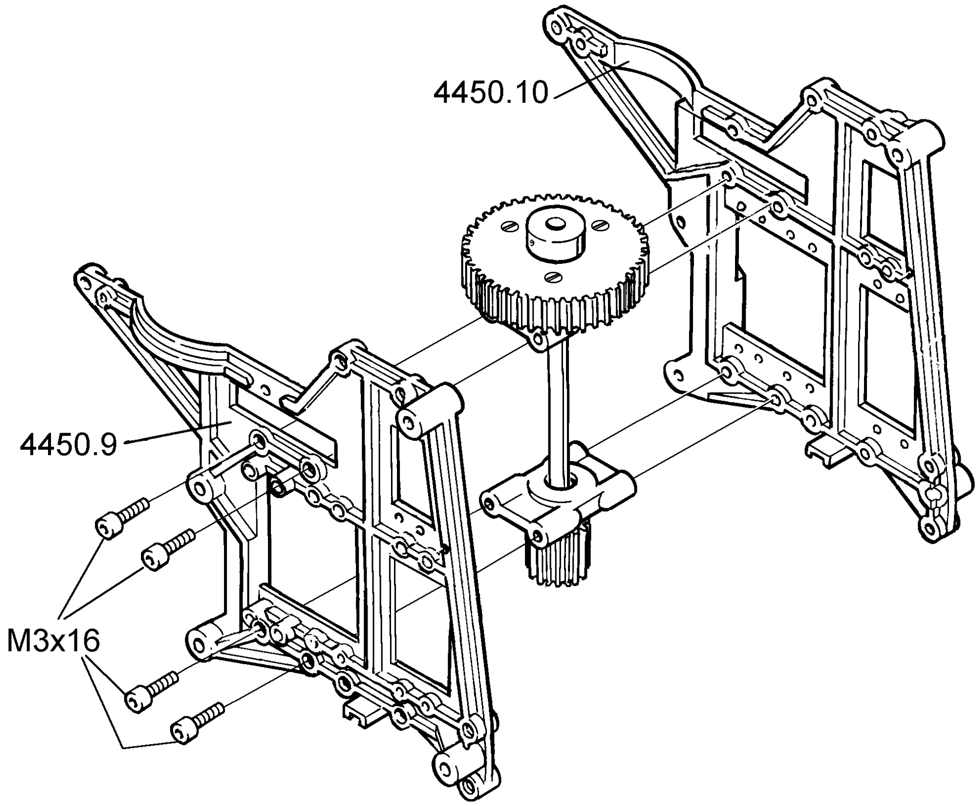


First slip the top bearing holder 4448.11 loosely on the shaft (note correct orientation: the bearing recess in this bearing holder faces up), then fit the top bearing 4448.31, followed by one shim washer and the ring gear you have just prepared. Line up the cross-holes in the shaft and the gear flange, and carefully press the roll-pin 4618.65 through both components, but only to the point where the pin engages in the shaft, so that you can still withdraw it if necessary.





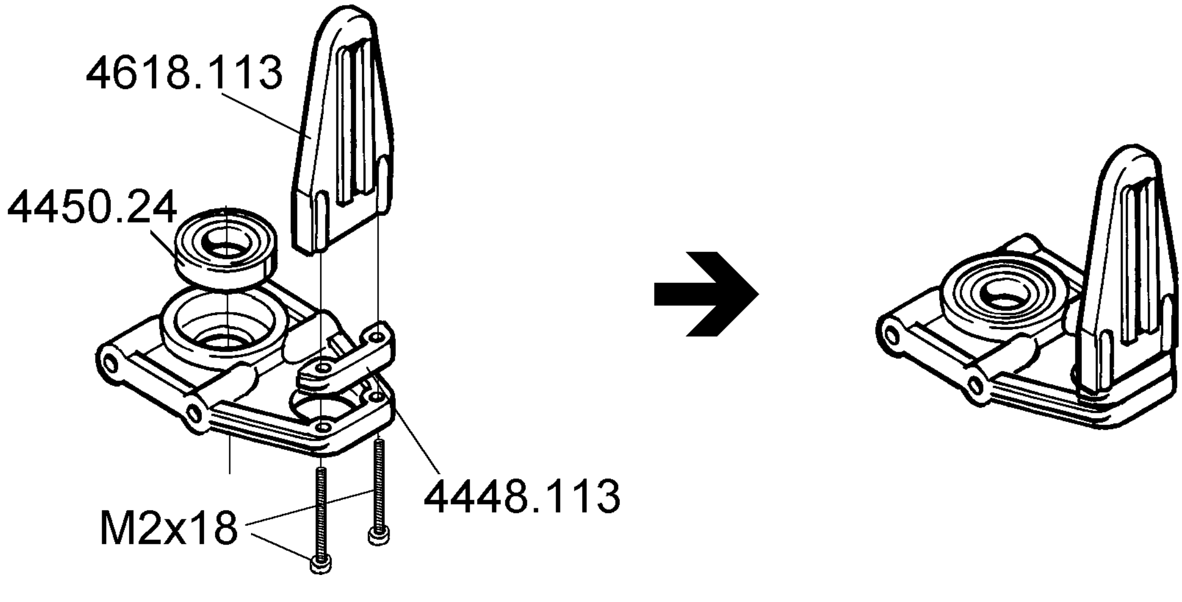
Now press the top bearing 4448.31 into the bearing holder 4448.11, and slide this assembly up against the shim washer below the freewheel sleeve. Now take the prepared layshaft assembly and place it between the mechanics side frames 4450.9 and 4450.10, so that you can check that the top bearing rests against the gear flange via the shim washer when the system is assembled. If there is a gap, you must fit additional shim washers to compensate, but don't fit so many shim washers that the bearings are under strain!



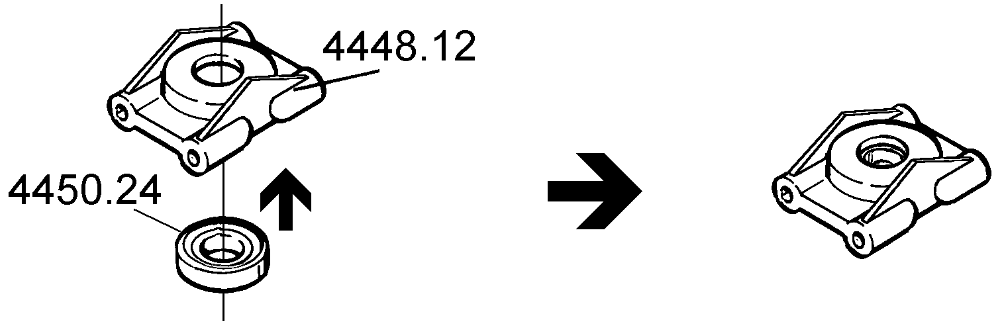
Once the spacing is set correctly, press the roll-pin into the gear flange completely and permanently; check that the shaft rotates freely in the bearings, and tap lightly on the ends of the shaft if necessary to help the bearings seat automatically.

1.3 Preparing the main rotor shaft bearing system *(bag U2-1C)*

Fix the swashplate guide 4618.113 and the spacer 4448.113 to the dome bearing holder 4448.8 using two M2 x 18 cheesehead screws. Press a ballrace 4450.24 into the underside of the dome bearing holder 4448.12. Grease the bearing.

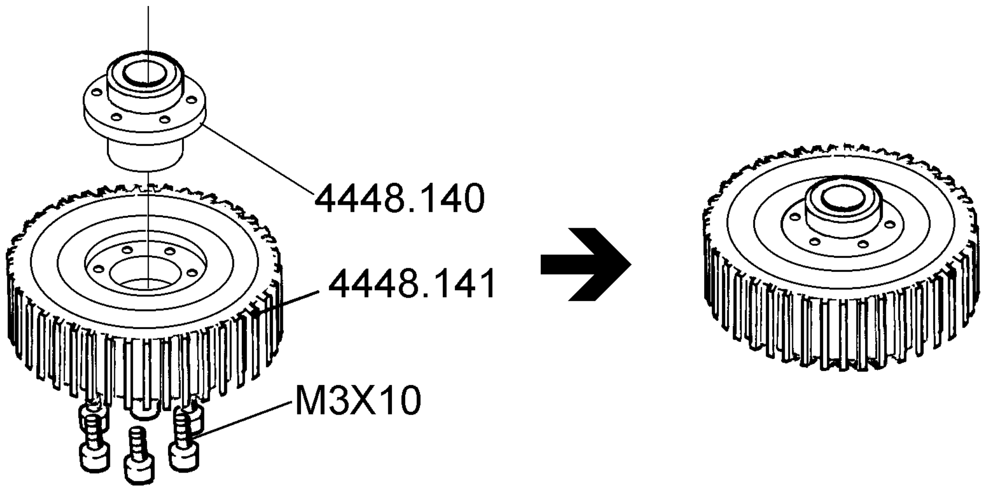


Press a ballrace 4450.24 into the underside of the bottom main rotor shaft bearing holder 4448.12.

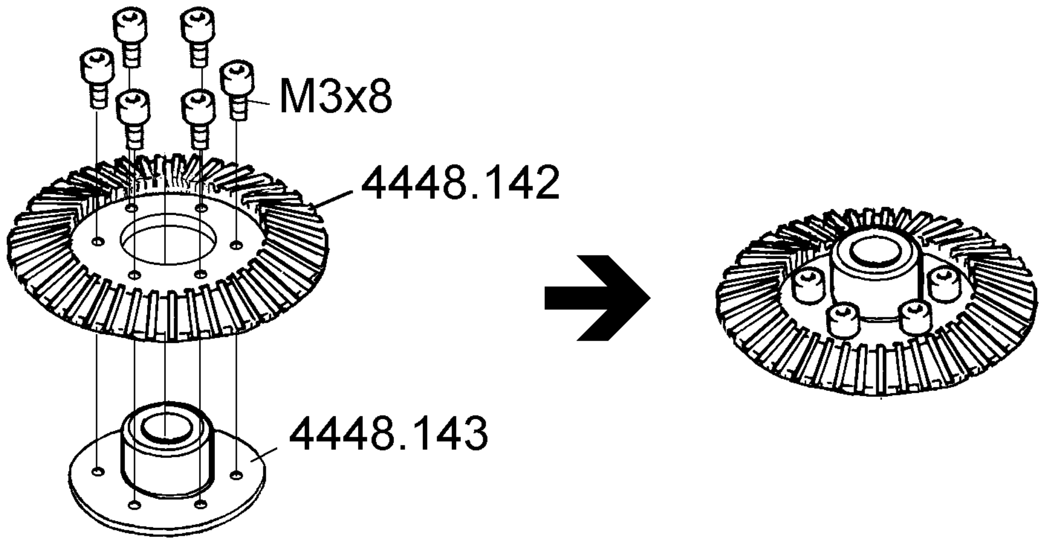


1.4 Preparing the main gear *(bag U2-1D)*

Fit the longer flange of the freewheel hub 4448.140 into the spur gear 4448.141, and fit the six M3 x 10 socket-head cap screws from the underside to secure it. Tighten the screws carefully, working alternately and diagonally, to avoid stressing the gear.

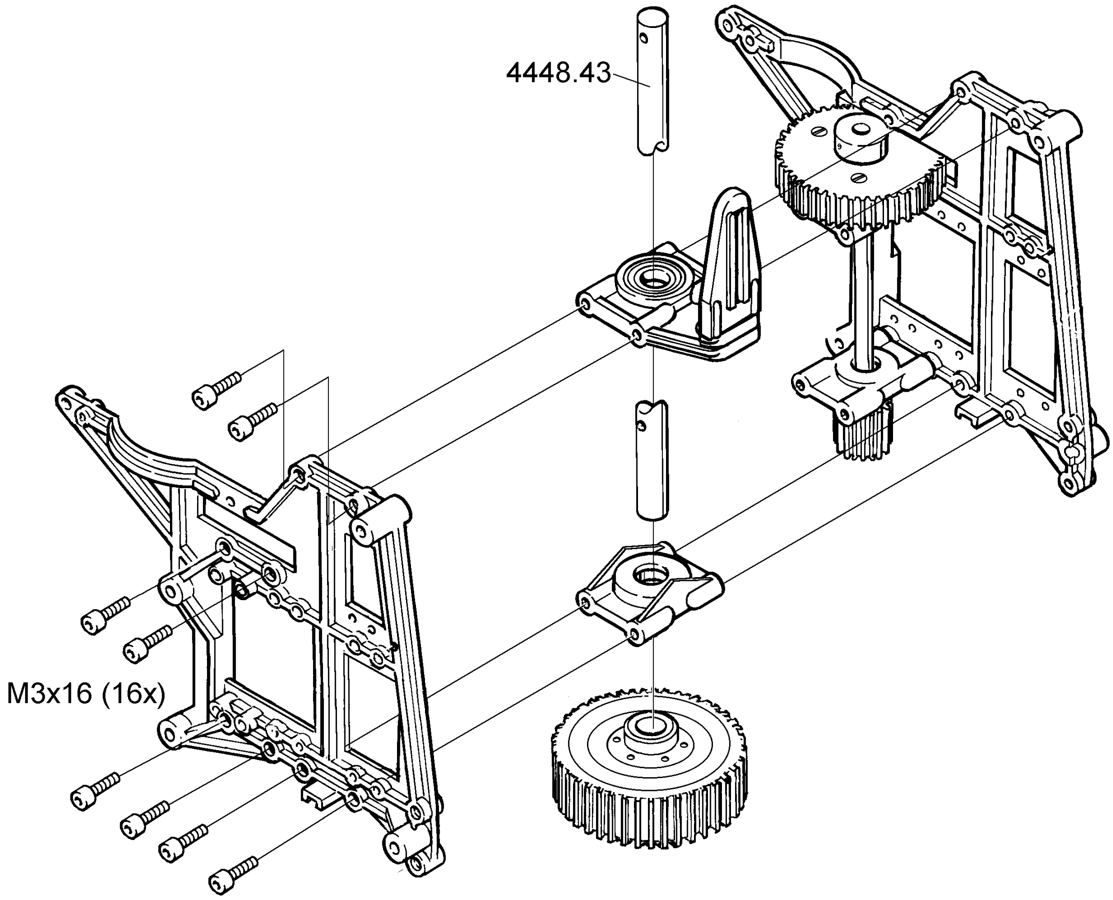


Fit the crown gear 4448.142 on top of the crown gear flange 4448.143, and secure it with six M3 x 8 socket-head cap screws as shown. Here again, tighten the screws fully, working alternately and diagonally.



1.5 Assembling the main gearbox

Fit the main rotor shaft bearing holder and the dome bearing holder between the mechanics side frames 4450.9 and 4450.10, and secure them using M3 x 16 socket-head cap screws as shown. Temporarily fit the main rotor shaft 4448.43 through both bearings, so that you can install the previously prepared spur gear and freewheel at the bottom, and engage it with the pinion on the layshaft, which is already installed.



Now check and adjust the meshing clearance of the spur gear and pinion. This is important, as this setting defines the maximum load capacity, durability and longevity of the mechanical system. It is very important to make this adjustment as carefully and as accurately as you can. The first step is to set up the gears without any play at all (i.e. the gears hard up against each other). The meshing clearance between the spur gear and the layshaft pinion can then be adjusted by loosening the M3 x 16 socket-head cap screws slightly in the bearing holders, winding a piece of thick writing paper in between them, and finally re-tightening the screws.

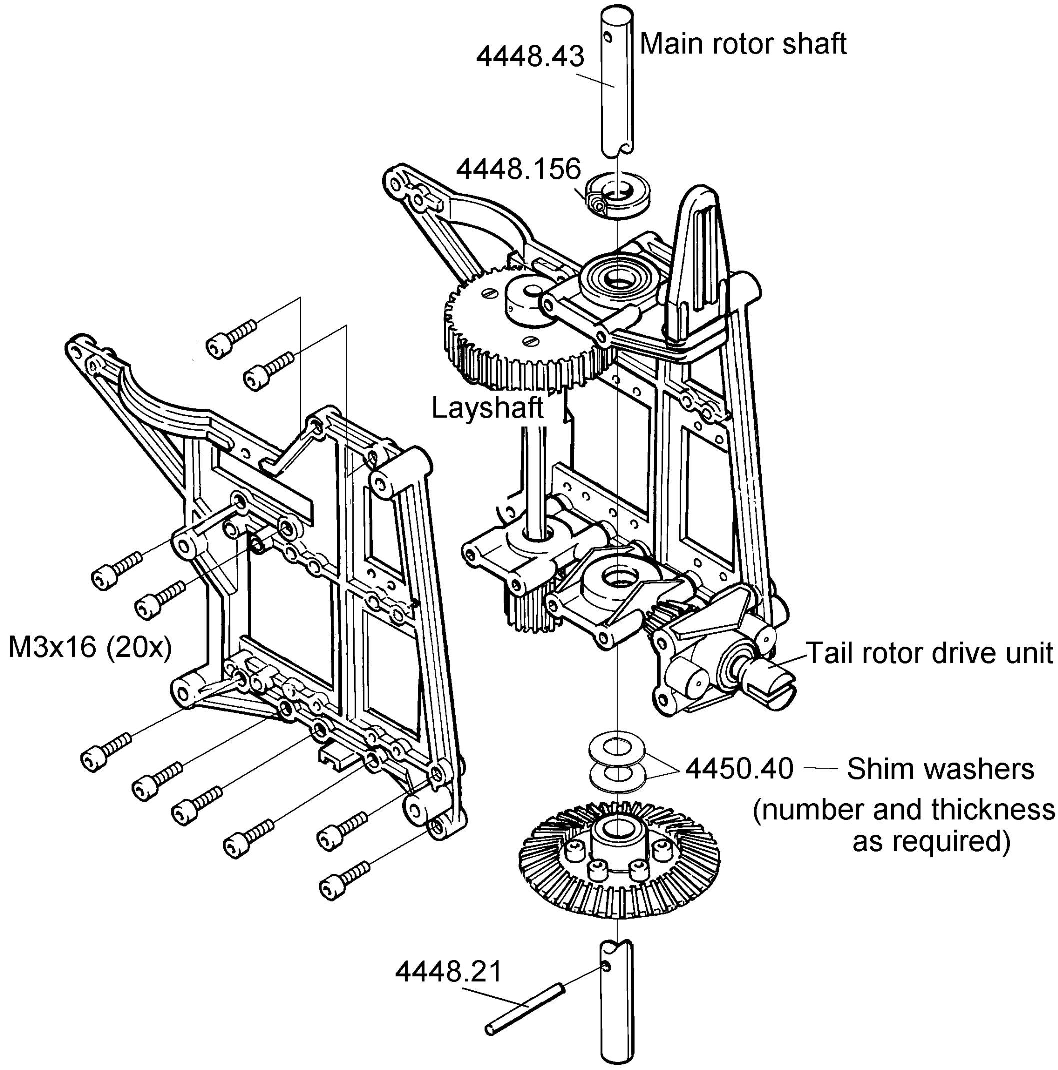
***Note:** the correct meshing of these two gears depends on several factors, and one of them is manufacturing tolerances in the bearing holders; i.e. a possible non-central location of the brass inserts to which the side frames are attached.*

If there is substantial meshing clearance evident when you first assemble the system, then your first step should be to remove the bottom main rotor shaft bearing holder, rotate it horizontally through 180º and install it again.

- If the gears are now hard up against each other, you can adjust the play as described above.
- If the meshing clearance is reduced when you do this, but does not disappear completely, then you also need to rotate the bottom layshaft bearing holder through 180º and re-install it. This second change must eliminate any play, and you can now make the adjustment as described above.
- If the amount of play is increased when you do this, then you should reverse the procedure, and install the bearing holder in its original position. In this case rotating the bottom bearing holder eliminates the play in the layshaft, which can then be adjusted as described above.

Fit the tail rotor drive unit (prepared in Stage 1.1) between the side frames and secure it using

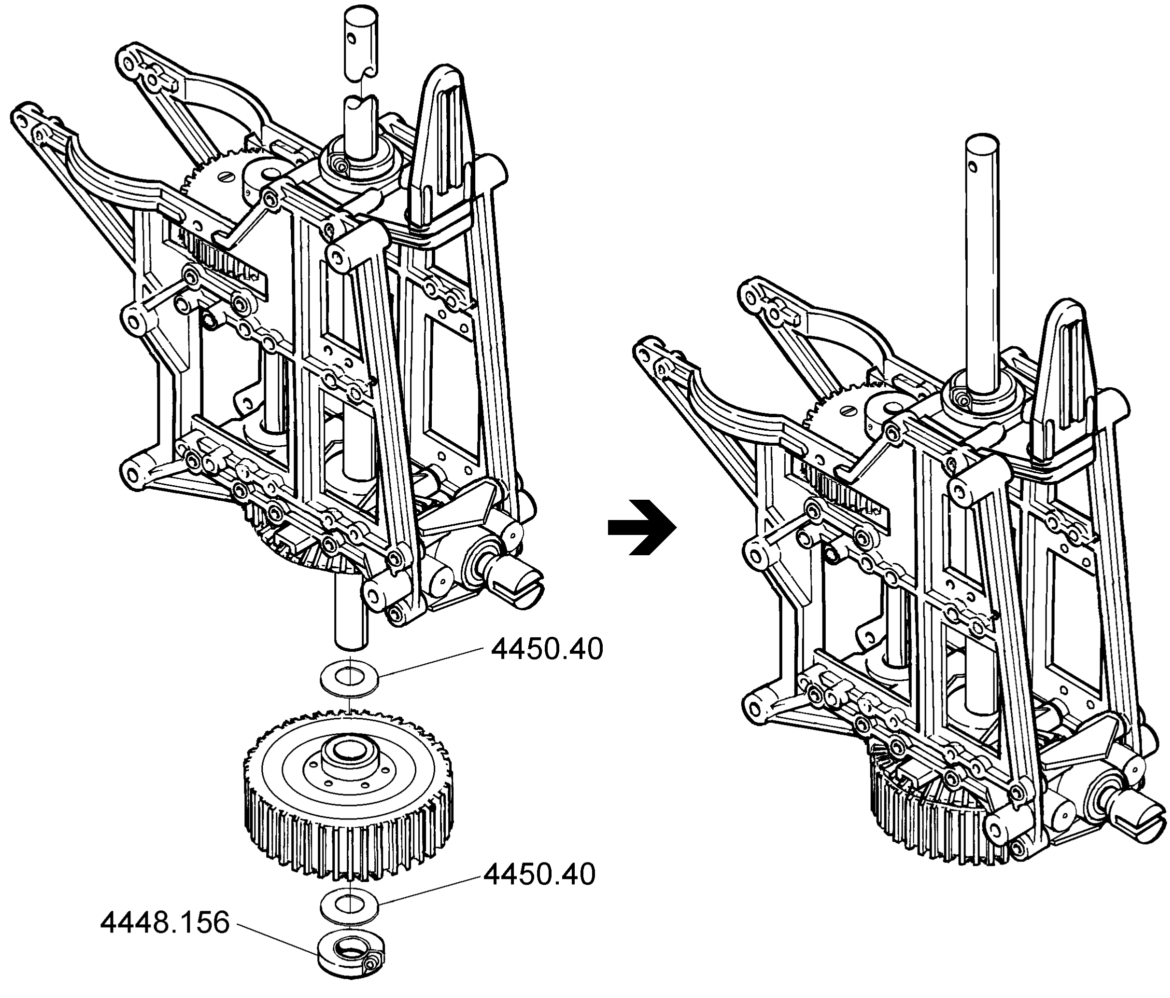
M3 x 16 screws as shown.
Locate the end of the main rotor shaft 4448.43 which has a cross-hole positioned about 26 mm from it, and fit that end of the shaft through both bearing holders from above, and then fit two or three shim washers on the end followed by the crown gear; you should now be able to push the pin 4448.21 through the cross-hole below the flange.
***Note**: as the outer edge of the crown gear engages behind the layshaft pinion, the best way to install it is as follows: first leave the main shaft projecting from the bottom bearing just far enough to enable you to fit the shim washers onto it. Now swivel the ring gear into place behind the pinion and slip it onto the end of the main rotor shaft. The main shaft can then be pushed right through.*



Now pull the main rotor shaft upward, so that the cross-pin engages fully in the channel in the underside of the crown gear flange. The crown gear now rests on the bottom rotor shaft bearing via the shim washers, and engages with the pinion 4448.41 on the tail rotor drive unit. Fit the annular clamp 4448.156 on the top end of the main rotor shaft and slide it down until it rests against the top rotor shaft bearing; there should be absolutely no axial play in the shaft between the bearings. Now check that the tail rotor drive unit runs correctly: the pinion 4448.41 should mesh smoothly with the crown gear, without any detectable play, but equally without any tendency to jam or bind at any point. If the system is stiff, you need to fit additional shim washers between the crown gear flange and the bottom bearing; if there is any detectable play, remove shim washers to eliminate it.

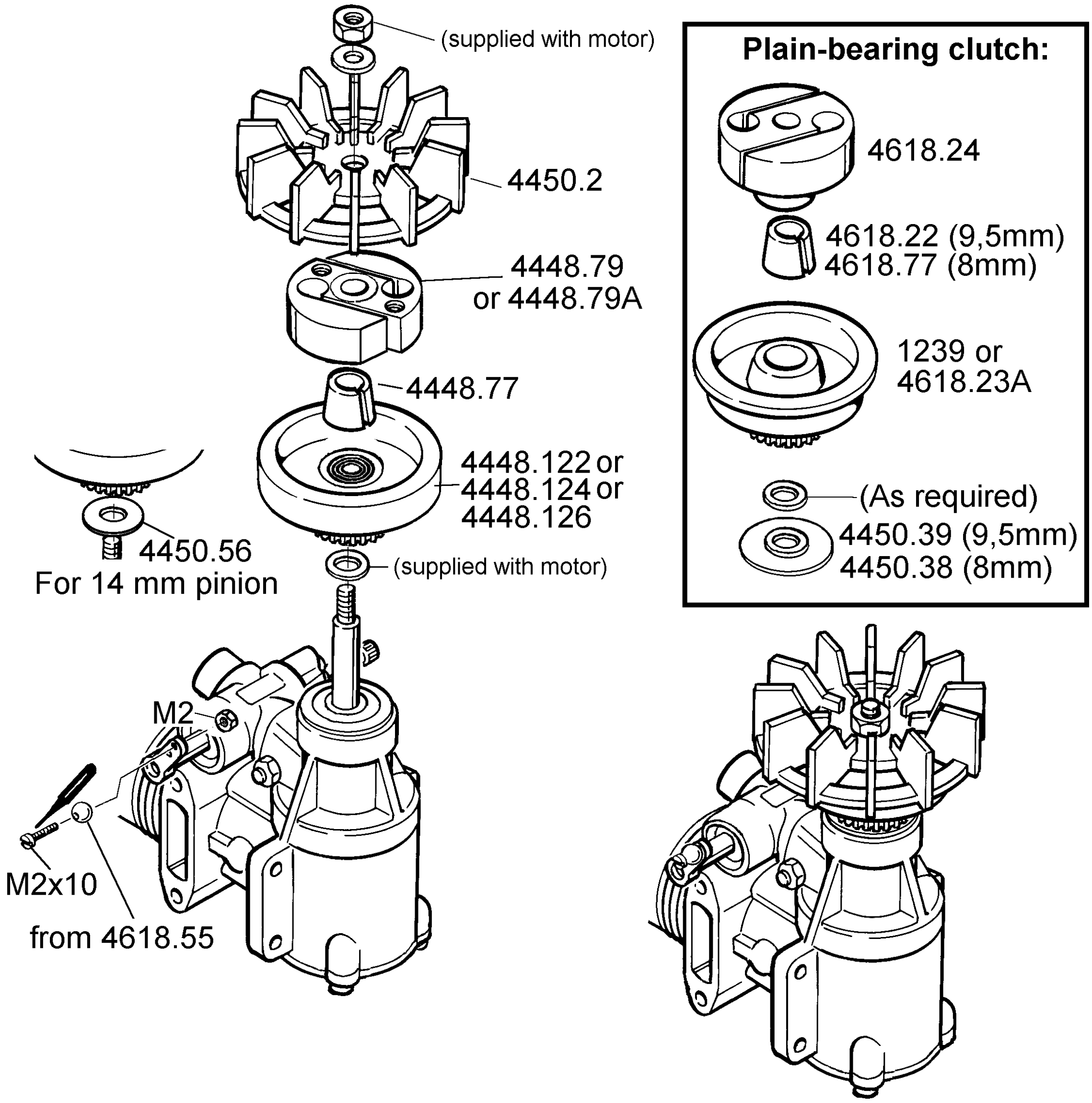
It is important to carry out this adjustment very carefully, as the durability and longevity of the tail rotor drive system depend upon it.

The main rotor shaft now projects from the crown gear flange at the bottom. Fit the following parts on the projecting end in this order: one shim washer 4450.40, the spur gear unit and freewheel (engage the spur gear with the layshaft pinion as you do this), a further shim washer 4450.40 and the annular clamp 4448.156 (with the support flange facing up). Apply a little grease between the shim washers and the freewheel hub at top and bottom. Slide the annular clamp up the shaft and position it so that the spur gear on the freewheel is free to rotate on the shaft, but without any detectable play in the assembly on the main rotor shaft. Tighten the annular clamp.
The gearbox should now revolve freely, without binding or jamming at any point; if this is not the case, you need to make further adjustments as described above.



1.6 Installing the motor *(bag U2-2)*
1.6.1 Preparing the motor
This mechanical system is designed for a motor with a long ground Graupner / Heim crankshaft (8 mm Ø). Other motors can be fitted at your discretion, but you will need to use the optional plain-bearing clutch which is available separately.
Select the appropriate clutch bell and pinion to suit your motor and the reduction ratio you intend to use (see table, page 6). If you are using an existing clutch bell (conversion project, new motor) you must first ensure that the clutch bell is fitted with the correct pinion; if necessary fit the appropriate replacement pinion. Note that the pinions used with our ballraced metal clutch bells feature a left-hand thread.
To replace the pinion, unscrew the existing unit clockwise, and screw the replacement into the bell anti-clockwise after applying a little thread-lock fluid. It is important that the spacer sleeve between the two ballraces is the correct length. If you wish to use the existing ballrace, first push it out of the pinion by pressing on the **outer ring** using a suitable mandrel. To replace the

bearing you must use two flat-ended mandrels, so that you can distribute the pressure evenly over the outer and inner rings of the two ballraces, in order to avoid stressing the bearings. There is a danger of damaging the bearings when tightening the crankshaft nut, but you can avoid this by tightening the pinion only moderately hard at first, before pressing the bearing into place. When the clutch is fitted on the crankshaft (see following section), apply thread-lock fluid to the threads, press the inner bearing rings firmly against each other, and rotate the pinion slightly in the threads to adjust the position of the outer bearing rings until the bearings rotate freely in their installed state.
Note that different centrifugal clutches are required for different motors: the standard centrifugal element 4448.79 is partly machined away internally, and features slightly shorter clutch shoes than the non-relieved centrifugal element 4448.79A, which is used for lower-revving motors (15 cc two-strokes).
Remove the nut from the crankshaft (leaving the thrust washer supplied with the motor in place), then fit the following parts on the crankshaft in this order: clutch bell, split taper collet 4448.77, clutch element 4448.79 or 4448.79A and cooling fan 4450.2; now fit the crankshaft nut and tighten it fully. Attach a linkage ball to the outermost hole in the carburettor arm using an M2 x 10 screw and nut.



Notes:
Two types of pinion are used in the metal clutch bells of the UNI-Mechanics 2000, and they differ in height: the current version is 10 mm high, whereas the older version is 14 mm high. If your pinion is the 14 mm version, use the (thinner) washer 4450.56 instead of the thrust washer supplied with the motor, and swap over the right and left motor mounts.

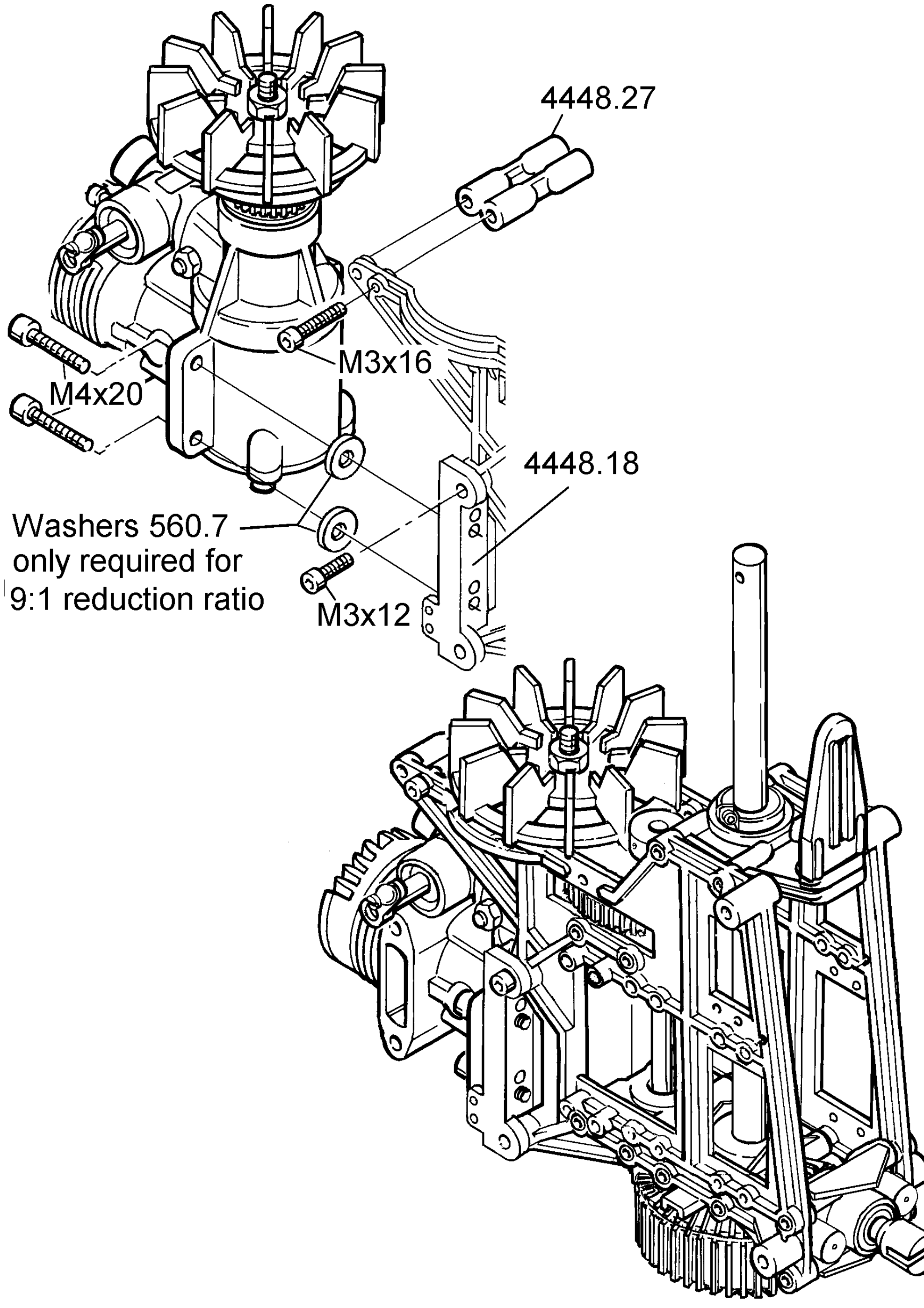
The motor's power is transmitted from the crankshaft to the clutch entirely by means of the pressure exerted by the split taper collet on the ground crankshaft, and by the tapered socket on the clutch. For this reason it makes sense to fit the clutch first, without the fan, and tighten it really firmly; you will need to use a suitable tool to hold the clutch securely.
When fitting the clutch bell on the crankshaft it is essential that the shaft should not be pushed back in its bearings!
Once the clutch is tightened correctly, you will not be able to remove it, even after removing the crankshaft nut, unless you use a puller tool (Order No. 4448.26),
In fact, the crankshaft nut does not contribute significantly to the power transmission system; its primary purpose is to secure the cooling fan. For this reason you don't need to worry if the crankshaft nut can only be fitted half-way onto the threads, for example, if you use the hexagon starter cone (Order No. 4448.103) in conjunction with the earlier type of taller clutch pinion: this is still sufficient to secure the fan and starter cone safely. If you use the hexagon starter adaptor you may find that the fan eventually starts to foul the fan housing at the bottom; if this should happen, fit a suitable washer between the clutch and the cooling fan.

Summary of motors / clutches / gears

Motor	Reduction ratio	Clutch bell	Replacement pinion	Taper collet	Centrifugal element	Spur gear
OS MAX 61 SX/RX-HGL"C" Order No. 1890 / 1892	9:1	4448.124	4448.224	4448.77	4448.79	4448.107
OS MAX 61 LX / SF / RF Order No. 1919	10:1	4448.122	4448.222	4448.77	4448.79	4448.107
OS MAX 91 FX Order No. 1816	7,7:1	4448.126	4448.226	4448.77A	4448.79A	4448.107B
OS MAX 91 FX / SX-HGL Order No. 1922, 1935	7,7:1	4448.126A	4448.226A	4448.77	4448.79A	4448.107B
OS MAX 91 FX / SX-HGL Order No. 1922, 1935	10:1	4448.122	4448.222	4448.77	4448.79A	4448.107
Motor without HEIM crankshaft	9:1	1239	-	4618.77 od. 4618.22	4618.24	4448.107
Motor without HEIM crankshaft	10:1	4618.23A	-	4618.77 od. 4618.22	4618.24	4448.107

1.6.3 Installing the prepared motor

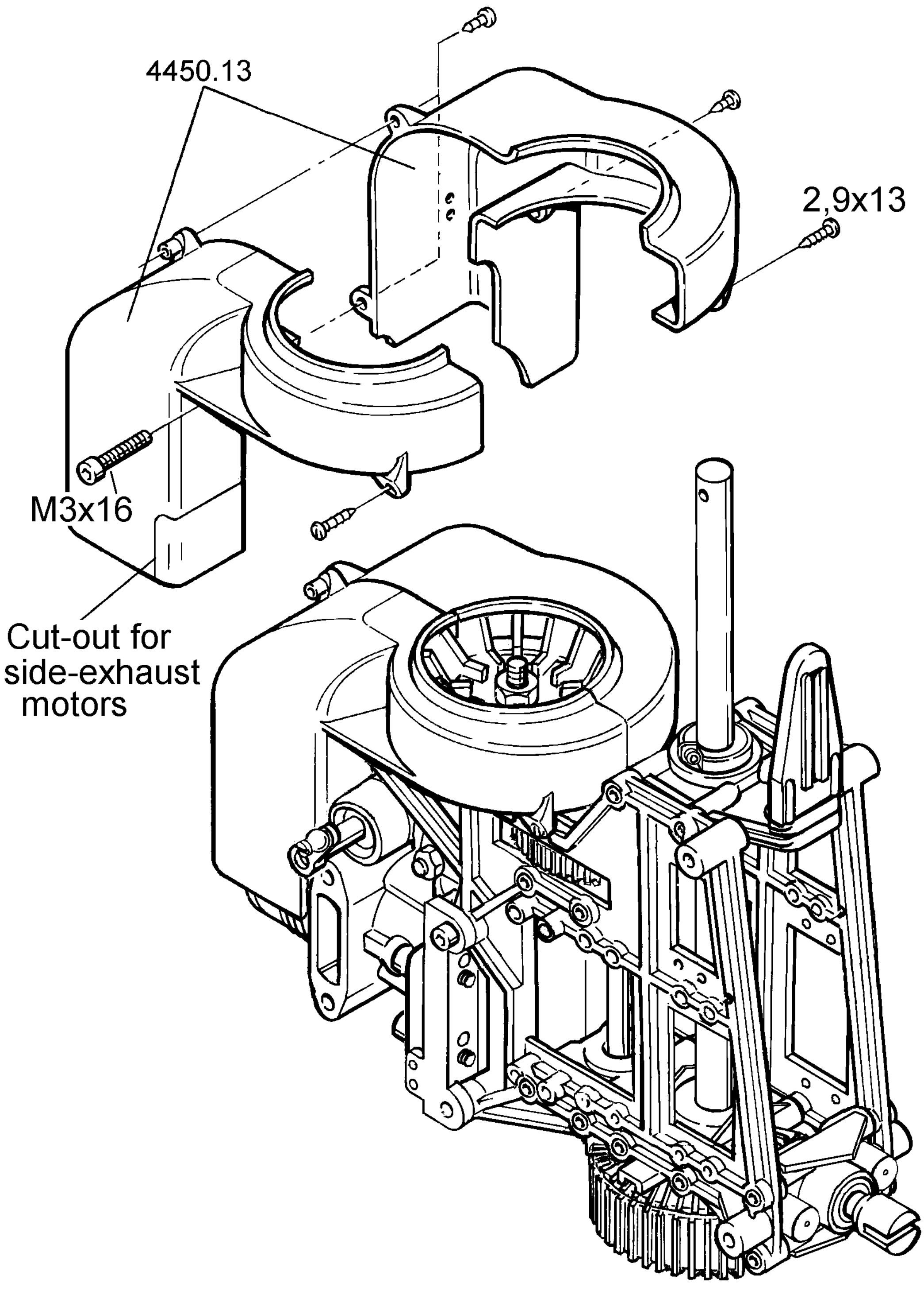
Fix the motor mounts 4448.18 to the motor using four M4 x 20 screws. If you are using the 9:1 reduction ratio, fit the washers 560.7 (9/4.3 x 0.8) between the motor mounting lugs and the motor mounts. Fit this assembly into the mechanics from the front (you will need to swivel it round slightly) and secure it using the stated sizes of socket-head cap screws. Fit the cross-piece 4448.27 using M3 x 16 screws as shown.



Check that the universal motor mounts 4448.18 are installed correctly:

- If you are using a metal clutch bell with a 14 mm pinion, the lower threaded holes in the motor mounts must be **16 mm** from the **bottom edge** of the motor mounts; if that is not the case, swap over the right and left motor mounts.
- If you are using a metal clutch bell with a 10 mm pinion, or a plastic clutch bell (plain-bearing clutch), the lower threaded holes in the motor mounts must be **19 mm** from the **bottom edge** of the motor mounts; if that is not the case, the right and left motor mounts must again be swapped over.

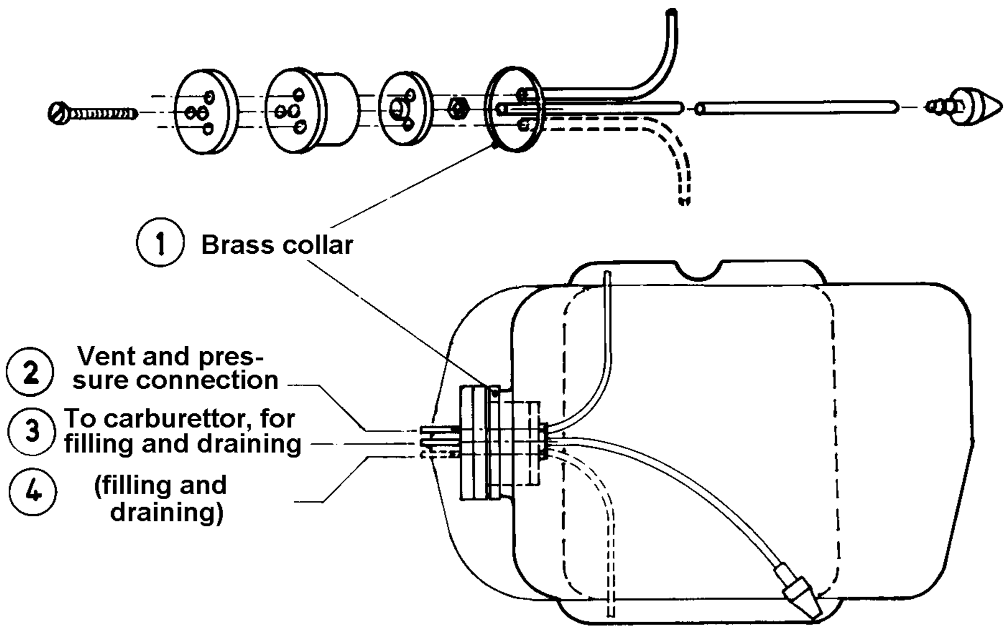
1.6.4 Installing the cooling fan housing *(bag U2-3)*



You may need to enlarge the carburettor opening in the fan housing, depending on the carburettor you are using.
If you have installed a **side-exhaust** two-stroke motor, you will need to cut an opening in the left-hand side to provide clearance for the exhaust manifold (see illustration); use a fretsaw for this.
Slide the fan housing over the motor and fix it to the mechanics with two 2.9 x 13 self-tapping screws at the rear, and two M3 x 16 socket-head cap screws at the front.

1.6.5 Fueltank *(bag U2-6)*

The shape of the fueltank has been designed specifically to suit the helicopter mechanics; the bung should be on the right-hand side. Bend the metal tube (or tubes) to the shape shown in the drawing. The tube ends must be located right at the top and right at the bottom of the tank. Check that the clunk weight is completely free to move, and that it always falls to the bottom when you swivel the tank by hand. Push the brass collar over the neck of the tank; it ensures that the neck cannot burst when the screw is tightened and the rubber bung is compressed.
The fueltank is assembled as shown in the exploded drawing. The rubber bung features a hole for the retaining screw, plus two through-holes for the brass tubes, and a third „blind" hole (for other optional purposes). The third hole can easily be continued through the bung if you wish. Assemble the fueltank, then tighten the central screw firmly to expand the rubber and seal all the joints.
The tube running to the top of the tank (the vent) should be used as the pressure line, and for this purpose it is connected to the pressure take-off nipple on the silencer. If you prefer to use only one tube (the top one) in addition to the clunk feed line, then you must disconnect the fuel line between the clunk weight and the carburettor for filling and draining the tank. You can avoid this awkward procedure by installing a two-way filler valve, Order No. 1657, in the appropriate hole in the switch console, and loop it into the fuel line from the fueltank to the carburettor; if you don't fit this valve, you will have to pull the feed line off the carburettor every time you refill the tank.
Make up the fuel line to the motor using fuel tubing and a fuel filter; note that the connection to the carburettor should be as short as possible.

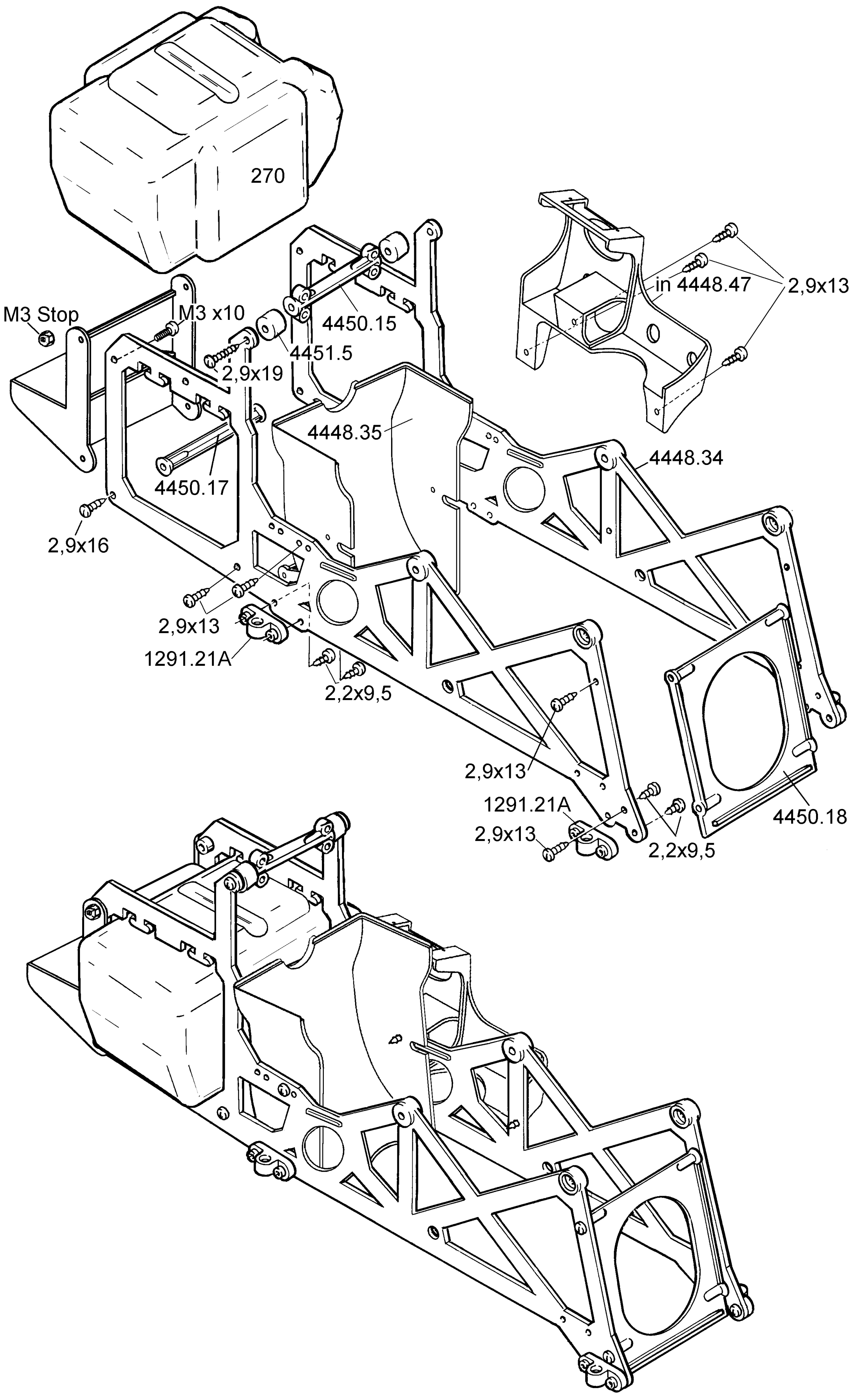


1.7 Assembling the chassis sub-structure *(bag U2-4)*

Assemble the chassis sub-structure from the components shown in the illustration, using the stated sizes of screws.

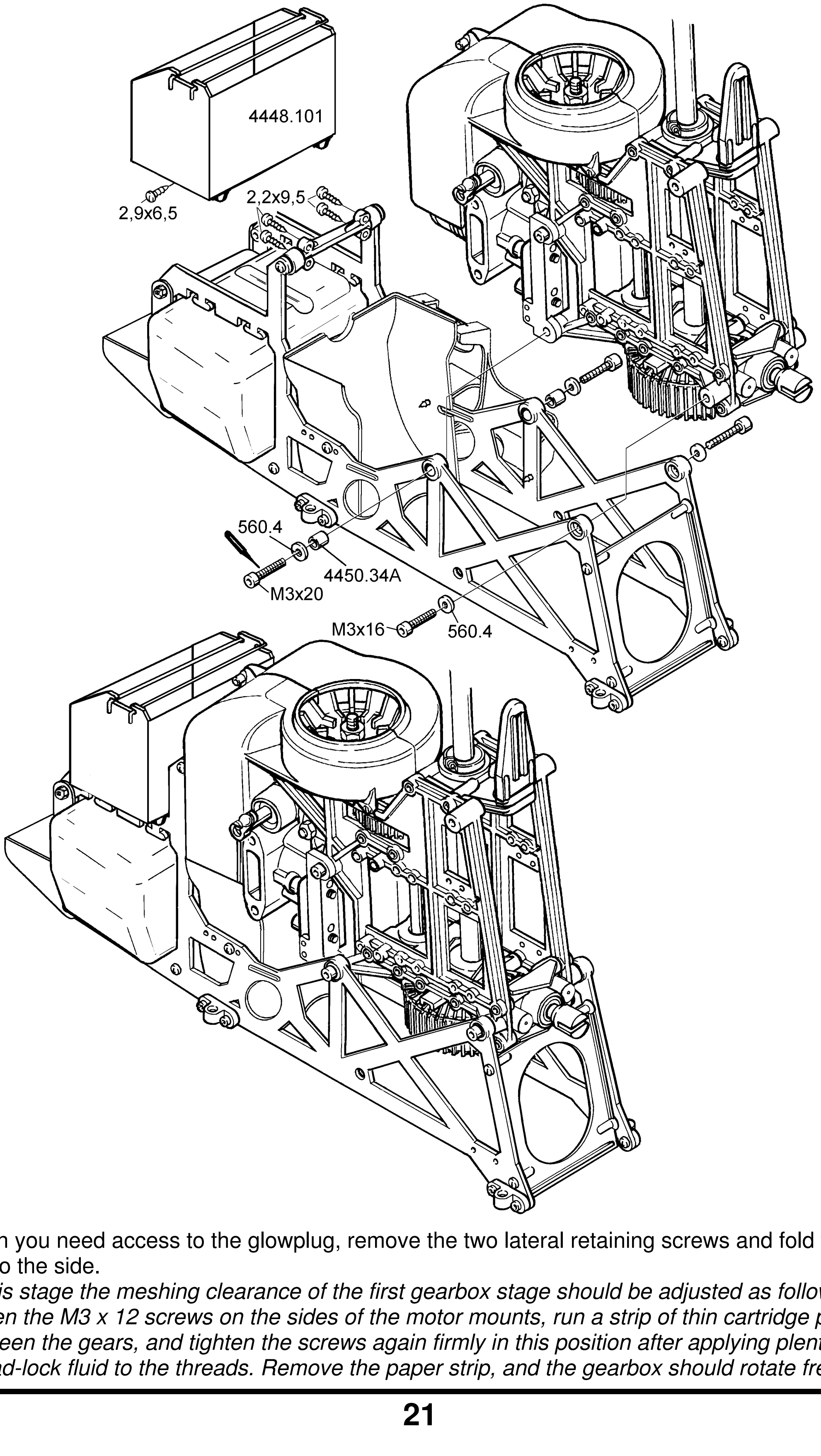
Note:
Remove all rough edges from the side frames 4448.34 where they contact the fueltank.

If you are using a clutch bell with a 14 mm pinion, you will need to enlarge the glowplug access opening in the air duct 4448.35 in such a way that the plug can easily be screwed in and out. Check this by holding the air duct against the bottom edge of the fan housing (already installed) before fitting it permanently.


270
in 4448.47
2,9x13
M3 Stop
M3 x10
4450.15
4451.5
2,9x19
4448.35
4448.34
4450.17
2,9x16
2,9x13
1291.21A
2,2x9,5
2,9x13
1291.21A
2,9x13
2,2x9,5
4450.18

1.8 Attaching the mechanics to the sub-structure *(bag U2-5)*

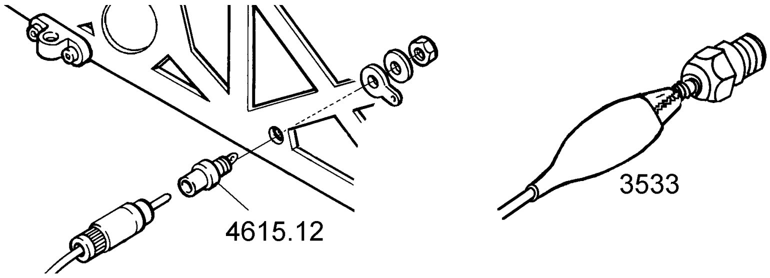
Place the main gearbox (from Stage 1.6) between the sub-structure side frames, engage the round shoulders in the sockets, and fit the M3 x 16 socket-head cap screws and washers to hold the parts together. At the front the mechanical aggregate is secured using M3 x 20 socket-head cap screws as shown in the illustration. Drill 1.5 mm Ø pilot-holes in the fan housing, and fix the front structure adaptor 4450.15 to the fan using 2.2 x 9.5 self-tapping screws. Attach the RC box 4448.101 as shown.



When you need access to the glowplug, remove the two lateral retaining screws and fold the RC box to the side.

At this stage the meshing clearance of the first gearbox stage should be adjusted as follows: loosen the M3 x 12 screws on the sides of the motor mounts, run a strip of thin cartridge paper between the gears, and tighten the screws again firmly in this position after applying plenty of thread-lock fluid to the threads. Remove the paper strip, and the gearbox should rotate freely.

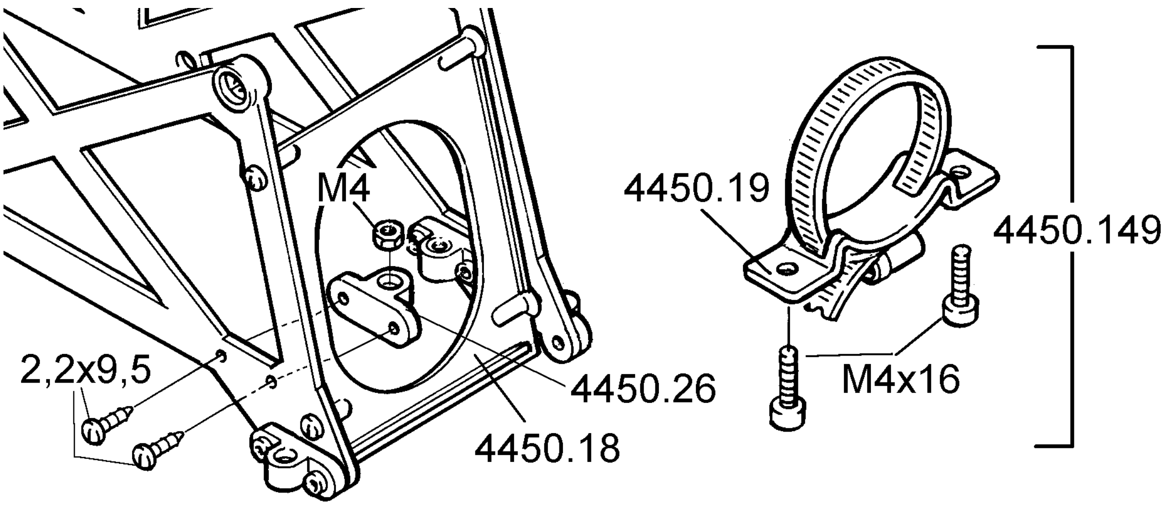
1.9 Remote glowplug connection *(bag U2-6)*



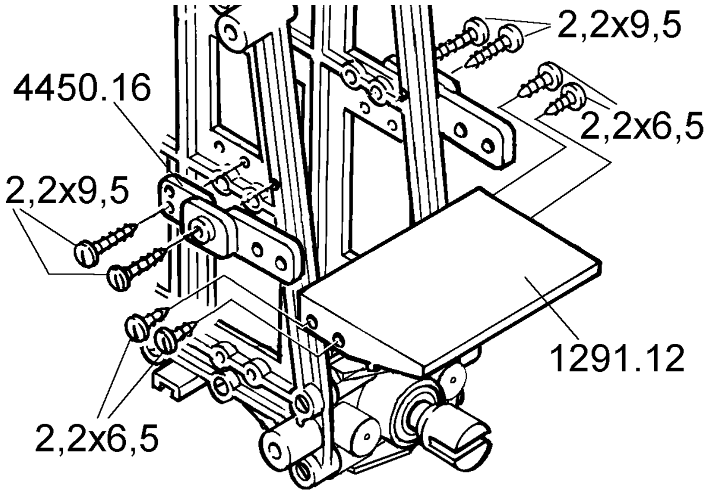
Work out the best position for the remote glowplug socket to suit your model, and fit the socket in one of the two holes in the switch console, or in the hole in the left-hand sub-structure side frame. Fit the solder tag, washer and nut on the socket in that order, and tighten the nut to secure the socket.
The socket can now be connected to the motor using the twin-core cable supplied. The crocodile clip is designed to provide easy access to the glowplug in order to fit a new one, and the clip should be soldered to the wire running from the centre contact of the socket. Attach the crocodile clip to the glowplug, and fix the other wire to one of the motor mount screws using an additional washer. Deploy the cable neatly, then solder one wire to the positive terminal of the socket, the other to the negative terminal.

1.10 Silencer

Select the appropriate exhaust manifold to suit your motor, and install it in such a way that the exhaust runs below the motor, and is directed towards the rear inside the sub-structure. Thread the tuned pipe silencer through the rear bulkhead 4450.18 from the rear, and connect it to the manifold using Teflon hose and hose clips; leave about 5 mm clearance between the manifold and the silencer inlet stub.
The method of supporting the silencer tailpipe varies according to the silencer used. An exhaust holder (e.g. ULTRA-STAR 2000) can be used at the rear end to support the tailpipe, or it can be supported at the fuselage exhaust outlet or - preferably - by means of a console (available separately, Order No. 4450.149). In this case the silencer is supported at the centre, and secured by tightening the clip provided. Take care not to overtighten the clamping screw.
In this case the two brackets 4450.26 should be screwed to the sub-structure at a suitable position, using the existing holes as reference points; note that the actual screw positions may have to be located differently to suit your silencer.



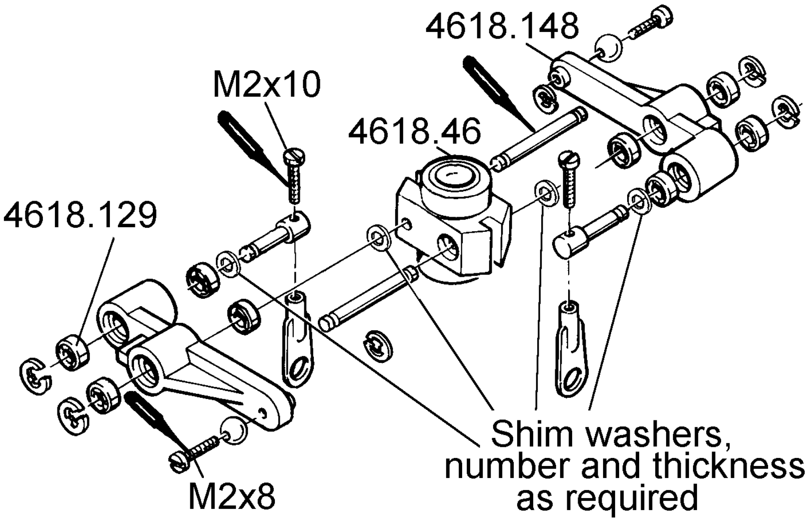
1.6 Installing the gyro platform *(bag UM-7)*



Fix the gyro platform holder 4450.16 to the side frames using 2.2 x 9.5 self-tapping screws. Fit the gyro platform 1291.12 on top, and secure it with four 2.2 x 6.5 self-tapping screws.

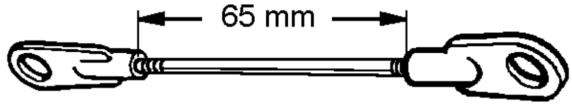
1.7 Collective pitch compensator and swashplate *(bag U2-8)*

The collective pitch compensator 4618.147 is assembled as shown in the illustration.

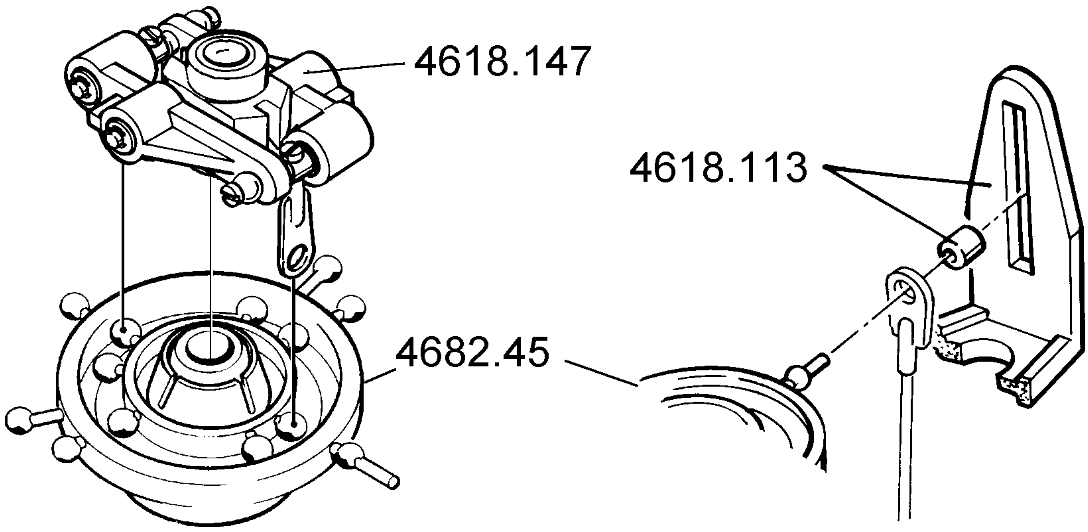


Start by fitting a circlip on each of the brass pins, and glue them in the holes in the collective pitch compensator centre piece 4618.46 using bearing retainer fluid, with the circlips located fully in the recesses. Press the ballraces 4618.129 in the arms of the collective pitch compensator and slip them on the projecting ends of the brass pins, fitting at least one shim washer between the centre piece and the arm on each side; check that the arms are free to rotate on the pins. Fit the outer circlips to retain the arms, and check that there is no axial play present in the arms on the pins. If there is detectable slop, fit additional shim washers to take it up.

Make up the pushrods as shown in the drawing from three threaded rods 1291.10 (2.5 mm Ø, 75 mm long) and six ball-links 4618.155; the stated dimension refers to the free space between the ball-links.



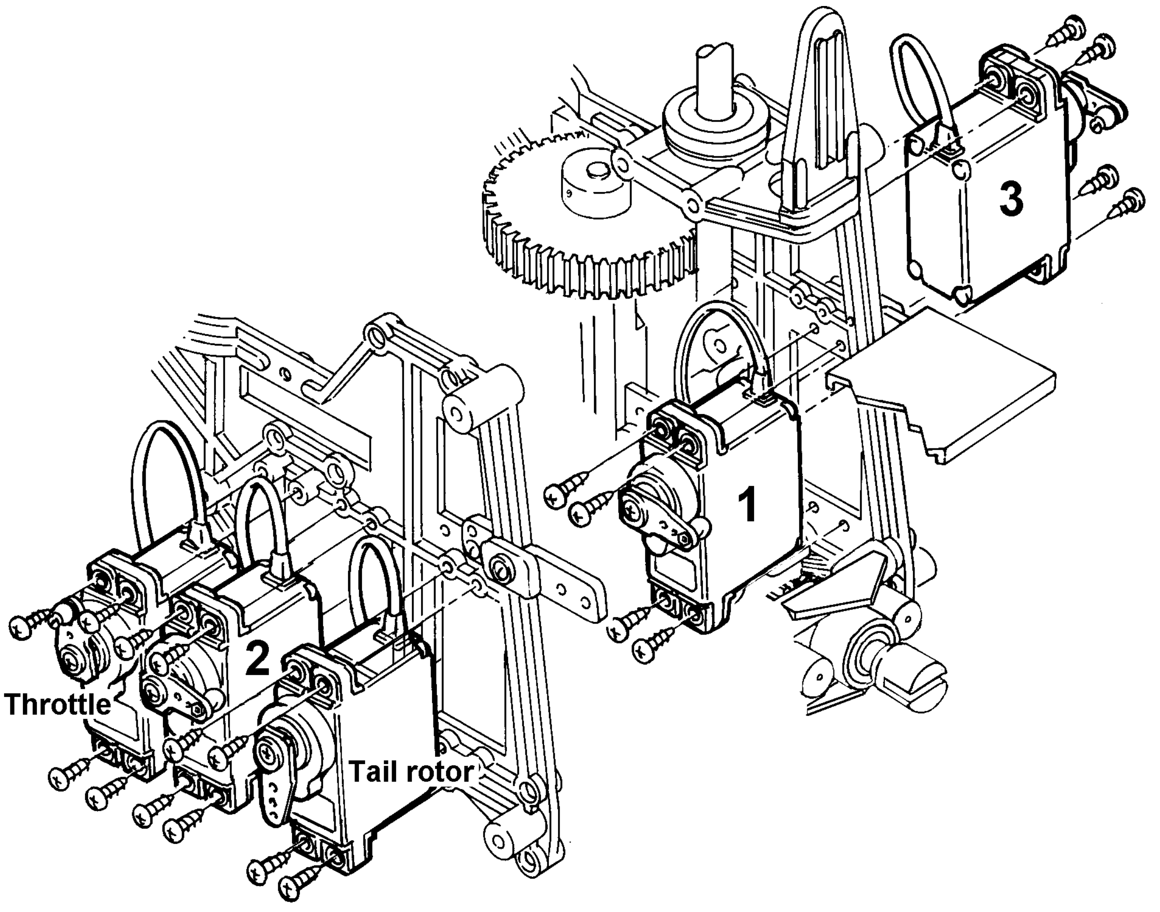
The first pushrod is used for the rear swashplate linkage; fit the ball-link over the guide spigot mounted on the swashplate 4682.45, and press it onto the linkage ball at the base of the spigot. Fit the brass sleeve (from 4618.113) on the guide spigot and grease it well. Slide the swashplate onto the main rotor shaft, and thread the connected pushrod down through the hole in the rear of the dome bearing holder; carefully ease the swashplate guide 4618.113 back, and allow the brass sleeve on the swashplate guide spigot to engage in the channel in the swashplate guide.
Fit the collective pitch compensator on the main rotor shaft, and press the two ball-links onto the appropriate balls on the inner ring of the swashplate, as shown in the illustration.



2. Installing the radio control system *(bag U2-9)*

2.1 Installing the servos

Fit brass linkage balls on the *inside face* of the output arms of the pitch-axis servo (1) and the roll servos (2) + (3) using M2 x 10 cheesehead screws, and secure each one with an M2 nut fitted on the outside. Apply thread-lock fluid between the screws and the balls, and also in the nuts. The distance from the servo output shaft axis to the ball centre should be around 18 mm.
Install the pitch-axis servo in the rectangular opening in the right-hand side frame, working from the inside; the output shaft must be at the top. Secure the servo with four screws, rubber grommets and tubular rivets (these items are supplied with the servos): the tubular rivets are pressed into the underside of the rubber grommets, and the screws fitted from the top.
The holes in the mechanics for the servo mounting screws are deliberately offset slightly towards the outside, so that the rubber grommets are under slight tension when the screws are fitted. This helps to produce precise control response.
Both the roll-axis servos are fitted in the right and left side frames working from the outside, again with the output shafts at the top (see drawing). Secure each servo with four screws as before. Connect the servos to the receiver in the sequence described in the RC system instructions, switch on the radio control system and activate the swashplate mixer at the transmitter (setting: symmetrical three-point linkage, two roll-axis servos, one pitch-axis servo at the rear). Set the collective pitch, pitch-axis and roll-axis controls to neutral (centre) and fit the output arms on the servos at right-angles to the rotor shaft. Secure them with the servo output screws.

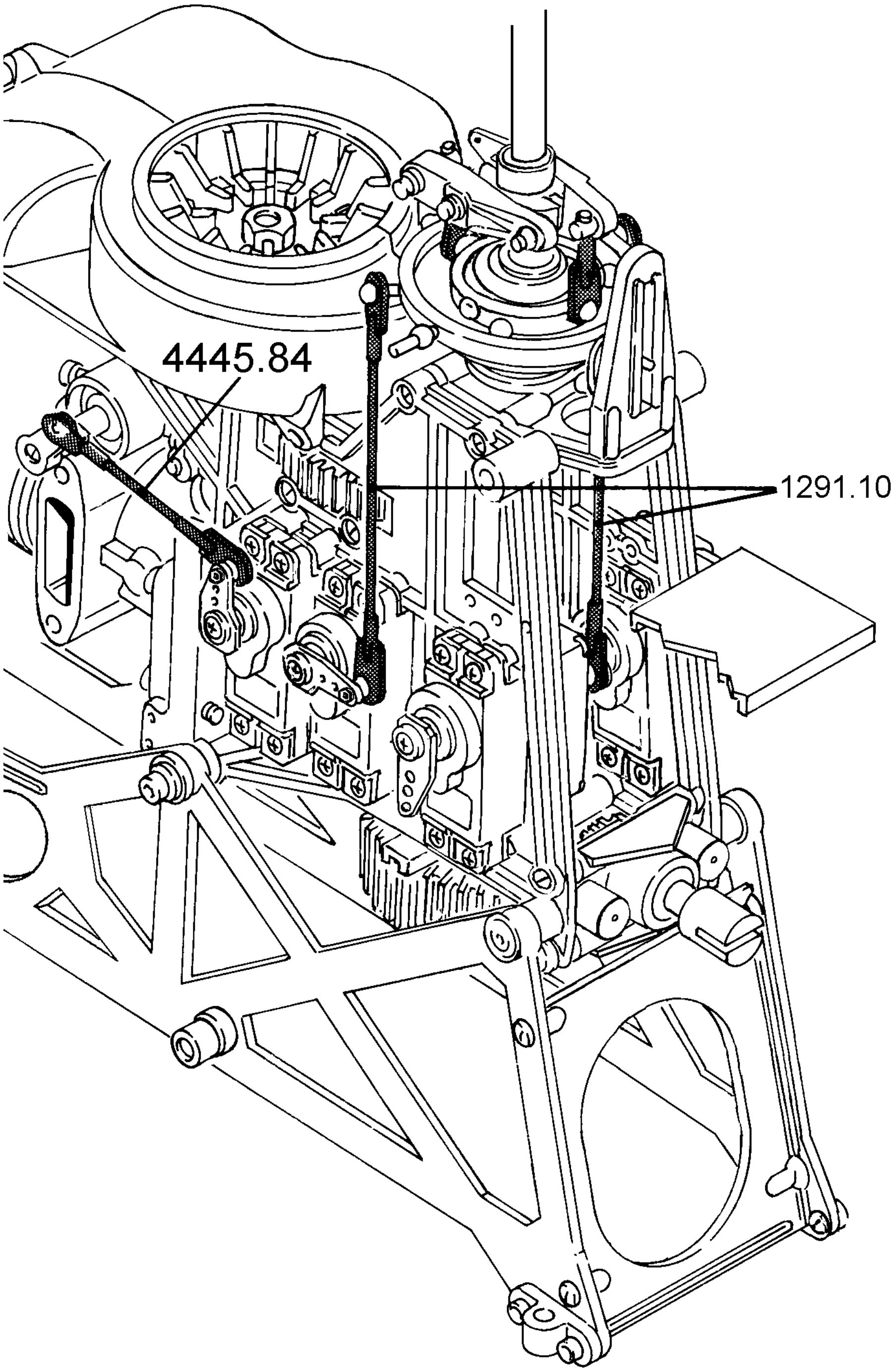


The tail rotor servo is installed in the left-hand side frame from the outside, with its output shaft at the top; secure it with screws in the usual way. The output arm of the tail rotor servo must face down, and should be parallel to the main rotor shaft when the collective pitch control is at centre.

Fix a brass linkage ball on the *outside face* of the throttle servo output arm using an M2 x 10 cheesehead screw, and secure it from the rear with an M2 nut, applying thread-lock fluid between the screw and the ball, and also in the nut. The distance from the servo output shaft axis to the ball centre should be around 11 mm. For two-stroke motors the throttle servo is installed in the left-hand side frame with the output shaft at the top and the servo output arm facing up. For four-stroke motors the throttle servo should be installed in the right-hand side frame, with the output shaft at the bottom and the output arm facing down.

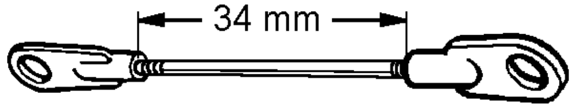
Deploy the servo leads along the chassis to the RC box, taking the greatest care to avoid potential sources of damage. Do not allow any cables to touch shafts or gears, as they could easily chafe through, and cause a short-circuit and crash.

Connect the swashplate servos to the swashplate to produce a 120º linkage, using the previously prepared pushrods.

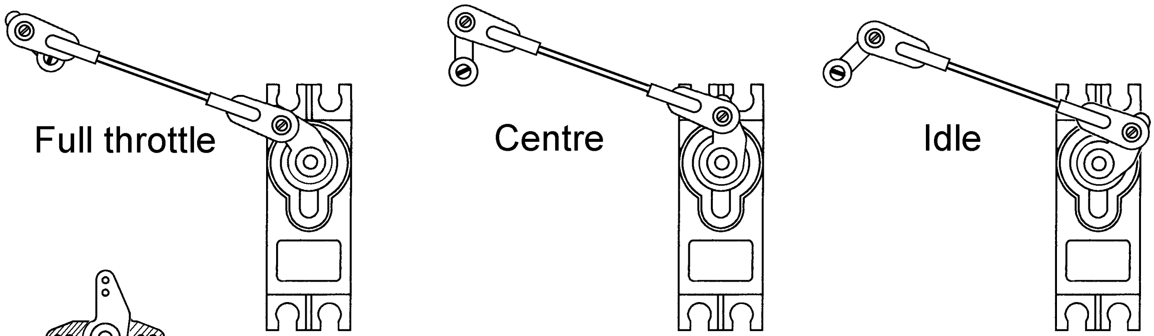


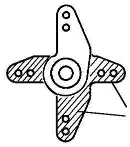
A four-point swashplate linkage is also possible, but you will need to use your own discretion for the detail solution. In this case an additional servo is installed in the vacant servo aperture in the mechanics, and should be connected to the front linkage point on the swashplate by means of a 2.5 mm Ø pushrod which will need to be angled for clearance. In this arrangement the pushrods from servos 2 and 3 are connected to the lateral (90 °) linkage points on the swashplate. You will need to activate the swashplate mixer for a four-point linkage at the transmitter.
If you wish to install a four-point linkage, please pay particular attention to accurate adjustment of the linkage pushrods, otherwise the servos may place strain on each other. This is the procedure: with the radio control system switched on, set the collective pitch stick to centre (the servo output arms should be at 90º to the pushrods), then disconnect one pushrod. Now adjust the remaining three pushrods until the swashplate is exactly horizontal. When you are satisfied, adjust the length of the fourth pushrod so that it can be pressed onto the linkage ball on the servo without causing any movement in the other pushrods.

Make up the throttle pushrod from one threaded rod 4445.84 (2 mm Ø, 45 mm long) and two ball-links 4618.55 as shown in the illustration; the stated dimension refers to the free space between the ball-links.



Use this pushrod to connect the carburettor arm to the servo output arm as shown in the illustration:





Remove superfluous arms from the servo output device.

2.2 Installing the remaining radio control system components

To attach the gyro system to the gyro platform we recommend the use of double-sided foam tape, e.g. Order No. 742. Run the cables forward along the side of the mechanics to the receiver, together with the servo leads.

Pack the receiver battery in soft foam, such as the foam sleeve, Order No. 1637, then mount it on the battery console and secure it with two cable ties.

The receiver, gyro electronics and speed governor (if present) can be installed in the RC box. Pack these items in soft foam and secure them by fitting the wire retainer bar.

Bundle together all the servo, gyro and battery leads, and wrap them in spiral tubing or fit cable ties round them. Run the loom forward to the receiver and fix it to the side of the mechanics.

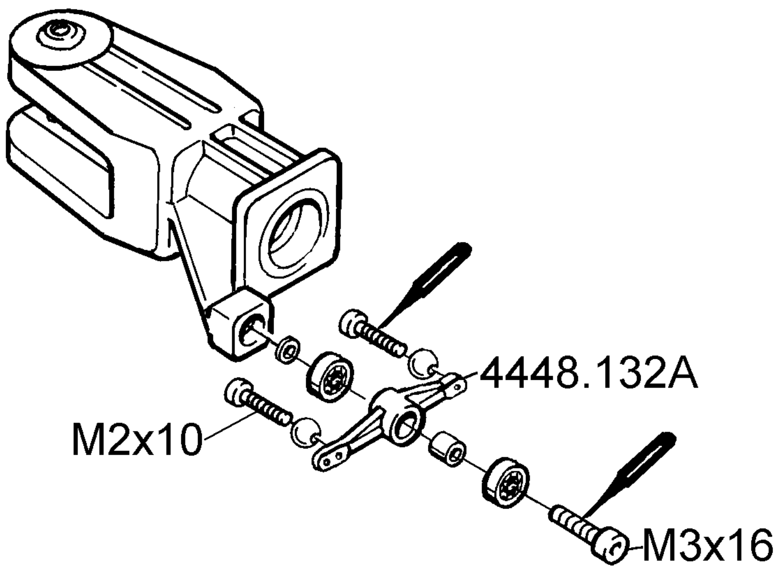
Attach the receiving system switch to the switch console mounted on the right-hand side of the sub-structure, and connect it to the battery and receiver.

3. Assembling the main rotor head *(bag U2-10)*

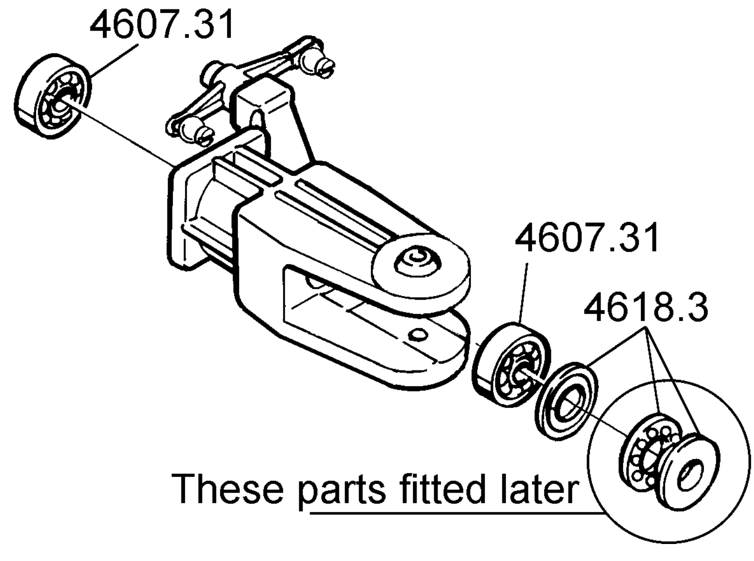
The main rotor head is assembled as shown in the illustrations. Remember to grease all ballraces.

3.1 Preparing the rotor blade holders *(bag U2-10A, U2-10B)*

First attach the two linkage balls to the mixer levers 4448.132A using M2 x 10 screws, then press the ballraces into both sides, not forgetting the brass spacer sleeve between them. Apply a little thread-lock fluid to the M3 x 16 screws along the entire length of the threads, and fit these through the ballraces and the spacer sleeve; take care that no thread-lock fluid gets into the bearings. Screw the mixer levers to the blade holders in this way, and check that the brass spacer washer is fitted between the inner ballrace and the blade pitch arm. The mixer levers should now rotate freely in their bearings; if necessary lubricate them with silicone oil.



Press the radial bearings 4607.31 and the bearing disc of the thrust bearing 4618.3 into the blade holders as far as they will go, as shown in the illustration.

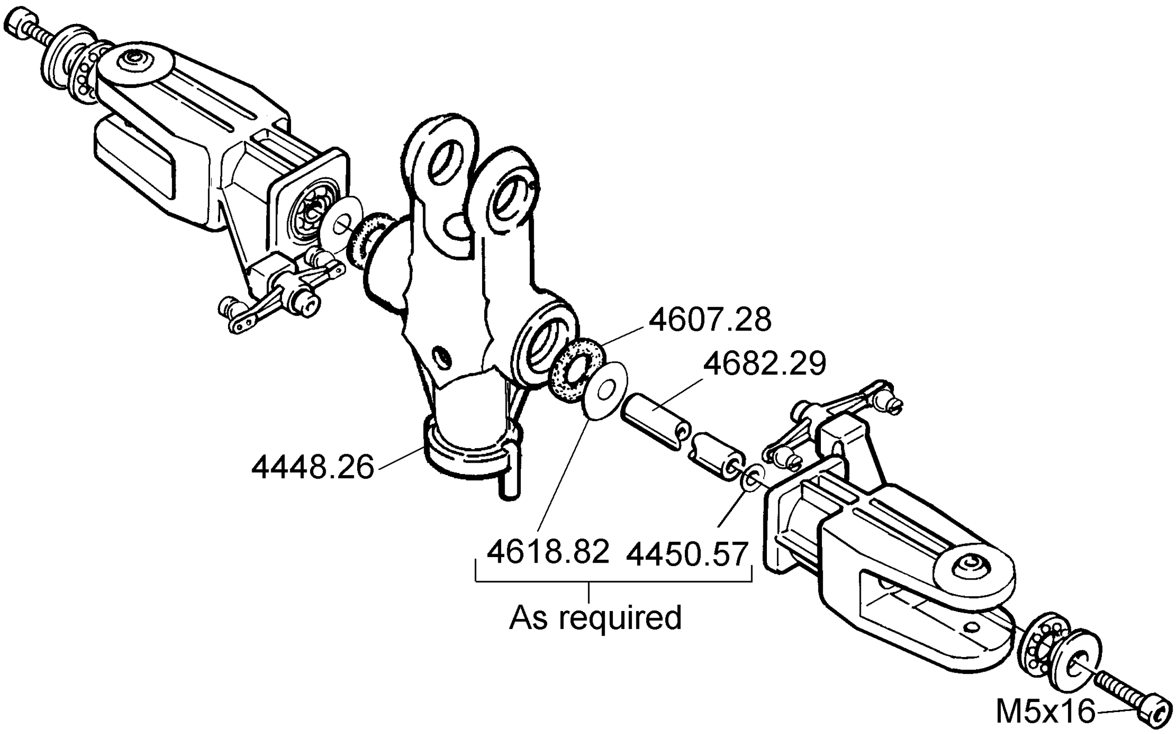


Now check that the bearings 4607.31 in the prepared blade holders are an easy sliding fit on the blade pivot shaft 4682.29. If necessary relieve the blade pivot shaft by rubbing down with fine abrasive paper (600-grit or finer) until the bearings are a smooth sliding fit.

3.2 Installing the blade holders

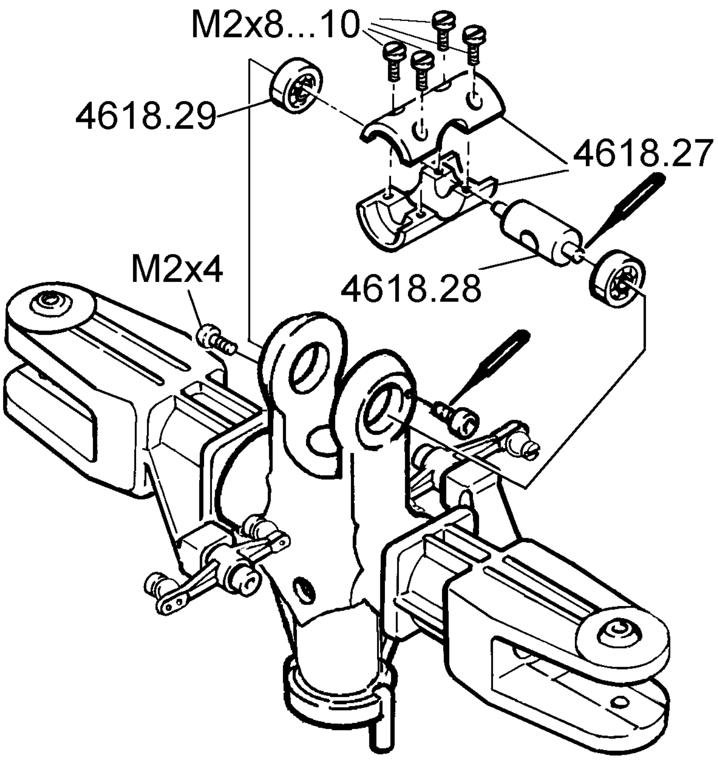
Press the two O-rings 4607.28 into both sides of the rotor head centre piece 4448.26, grease the blade pivot shaft and slide it through. Centre the shaft, so that it projects by an equal amount on both sides, then check that the O-rings are still in place. Fit 0.3 mm shim washers (from 4450.56) on the shaft on both sides of the centre piece, followed by the blade holders, noting that the blade holders must be orientated correctly: the blade pitch arm carrying the mixer lever must be in front of the blade (see illustration). Thoroughly grease the ball cages and thrust washers of the thrust bearings 4618.3, fit them on the shaft and tighten the two M5 x 16 socket-head cap screws.

Check that the blade holders rotate freely, and if necessary tap on the blade holders and the centre piece with a screwdriver handle to encourage the bearings to seat themselves correctly, so that they are not under strain. If the blade holders do not move freely because they are pressing against the centre piece, fit a spacer washer 4450.57 between the thrust washer of one of the two combination bearings and the blade pivot shaft.
Once you are satisfied that the blade holders rotate freely, apply thread-lock fluid to the M5 x 16 socket-head cap screws, and tighten them fully and permanently. If you had to fit a spacer washer 4450.57, take care not to over-tighten the socket-head screw, to avoid deforming the brass washer.

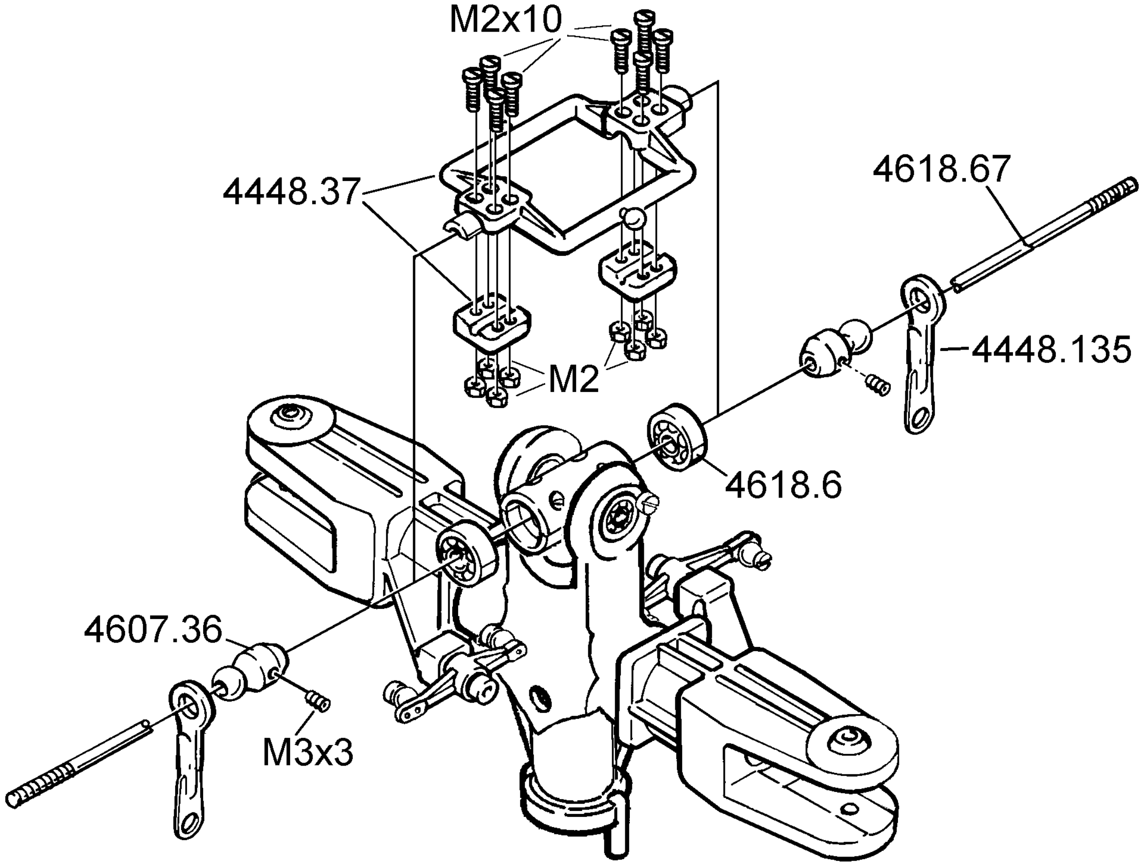


3.3 Assembling the Hiller rotor *(bag U2-10C, U2-10D)*

The rocker 4618.27 is assembled and installed as shown in the illustration. The hole in the pivot rod 4618.28 must line up with the axial bore in the rocker, so that the flybar can be fitted through it later without jamming or binding. Initially the two rocker shells are held together temporarily using four M2 x 8 ... 10 screws („borrowed" from other sub-assemblies); eventually they will be replaced by the longer screws used to retain the rotor brake plate. Secure each of the two ballraces on the outside by fitting an M2 x 4 screw in the centre piece. Check that the rocker rotates freely.
Roughen the flybar with abrasive paper at the points where the control bridge 4448.37 will be clamped. The control bridge is screwed in place, applying thread-lock fluid between the flybar and the control frame; this prevents any danger of the flybar twisting in the control bridge during violent aerobatic manoeuvres.

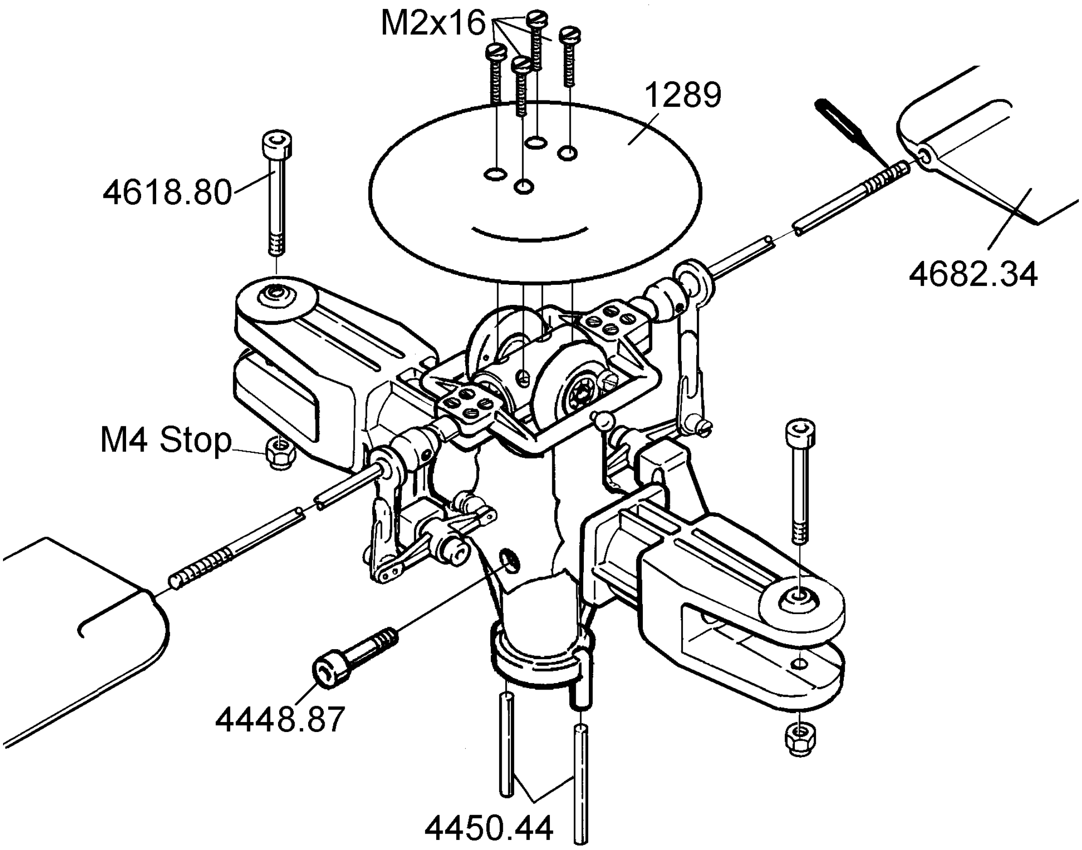


Press the ballraces 4618.6 into both sides of the rocker. Fit the flybar 4718.67 through the rocker and set it exactly central, i.e. it must project by the same amount on both sides of the bearings. Install the control bridge 4448.37 as already described.



Fit the ball collets 4607.36 on both ends of the flybar, and slide them along until they rest against the control bridge. Apply thread-lock fluid to the threaded holes in the ball collets, then fit and tighten the M3 x 3 grubscrews. Press the double ball-links 4448.135 onto the collets.

Apply thread-lock fluid to the sockets in the flybar paddles 4682.34, and screw them onto the ends of the flybar to a depth of exactly 15 mm. Set them exactly parallel to each other and to the control bridge.

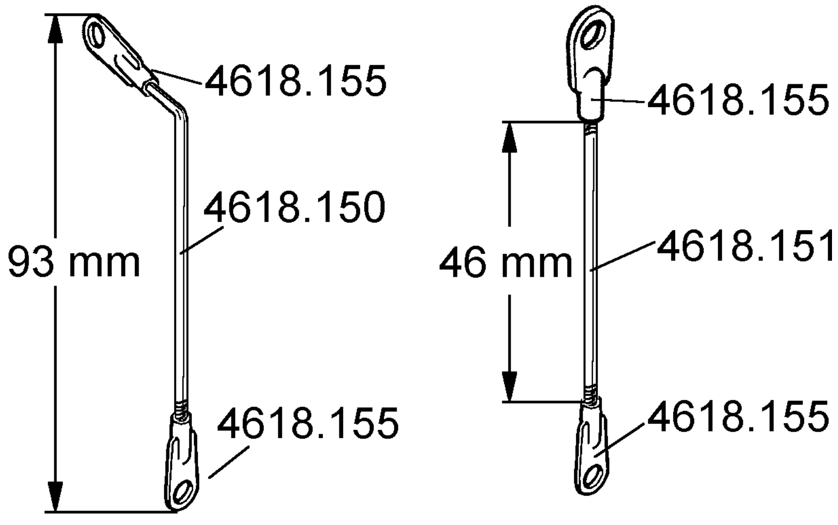


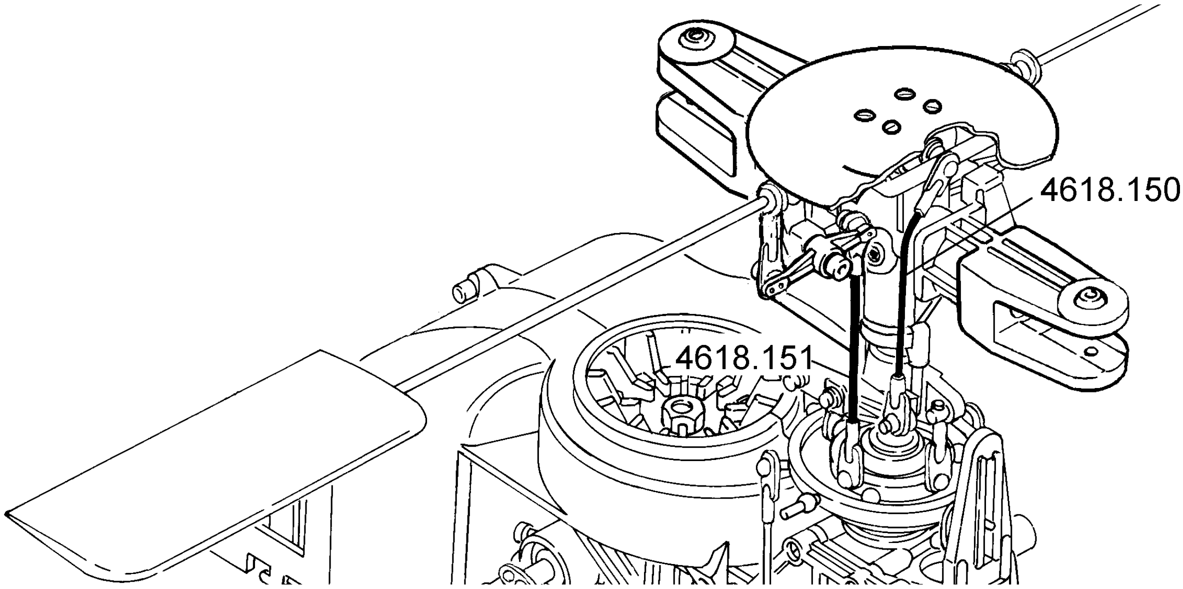
Remove the temporary screws from the top section of the rocker, and fix the rotor brake plate 1289 to the rocker using four M2 x 16 screws.
Apply thread-lock fluid to the two guide pins 4450.44 for the collective pitch compensator, and press them into the rotor head centre piece.

3.4 Installing the main rotor head *(bag U2-10E)*

Place the main rotor head on the main rotor shaft, and line up the hole in the rotor head with the upper cross-hole in the main rotor shaft. Insert the special screw 4448.87 and tighten it to secure the rotor head. The pushrods 4618.150 and 4618.151 are made up and installed as shown in the drawing.

Make up two straight and two angled pushrods as shown in the drawing.





The pushrods 4618.150 now have to be adjusted to obtain the maximum possible collective pitch range. This is the procedure:

Slide the swashplate up as far as it will go (you may have to disconnect the ball-links on the outer ring to make this possible). The swashplate should then rest exactly against the collective pitch compensator when the compensator itself rests against the underside of the main rotor head. If this is not the case, you must adjust the angled pushrods 4618.150 as follows:

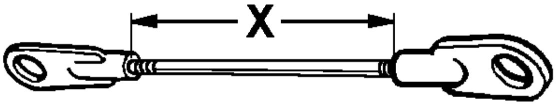
- The swashplate contacts the collective pitch compensator, but there is a gap between the collective pitch compensator and the rotor head there: ➔ shorten both pushrods.

- The collective pitch compensator contacts the rotor head, but there is a gap between the swashplate and the collective pitch compensator: ➔ lengthen both pushrods.

Note that it is essential to adjust both pushrods by the same amount, i.e. they must remain the same length.

The final step is to carry out the fine adjustment of the auxiliary rotor, to ensure that the Hiller paddles are exactly parallel to the swashplate when the swashplate is set horizontal. If you need to make adjustments here, rotate the pushrods 4618.150 in opposite directions by the same amount; don't adjust only one pushrod!

Set the two pushrods between the swashplate and the mixer levers as stated below:



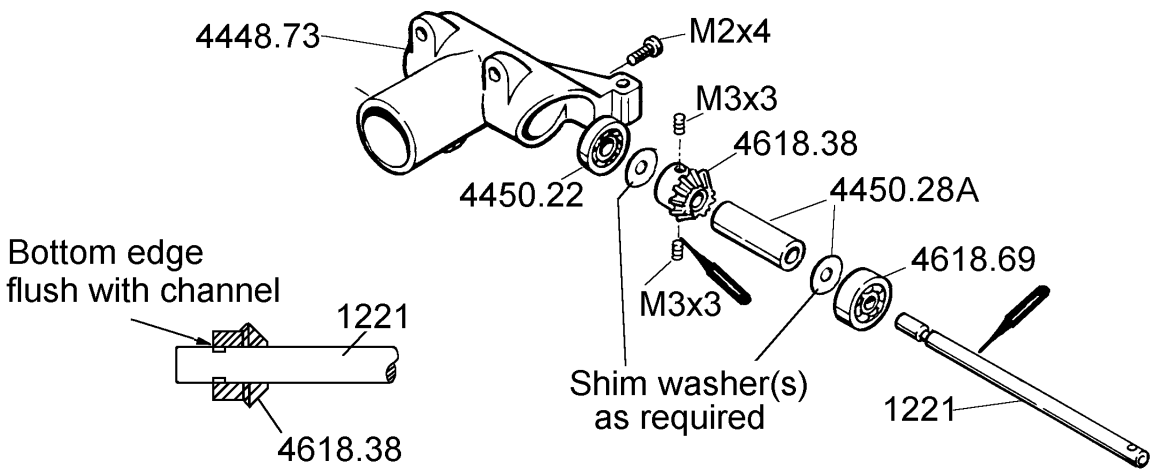
The pitch range of the rotor blades depends amongst other things on the position of the linkage balls to which the double ball-links (between the flybar and the mixer levers on the blade holders) are fitted: fitting the balls in the inner holes sets the standard range, but fitting them in the outer holes expands the collective pitch range by about 4.5°.

When the servos are at centre, you should obtain the following range of blade pitch angles:
(Note: you can fine-tune the collective pitch setting for the hover by making adjustments at the transmitter)

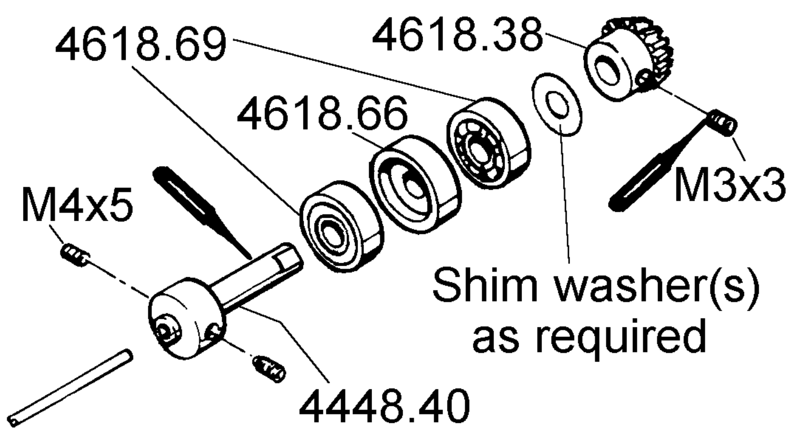
Length „X“	Hover coll. pitch (ball inside)	Hover coll. pitch (ball outside)	Note
43 mm	0°	0°	For „3-D" flying
46 mm	3°	4°	Normal setting, equally suitable for hovering and aerobatics
48 mm	5,5°	7°	Hover at low main rotor rotational speed

4. Assembling the tail rotor gearbox *(bag U2-11, UM-11A)*

Fit the bevel gear 4618.38 on the tail rotor shaft 1221 as shown in the illustration. Apply thread-lock fluid to the threaded holes in the bevel gear, then tighten the M3 x 3 grubscrews fully; note that one of the two grubscrews must engage squarely on the flat section of the tail rotor shaft. Do not tighten the grubscrews to the point where the bevel gear is under strain, as it will then run out of true. Fit the spacer sleeve 4450.28A and the bearings 4618.69 and 4450.22 on the shaft, pushing the parts hard up against each other. Slide this assembly into the tail rotor housing 4618.73 as far as it will go, and secure it with the M2 x 4 retaining screw. Check that there is absolutely zero axial play, and fit 5/10 x 0.1 shim washers if necessary.

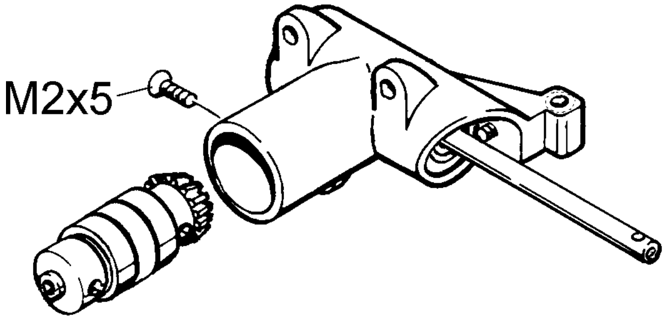


Fit the ballraces 4618.69 and the spacer 4618.66 on the tail rotor input shaft 4448.40 as shown in the illustration. Apply bearing retainer fluid, Order No. 951, before fitting the bearings.
The bearings must not be under stress; if necessary tap on them using a screwdriver handle or similar, so that they automatically seat correctly on the shaft. Allow the bearing retainer fluid to dry.
Fit a 5/10x0.1shim washer and a bevel gear 4618.38 on the tail rotor input shaft 4448.40 as shown in the illustration without using bearing retainer fluid at this stage.
Fit and tighten the M3 x 3 grubscrews in the bevel gear. Note that one of the two grubscrews must engage squarely on the machined flat in the tail rotor input shaft.



Now fit the prepared drive shaft assembly into the tail rotor housing, and line up the hole in the spacer 4618.66 with the hole in the tail rotor housing, then secure it with an M2 x 5 countersunk screw.
Fit a steel rod (screwdriver blade or similar) through the threaded holes in the coupling 4448.40. Using the rod as a handle, pull hard on the coupling (against the countersunk screw joint), so that the tail rotor drive assembly seats itself in the housing with maximum possible gear

meshing clearance between the bevel gears, as if under maximum load. Now check that the tail rotor gearbox runs smoothly, with just detectable meshing clearance in the bevel gears.



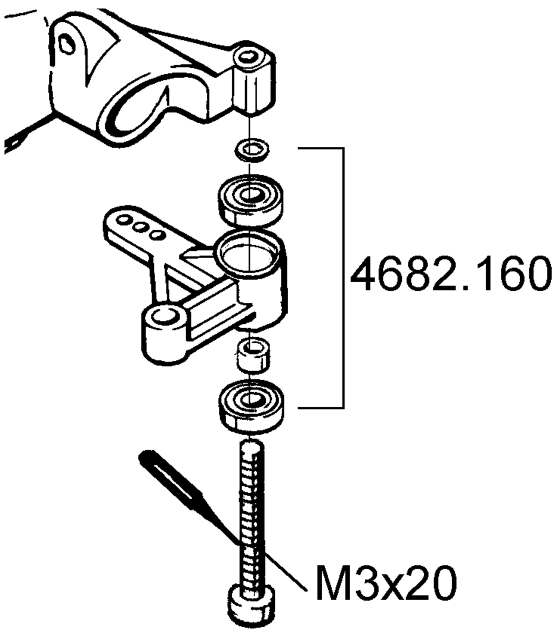
If the play in the gears is too slight, i.e. the gears are stiff to move, you will need to remove the drive assembly again and remove the shim washer under the bevel gear. If, however, there is too much play in the gear meshing insert additional shim washers. If you work carefully, making small adjustments, it is possible to set up the bevel gears so that they work freely but **without** backlash. Reinstall the unit, repeat the pulling procedure as described above, and you should find that the gear meshing clearance is correct.

***Note**: if you still cannot set the gear meshing clearance to your satisfaction, the problem may be that the bevel gear on the tail rotor shaft is located too far outward due to manufacturing tolerances, and is not engaging correctly with the bevel gear on the input shaft. If this is the case, you will find that the tips of the teeth of the bevel gear 4618.41 are already fouling the spacer sleeve 4450.28A, and yet there is backlash in the meshing clearance. In this case you must fit the shim washers between the bevel gear 4618.38 and the bearing 4450.22, instead of between the spacer sleeve and the bearing 4618.69, until the desired slight meshing clearance is present.*

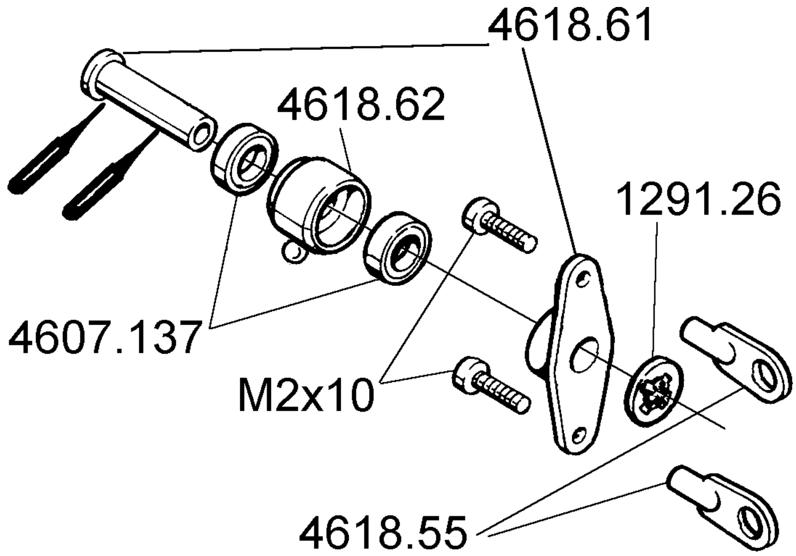
Now remove both assemblies again, apply bearing retainer fluid, Order No. 951, to the bearings, the setscrews, and the bevel gear on the input shaft, re-fit them on the tail rotor shaft and the input shaft, and assemble the parts permanently.

5. Installing the bellcrank and control bridge *(bag U2-11B)*

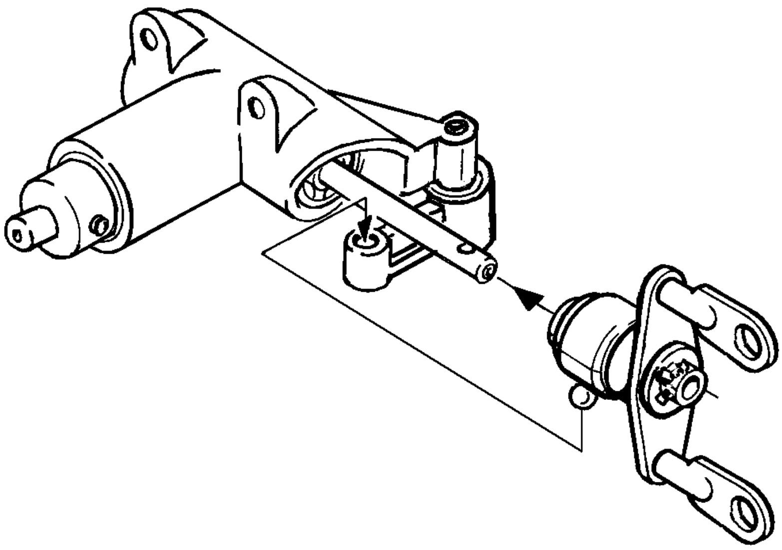
Press the ballraces into the tail rotor bellcrank 4682.160, not forgetting the spacer sleeve, and fit the M3x20 socket cap screw through the bellcrank. Fit the spacer washer on the screw as shown.



Fit the screw, with the bellcrank mounted on it, into the shoulder of the tail rotor housing and screw it in by a few turns, but do not tighten it at this stage since the control bridge must first be fitted as described in the next section.
Press the ballrace 4607.137 into the control ring 4618.62 as far as it will go. Apply a little thread-lock fluid to the assembly (don't let it run between the control ring and the control sleeve!) and push it onto the control sleeve (from 4618.61) until the inner ring of the ballrace rests against the flange of the sleeve.



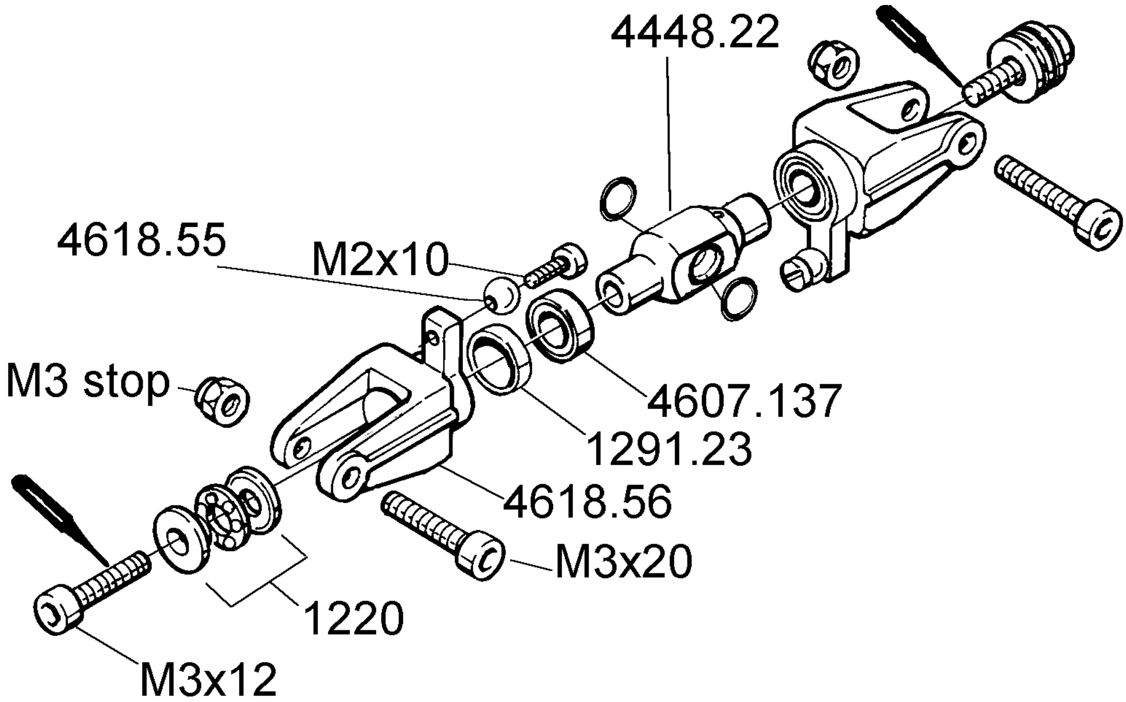
Attach the two ball-links 4618.55 to the control bridge (from 4618.61), then slide it onto the control sleeve and press it against the inner ring of the other ballrace. Press the shakeproof washer 1291.26 onto the control sleeve and up against the control bridge.
Now check that the control ring can revolve freely on the control bridge, but without any hint of axial play. If the ring is stiff to move, then there is probably tension between the two bearings. This can usually be eliminated by tapping them with the handle of a screwdriver.
Fit the control bridge on the tail rotor shaft, then press the bellcrank over the ball on the control ring, and tighten the M3x20 screw.



6. Assembling the tail rotor head *(bag UM-11C)*

Assemble the tail rotor head as shown in the drawing, not forgetting to grease all the bearings. Apply some bearing lock fluid to the Screws M3x12 and tighten them only so far that the bladeholders still rotate smoothly.

Take care not to allow the bearing lock fluid to get into the bearings!

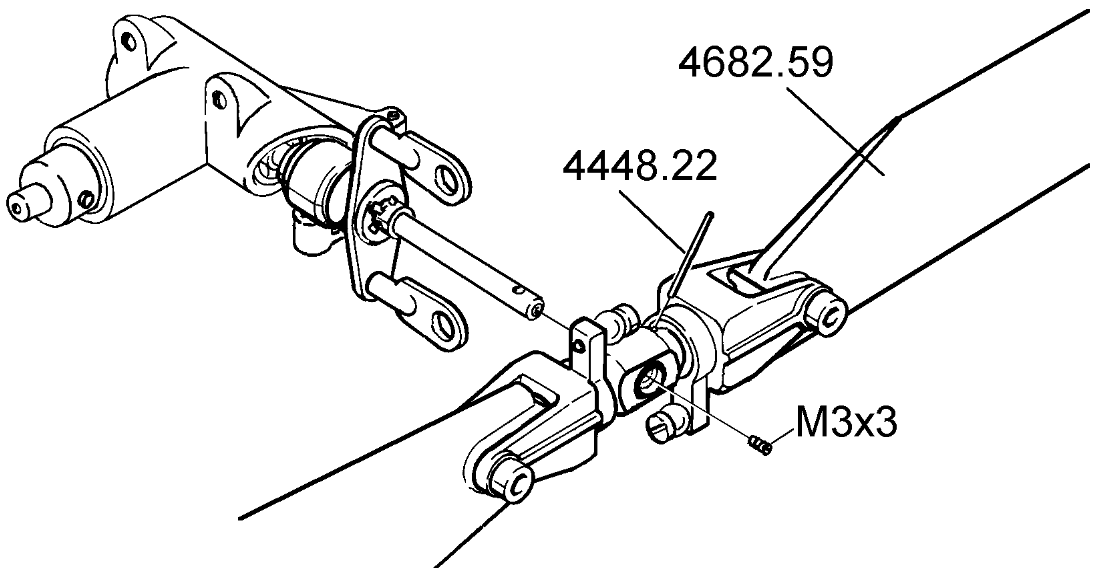


Press the two O-rings into the hub 4448.22 so that they are located fully in the recesses. Oil the O-rings, and slide the tail rotor head onto the tail rotor shaft. The cross-hole in the shaft must line up with the hole in the hub; the pin 4448.22 can then be pushed through to secure the parts. The pin in turn is retained by the M3x3 grubscrew.

Note the orientation of the hub (see illustration).

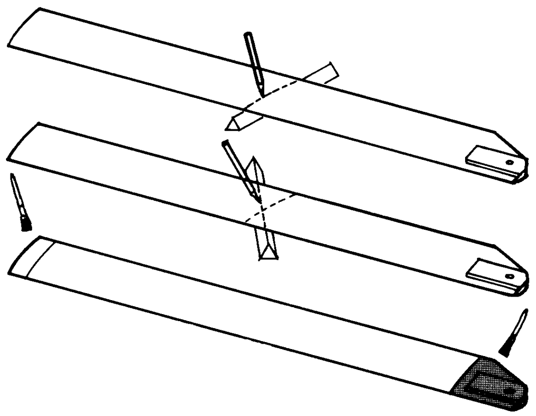
Fit the tail rotor blades in the blade holders using the M3x20 screws. Tighten them to the point where they can swivel quite easily, so that they find their optimum position automatically when the system is operating.

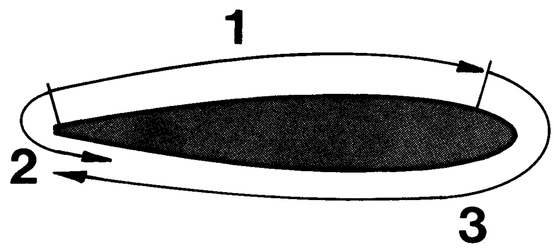
Note the orientation of the tail rotor blades: when viewed from the left-hand side, the tail rotor spins clockwise („bottom blade forward"), and the blade pitch arms on the blade holders must be in front of the blades.



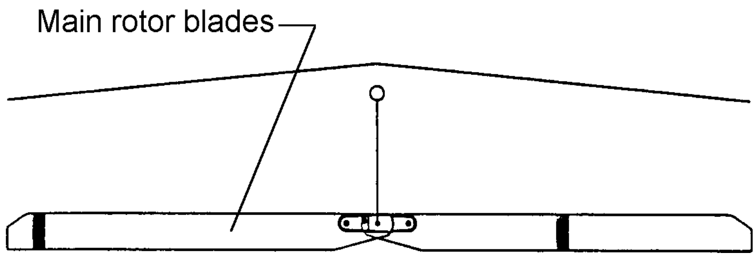
7. Main rotor blades

The UNI-Mechanics 2000 system is designed to be used with high-quality GRP or CFRP main rotor blades, e.g. Order No. 1266. Naturally it is also possible to install simple wooden rotor blades, such as Order No. 74A, but in this case the blades are supplied in kit form, and must be completed following the instructions supplied with them.
Epoxy the blade sleeves supplied with the rotor blades in the holes in the rotor blades, if your blades are not supplied with the sockets already installed.
When the epoxy has set hard sand the whole blade overall using fine glasspaper, Order No. 700.1 or 700.2.
The weight of the two rotor blades must be the same, as must be the CG (balance point) of both blades. The method of checking this is shown in the drawing below. First balance the blades over a triangular pivot, and mark the line of balance twice as shown; the crossing point of the lines is the CG. Apply several coats of GLATTFIX sanding sealer, Order No. 207, at both ends of the blade and sand smooth after each coat. Now correct the CG position if necessary (1.) and carefully equalise the weight of the two blades (2.). Apply colour paint to the doubler region at the root (approx. 70 mm wide) and at the tip (approx. 20 mm wide), using two colours which are easily differentiated. This makes it much easier to check blade tracking later. Apply the film covering as shown in the drawing; first the top surface, then the trailing edge wrap-around, then the underside. Leave about 12 mm of blade uncovered at each tip (same width on each blade!). It is important that the covering should be completely smooth and devoid of wrinkles.





7.1 Balancing the rotor blades



Screw the main rotor blades together as shown and hang them up by a length of thread. Apply adhesive tape to the tip of the lighter blade.
Take your time over the balancing procedure, as properly balanced rotor blades are a basic necessity if the main rotor is to run smoothly, and not vibrate.

8. Installing the mechanics in the fuselage

You can install the mechanics in one of the many separately available fuselages, or complete the model as an open-style trainer. In either case follow the instructions supplied with the fuselage kit.

9. Setting up

9.1 Setting up the cyclic control system

The basic settings of the roll and pitch-axis control systems should already be correct if you have fitted the pushrods exactly as described in these instructions. The pushrod linkage points on the servo output arms are pre-defined, so any servo travel adjustment required must be carried out via the transmitter's electronic adjustment facilities. Please note that servo travel must not be set at too high a value; the swashplate must not foul the main rotor head when the roll and pitch-axis stick is at its end-points, as this would mean that smooth collective pitch control would no longer be possible, since the swashplate could not move any further along the shaft.

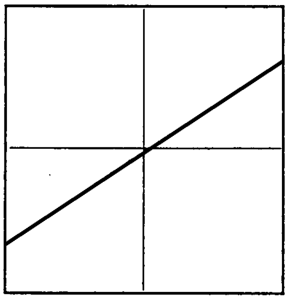
9.2 Main rotor collective pitch settings

The collective pitch values are measured using a rotor blade pitch gauge (not included in the kit). The following table shows good starting points; the optimum values may vary according to the rotor blades you are using and the model itself.

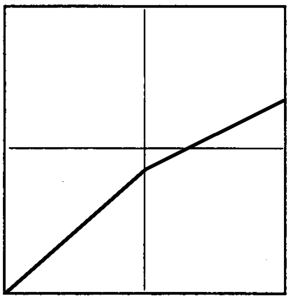
	Minimum	Hover	Maximum
Hovering, practice flying	-2°	5,5°...6°	12°
Aerobatics	-4°	5°... 5,5°	8°... 9°
Auto-rotation	-4°	5,5°	13°

The collective pitch settings are adjusted at the transmitter. This is the procedure:

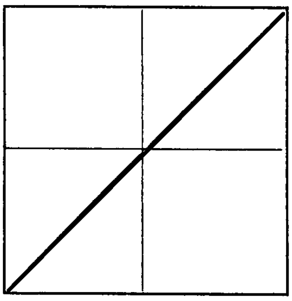
1. Measure the setting for hovering collective pitch and set it correctly;
2. Measure collective pitch maximum and minimum, and adjust the values using the collective pitch adjustment facility on your transmitter, following the diagrams shown below:



Hovering, practice (linear)



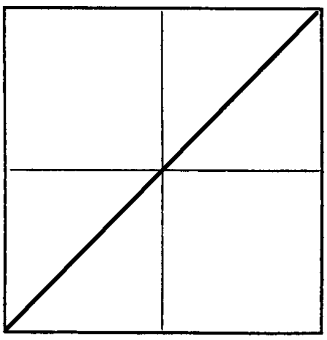
Aerobatics



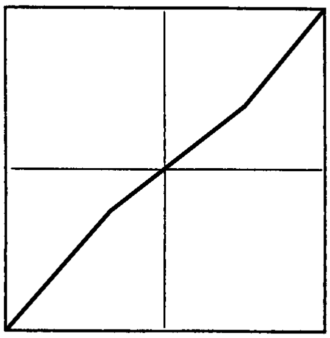
Auto-rotation

9.3 Adjusting the carburettor control system

The following diagrams show two possible carburettor control curves:



linear

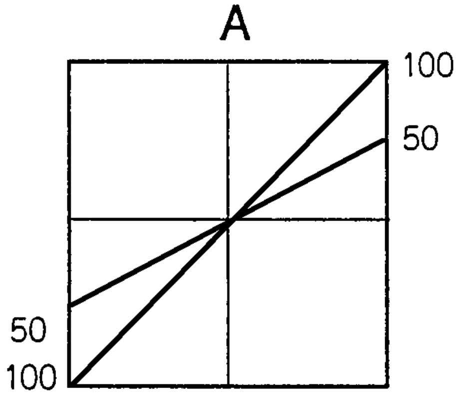


optimised for hovering

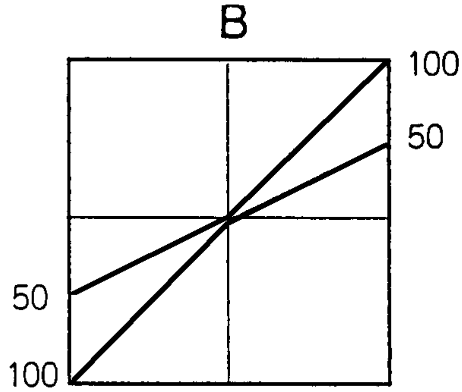
- The hover-optimised throttle curve produces smooth, gentle control response in the hovering range.
- The values stated here vary greatly according to the motor, fuel, silencer etc. you are using. The only means of establishing the ideal settings is to carry out your own series of practical test-flights.

If you have made up all the linkages exactly as described in the previous sections, the following adjustments can all be carried out at the transmitter:

1. **Servo direction**
   Set the „sense“ (direction of rotation) of all servos as stated in the instructions. Check the throttle servo in particular!
2. **Dual Rates**
   You can set switchable travels for roll, pitch-axis and tail rotor. As a starting point we recommend 100% and 75% as the two settings.
3. **Exponential**
   For the basic set-up you should leave all control systems set to „linear“.
4. **Servo travel centre offset**
   Do not make any adjustments to this point. At a later stage you may wish to make minor corrections here.
5. **Servo travel adjustment**
   This is where you can adjust the maximum servo travel. Note that the travels should always be the same on either side of neutral, otherwise you will end up with unwanted differential effects:



Equal set values:
linear control response



Different set values:
differential control response

   For the throttle and swashplate servos (collective pitch function) it is important to check that servo travels are symmetrical, i.e. with the same values for both directions, and that the throttle servo can move the carburettor barrel from the completely closed position (motor stopped) to full throttle, without being mechanically stalled at any point. The collective pitch function of the swashplate servos should produce a range of blade pitch angles covering -5° to +13°, also with symmetrical travels; you may find it necessary to remove the servo output arms, move them round by one spline and fit the retaining screws again.

   The mechanics should now be set up virtually perfectly. When the throttle/collective stick is at centre (hover point), collective pitch should be about 5.5°, and the carburettor barrel should be half-open.
   Note:
   The collective pitch and throttle curves can be adjusted later to meet your exact personal requirements. However, if you have already set differential travels in the basic set-up procedure, as shown in diagram „B“ above, any fine adjustments required subsequently will be much more difficult to get right!
6. **Collective pitch and throttle curves**
   These adjustments are of fundamental importance to the flight performance of any model helicopter. The aim of the procedure is to maintain a constant rotor speed when the model is climbing and descending, i.e. regardless of load. This then represents a stable basis for further fine-tuning, e.g. of the torque compensation system etc. (see also collective pitch and throttle curves).
7. **Static torque compensation**
   The tail rotor servo is coupled to the collective pitch function via a mixer in the transmitter in order to compensate for torque changes when you operate the collective pitch control. On most transmitters the mixer input can be set separately for climb and descent.
   Recommended values for the basic settings are: climb: 35%, descent: 15%.

8. **Gyro adjustment**
   Gyro systems damp out unwanted rotational movements around the vertical (yaw) axis of the model helicopter. They do this by detecting the unwanted motion and injecting a compensatory signal into the tail rotor control system, and in order to achieve this effect the gyro electronics are connected between the tail rotor servo and the receiver. Many gyro systems also allow you to set two different values for gyro effect (gain), and switch between them from the transmitter via a supplementary channel. Some gyros even offer proportional control of the gain setting. The extra channel is controlled via a proportional slider or rotary knob, or a switch, depending on the gyro system.

   If your gyro system features an adjustor box with two rotary pots for two fixed gain settings, and you can switch between them from the transmitter, it is best to set one adjustor approximately to centre (50%), and the other to 25%. If the gyro system provides proportional control between the two set values, then the one pot should be set to „0“, the other to about 80%.

   If you have a gyro system whose gain cannot be adjusted from the transmitter, i.e. there is only a single adjustor on the gyro electronics itself, the pot should be set to 50% gain as a starting point.

   Check that the direction of the gyro’s compensatory action is correct, i.e. that it responds to a movement of the tail boom with a tail rotor response in the opposite direction. If this is not the case, any yaw movement of the model would be amplified by the gyro! Most gyro systems are fitted with a change-over switch which reverses their direction, and this must then be moved to the appropriate position.. However, some systems have no such switch, and in this case the solution is to mount the gyro inverted.

   One factor which all gyro systems have in common is that flight testing is necessary in order to establish the optimum settings, as so many different influences affect the settings.
   The aim of the gyro adjustment process is to achieve as high a level of gyro stabilisation as possible, without the system causing the tail boom to oscillate.

Notes regarding the use of the Graupner/JR „PIEZO 450...5000" piezo gyro system in conjunction with a computer radio control system (e.g. mc-12 ... mc-24)
The advanced design of this gyro system necessitates a different set-up procedure to the one described above. Please keep strictly to this procedure:

1. 1. Set the servo travel for the tail rotor channel to +/-100% at the transmitter.
2. If you have a gyro mixer („Gyro-Control“) which suppresses gyro gain when you operate the tail rotor control, it is essential to disable it permanently.
3. Disconnect the tail rotor pushrod at the tail rotor servo.
4. Operate the tail rotor control at the transmitter; at about 2/3 of full travel in either direction the servo should stop, even when the stick is moved further (travel limiting).
5. Connect the tail rotor pushrod to the servo in such a way that the tail rotor’s mechanical end-points in both directions are the same as the travel set by the travel limiter (servo should be just short of stalling on its mechanical end-stop at this point).
   It is essential to make these adjustments mechanically, i.e. by altering the linkage points and pushrod length. Don’t try to do it electronically using the transmitter’s adjustment facilities!
6. Now correct the tail rotor setting for hovering, i.e. when the collective pitch stick is at centre, using the servo travel centre adjustment facility at the transmitter.
7. Gyro gain can now be adjusted between „0“ and maximum effect via the auxiliary channel only, using a proportional control on the transmitter. If required, maximum gain can be reduced by adjusting the travel of the auxiliary channel or by adjusting the transmitter control. This gives you a useful range of fine adjustment for tailoring gyro response to your requirements.
8. If you find that the tail rotor control system is too responsive for your tastes, adjust it using the exponential control facility; on no account reduce servo travel, as it must be left at +/-100%!

10. Pre-flight checks

When you have completed the model, run through the final checks listed below before carrying out the helicopter's first flight:

- Study the manual once more, and ensure that all the steps of assembly have been carried out correctly.
- Check that all the screws in the ball-links and brackets are tightened fully after you have adjusted gear meshing clearance.
- Can all the servos move freely, without mechanical obstruction at any point? Do they all rotate in the correct direction? Are the servo output arm retaining screws in place and tight?
- Check the direction of effect of the gyro system.
- Ensure that the transmitter and receiver batteries are fully charged. We recommend using a voltage monitor module (e.g. Order No. 3157) to check the state of the receiver battery when you are at the flying field.

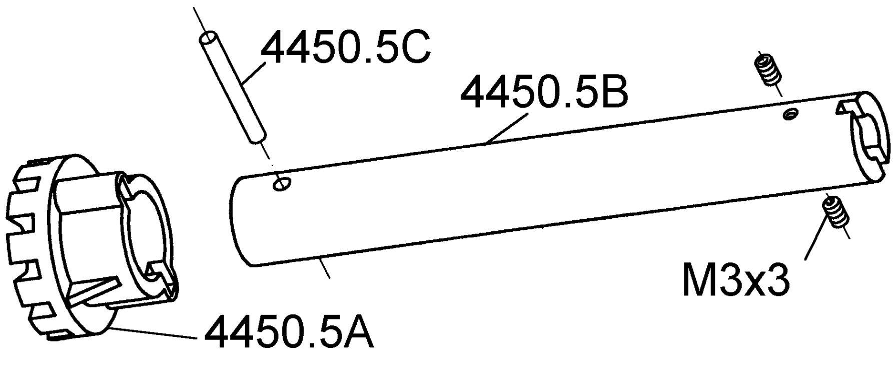
Don't attempt to start the motor and fly the helicopter until you have successfully checked everything as described above.
Bear in mind that the running qualities of your motor will vary widely according to the fuel in use, the glowplug, the height of your flying site above sea level and atmospheric conditions.
Please read the notes on motor set-up which you will find later in this manual.

Maintenance

Helicopters, whether large or small, place considerable demands on maintenance. Whenever you notice vibration in your model, take immediate steps to reduce or eliminate it. Rotating parts, important screwed joints, control linkages and linkage junctions should be checked before every flight. If repairs become necessary, be sure to use original replacement parts exclusively. Never attempt to repair damaged rotor blades; replace them with new ones.

Fitting the starter adaptor

The starter adaptor supplied with the mechanics consists of three parts which have to be fitted to your electric starter as shown in the drawing below. First insert the pin 4450.5C through the extension 4450..5B, then push the plastic adaptor 4450.5A on it, and engage the pin in the channel of the adaptor. To mount the starter adaptor you first have to remove the rubber insert holder from the starter. Push the starter adaptor onto the starter shaft until the cross-pin in the shaft engages in the channel of the adaptor. Tighten the two grubscrews fully to secure the adaptor.
Ensure that the adaptor runs „true", i.e. does not wobble from side to side.



To start the motor rotate the rotor head until the starter adaptor can be engaged in the cooling fan, holding the starter vertical. Please note the following points:

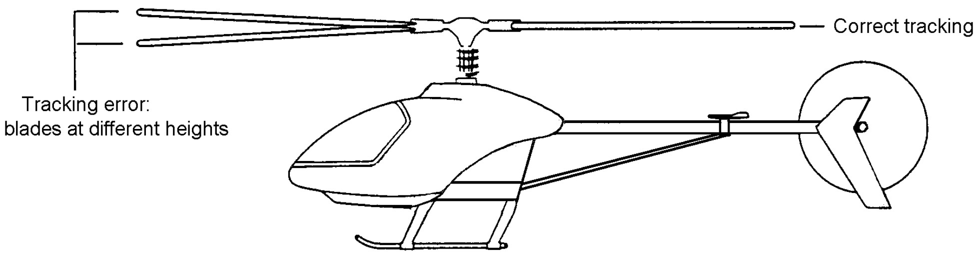
- **Do not switch the starter on until you are sure that the teeth in the cooling fan are correctly engaged with the teeth on the adaptor.**
- **When the motor is running, switch off the starter before withdrawing it.**

11. Adjustments during the first flight

11.1 Blade tracking

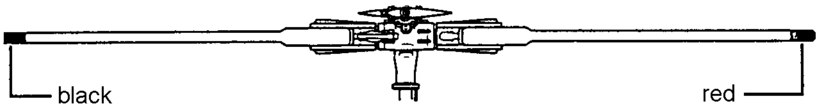
„Blade tracking" refers to the height of the two rotor blades when they are spinning. The adjustment procedure aims at fine-tuning the pitch of the main rotor blades to exactly the same value, so that the blades rotate at the same level.

Incorrectly set blade tracking, with the blades revolving at different heights, will cause the helicopter to vibrate badly in flight.

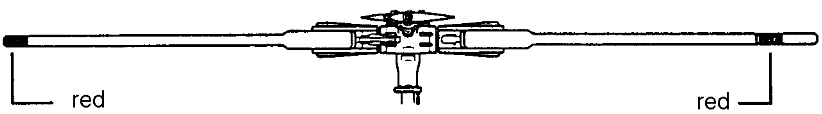


When you are adjusting blade tracking you are exactly in the „firing line" of the blades. In the interests of safety you should keep at least 5 metres away from the model when you are doing this.

You can only check blade tracking if you are able to see clearly which blade is higher and which is lower. The best method is to mark the blades with coloured tape as follows:



A



B

There are two alternative methods: figure „A" shows the use of different colours on the blade tips; fig. „B" shows the use of the same colour, but applied at different distances from the blade tips.

Procedure for adjusting blade tracking

1. Set the helicopter to the point where it is almost lifting off, then sight directly along the rotor plane.

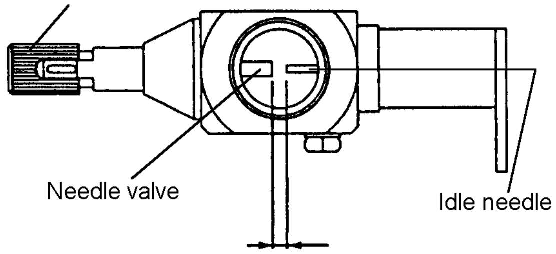
2. If you can see clearly that the rotor blades are running in the same plane, no adjustment is required; however, if one blade is running higher than the other, the settings must be corrected.

3. Locate the pushrods between the swashplate and the mixer levers (4618.150); the adjustment is made at the ball-links on both ends of these pushrods: unscrew the links to raise the blade, screw them in to lower it.

11.2 Adjusting the motor

Please be sure to read the operating instructions supplied with your motor before you start this section.

The correct matching of collective pitch and throttle when the helicopter is hovering is of crucial importance to the model's flying characteristics and performance. For example, if the pitch of the main rotor blades is too high, the motor may not reach the rotational speed intended, and this may cause you to think that the motor is not powerful enough for the job. The fact that the motor will overheat and thereby lose more power tends to reinforce that idea. For this reason first set the hovering collective pitch value exactly as described earlier in these instructions, then match the motor settings to that.
Although most motors nowadays are supplied with the carburettor factory-adjusted to approximately the right settings, final adjustment of the needle valves can only be made under practical test conditions. Most motors now feature twin-needle carburettors, and in this case the starting point for adjusting the idle / mid-range needle is to screw it in to the point where it just dips into the needle valve on the opposite side when the carburettor is half-open.



Typical twin-needle carburettor

For your first attempt at starting the motor open the needle valve 1½ to 2 full turns from closed, connect the glowplug to the plug battery and start the motor by engaging the adaptor on the electric starter in the teeth of the fan and switching the starter on.

Caution: when the motor starts withdraw the electric starter from the fan teeth immediately, otherwise you could damage the model.

When the motor is running, slowly increase throttle/collective pitch. If the fuel mixture is too „rich" and the model fails to lift off, close (screw in) the needle valve in small stages. In order to set the motor correctly for hovering you will need to adjust the idle needle, which also governs the mid-range settings. Note that any adjustment you make here is also influenced by the needle valve setting. Carefully close (screw in) the idle needle until the motor runs smoothly at hover, without any tendency to cut due to an excessively rich mixture. If motor speed is then too low, increase the hover throttle setting at the transmitter. Never attempt to increase the motor speed for hovering by setting the idle needle too lean.
The final needle valve setting can only be made with the model flying under power with „full collective", and for this reason you are bound to start by „feeling your way" slowly to the correct setting.

If in any doubt, always set the mixture on the „rich" side. Initial hovering flights should always be carried out with the motor set distinctly rich.

12. General safety measures

- Take out adequate third-party insurance cover.
- Wherever possible join the local model flying club.

12.1 At the flying site:

- Never fly your model above spectators.
- Do not fly models close to buildings or vehicles.
- Avoid flying over agricultural workers in neighbouring fields.
- Do not fly your model in the vicinity of railway lines, major roads or overhead cables.

12.2 Pre-flight checks, flying safety:

- Before you switch on the transmitter check carefully that no other model flyer is using the same frequency.
- Carry out a range check with your RC system.
- Check that the transmitter and receiver battery are fully charged.
- Whenever the motor is running take particular care that no item of clothing can get caught on the throttle stick.
- Do not let the model fly out of safe visual range.
- There should always be a safe reserve of fuel in the tank. Never keep flying until the fuel runs out.

12.3 Post-flight checks:

- Clean oil residues and dirt from the model and check that all screws etc. are still tight.
- Look for wear and damage to the helicopter, and replace worn parts in good time.
- Ensure that the electronic components such as battery, receiver, gyro etc. are still securely fixed. Remember that rubber bands deteriorate with age and may fail.
- Check the receiver aerial. Conductor fractures inside the flex are often not visible from the outside.
- If the main rotor should touch the ground when spinning, replace the blades. Internal blade damage may not be visible from the outside.
- Never carry the model by the tail boom: too firm a grip can easily deform the tail rotor pushrod.

13. A few basic terms used in model helicopter flying

The term „rotary wing machine" indicates that the helicopter's lift is derived from rotating „wings" which take the form of rotor blades. As a result, a helicopter does not require a minimum forward speed in order to fly, i.e. it can hover.

13.1 Cyclic pitch

Cyclic pitch variation is used to steer the machine around the roll and pitch axes. Changing cyclic pitch has the effect of altering blade pitch depending on its position in the circle. The effect is caused by tilting the swashplate, which then effectively tilts the helicopter in the required direction.

13.2 Collective pitch

Collective pitch provides control over vertical movement, i.e. for climb and descent. The pitch of both rotor blades is altered simultaneously.

13.3 Torque compensation

The spinning rotor produces a torque moment which tends to turn the whole helicopter in the opposite direction. This effect must be accurately neutralised, and that is the purpose of the tail rotor. Tail rotor blade pitch is altered to vary torque compensation. The tail rotor is also used to control the model around the vertical (yaw) axis.

13.4 Hovering

This is the state in which the helicopter flies in a fixed position in the air, without moving in any direction.

13.5 Ground effect

Ground effect is a phenomenon which only occurs when the machine is close to the ground, and it falls off as altitude rises. At an altitude of about 1 - 1.5 times the rotor diameter, ground effect is completely absent. Normally the revolving airflow from the main rotor is able to flow away freely, but in ground effect the air strikes a fixed obstacle (the ground) and forms an „air cushion“. In ground effect a helicopter can lift more weight, but its positional stability is reduced, with the result that it tends to „break away“ unpredictably in any direction.

13.6 Climb

Any excess power above that required for hovering can be exploited to make the helicopter climb. Note that a vertical climb requires more energy than an angled climb, i.e. one which includes forward motion. For this reason a model with a given amount of motor power will climb more rapidly at an angle than vertically.

13.7 Level flight

A helicopter absorbs least power when flying straight and level at about half-power. If you have trimmed the machine carefully for a steady hover, it will tend to turn to one side when flown forward. The reason for this phenomenon is that the rotor blade which is moving forward encounters an increased airflow caused by the wind, and this increases its upthrust compared with the blade which is moving downwind, where the same airflow has to be subtracted. The net result is a lateral inclination of the helicopter.

13.8 Descent

If the helicopter's rotor speed is relatively low and you place the helicopter in a fast vertical descent, the result may be that insufficient air flows through the rotor. This can cause what is known as a „turbulence ring“, i.e. the airflow over the blade airfoil breaks away. The helicopter is then uncontrollable and will usually crash. A high-speed descent is therefore only possible if the helicopter is moving forward, or if the rotor is spinning at high speed. For the same reason care should be exercised when turning the model helicopter downwind after flying into wind.

13.9 Flapping motion of the rotor blades

As we have already seen, the forward-moving blade produces greater upthrust than the other blade. This effect can be minimised by allowing the forward-moving blade to rise and the other blade to fall. The rotor head is fitted with what is known as a flapping hinge to allow this movement, and this prevents the rotor plane tilting excessively in forward flight. In model helicopters a single hinge shared by both blades has proved a good solution to the problem.

13.10 Auto-rotation

This term refers to a helicopter flying without motor power. The rotational speed of the main rotor can be kept high by setting both blades to negative pitch, and the airflow through the rotor as it descends then keeps the blades turning. The rotational energy stored in the rotor by this means can be converted into upthrust when the helicopter is close to the ground, by the pilot applying positive collective pitch. Of course, this can only be done once, and it has to be done at the correct moment. Auto-rotation allows a model helicopter to land safely when the motor fails, just like a full-size machine.

However, auto-rotation places considerable demands on the pilot’s judgement and reflexes; you can only halt the machine’s descent once, and you must not „flare“ too early or too late. Much practice is required to get it right.