Graupner

Assembly instructions

to order No. 79

to order No. 98

for the BELL 222 model copter compact chassis

consisting of:	order No. 79	main drive mechanics
	order No. 98	platen set
	order No. 99	main rotor blades

Also contains:

1. assembly instructions for conversion kit, No. 78, using the MECHANIK group, order No. 80,
   in conjunction with the platen set, order No. 1582
2. assembly instructions for a model copter equiped with a tuned-pipe silencer, order No. 1564,
   with exhaust manifold, order No. 1581,
   and mounting hardware, order No. 1582.

Subject to change!

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Preface

1. The fullsize helicopter

Messrs. Bell Helicopters are going to market their new model BELL 222 copter in the course of 1979.

It will be a medium-sized helicopter equipped with two turbines and seating 8–10 persons. In the course of several years five prototypes have been built and thoroughly tested; the results of these tests will help to optimize the configuration and other technical aspects of the new rotary wing craft.

Technical data

main rotor diam.	12.12 m	= 39′ 9″
length o.a.	14.52 m	= 47′ 8″
max. take-off weight	3470 kg	= 7650 lb.

2. The copter model

The flyable compact chassis is assembled from the following items:

order No. 79	main drive mechanics group
order No. 98	platen set
order No. 99	main rotor blades

Recommended R/C equipment: 8-channel GRAUPNER/GRUNDIG proportional R/C equipment; see main catalog and/or prospectus RCP.

The model may by equipped with any of the power supply- and servo-variants listed below.

1. For normal operating conditions

power supplies: order No. 3427, VARTA 4/1.2 RSH, quick-chargeable, for extended operating time and great reliability,
order No. 3429, VARTA 4/500 RS, quick-chargeable, for shorter operating times,
order No. 3008, VARTA 4/500 DKZ, not quick-chargeable, shorter operating time*,

servos: order No. 3831, VARIOPROP CL servo, 4 requ'd, or
order No. 3888, VARIOPROP CRN servo, 2 requ'd, (same direction of rotation as CL servo) plus
order No. 3831, VARIOPROP CL servo, 2 requ'd.

2. for heavy duty operation (competition work etc.)

power supplies: order No. 3427, VARTA 4/1.2 RSH, quick-chargeable, or
order No. 3429, VARTA 4/500 RS, quick-chargeable, for shorter operating time*

servos: order No. 3839, VARIOPROP servo WP-HD (heavy-duty tape), 2 requ'd, for swashplate control (pitch and roll servos) plus
order No. 3831, VARIOPROP servo CL, 2 requ'd.

When using the MECHANIK group, order No. 80, with auxiliary rotor control, four VARIOPROP CL servos, order No. 3831, and power supply, order No. 3008 (500 mAh, DKZ) may be used.

Design and configuration of the compact chassis ensure complete control of the vehicle at any attitude and allow the pilot to fly it through extreme maneuvers, such as loops, rolls, turns etc. without any problems. This has been made possible mainly by direct rotor blade control and, in conjunction with same, a function-tailored swashplate and an optimized rotor system.

While the compact chassis is perfectly capable of being flown under remote control its visibility is such as to make it rather diffcult to establish its flight attitude correctly even at a short distance. What's more: it is only by the addition of a copter body or fairing that the airframe gets that "realistic" look in addition to improving the low visibility of the craft.

* With a plurality of factors, such as charging condition, temperature, degree of friction in linkages, the pilot's style of controlling his copter etc. affecting operating times, it is impossible to make a binding statement concerning the duration of the latter.

The following options are offered:

a) **BELL Trainer**
A simple, lightweight fairing which is assembled from two parts formed of hi-impact LEXAN plastic; order No. 4603. The contents of set, order No. 75, is required for mounting the Trainer body.

b) This rather basic fairing may be supplemented by a stern section, also formed of LEXAN, order No. 4604.

For the latter the following items will be required:

order No. 1581	exhaust manifold
order No. 1582	mounting hardware for the tuned-pipe silencer
order No. 1564	tuned-pipe silencer

The model may be optionally equipped with a wheel-type undercarriage, order No. 4602/74.

c) **BELL 222**

May be optionally equipped with the semi-scale body BELL 222 order No. 4605 (front section) and order No. 4606 (aft section).

The main body parts are formed of LEXAN. The realistic looks of the semi-scale body equipped copter are enhanced by the wheel-type undercarriage, order No. 4602/74, which can be installed in place of the standard-type skid undercarriage.

A set of mounting hardware, order No. 75, is required for fastening the body.

3. Technical data of the model copter

main rotor diam.	1470 mm	= 57⅞″
length of compact chassis approx.	1146 mm	= 45⅛″
length o.a., incl. rotor	1735 mm	= 68 5/16″
tail rotor diam.	175 mm	= 6⅞″
main rotor gear ratio	9.928 : 1	
tail rotor gear ratio	2.142 : 1	
weight of flyable compact chassis, depending on R/C gear installed, about	4200 g	= 9 lb. 7 oz.

main gearbox oilsump; needs neither lubrication nor maintenance.

powerplant: HB 61 PDP STAMO glo engine, 9.97 cc displ.; special version sporting a radial-type cooling fan.

General information:

For model aircraft, the weight of which exceeds 5 kg at take-off, special regulations are applicable. A permission, issued by the national aviation authority, is required for take-offs and landings of model aircraft the take-off weight of which exceeds 5 kg.

The major points of the legal aspects of the operation of model aircraft are presented in the brochure "Luftrecht für Modellflieger" written by Berthold Petersen, order No. 8032/79, published by Johannes Graupner, D-7312 Kirchheim/Teck, W. Germany. Your local hobby shop probably has a copy on hand for your information.

4. General remarks re. kits: order No. 79 MECHANIK order No. 98 platen set

Prominent feature of MECHANIK is its direct main rotor control which does away with the earlier, Hiller-type of control and reacts much faster, without the time-lag associated with the afore-mentioned type of control. The main rotor blades, order No. 99, are foldably attached to the rotor head, enabling them to be folded back for ease of transport. The powerful powerplant has been equipped with a special heat-sink cylinder head and a cooling fan; the new silencer is very efficient, without affecting engine output noticeably. The carburettor ensures a correct air/fuel mixture over the entire speed range and is quite uncritical as regards adjustments.

The compact chassis of the model copter is assembled from the **platen set** which builds into a self-supporting, bolted-together aluminum basic airframe. Profusely pre-fabbed parts drastically cut down the time required for its assembly. Main drive unit and R/C gear (not included in the platen set) are readily accessible for adjustments and maintenance. In fact the ease with which the units may be serviced is one of the advantages offered by the compact chassis.

The parts of this set are the joining members to the various mechanical elements. The compact chassis also comprises the bearing and mounting parts as well as the linkages required for R/C installation.

A mechanical mixer which – on operation of the throttle – governs tail rotor torque compensation is also provided. The all-metal skid-type undercarriage is simply bolted together and attached to the compact chassis using vibration-dampening elements.

A special stunt tank which is simply press-fitted into a side part is included.

This set was designed to fit the main drive mechanical parts set order No. 79 and the rotor blades of order No. 99.

But it may also be employed in conjunction with the MECHANIK set order No. 80 of the BELL 212 TWIN JET helicopter. In the latter case a conversion kit order No. 78 will be required, as well as main rotor blades order No. 82 and 82/10, respectively, which have to be shortened by approx. 65 mm = 2 9/16". In addition a tail rotor gear box order No. 79/31 and tail rotor blades order No. 79/4 will be required.

Be sure to note that the tail rotor gearbox of MECHANIK order No. 80 of the BELL 212 TWIN JET model copter may not be used here.

5. Contents of the kit

The list of parts is your guide. Several illustrations may deviate slightly from the list.

5.1. Order No. 79 MECHANIK

Fig. No.	Order No.	Designation
3	79/1	main drive aggregate with STAMO, clutch and main rotor gear box
4	79/2	swashplate with main rotor shaft
5	79/3	tailrotor gear box with blade connectors
4	79/355	pitch lever
2 5	79/4	2 tailrotor blades
6	79/5	main rotor head with central piece and blade holder
	79/6	bag of accessories
	79/7	bag of accessories "D"
	1588	silencer
	1643/1	fuel tube

Assembly group 79/11 main drive components

Part. No.	Designation	Quantity	Remarks
80/4	gear plate	1	plastic
80/55	clamping plate	2	
301	Inbus screw	2	M3×25 (1/8×1) } assembled
005	STOP nut	2	M3 (1/8) } assembled
022	toothed disc	2	steel 3.2 (1/8)
302	Inbus screw	2	M3×8 (1/8×5/16)
80/6/7	gear platen	2	aluminum } assembled
	threaded bush	4	brass } assembled
302	Inbus screw	8	M3×8 (1/8×5/16)
022	toothed disc	8	steel 3.2 (1/8) diam.
80/99	lower rotor shaft bearing	1	plastic } assembled
303	bearing		steel } assembled
80/5	spacer tube	1	aluminum 12 diam. × 1 (15/32×3/64)
351	blind plug	1	aluminum 10 (25/64) diam.
304	cylinder bolt	4	M3.5×12 (9/64×15/32)
305	toothed disc	4	steel

Assembly group: 79/12 intermediate bearing with clutch bell

Part. No.	Designation	Quantity	Remarks
80/3	intermediate bearing, cpl.	1	} assembled
506	ball bearing	2	} assembled
80/13	intermediate shaft with pinion	1	assembled
80/11	shaft coupling	1	} assembled
014	grub screw M3×4 (1/8×5/32)	8	} assembled
80/17	pitch bearing block	1	
80/2	pressing roller	1	cpl.
80/18	shoulder bolt	1	SW 10
302	Inbus screw	5	M3×8 (1/8×5/16)
022	toothed disc	4	DIN 6797
80/14	cylinder bolt	1	M4×20 (5/32×51/64)
80/19	springwasher	1	DIN 137
503	nut	1	M4 (5/32), DIN 934
80/16	nut	1	M6 (1/4), DIN 934
87/38	clutch bell	1	cpl., incl. hub
005	STOP nut	1	M3 (1/8)
016	Inbus screw	1	M3×18 (1/8×23/32)

Assembly group 79/13 STAMO model copter type

Part. No.	Designation	Quantity	Remarks
1533/6	crankcase	1	
1531/7	bearing housing	1	
1590	heat sink cylinder head	1	
1547/17	cylinder liner	1	chrome-plated, steel
1545/19	piston	1	
1545/18	piston ring	1	
1545/10	gudgeon pin	1	
1545/54	safety ring	2	
1545/9	conrod	1	
1545/5	crankshaft	1	
1531/12	cover gasket	2	
1545/13	Inbus screw	14	6-32 UNC
1525/16	grub screw	2	10-32 NF
1531/21	ball bearing, front	1	
1531/22	ball bearing, aft	1	

Assembly group: 1584, carburettor for STAMO

Part. No.	Designation	Quantity	Remarks
1	carburettor body	1	
2	idle stop	3-parts	
3	return spring	1	
4	barrel	1	
5	actuating lever	1	
6	main jet needle	1	cpl
7	low-speed needle	1	
8	needle valve assembly	1	
9	low-speed insert	1	
12	O-ring	1	
10	nut	1	5×.5 (13/64×.020)
11	ratchet spring	1	
007	cylinder head bolt	1	M2×8 (5/64×5/16)
002	nut	1	M2 (5/64) DIN 934
024	ball joint	1	

Assembly group: 1545/4 cooling fan for STAMO

Part. No.	Designation	Quantity	Remarks
1545/45-0	fan housing		
516	self-tapping screw	4	2.2×9.5 (3/32×3/8), DIN 7971
1545/44-0	cover platen	1	
1545/41	driving plate with shaft	1	
1545/8-0	aft cover	1	} assembled
506	ball bearing	2	} assembled
1545/40	driving bolt	1	
1545/43	fan wheel with hub	1	} assembled
306	Inbus screw	2	M3×10 (1/8×13/32) } assembled

Assembly group: 1545/65 flywheel with clutch

Part. No.	Designation	Quantity	Remarks
1532/27	flywheel	1	cpl.
80/40	crankshaft nut	1	cpl., with bearing
80/39	clutch shoe	2	assembled with spring
1525/2	disc	1	
87/5	V-belt	1	
1588	special silencer	1	

Assembly group: 79/2 swashplate with main rotor shaft

Part. No.	Designation	Quantity	Remarks
352	main rotor shaft with bush	1	
353	pitch actuating lever	1	assembled, with bearing
80/21	bearing bush	1	diam. 5×1 (13/64×3/64), brass
016	Inbus screw	1	M3×18 (1/8×23/32)
005	STOP nut	1	M3 (1/8)
354	sliding block	1	plastic
80/10	upper rotor shaft bearing	1 }	assembled
303	ball bearing	1 }	
532	Inbus screw	1	M3×12 (1/8×15/32)
359	swash plate	1	basic unit
357	driving pin	2	steel
358	driver	1	plastic
	washer	2	diam. 7 (9/32) steel assembled
005	STOP nut	1	M3 (1/8)
301	Inbus screw	1	M3×25 (1/8×63/64)
022	toothed disc	6	steel
356	ball-headed pin	4	steel
306	Inbus screw	5	M3×10 (1/8×13/32), steel
324	washer	5	diam. 3.2 (1/8) steel
005	STOP nut	4	M3 (1/8)
360	stopper	1	plastic
037	threaded bush	1	aluminum
655	rod	2	diam. 2.5 (3/32) steel
521	hexagonal nut	4	M2.5 (3/32) steel
656/3	link bracket	4	M2.5 (3/32) aluminum } assembled
656/1	wire ring	4	steel }
79/355	pitch lever	1	aluminum

Assembly group: 79/3 tailrotor gearbox and blade roots

Part. No.	Designation	Quantity	Remarks
79/31-0	tailrotor gearbox	1	cpl. assembled
234	shaft driver	1	steel
235	grub screw	1	steel
382	bladeholder with arm	2	cpl. set, plastic
	ditto, without arm	2	
80/42	blade connecting hub	1	brass
363	pitch actuating bridge	1	assembled with bearing
519	cylinder bolt	12	M2×10 (5/64×13/32) steel
002	hex. nut	10	M2 (5/64) steel
016	Inbus screw	2	M3×18 (1/8×23/32) steel
005	STOP nut	2	
014	grub screw	3	M3×4 (1/8×5/32), steel
025/1	ball bearing	2	
025	ball bearing	2	
383	spacer disc	2	brass
520	washer	6	steel
3499/20	pivoted part, cpl.	2	M2 (5/64) assembled
365	journal bearing shaft	1	steel
518	washer	1	steel
319	safety disc	1	diam. 3.2 (1/8), steel
522	Inbus screw	2	M3×16 (1/8×41/64), steel
79/4	tailrotor blade	2	plastic

Assembly group: 79/5 rotor head with central piece and bladeholder

Part. No.	Designation	Quantity	Remarks
366	rotor head platen	2	
501	hex. bolt	10	M3×25 (1/8×63/64), steel
005	STOP nut	10	M3 (1/8)
309	threaded rod	2	25 (63/64) lg.
669/3	joint bracket	4	M2 (5/64) } assembled
656/1	wire ring	4	steel } assembled
002	hex. nut	4	steel
80/34	central piece	1	plastic
80/31	seesaw hub	1	plastic
80/55	clamping plate	1	threaded
80/56	clamping part	1	unthreaded
80/54	dowel pin	2	diam. 4 (5/32), steel
302	Inbus screw	1	M3×8 (1/8×5/16), steel
301	Inbus screw	3	M3×25 (1/8×63/64), steel
022	toothed disc	5	diam. 3.2 (1/8), steel
005	STOP nut	2	M3 (1/8)
367	spacer sleeve	1	diam. 5×1 (13/64×3/64), brass
523	hex. nut	1	M3 (1/8), steel
80/27	actuating slider	1	plastic
368	slider shaft	1	plastic
80/33	shoulder bolt	2	steel
369	mixer lever, short	2	with link ball
316	nut	2	M5 (13/64), steel
317	toothed disc	2	diam. 5.3 (7/32), steel
370	bolt extension	2	SW), aluminum
371	ball-headed pin	2	SW 5.5, steel
373	rotor blade coupling	2	cpl. assembled
374	disc	2	steel
312	ball bearing	2	
506	ball bearing	2	
313	thrust bearing	2	
375	blade bearing	2	aluminum
376	actuating lever	2	steel
377	locking nut	2	SW 10, steel
314	dowel pin	2	diam. 2×10 (5/64×13/32), steel
378	rotor blade bush	2	diam. 6×1 (1/4×3/64), brass
510	hex. bolt	2	M4×35 (5/32×1 3/8), steel
518	washer	M	.4 (1/64), steel
512	STOP nut	2	m% (5/32)
379	damper	2	diam. 8×15 (5/16×19/32), rubber
380	damper housing, cpl.	2	bushes, assembled
530	Inbus screw	2	M4×16 (5/32×41/64), steel
381	damping disc	2	diam. 8 (5/16), aluminum
503	nut	2	M4 (5/32), steel

Accessory bag 79/6

Part. No.	Designation	Quantity	Remarks
	Inbus key	1	SW 2.5, steel
105	Inbus key	1	SW 1.5, steel
382	pitch gauge	1	plastic, grey
356	ball-pointed pin	2	SW 5.5, steel
1531/24	silencer mounting hardware	2	steel
1659	fuel filter	1	

Accessory bag 79/7 'D'

Part. No.	Designation	Quantity	Remarks
021	self-tapping screw	4	2.2×13 (3/32×33/64), steel, nickel-plated
315	washer	4	steel
1643/1	fuel tube	1	500 (20) lg.

Assembly group: 98/11 platen – fuselage front section

Part. No.	Designation	Quantity	Remarks
400	upper longitudinal beam	2	aluminum
401	lower longitudinal beam	2	aluminum
402	servo base plate	1	aluminum
403	main rotor bulkhead	1	aluminum
404	tailboom bulkhead	1	aluminum
405	undercarriage support	2	plastic
037	threaded bush	8	aluminum
406	tailboom flange	1	plastic
452	V-belt protective cover	1	plastic

Assembly group: 98/12 front section mounting hardware

Part. No.	Designation	Quantity	Remarks
302	Inbus screw	16	M3×18 (1/8×23/32), steel
005	STOP nut	23	M3 (1/8)
306	Inbus screw	12	M3×10 (1/8×13/32), steel
503	nut	4	M4 (5/32), steel
518	washer	24	diam. 4.3 (11/64), steel
320	hex. bolt	10	M4×12 (5/32×15/32), steel
512	STOP nut	10	M4 (5/32)
524	washer	46	diam. 3.2 (1/8), steel
527	self-tapping screw	8	2.2×6.5 (3/32×1/4), steel
708	clip	2	plastic
409	rubber, sectional	1	200 (8) lg.
315	washer	3	diam. 2.7 (7/64), steel
459	silicone tube	1	diam. 4×1 (5/32×3/64), 100 (4) lg.

Assembly group: 98/21 and 98/22, tailboom with shaft bearing and shaft

Part. No.	Designation	Quantity	Remarks
98/21	tailboom	1	assembled
98/22	drive shaft mounting	1	
4600/3	drive shaft	1	diam. 1.2 (3/64), steel wire

Assembly group: 98/23 set of tail parts

Part. No.	Designation	Quantity	Remarks
415	tail strut	2	assembled
416	vertical tail	1	plastic
419	tailskid wire	1	diam. 3 (1/8), steel
418	tail clamp with threaded insert	2	
419	tail support with threaded insert	1	
420	tail flange	1	aluminum

Assembly group: 98/24 tail mounting hardware

Part. No.	Designation	Quantity	Remarks
708	clamp	3	plastic
527	self-tapping screw	6	2.2×6.5 (3/32×1/4), steel
520	washer	6	diam. 2.2 (3/43), steel
524	washer	18	diam. 3.2 (1/8), steel
510	hex. bolt	1	M4×35 (5/32×1 3/8), steel
518	washer	2	M 4.3 (11/64), steel
532	Inbus screw	18	M3×12 (1/8×15/32), steel
512	STOP nut	1	M4 (5/32)
005	STOP nut	4	M3 (1/8)

Assembly group: 98/25 horizontal tail

Part. No.	Designation	Quantity	Remarks
421	set of half-sheels	1	plastic
503	nut	4	M4 (5/32), steel
422	threaded rod	2	diam. 5 (13/64), aluminum
518	washer	2	diam. 4.3 (11/64), steel
423	airfoil-shaped fin	2	plastic
424	damping surface	2	plastic
532	Inbus screw	2	M3×12 (1/8×15/32), steel
524	washer	6	diam. 3.2 (1/8), steel
005	STOP nut	2	M3 (1/8)
317	toothed disc	2	J 5.3, steel

Assembly group: 98/3, skid-type undercarriage

Part. No.	Designation	Quantity	Remarks
430	tubular skid	2	diam. 12×1 (15/32×3/64), aluminum
431	strut	2	aluminum
432	clamp	4	steel
4600/179	vibration-dampening element	4	diam. 15×15 (19/32×19/32), rubber/steel
533	Inbus screw	4	M4×8 (5/32×5/16), steel
518	washer	5	diam. 4.3 (11/64), steel
013	hex. bolt	8	M3×10 (1/8×13/32), steel
005	STOP nut	8	M3 (1/8)
433	V-belt suspension	1	plastic
503	nut	1	M4 (5/32), steel
502	hex. bolt	1	M4×16 (5/32×5/8), steel

Assembly group: 98/4 throttle/tail mixer

Part. No.	Designation	Quantity	Remarks
435	mixer lever	1	plastic
436	adjusting arm	1	plastic/brass
524	washer	3	diam. 3.2 (1/8), steel
437	lower receptacle	1	SW 8, aluminum
438	spacer	1	SW 5.5, aluminum
501	hex. bolt	2	M3×25 (1/8×63/64), steel
005	STOP nut	3	M3 (1/8)
462	brace	1	aluminum
302	Inbus screw	1	M3×8 (1/8×5/16), steel

Assembly group: 98/5 and 98/52, servo installation with hook-up hardware and servo bracket parts

Part. No.	Designation	Quantity	Remarks
98/51	guide tube for tail controls	1	aluminum/plastic
510/.8	tail control linkage	1	diam. .8 (1/32), steelwire
445	servo bracket "roll"	1	plastic
446	servo bracket "pitch"	1	plastic
019	lenticular head bolt	8	M2.6×44 (7/64×1 3/4), steel
013	nut	20	M2.6 (7/64), aluminum
306	Inbus screw	2	M3×10 (1/8×13/32), steel
324	hex. bolt	8	M2.6×15 (7/64×19/32), aluminum
005	STOP nut	2	M3 (1/8)
524	washer	4	diam. 3.2 (1/8), steel
018	lent. head bolt	4	M2.6×33 (7/64×1 5/16), steel
50/25	elastic	4	diam. 25×5×1 (1×13/64×3/64)
701/3	foam plastic sheet	1	3 (1/8) thick
1004/1.4	iron wire, zinc-plated	1	diam. 1.4 (1/16)
1625/2	rubber tube	1	diam. 5/3 (13/64 OD 1/8 ID) 50 (2) lg.
453	switch panel	1	plastic

Assembly group: 98/53 linkage components

Part. No.	Designation	Quantity	Remarks
3499/20	articulated joint with ball	7	assembled
699/3	joint bracket	2	aluminum } assembled
656/1	wire ring	2	steel } assembled
145	bellcrank with bushing	2	plastic
3548	clevis	10	steel, nickel-plated
3602	threaded bushing	5	M2 (5/64), steel, nickel-plated
3522	threaded rod	4	M2 (5/64), steel
259	threaded rod	1	M2, 55 lg (5/64×2 3/16), steel
309	threaded rod	1	M2, 25 lg (5/64×63/64), steel
325	threaded rod	2	M2, 35 lg (5/64×1 1/8), steel

Assembly group: 98/54 mounting hardware

Part. No.	Designation	Quantity	Remarks
524	washer	5	diam. 3.2 (1/8), steel
005	STOP nut	2	M3 (1/8)
519	cylinder bolt	5	M2×10 (5/64×13/32), steel
520	washer	13	diam. 2.2 (3/32), steel
002	hex. nut	24	M2 (5/64), steel
330	cylinder bolt	1	M2×15 (5/64×19/32), steel
522	hex. bolt	2	M3×16 (1/8×41/64), steel
3513/3	rubber grommet	1	
360	stopper	1	plastic
037	threaded bushing	1	aluminum
708	clamp	2	plastic
516	self-tapping screw	2	2.2×9.5 (5/64×3/8), steel
529	Inbus screw	1	M3×10 (1/8×13/32), steel
381	dampening disc	2	aluminum

5.2. Assembly set, order No. 98 platen set

Fig. No.	Order No.	Designation
7	98/11	fuselage front section, platens
8	98/12	fuselage front section mounting hardware
9	98/21	tailboom with } assembled
9	98/22	drive shaft bearing } assembled
9	4600/3	tailrotor drive shaft
10	98/23	set of tail parts
11	98/24	tail mounting hardware
12	98/25	horizontal tail
13	98/3	skid-type undercarriage
14	98/4	mechanical mixer throttle/tailrotor
	98/51	guide tube for tail rotor control with steelwire order No. 519/.8
15	98/52	servo bracket parts
16	98/53	linkages, clevises and bellcrank
17	98/54	mounting hardware
	264	fuel tank

5/3 Assembly set: order No. 99 main rotor blades

Material	Quantity	Designation
beech/balsa	2	main rotor blade with balancing weight insert
beech	2	doubler, right
beech	2	doubler, left
plastic	2	film patterns for covering the rotor blades

6. Assembly

6.1 Very important hints

Be sure to follow instructions listed below strictly:

6.1.1. Only by building your model exactly as per these building instructions will success be ensured.

6.1.2. Careless building, faulty assembly, deviations and modifications may result in serious, perhaps fatal injuries to pilot and spectators. Remember: the tips of the rotor blades travel at speeds of some 400 km/h = 250 m.p.h. and the centrifugal forces acting on the blade holders at the rotor head build up to 1600 N (= 160 kg) or, in plain language, to the weight of two adult persons!

6.1.3. Do not, repeat NOT, use damaged, bent or straightened parts.

6.1.4. Do use original spare parts, bolts and screw of specified quality and dimensions and original rotor blades only – under any circumstances!

6.1.5. Follow maintenance instructions for the copter exactly.

6.1.6. Safety all bolted and screwed connections indicated in the building instructions by application of LOP bolt-safetying varnish order No. 966.

6.1.7. Linkages etc. must be soldered with extreme care.

6.1.8. It is urgently recommended that the aluminum parts (656/3), (669/3) and (3499/20) be safetied by springs, order No. 3589.

6.2. Pre-assembly of components

6.2.1.

Fasten the V-belt protective cover (452) ex 98/11 to the servo base plate (402) ex bag 98/11. This is achieved by inserting 3 self-tapping screws (527) ex 98/12 from the underside. Then a suitable lenght of foam plastic ex bag 98/52 is cut off aft of the V-belt protective cover to serve as support for the servo; cement foam plastic to base plate (420). Two VARIOPROP CL servos, order No. 3831, are then fastened using two lenticular head bolts (018) and nuts (013), ex bag 98/52, each for fastening a servo; the foam plastic is compressed firmly in the process. Bolts and nuts are safetied with LOP varnish.

In case the power supply, order No. 3429, or power supply, order No. 3008, has been selected for installation, fasten the battery in question by installing in the four foremost holes provided for the purpose two clamps (708) with two bolts (527) each, which are taken out of bag 98/12. This step is illustrated by fig. 18.

6.2.2.

Fasten the tailboom flange (406) to the tailboom bulkhead (404) ex 98/11 by four Inbus screws M3 × 10 (306), 4 washers (524) and 4 STOP nuts (605). Be sure to position part (406) in such a manner that the lateral hole faces to the right, viewed in the direction of flight (see fig. 19).

6.2.3.

If the MECHANIK, order No. 80, of the BELL 212 TWIN JET model copter is used, refer to chapter 11.5.

Take main rotor bulkhead (403) out of bag 98/11, and the upper rotor shaft bearing (8ß/10) out of the main drive Mechanics group, order No. 79. Out of bag 79/23 of the main drive mechanics take stopper (360), five Inbus screws M3 × 10 (306), 5 washers (524) and four STOP nuts M3 (005). Put main rotor bearing (80/10) and stopper (360) onto main rotor bulkhead (403). Do not tighten the bolts yet (see fig. 20).

6.2.4.

When using two VARIOPROP WP-HD servos, remove their outputs and ream the holes of the latter to 2 mm = 5/64" diam. Take out of bag 98/53 two articulated joints M2 (3499/20) with balls, two threaded rods (3522) and out of bag 98/54 two nuts M2 (002). Screw one nut M2 (002) onto each of the threaded rods (3522). Then screw rods, complete with nuts, into parts 3499/20, all the way home; secure in place by contra nuts.

Pass two cylinder bolts M2 × 10 (519), taken out of bag 98/54, through the balls of the two articulated joints. Also remove from bag 98/54 four nuts M2 (002) and 2 washers (520). Fasten them to servo outputs as per diagram 21.

6.2.5.

Fasten the pitch servo bracket (446) of bag 98/52 by four hex. bolts M2.6 × 15 (324) and nuts M2.6 (013) to one of the upper longitudinal beams (400) ex bag 98/11. Fasten the roll servo bracket (445) – also ex bag 98/52 – by two Inbus screws M3 × 10 (306), four washers (524) and two STOP nuts M3 (005), too. See fig. 22.

When using MECHANIK, order No. 80, see chapter 11.5.4.

The VARIOPROP WP-HD servos are fastened to the servo brackets by four lenticular head bolts (019) and four nuts M2.6 (013) each, taken out of bag 98/52. In order to reduce vibrations a suitable length of foamplastic sheet is sandwiched between servo and bracket. Put on the servo outputs with linkage as per fig. 23.1. and screw them fast.

Servos CL (3831) and CRN (3838), respectively, if used are also fastened in the manner described above. In this case the linkage is connected via a single clevis (3548) ex 98/53 per servo. Refer to fig. 23.2.

6.2.6.

Bolt the throttle/tail pitch mixer (98/4) to the second upper longitudinal beam (400) ex bag 98/11, using hex. nut M3 × 25 (501), washer (524) and hex nut (005), as per fig. 24; do not tighten nut yet. Watch for brace (462).

6.2.7.

Take one bellcrank (415) out of bag 98/53, ream holes of one of the shanks (the **right** one!) as per fig. 25.

Install an articulated joint M2 with ball (3499/20) ex 98/53 into the innermost hole of the bellcrank by a cylinder bolt M2 × 10 (519), nut M2 (002) and washer (520) es bag 98/54, as per fig. 26.

A nut M2 (002) es 98/54 is screwed onto the threaded rod (259) ex bag 98/53. The assembly is then screwed into the articulated joint M2 (3499/20), all the way home; safety by contra nut.

The thusly prepared bellcrank is then fastened at the front end of the upper longitudinal beam using a hex bolt M3 × 16 (522), 2 washers (524) and STOP nut M3 (005) ex bag 98/54.

Modify and ream a second bushed bellcrank (145) ex bag 98/53.

Screw one nut M2 (002) ex 98/54 onto threaded bushing (3602) ex bag 98/53. Then screw assembly into an articulated joint M2 (3499/20) all the way home; safety by contra nut.

Screw one nut M2 (002) onto threaded rod (3522), screw assembly into an articulated joint M2 (3499/20) all the way home, safety by contra nut.

The two thusly prepared joints are then screwed fast at the bellcrank as shown by fig. 28. The hardware required is taken out of bag 98/54.

The bellcrank with the joints and threaded rod and threaded bushing, respectively, is fastened at the aft end of the upper longitudinal beam by a hex. bolt M3 × 16 (522), two washers (524) and STOP nut M3 (005), as per fig. 29.

The following diagram, fig. 30, indicates the ensuring steps of installing the linkage and mounting the joints at the throttle/tail rotor mixer. The required parts are taken out of bags 98/53 and 98/54. Fig. 31 provides additional information. Make sure that the threaded rod (3522) with threaded bushing (3602) are soldered at the throttle/tail rotor mixer with the levers arranged parallel to eachother.

A linkage must be engaged at the forward bellcrankl as per fig. 31 and fig. 32.

6.3. Installation of the prepared platen parts

6.3.1.

Bolt the two upper longitudinal beams to the inner faces of the bent-up shanks of the servo base plate (402) – servo assembly, in the position shown by fig. 33, using three Inbus screws M3 × (302), six washers (524) and three STOP nuts (005) each, taken out of bag 98/12.

The aluminum bracket of the mixer is fastened onto the base plate (402) by bolt M3 × 8 (302) ans STOP nut M3 (005). Hex. bolt (501) may now be tightened, too.

6.3.2.

Engage the clevises of the linkages in the servos mounted on the servo base plate.

6.3.3.

The motor/pitch servo linkage layout is identical to the one proposed for the transmitter stick allocation in paragraph 6.15.6.: full throttle (climb by pulling the stick back). He who prefers things in reverse order, that is full throttle (climb) by pushing the stick forward, must arrange the linkage to suit. Two options are proposed for the latter case:

1. move the collective pitch linkage at the long throttle/tail mixer arm to the opposite side of the lever. The linkage connected to the engine must be bent to suit in this case so it won't contact the V-belt protective cover; a short clevis, such as order No. 3509, should preferably be used. The linkage may be fashioned from order No.3522.
2. another alternative is replacing the VARIOPROP CL servo, order No.3831, by a VARIOPROP CR servo, order No.3834, which sports an opposite direction of rotation. Linkage hook-up can be achieved via two articulated joints order No.3582, screwed together one atop the other, with the lower attach point used for the engine, the upper one for the throttle/tail rotor mixer.

6.4. Installation of the power plant

6.4.1.

Remove the large plastic cog wheel of the pre-assembled main drive aggregate with combustion engine STAMO (79/1), after prior removal of the pressing roller.

Remove the aluminum shaft of the large plastic cog wheel. The shaft is no longer required, unlike the aluminum tube (80/5) slipped onto the shaft. Be sure to retain that tube for a later phase of the installation.

6.4.2.

Place the platens bolted together so far onto the gearbox platens (80/6/7). Insert one hex. bolt M4 × 12 (320), two washers (518) and one STOP nut (512) ex bag 98/12 into each of the four forward holes at the engine; assemble asnd tighten lightly. Fasten the two lower longitudinal beams (401) ex bag 98/11 to the gearbox platens of the powerplant, using 3 hex. bolts M4 × (320), six washers (518) and 3 STOP nuts M4 (512) for each of them. The STOP nuts M4 must rest on the upper longitudinal beam. Do not tighten nuts firmly, just lightly; see fig. 34.

6.4.3.

The tailboom bulkhead (404) is fastened inside the upper longitudinal beam by four INBUS screws M3 × — (302), with a washer at either side of the sheet metal parts and by four STOP nuts M3 (005). Here again the nuts are only screwed on, but not yet tightened. See fig. 36.

6.5. Assembly of the undercarriage chassis

6.5.1.

Take four vibration-dampening rubber elements (4600/179) out of bag 98/3, two plastic undercarriage struts (405) out of bag 98/11. Install two of the rubber elements into each of the undercarriage struts, fastening the nuts M4 (503) and washers (518) ex bag 98/12. Insert threaaded bushes (037) into the recesses provided in the chassis (with the countersunk section of the threads facing outward); see fig. 35.

6.5.2.

The assembled undercarriage chassis is attached to the fore and aft ends of the lower longitudinal beams by four INBUS screws M3 × 10 (306) and four washers (524). Tighten screws firmly.

Then tighten all other bolted connections at powerplant and tailboom bulkhead firmly (fig. 36).

6.6. Installation of main rotor bulkhead and rotor shaft

6.6.1.

Bolt pre-assembled main rotor bulkhead (403) to the upper longitudinal beams by six Inbus screws M3 × 8 (302), 12 washers (524) and 6 STOP nuts M3 (005).

6.6.2.

The main rotor shaft (79/21/352) is slipped through the two shaft bearings. The upper rotor shaft bearing is then trued up in such a manner as to permit the shaft to rotate freely and to be slideable axially. The top rotor shaft bearings (80/10) is then fastened in that position, using four screws. Then remove the main rotor shaft again.

6.7. Tailboom installation

6.7.1.

The vertical tail is assembled from the following parts: fin (416) ex bag 98/23, 2 tail clamps with threaded insert (418) and six Inbus screwsd M› × 12 (532), — washers (524) and two STOP nuts M› (005) ex bag 98/24, as per fig. 39. If the vertical tail is to be painted use ALKYFIX, ACRYLFIX or UNIVERSAL varnishes only (your choice of colours).

6.7.2.

The tailskid wire (417) ex bag 98/23 is bent as per fig. 38 and fastened, using two clamps (708) and four self-tapping screws 2.2 × 6.5 (527) ex 98/24; see fig. 39.

6.7.3.

Press tailboom (98/21) into the clamps attached to the fin, with the tenons of the clamps engaged in the holes of the tailboom tube. The tail flange (420) ex bag 98/23 is fastened to the two tail shells by four Inbus screws M3 × 12 (532) and four washers (524); see fig. 40.

6.7.4.

The tail brace with threaded insert (419) and two tail struts (415) are taken out of bag 98/23. Fasten the struts to the brace by two Inbus screws M3 × 12 (532) and two washers (524). Slip tailbrace onto tailboom tube until the tenon of the brace engages the hole in the tailboom tube. Then clamp parts together by hex. bolt M4 × 35 (510), STOP nut M4 (512) and washers (518). See fig. 21. Do not tighten nut yet!

6.7.5.

Of the tailrotor gearbox (79/3) with mounted tail rotor shaft and coupling, the rotor shaft is slipped into the shaft guide tube from the side of the vertical tailsurfaces. The tail rotor gearbox is attached to the tail flange by four self-tapping screws M2.2 × 13 (021) and four washers (315) ex accessory bag "D" of the powerplant; see fig. 42.

6.7.6.

Slip the tailboom tube, complete with tail rotor gearbox, vertical tail and struts into the tail flange, all the way home against the stop, then trim length of the tail rotor shaft to suit coupling sleeve (80/11) on the bevel gear (80/13) of the powerplant. The shaft must be free to be inserted some 18 mm = 23⁄32" into the sleeve, that is up to the shoulder. Pull tailboom out again until the shaft, cut to proper lenght, can be slipped into the coupling sleeve.

The tailgroup is now trued up at proper right angles, with fin set up perfectly vertically.

Prior to screwing the tail shaft fast in sleeve (80/11) make sure that

a) the tailboom has been pushed into the flange all the way home against the stop,

b) the tail rotor shaft has been mounted in such a manner that its bent rear end is provided with ample slop in either direction in the shaft driver (234).

Bolt the tailrotor tube to the tailboom flange by a self-tapping screw 2.2 × 6.5 (527). Fasten the two tail struts (415) to the main rotor bulkhead (403) by two Inbus screws M3 × 12 (532) and four washers (524); see fig. 43. Tailbrace (419) is bolted to the tube.

6.8. Installation of the main rotor shaft

6.8.1.

Install main rotor shaft (352) from the powerplant (under-) side in such a manner that the shaft end featuring the two transverse holes faces the powerplant.

6.8.2.

Slip on aluminum spacer tube (80/5).

Attention!
The spacer tube must be installed under any circumstances; without that spacer tube the copter won't be fit to work!

6.8.3.

Slip the large cog wheel (80/4) onto the main rotor shaft.

6.8.4.

Screw the central Inbus screws M3 × 8 of the clamp lugs into the large cogwheel. The central screws must penetrate into the transverse holes of the main rotor shaft.

6.8.5.

Tighten outer screws at the clamp lugs firmly. Torque is transmitted by the large cogwheel firmly clamped to the rotor shaft.

Attention

The plastic material of the large cogwheel (80/4) is resilient and flexible. For that reason the screws must be checked and tightened firmly after each flying session. The two central screws do more than merely fix the axial position of the cogwheel relative to the rotor shaft; they actually serve as an additional safety measure against slippage between rotor shaft and cog wheel when the assembly is subjected to high torque. These screws, if not assisted by the outer screws when transmitting torque, will deform the holes in the rotor shaft! (The ridges resulting from such deformation make removal of the motor shaft from the large cog wheel impossible.

6.8.6.

Pressing shaft (80/2) is slipped into the 4 mm = 5/32" bore of the intermediate shaft bearing housing (80/3). The ball bearing pressing against the large cog wheel and the bearing housing should be 4 mm = 5/32" spaced apart. (see fig. 44).

6.8.7.

Clamp pressing shaft fast by Inbus screw M3 × 8 (302).

6.8.8.

Check operation of gearbox; must rotate freely. Very little lateral backflash between teeth should exist between the large cog wheel (80/4) and the bevel gear pinion (80/13) on the intermediate shaft. If the adjusting screw M4 × 20, with contra nut M4 (80/14) in the slot, has not been adjusted one way or the other, backlash should be just right. If it is not – either too little or too much backflash – find cause. The following faults may occur:

main rotor shaft not properly trued-up as per instructions (refer to chapter on fitting the main rotor shaft, 6,6,2.),

spacer tube has been omitted,

adjusting screw M4 × 20 (80/14) with contra nut (503) at intermediate bearing set wrongly.

6.9. Installation of pitch controlling linkage

6.9.1.

Loosen contra nut M6 (80/16) under aluminum abutment (80/17) on the intermediate shaft bearing housing.

6.9.2.

Remove the shoulder bolt (80/18) and the spring washer (80/19) from the abutment (80/17).

6.9.3.

Install the pitch rod (353) into the main rotor shaft (352) from the side of the power plant. Remove the M3 × 18 Inbus screw with STOP nut and brass tube (80/21) and sliding block (354) from the bearing end of the pitch rod.

6.9.4.

Put the pitch rod (355) with sliding block (354) into the slot of the bearing head of the pitch rod in the oval opening.

6.9.5.

Install the brass tube (80/21) – with Inbus screw M3 × 18 put through – into the bearing head. The STOP nut on the Inbus screw should be tightened moderately only.

Attention!

The pitch lever (355) must be perfectly straight (see fig. 45). Do not, repeat NOT, bend that lever trying to obtain a stress-free, centric position of the pitch rod in the rotor shaft. A bent lever may give way in flight on operation of the collective main rotor pitch control, destroying the ball bearing in the head of the pitch rod (353) in the process, with dire results.

6.10. Mounting the skid-type undercarriage

6.10.1

Fasten the two bow-legged undercarriage struts (431) atop the vibration-dampening rubber elements (4600/179) by four Inbus screws M4 × 8 (533) and four washers (518).

6.10.2.

Mount tubular skids (430) with two clamps (432) by two hex. bolts M3 × 10 (013) and two STOP nuts M3 (005) on either side. Tighten bolt connections firmly.

6.10.3.

V-belt suspension (433) ex bag 98/3 is attached at the center of the forward bow-legged U.C. strut by hex. bolt M4 × 16 (502), washer (518) and nut M4 (503). See fig. 46.

6.11. Installation of horizontal tailsurfaces

6.11.1.

All parts required are contained in bag 98/25. Screw a nut M4 (503) onto the short threaded section of the two threaded rods (422). Install the rods with nuts into half-shells (421).

6.11.2.

Attach the two half-shells to the tailboom in such a manner tha the one sporting the longer neck is positioned on the right sid viewed in the direction of flight. The distance between th center of flange (421) to the rear edge of the tailboom bulkhea (404) should be 506 mm = 19.59/64". Fasten by two Inbus screws M3 × 12 (532), four washers (524) and two STOP nuts Me (005), with the rods in level position (horizontal).

6.11.3.

Onto the two threaded rods slip a toothed disc, followed by one airfoiled stab section (432), using the central opening of the latter; add a fin (424) on either side. Bolt assembly together by washer (518) and nut M4 (503) screwed onto the rod, see fig. 47.

6.12. Installation of the tailrotor pitch control guide tube

6.12.1.

A clamp (708) is fastened to the flat side of stopper (360) ex bag 98/54 by two self-tapping screws (516) and two washers (520); do not tighten screws firmly yet.

6.12.2.

Slip a rubber grommet (3513/3) into the slot of the tailboom bulkhead (404). Guide tube 98/51 of the tailrotor pitch control is first passed through the rubber grommet (3513/3) and finaly clamp (708), so it stands 5 mm = 13/64" proud of the latter, as shown by fig. 49.

6.12.3.

Attach a clamp (708) to the vertical tail with installed guide tube, using two self-tapping screws 2.2 × 6.5 (527).

6.12.4.

Solder .8 mm (1/32") diam. steelwire (519/.8) to a clevis (3548) ex bag 98/53, after bending the wire over; see fig. 48.

6.12.5.

Thread the steelwire, prepared in this manner, into the guide tube from the front. Attach the clevis in the lowest hole of the throttle/tail rotor mixer. True up clamp and guide tube on the stopper (360).

6.12.6.

After tightening the clamp, bolt the stopper to the upper longitudinal beam by cylinder head bolt M3 × 10 (529) and washer (524), see fig. 49.

6.12.7.

Take one clevis (3548), one threaded bush (3602) and one nut M2 (002) out of bag 98/53, assemble them, fasten to inner hole of the bellcrank of the tail rotor gearbox. In a later phase the steelwire will have to be trimmed to proper length and soldered into the threaded bush.

6.13. Mounting the tailrotor blades

Install tailrotor blades (79/4) into bladeholders of the tailrotor gearbox. Tighten screws moderately only, so the tailrotor blades remain movable (see fig. 50).

6.14. Swashplate installation

Be sure to follow instructions for the installation of this item provided with the BELL 212 TWIN JET kit, if the drive mechanics and the rotor head, order No. 78 of the kit are used. For further installation hints in conjunction with conversion kit order No.78 refer to chapter 11.

6.14.1.

The pre-assembled swashplate (359) is slipped onto the main rotor shaft (352) all the way home against the stopper at the upper main rotor shaft bearing. Install driving pin, mounted at the outer circumference of the swashplate into the slot of stopper (360).

6.14.2.

True up stopper (360) with the hex. section of the driving pin, with the two parts spaced 1 mm = 3/64" apart, and screw the stopper fast.

6.14.3.

Check swashplate operation; must be able to move freely in either direction.

6.14.4.

Shift driver (358) on rotor shaft against stopper of swashplate, engage the inner driving pin in doing so.

6.14.5.

Provisionally fasten driver by Inbus screws M3 × 25 (301), two washers and STOP nuts M3; do not tighten connection yet.

6.14.6.

Take two joint brackets M2 (699/3) without ball out of bag 98/53 and screw them onto threaded bush (3602) and nut M2 (002), both ex 98/54.

6.14.7.

The joint brackets M2 prepared in this manner are slipped onto the ball-headed pins of the swashplate. The threaded rods are trimmed to proper length and soldered later in the course of adjusments to be made; see fig. 51.

6.14.8.

Install a threaded rod (3522) with a clevis (3548) attached at one end and a contra nut M2 ex bag 98/53 into the pitch lever. The threaded rod will be trimmed to proper length later in the course of adjustments still to be performed.

6.15. Installation of R/C equipment

6.15.1.

Mount receiver and receiver power supply on suitable pieces of foam plastic ex bag 98/52 for vibration-dampening. Glue at least two layers of foam plastic under the power supplies. The power supply is installed in front of the V-belt protective cover, the receiver of the MICROMODUL or compact series aft of same; see fig. 53.

6.15.2.

Fashion S-shaped hooks from 1.4 mm = 1/16" diam. wire ex bag 98/52, which are required for attaching elastics.

6.15.3.

If a receiver supply, order No. 3427, is used, it must be secured in place by two elastics which are engaged in S-hooks which in turn are fastened in the engine throttle recess of base plate (402) and the left upper longitudinal beam (400). Power supply order No. 3429, as well as power supply order No.3008 are secured by two elastics which are fastened via S-hooks in the plastic clamps mentioned in chapter 6.2.1.

6.15.4.

Installation of the switch.

Start by attaching the switch panel (453) with bolts and nuts (013), as per fig. 53, after screwing the switch to its panel (453) with the self-tapping screws supplied. If the compact-chassis is to be faired by a body, the switch may be

a) attached to the body proper, a method which simplifies charging the airborne battery off an external source,
b) equipped with a suitable linkage which is exited through the wall of the body, such as the transverse switch extension, order No. 66.

6.15.5.

The antenna cable of the receiver is routed from the latter to the bow-legged U.C. strut, where it is fastened on the left side. When routing the cable through the compact chassis and – possibly * the body, the hole(s) should be padded by a small length of rubber tube (ex 98/52) to protect the cable. At the receiver end the antenna should be tension-relieved; this is easily achieved by knotting a short length of rubber tube into the cable. The antenna may then be run rather loosely from the front to the aft undercarriage strut, from where it may be left dangling downward. The freely dangling end must not be overly long to prevent it from getting in the way of the rotor disc. It may also not get into contact with any other rotating part of the model. Under any circumstances the antenna must not be routed parallel to metal parts for longer distances.

6.15.6.

Proposed transmitter control stick allocation.

6.15.7.

Hook up the servos to the receiver in the same manner. The receiver, too, should be thoroughly embedded in foam plastic and secured in place by elastics and S-hooks.

6.15.8.

Check servo operation, travel and centering with properly centered trim position of the transmitter, control stick allocation and coordination.

6.15.9.

Route all cables in such a manner that they cannot touch rotating or moving parts and/or rub against metal parts.

6.16. Preliminary linkage adjustments

6.16.1.

With transmitter trim in neutral position check all servos for proper centering; adjust servo center position, if necessary (refer to operating instructions for R/C gear in question).

6.16.2.

Adjust position of swashplate; must be parallel to main rotor bulkhead (403); keep parallel to the latter throughout all ensuring steps and adjustments.

6.16.3.

Trim rods connecting servos and swashplate to proper lenghts.

6.16.4.

Slip threaded bushings onto rods and solder them well. Be sure to keep swashplate and main rotor bulkhead (403) parallel to eachother and to leave sufficient length of threaded section available at the threaded bushing, so micro adjustments can be performed in either direction.

6.16.5.

Shift throttle servo to idle (low-speed) position. To this end both the control stick and the trim of the transmitter must be shifted to the low-speed position. Then the plastic body of the ball-joint at the carburettor is screwed onto the lever operating the throttle linkage thereby closing the throttle insert in the carburettor fully. Should the threaded section of the operating lever plus the one in the plastic part of the ball joint prove inadequate for obtaining proper adjustments, alter the length of the linkage joing servo and bellcrank accordingly.

6.16.6.

After shifting the throttle control stick to the center position, trim against the low-speed stop at the transmitter and positioning the pitch lever (355) parallel to the large plastic cog wheel, trim the linkage connecting the pitch lever and the bellcrank to proper length, then solder it fast in the threaded bush at the bellcrank.

6.16.7.

Retaining the throttle position at the transmitter, shift the bellcrank at the tailrotor gearbox to the indicated position, then solder the threaded bush (3602) to the steelwire of the tailrotor control.

6.17. Installation of the fuel tank

6.17.1.

Assemble the tank (263) as per fig. 55. Under any circumstances use silicone tube (459) ex bag 98/12 for the clunk-type fuel line. The vent tube must be positioned at the uppermost point of the tank.

6.17.2.

The rubber section (409) ex 98/12 must be cut into five sections of different lengths to suit the cutout at the left lower longitudinal beam (401). Its parts are slipped over the edges of the platen at the appropriate stations of the cutout in order to protect the fuel tank.

6.17.3.

Press tank lightly together and install it into the cutout prepared in this manner. Allow to snap into place in the first groove.

6.17.4.

The fuel line, with filter (ex bag 79/6) inserted, is run to the carburettor of the engine. This line serves as a filler line when fuelling. To this end the fuel line is pulled off the filter at the side facing the tank.

6.17.5.

Using two bolts (1531/24) ex bag 79/6 the silencer (1588) is now fastened. If the engine is to be equipped with a tuned-pipe silencer refer to chapter 12.

6.17.6.

The tank vents also serve as pressurizing connections by joining them to the nipple of the silencer. The tube is routed through the hole of the intermediate bearing (803). On filling the tank this line serves as an overflow pipe; it must therefore be pulled off the silencer for fuelling. Tank installation see fig. 56.

This step completes the pre-assembly and pre-adjustment phase of compact-chassis assembly.

7. Preparing the rotor blades, order No. 99, for MECHANIK, order No. 79

For copter models using the main drive mechanics and the rotor head order No. 80 of the BELL 212 TWIN JET: use rotor blades order No. 82 or order No. 82/10, shortened by 65 mm = 2⁹⁄₁₆"; also see chapter 11 in this context.

Prior to modifying the main rotor blades **be warned that the centrifugal forces excerted on the rotor blade attach points at the rotor head by the whirling rotor blades build up to 160 kg = 350 lbs, that is the weight of two adults!**

For that very reason never use:
home-built main rotor blades,
splintered, cracked or repaired rotor blades,
as cementing rotor blades is not permissible!

Please do realize that the tips of the main rotor blades of your copter travel at a speed of nearly 400 km/h = 250 m.p.h.! A broomstick held into the revolving blades will be sliced into two like butter.

And worse: Flying off main rotor blades or parts thereof are dangerous missiles and may hit spectators and/or pilot and cause severe injuries. So be warned!

While rotor blades are carefully checked during their manufacture and matched pairwise for equal weight at the factory, they should, on principle, be checked by the builder whether they are actually alike.

7.1.

Carefully cement one right and one left wooden doubler to each rotor blade, as shown by fig. 57, using a white glue, such as UHU-coll or PONAL. In order to ensure proper alignment of the parts a 6 mm = ¼" diam. pin or a similiar tool should be installed into the three bores while the parts are being glued together. Press parts together until the glue has set fully. The blade root section should be 13.9 mm = ³⁵⁄₆₄" thick and the two outer surfaces must be plane-parallel. If necessary re-work to suit, until the rotor blades fit the blade holders of the rotor head precisely, without slop.

7.2.

Matching blade weight should be obtained by applying a corresponding number of coats of GLATTFIX porefiller order No. 207. Carefully sand with fine sanding paper grade 400 between coats.

7.3.

Not only must the weights of the rotor blades be equal, but their centers of gravity must coincide, too. Fig. 58 indicates how rhey can be balanced, using a straightedge or triangular molding.

Matching center of gravity positions are achieved by applying coats of varnish on the lighter rotor blade section. With their centers of gravity properly matched, the blades must be weighed again singly to find out whether they now differ in weight. If they do give the lighter blade an appropriate number of additional coats of varnish. Do work with care and patience: a weight difference of one gramm between blades results in an unbalance of the order of 400 g = q/10th of a lb., at a rotor speed od 1,000 r.p.m.!

7.4.

Paint the rotor blade attach points with black colour for a length of 70 mm = 2¾", using UNIVERSAL varnish order No. 921/7. The earlier coats of GLATTFIX porefiller as well as these colour coats should be applied as thin as possible and sanded carefully between coats.

If this is not done and varnish applied too thickly, the rotor blades may prove too thick on trying to install them into the blade holders of the rotor head.

7.5.

Paint the tips of the rotor blades with various contrasting colours approx. 20 mm = ¾" inboard of the tips. The multicoloured blade tips form a useful reference when testflying the copter.

7.6.

Cut patterns for covering the rotor blades from the covering film supplied; cover blades by putting them in front of you, with the holes of the blades on the right side and the trailing edges of the blades facing you. Commence the covering procedure at the trailing edges, as per fig. 59. Overlap the film at the bottom side of the blade.

The rotor blade tips, pointing to the left, remain uncovered for a distance of 12 mm = ½", measured from the outer end. Be sure to stick to this dimension at both blades to simplify the subsequent balancing of the main rotor.

Attention!

Be sure to apply the film in exactly the manner shown by the illustration. If overlapping the film is not performed in the correct manner – as described – the film may lift off and break up the airflow with dire results.

Do not cover or dress up rotor blades by emblems, numerals or letters (decals etc.) as they have a similar effect and impair the efficiency of the rotor blades.

8. Balancing the main rotor

8.1.

Build a balancing jig as per dimensioned figure 60.

8.2.

Then install the rotor blades in the blade holders of the rotor head. To this end the rotor blade bush (378) is slipped through the holes of bladeholder and rotor blade (must be a tight fit) and tightened by hex. bolt M4 × 35 (510), two washers (518) and STOP nut M4 (512). Do not tighten excessively, so the rotor blades will still be able to align themselves during operation.

8.3.

True up rotor blades with eachother and with the rotor head (180°).

8.4.

Put the rotor head with tenons of the central part onto jig and balance it. By applying coats of varnish at the uncovered blade tip of the lighter rotor blade, unbalance, if any, can be compensated; see fig. 61.

9. Main rotor installation

If using MECHANIK, order No. 80, of the BELL 212 TWIN JET copter, refer to chapter 11 for info.

9.1.

Slip main rotor onto rotor shaft (352); check for equal spacing of the two rotor blades in relation to the tailboom. The spacing can be adjusted by turning one of the two screws at housing (503); see fig. 62. Make sure the pitch operating rod (353) has been threaded into the bore of sliding piece (80/27).

9.2.

Screw in the central Inbus screw M3 × 8 at the clamp lugs at the bottom end of central piece (80/34). The screw should penetrate into the transversal hole of the main rotor shaft (352). This screw, penetrating into the transverse hole, merely serves to properly fix the position of the rotor head.

Caution!

The central Inbus screw M3 × 8 at the clamp lug does not act as a driver between rotor shaft and rotor head. Torque must be transmitted solely by firmly clamping the central piece on the rotor shaft. If the Inbus screw is used to transmit torque via the transverse hole it will de-form the rim of the hole to a ridge which in turn will make it impossible to remove the rotor head from the rotor shaft.

9.3.

Tighten the outer screws at the clamp lugs now. This clamps the central piece (80/34) of the rotor head firmly to the main rotor shaft.

9.4.

Slip bolt M3 × 12 through the lateral bore at the lower end of the sliding piece (80/27) and install it into the M3 threads machined transversally into the pitch operating rod (353). If necessary the latter may be rotated slightly, until it permits screwing the M3 × 12 bolt into the threads; screw bolt firmly in.

9.5.

Attach the control rods (655) with joint brackets (650/3) and nuts M 2,5 (251) to the ball-headed pin of the seesaw frame and the swashplate; also see 10.3., 10.4.

9.6.

The swashplate driver (358) is now rotated until the driving pin of the rotating part of the swashplate is aligned with the ball-headed pin of the fixed part of the swashplate (pitch servo = forward/backward tilt). Now true up the rotor head in the same direction while holding the driver fast. All control rods (655) must be standing vertically. Prior to tightening make sure there is no axial play for the swashplate.

9.7.

The swashplate driver (358) may now be tightened firmly pn the rotor shaft; see fig. 63.

10. Final adjustments

If using MECHANIK order No. 80 of the BELL 212 TWIN JET model copter, refer to chapter 11 for relevant information.

10.1.

Shift pitch and roll servo operating control sticks of the transmitter to neutral position. Shift pitch servo trim all the way aft, roll servo trim all the way to the left.

10.2.

Check swashplate for proper plane-parallelity to main rotor bulkhead (403). Checking is simplified by placing straight moldings on the swashplate and the main rotor bulkhead (must be checked in transverse as well as longitudinal direction). See fig. 64. If necessary, re-adjust lengths of steering rods.

10.3.

Position seesaw frame (80/31) parallel to swashplate (and thereby to main rotor bulkhead as well). To this end connect swashplate and seesaw frame by one of the steering rods only. Perform the necessary adjustments. Here again this procedure is simplified by a molding put on the seesaw frame (refer to figures 65 and 66).

10.4.

Adjust the length of the second steering rod connecting swashplate and seesaw frame in such a manner that the ball links can be engaged stress-free.

10.5.

Counter all ball links of the two steering rods by contra nuts.

10.6.

Be sure to check – with the throttle stick in neutral (central) position – whether the mixer levers in the seesaw frame are parallel to the latter. If they are not, alter the length of the control rod connecting the aft bellcrank (145) with the pitch lever (355). If parallelity of the pitch lever to the larger plastic cog wheel cannot be obtained in this manner, adjust the vertical position of the abutment (80/17) in the intermediate bearing of the powerplant to suit.

10.7.

Make sure the pitch operating rod (353) does not run against the main rotor shaft when the transmitter stick occupies the low-speed (idle) position. The sliding piece (80/27) in turn must not run against the rotor head at the top in any of the full deflection positions.

10.8.

Slip gauge (382) onto rotor blade tip.

10.9.

Shift throttle control stick of transmitter and its trim to the low-speed (idle) position.

10.10.

Provide parallelity between the moldings put on the seesaw frame and the blade pitch gauge by adjustings the length of the short rod connecting the seesaw frame to the rotor blade actuating levers to suit. Counter the nuts at the ball joints, see fig. 65.

10.11.

Shift throttle control stick of the transmitter to maximum speed (full throttle) position.

10.12.

Make sure maximum angle of incidence of the rotor blades can be reached. If this is not the case, alter lengths of levers at aft bellcrank (145) to suit. If necessary increase pitch (approx. 5°), as per fig. 66.

10.13.

The blade angles of the tail rotor blades are roughly pre-adjusted at the factory.

11. Assembly instructions for models equiped with MECHANIK and rotor head, order No. 80

of the BELL 212 TWIN JET model copter in conjunction with a platen set, order No. 98.

11.1.

Refer to the instructions supplied with MECHANIK order No. 80 for information on the flight characteristics, assembly and adjustments. The following description provides supplementary information only where necessary.

11.2.

Additionally required parts:
conversion set, order No. 78
tailrotor gearbox with blade holder, order No. 79/3
tailrotor blades, order No. 79/4.

Be sure to note that the tailrotor gearbox of MECHANIK order No. 80 cannot be used here.

11.3.

Only the main rotor blades order No. 82 and 82/10, respectively, which fit MECHANIK order No. 80, may be used. their outer ends (tips) must be shortened by 65 mm = 2⁹⁄₁₆". Make sure both blades are trimmed exactly alike. Complete as described in chapter 7 (excepting 7.1.). Also shorten covering film accordingly.

11.4.

Conversion set order No. 78.

Conversion set, list of materials

Order No.	Quantity	Designation	Remarks
92/1	1	dome-shaped bearing with ball races	ball bearing (303) installed
92/5	1	ball-headed bolt, long	steel
524	1	washer	steel
005	1	STOP nut	M3 (1/8)
3548	2	clevis	steel
252	2	female thread bolt	aluminum, 18 (23/32) lg.
010	2	hex. bolt	aluminum M2.6×10 (7/64×13/32)
3522	1	threaded rod	steel, 2 (5/64) diam. M2
3602	1	threaded bush	steel, M2 (5/64)
354	1	sliding block	pastic
79/355	1	pitch lever	aluminum
250	2	female thread bolt	aluminum 6 (1/4) lg.
003	2	nut	M2.6 (7/64)

11.5.1.

The dome-shaped bearing (92/1) serving as upper rotor shaft bearing is bolted to the main rotor bulkhead (403); also see chapter 6.2.3.

11.5.2.

The swashplate is fixed in position by screwing it fast in the aft hole at the right side (viewed in the direction of flight) of the main rotor bulkhead (403), using a ball-headed bolt (92/5) with washer (524) and nut (005).

11.5.3.

The pitch lever (79/355) with gate (354) is installed in the manner described in chapter 6.9.

11.5.4.

As mentioned earlier four VARIOPROP servos CL may be used in conjunction with MECHANIK order No. 80. As shown by figures 68 and 69 these servos must be screwed onto the threaded bolts, with the roll servo)left/right) put into the 6 mm = ¼" lg. bolts, the pitch servo (forward/backward) onto the two longer ones (252). The latter are fastened to the servo bracket (446) by holts (010).

11.5.5.

The CL servos are connected to the linkage by two spring steel clevises (3548).

11.5.6.

The linkage joining the rotating section of the swashplate with the auxiliary rotor (80/28) must be fashioned from threaded rod (3522) and soldering sleeve (3602). Trim to proper length as per instructions for order No. 80. Be sure to solder parts firmly and securely together!

11.5.7.

The tailrotor shaft is connected to the tail rotor gearbox by parts (234) and (235) as described in chapter 6.7.6.

11.5.8.

Fuel filter and fuel line are available separately; ask for order No. 1648 and 1643 (or 1643/1), respectively.

12. Outfitting the copter with a tuned-pipe silencer

12.1.1.

The following items will be required:
a) exhaust manifold, order No. 1581
b) tuned-pipe silencer, order No. 1564
c) Mounting hardware, order No. 1582

12.1.2.

The illustration shows components of order No. 1582.

Order No. 1582 tuned-pipe silencer mounting hardware

Part. No.	Designation	Quantity	Remarks
317	toothed disc	1	steel, 5.3 (7/32) diam.
1582/1	clamp	1	plastic
432	metal clamp	1	steel
421	set of half-shells (2 off)	1	plastic
532	Inbus screw	2	steel, M3×12 (1/8×15/32)
005	STOP nut	4	M3 (1/8)
524	washer	4	steel, diam. 3.2 (1/8)
013	hex. bolt	2	steel, M 3×10 (1/8×13/32)
518	washer	2	steel, M 4.3 (11/64)
503	hex. nut	1	steel, M4 (5/32)
4600	vibration-dampening element	1	steel/rubber, diam. 15×15 (19/32×19/32)
340	cyl. head bolt	1	steel, M4×10 (5/32×13/32)
1582/2	support	1	aluminum, 15×4 (19/32×5/32)
1582/3	silencer mounting bolt	1	steel
341	Inbus screw	1	steel, M4×30 (5/32×1³⁄₁₆)
512	STOP nut	1	M4 (5/32)
1582/4	nipple	1	brass, .8 (1/32)
	nut	1	brass, nickel-plated, M5×.5 (13/64×.02)

12.2. Mounting the silencer to the compact-chassis

12.2.1.

The manifold, order No. 1581, is fastened to the engine by the mounting bolt of the standard silencer at the front end and by the shorter bolt supplied in the mounting hardware pack order No. 1582 at the rear end.

12.2.2.

The pressure line nipple (1582/4) is attached to the tuned-pipe silencer order No. 1564 at a distance of approx. 165 mm = 6½" measured from the inlet side of the latter. To this end drill a 5 mm = 13/64" diam. hole in the silencer at that station. as the nipple must be installed from inside the silencer a length of wire is required to get it in place. The wire is threaded through the hole and exited at the front end; slip on the nipple and secure provisionally in place on the wire (by bending the latter or any other convenient manner), then install nipple into hole from inside. Secure in place by a washer and a nut M5 × .5 = 13/64" × .020.

12.2.3.

From the silicone tube supplied with the tuned-pipe silencer cut off a length of approx. 120 mm = 5" and slip 50 mm = 2" onto the silencer. Secure in place by clamp (1582/1).

Aluminum bracket (1582/2) is fastened at the small diam. exhaust tube of the silencer by clamp (432) and two hex. bolts M3 × 10 (1/8 × 13/32") and STOP nuts M3.

12.2.4.

Take half-shell (431)with short shoulder out of bag 1582, attach vibration-dampening element to same by cylinder bolt M4 × 10 (5/32" × 13/32"), part 340. The second half-shell, together with the first one is now fastened (but not yet tightened) to the tailboom between braces, using two M3 × 12 Inbus screws (1/8" × 15/32"), four washers and M3 STOP nuts.

12.2.5.

Drill 4 mm = 5/32" diam. hole in lower longitudinal beam as per fig. 71.

12.2.6.

The pre-assembled tuned-pipe silencer is now attached to the chassis. Prior to slipping the silicone tube onto the manifold the hose strap (ex bag 1564) must be put on. Clamp (1582/1) is fastened, using the M4 × 30 (5/32" × 1 3/16") Inbus screw, washer and STOP nut. Do not yet tighten!

12.2.7.

Attach rear end of tuned-pipe with mounted aluminum bracket at the lower end of the vibration-dampening element by M4 hex. nut and washer; tighten.

12.2.8.

Adjustment of the length of the tuned-pipe is performed as per operating instructions supplied with 1566. To this end the position of the tuned-pipe with the two half-shells may be altered at the tailboom and in the mounting clamps. Once properly adjusted the position established in this manner is secured by tightening all bolts firmly; fig. 72.

13. Testrunning and breaking-in the engine

13.1

Provision of a starter box or cradle is recommended, so the copter can be securely held or strapped down and is readily accessible from below for starting the engine. Make sure the rotor disc of the main rotor is above head level under any circumstances! This is a precaution against accidents should the model shed parts of the rotor blades as a result of shoddy assembly. The same precaution should be taken when running the rotor after repairs of the copter.

13.2.

Fuelling: refer to chapter 6.17.4.

13.3.

Starting the engine.

Turn on transmitter and receiver. Unscrew the glo plug (preferably use a glo plug order No. 1681), using wrench order No. 1610.

Connect glo plug to starter battery (1.5–2.0 volt), blow out oil residue. For engines equipped with a heat-sink cylinder head use special glo plug wrench order No. 1658. Make sure the gasket of the glo plug is not lost.

Shift transmitter stick to the full-throttle position. the engine, still minus its glo plug, is then turned over with the aid of a suitable electric starter, while the carburetor intake is closed by a finger. Direction of rotation is clockwise when viewing the copter from head-on position. The carburetor needle should be openend two turns. Once your finger is wetted by fuel the engine is sucking fuel; stop turning over the engine now.

Shift transmitter stick to a fast-idle position. Install glo plug, with gasket in place, and connect to power supply.

Make sure rotor discs are free of any obstacles and that the copter is firmly fastened or held.

Start engine by starter and V-belt. If all instructions given above have been followed, the engine should start immediately.

Attention! Should the helicopter start vibrating with increasing r.p.m., close throttle immediately to an idle. Trace cause of vibrations.

They may be induced by:

- unbalance of rotor
- rotor head not adjusted as per instructions
- engine maladjusted, loose screws
- unbalance of tail rotor

Never run engine minus main rotor in place. Under any circumstances do not hold rotor blades fast while applying full throttle, as the clutch will heat up excessively and get damaged.

13.4.

Adjust low speed and high speed mixture for engine as per carburettor instructions (below); see chapter 3.1.

Adjusting the carburetor

Open main needle jet (6) two turns, start engine. By screwing the needle in while keeping throttle part (4) wide open, the engine is adjusted to maximum speed. The fuel/air mixture is then optimized for the full throttle position.

Then close 50% of the intake cross-sectional area by throttle part (4). Screw low speed needle (7) still further into the low-speed insert (9) when the engine starts to four-stroke and misfires. This indicates the mixture is too rich; it can be turned meager again by screwing the low speed needle in still further. Proceed with screwing in the latter until the engine runs smoothly without misfiring. If engine stops with throttle part (4) half-closed this is proof of excessively meager mixture. This is cured by unscrewing the low speed needle (7) until the engine runs smoothly without misfiring.

With throttle part (4) in the low-speed position (that is: almost closed) the fuel/air mixture must be adjusted once again! Adjustments are made via the low speed stopper bolt. The adjustments must not infere with servo operation, restraining the latter's range of travel! This completes the adjustments of the engine. If necessary repeat procedure after the break-in period of the engine.

The engine will run smoothly provided the carburettor is mounted gas-tight to the engine casing and the engine is in working order mechanically. Should the engine fail to idle reliably, be sure to check the following points:
1. gas-tight connection of carburettor to engine
2. foreign matter in fuel or carburettor; blow out or wash with fuel
3. engine intake not gas-tight, engine defective
4. inadequate engine cooling

13.5.

Hints re. breaking-in the engine

A reliably running engine is a prerequesite for the operation of a copter model.

From 5 to 10 fillings of the fuel tank are generally required for breaking in an engine properly. In the initial stages an engine should be run on a rich mixture. This requires unscrewing the main jet needle, changing its setting from the optimized one.

Operate engine at changing speeds Allow engine to cool between runs.

13.6.

Check tracking of main rotor blades at high r.p.m.

Thanks to the contrasting colouring of the rotor blade tips an out-of-track tip can be easily identified. Increase length of pushrod connected to pitch setting lever of the higher running rotor blade to reduce the blade angle.

Attention!

Be sure to keep in mind that fast-revving rotor blades represent a potential hazard. Make sure that other persons do not come close to the main rotor and the rotor disc level.

Inspite of careful balancing of, and the use of selected wood for, the rotor blades, their bending and torsional properties may differ, a fact that may show up when the blades are subjected to the high centrifugal forces induced by a fast spinning rotor. Elastic asymmetry can be corrected by lengthening or shortening the linkage connecting the collective pitch lever and the mixer lever, as the case may require. Be sure to keep adjusting until the two rotor blades are tracking as true as possible over the entire speed regime.

13.7.

Check all bolted connections of the helicopter; they must be tightened firmly. On principle check all aggregates, as well. During operation of the copter these checks should be repeated frequently.

13.8.

Check center of gravity position of the model. Must be coincident with the centerline of the main rotor shaft. If it is not, correct by adding ballast weight at tail or nose of model, as the case may require.

14. Care and maintenance

14.1.

Check all bolts, screws and other components for firm seat and flawless condition prior to each day's flying session.

This applies in particular to all engine bolts (at casing etc.), as well as servo mounting bolts. These bolt connections should be checked frequently and tightened, if required.

14.2.

Prior to each day's flying session the screws of the clamp flanges of the large cog wheel must be tightened and proper function of the main rotor damper checked.

14.3.

Use only clean, filtered and water-free fuel.

14.4.

Use original ball bearings only. These ball races are special models specifically tailored to the requirements of model copter operation.

15. Lubrication

15.1.

Lubricate the tail rotor bearing between driven shaft and pitch operating rod by a **single** droplet of automotive oil (HD oil – SAE 20) after every five hours of operation. Also lubricate bearings at the tailrotor pitch bridge (363) and the ball-headed pins of the aluminum joint brackets. The hardened bevel gears of the tailrotor gearbox should be permanently and continuously covered by grease. This ensures smooth and wear-resistant operation of the wheels and prevents dirt particles from getting on the tooth flanks.

Attention!

All other parts need no maintenance and must not be lubricated! This applies, in particular, to the cogs of the bevel pinion and the large cog wheel,. which must not be lubricated or greased, as this would only result in an undesirable accumulation of grit and sand in the lubricant, causing excessive wear.

Under any circumstance the ball bearings must NOT be lubricated. They contain a special type of lubricant which provides safe operating times in the order of several hundred hours.

16. Cleaning

16.1.

Do not wash MECHANIK parts with soapy or warm water ever!

16.2.

Do not use cleansing liquids, such as gasoline, petroleum, thinner, tri, trtramethane, aromatics, such as benzene, xylol, diaoxane, stain remover etc.

16.3.

Wipe model and mechanical parts with paper handkerchiefs, such as Kleenex etc. only, or with a clean linnen cloth.

16.4.

Cleaning the carburettor

After removal of the nut, remove the low-speed stop screw. The throttle part (4) with lever and low-speed jet needle can then be extracted from the carburettor housing. Remove return spring. Unscrew the main jet needle, after marking its setting for future reference (re-installation). The main jet in the carburettor body may be cleaned with fuel (or Methanol). The nozzle holder may also be cleaned in throttle part (4). After cleaning all parts the carburettor is re-assembled. Re-adjust setting of the main and low speed needles, if necessary.

17. Testflying the helicopter

17.1.

Flying a copter, be it fullsize or a model, requires above-average piloting skill.

A copter tyro is therefore well advised to ensure the assistance of a modeller skilled in the art of flying rotary wing models in the early phase of his copter activities. This will greatly reduce the risks encountered in testflying his model.

The modeller must be reminded once again to abide by the regulations etc. which apply to the operation of model aircraft and to model sites. And he must also be reminded of the previously mentioned pointers on the dangers and hazards encountered while operating a copter model:

Do not try to testfly a model copter until the preceeding bench tests have been performed as per instructions and have proved successful and satisfactory in every respect.

It is recommended that the Trainer-type of undercarriage No. 90 be used for initial tests, as it improves the ground stability and handling of the model.

Under any circumstances select a hard, smooth and dustfree tarmac (concrete, bitumen etc.) for your first test hops. Take-offs from grass present no difficulty for an experienced pilot, provided lift-off is executed smartly (jumping take-off) so that the helicopter is not caught by weeds which could make it topple.

For piloting his copter the pilot should position himself to the left and aft of the model (7 o'clock position). When applying the controls the pilot must keep his eyes on the **front** end of the copter so he'll apply the controls correctly.

During initial test flights open the throttle slowly. With increasing revs the aft end of the copter will try to move either clock- or counterclockwise. Observe to which side the helicopter tries to turn immediately before lift-off takes place. This turning tendency must be suppressed under any circumstances by adjusting the trim lever of the transmitter accordingly, before any attempt is made to fly the helicopter in the hover mode. Stop engine after trim adjustments have been made. The pitch angle of the rotor blades determined in this manner must now be set by re-adjusting the position of the lock ring on the control rod of the tailrotor drive shaft to suit, while the trim of the transmitter control stick concerned is in neutral position.

Proceed in the same manner if the helicopter tries to move forward, backward or to the right or left prior to lift-off. Do not allow model to lift off the ground until all linkages have been adjusted in such a manner that all transmitter sticks and trim controls occupy their proper center stations. Full trim range must be available later for forward flight and other maneuvers, such as airfield circuit flying.

Attention!

Just like conventional, fixed-wing models, a helicopter model, too, must be launched and landed against the wind!

The mechanical mixer for pitch and tailrotor blade control compensates mainrotor torque to a large degree.

Should the model try to turn to port (left) on opening the throttle or increasing the pitch, the throttle/tailrotor mixer lever must be moved slightly up, should it turn to starboard (right) it must be lowered a bit. Thanks to direct blade pitch control all movements of the copter are executed instantly, without any time-lag. The experienced copter pilot may exchange the ball-headed pins (371) at the seesaw frame by the shorter ones (356) supplied in bag (79/6) for even faster control response – a measure mainly meant for aerobatic copter flying.

Response to the controls can also be affected by adjusting the rotor head damper accordingly. The deeper the bolts are screwed in, the more directly will the copter react to the controls. When adjusting these bolts make sure the rotor blades are uniformly spaced apart from the tailboom. Adjustments should be made at one of the screws. See chapter 9.1. and fig. 62.

Should the two bolts be blocked by the stop while the damping action is still inadequate, the bolts must be unscrewed, the vibration-dampening rubber removed and one additional dampening disc (381) ex bag 98/54 per main rotor dampening element be inserted. The latter is then re-installed and the dampening action adjusted as described above.

The duration of flight depends on the amount of fuel carried by the model. Be sure to remember that the fuel carried in the tank can't be consumed to the last drop in flight. The quantity of residual fuel depends on the position of the clunk line and the attitude of the copter.

17.2.

More hints on copter flying.

Prior to trying to perform forward flight and flying site circuits you have got to master the hovering mode.

Prerequisite of a successfully performed landing is complete mastery of hovering flight!

In a hover in particular it is important to notice even the slightest tendency of the copter to move this way or that way already in the initial phase in order to enable the pilot to take corrective measures to counter any such tendency.
Be sure not to overcontrol by applying the controls too deftly or for too long a time. Start with hovering the model for a short time only and at low altitude (not more than 2–4 ft.). Nothing proves more difficult for the tyro than landing a model copter descending from high altitude really softly! Be sure to read chapter 18.4.

18. Mechanics of flight of the helicopter

With the aerodynamics of, ant the aerodynamic forces encountered by, the helicopter differing somewhat from those of fixed-wing aircraft, a short introduction to the basic mechanics of flight of the helicopter won't be amiss.

Getting familiar with the forces induced by the various maneuvers of a helicopter will facilitate its operation and reduce the danger of a crash landing caused by pilot's error.

The main disadvantage of fixed-wing aircraft featuring fuselage and empennage is the loss of control encountered when flying too slowly. Another disadvantage of this type of flying machine, both fullsize and scaled-down model version, is the need for a runway on which to perform take-off and landing. The desire to create a flying machine capable of vertical ascent and descent, of flying slow or fast, of being supported motionless in the air and hover, is an old one. In fact Leonardo da Vinci sketched his idea of a technical solution to this problem as early as in the 16th Century.

Experimental types of vertically rising and landing aircraft were not built and sucessfully flown until the beginning of this century, however.

The basis idea for this type of flying vehicle consists in replacing the fixed wings of conventional aircraft by a system of rotating wings or rather by a horizontal airscrew, a lifting propeller. The first helicopters to fly sucessfully and with acceptable control characteristics were those built by H. Focke (1936), Flettner (1939) and Sikorsky (1941). All of them were, to some extent, based on the valuable data collected by Juan de la Cierva since 1926 with a couple of experimental autogiros or gyroplanes. This type of rotary wing aircraft differs from the helicopter in that its rotor is not driven by an engine, but by air forces resulting from the motion of the craft through the air.

Forward propulsion is provided independently of the rotor, generally by the thrust of a propeller, as in the manner of fixed wing aircraft.

While modellers succeeded in building and flying scaled-down autogiros quite early, the problems posed by the mechanically driven helicopter remained unsolved for a long time. As a lesson from many failures it was finally realized that the only answer would be a remotely controlled model helicopter flown under constant control, hence quasi-stable and therefore flyable. The possibility of flying a model at any arbitrarily selected low speed, of hovering flight, vertical take-off and landing, can in fact be provided by the remotely controlled model only. Let's now take a short look at the mechanics of flight of the helicopter and the latter's peculiarities differing from those of fixed-wing aircraft.

One of the major problems of helicopters with mechanical rotor drive is compensation of the torque generated by the engine and acting on the rotor blades. While the torque effect of propeller driven fixed-wing models or planes can be compensated rather simply by appropriate adjustments of ailerons and thrustline deflection (sidethrust), the compensation of the torque affecting a helicopter requires other methods and devices. To get around the torque problem of the helicopter with mechanically driven rotor a second, vertically mounted, rotor must be provided at the aft end of the fuselage; it is called tail rotor or antitorque rotor. Ideally such a tail rotor provides just the right amount of side thrust to compensate the torque acting on the main rotor, by employing the fuselage for a lever. To fill that requirement the thrust of the tailrotor must be constantly adapted to prevailing conditions, in particular to any change of engine output applied to the main rotor. This adaption is performed by changing the angle of pitch of the tail rotor blades accordingly. For that reason the tail rotor is designed as kind of a variable pitch propeller. It is generally a rather complicated component which, being mounted in an exposed position near the tail end of the fuselage, is rather vulnerable in the event of crash landings.

18.1. Hovering flight

Fig. 73 shows a helicopter in stationary flight, e.g. in the hover mode, schematically.

Much like a conventional propeller or airscrew, a helicopter's main rotor provides thrust, or rather up-thrust = lift. The helicopter hovers stationary when lift and weight of the helicopter balance eachother. In reality the lift must exceed the weight slightly because of the downwash of the rotor hitting fuselage, tailboom, undercarriage struts etc., thereby producing negative lift. The tail rotor provides torque compensation. Without such a device the tail end of the fuselage would swing in a direction opposite to that of the rotor.

18.2 Ground effect

Modellers are well aware of the fact that a spinning propeller produces a blast of air which is felt when one sticks one's hand into the airstream aft of a rotating propeller. Just like the propeller the helicopter's rotor produces a blast of air, which is directed downward. When a helicopter gets close to the ground, during landing for example, the downwash of the rotor is increasingly deflected outwards instead of downwards, thereby creating an air cushion on which the copter floats. This phenomenon is called ground effect. While skipping the mysteries of rotor aerodynamics let's mention the positive effect of that air cushion: it permits a helicopter floating on that air bubble to lift more weight for a given engine power. This effect diminishes as a function of height above the ground and is restricted to a height equalling one rotor diameter above the ground. This provides the answer to the disturbing fact that an under-powered helicopter, though capable of lift-off, will be unable to leave the ground effect zone.

18.3. Vertical climb

The transition from hovering to ascending flight requires extra power, e.g. the throttle must be opened by the pilot. Increased power means increased rotor lift: the copter climbs.

In the case of helicopters sporting rotor blades with **fixed** pitch higher lift is achieved by increasing the rotor speed. Response is **somewhat slow** with this method of increasing the lift of a model helicopter, because the combined masses of flywheel, gears and rotor have to be accelerated by the engine before the faster spinning rotor produces more lift. With a helicopter sporting constant pitch rotor blades the rotor speed must be increased with any increase of the rate of climb in order to retain the angle of attack of the rotor blades.

A helicopter featuring adjustable pitch rotor blades reacts much faster when ordered to climb, however. And during the approach to landing flare-out is quickly achieved by adjusting the pitch of the rotor blades accordingly. As a fast rule a helicopter equipped with pitch control will be much more maneuvrable than a constant pitch model and for that reason it will be much easier to control and fly. The kinetic energy stored in the rotor system by changing the blade pitch slightly without altering the power setting, enables the pilot to perform a jumping take-off with his helicopter model, with the latter showing no tendency to swing to either side. If engine power is increased simultaneously and proportionally with the alteration of the pitch angle, the rotor speed will remain constant and there will be no time-lag in sesponse due to masses requiring acceleration. Any increase of engine power caused by opening the throttle and the resulting higher torque acting on the rotor do, of course, necessitate a corresponding adjustment of tail rotor thrust to retain the equilibrium of moments. The main advantage of pitch control is that the kinetic energy stored in the main rotor may be used to permit flaring the helicopter on landing or in a critical situation, without any tendency of the model to swing to right or left and without any need for actuating directional control via tail rotor adjustment.

18.4. Vertical descent

A pelicular characteristic is combined with the vertical descent of a helicopter. When its rate of sink almost equals the downwash velocity of the rotor, the latter enters into a critical flow condition called the vortex-ring phase of flow (see fig. 74).

In this phase the rotor is unable to produce the required amount of downwash because air from beneath flows against the rotor as a result of excessive rate of sink. The rotor is in fact settling in its own downwash. Instead of flowing straight downward through the rotor, the air passing through the rotor is deflected laterally and moves about the rotor blade tips.

As a result the airflow about the outer blade sections is highly turbulent, resulting in separation of the boundary leyer. The lift produced by the rotor diminishes rapidly and the helicopter crashes. This critical phase can be avoided by descending the helicopter in forward flight, because forward speed keeps providing the rotor with non-turbulent inflow. For this reason a fast descent must be coupled with forward flight; this applies to fullsize as well as model helicopters.

A helicopter may also encounter the dangerous vortex ring phenomenon when turning from upwind into downwind flight, as the wind then blows from underneath against the tilted rotor or the copter flies with the wind with zero speed relative to the latter.

18.5 Level flight

A helicopter travelling in level forward flight at constant speed is subjected to the forces shown by fig. 75.

Weight G is directed downward, as usual. Fuselage, rotor and undercarriage on passing through the air create parasitic drag W which acts in an aft direction. A rotor spinning in hovering flight creates lift which acts in the direction of, and concentric with, the rotor shaft. With the helicopter travelling in forward flight the direction of the lifting force is no longer identical with that of the rotor shaft. The lifting force, designated P here, is now inclined in relation to the rotor axis. This is the result of dissymetry of rotor lift which occurs when a rotor is in forward flight. In a spinning rotor one of the blades moves forward, the opposite blade moves backward. The advancing one produces more lift because forward speed and rotational speed add up to a higher total blade speed than in the case of the retreating blade, where the aircraft's speed must be subtracted from the rotor speed. The combination of rotational and forward velocities results in a dyssemetry of the lift distribution between the two sides of a rotor disc. By splitting up the lift force into two components one obtains lift A, which should be equal to weight G, and forward thrust Z; the latter being, of course, the equivalent of the thrust of the conventional propeller. In order to point the forward thrust component Z in a forwardly direction or any desired direction of flight, one must tilt the rotor disc towards the horizontal accordingly.

Rotor blade flapping

The advancing blade of a rotor tends to rise as a result of the higher lift it produces. This would cause toppling of the rotor axis if the rotor blades were rigidly attached to the rotor shaft. The main rotor is prevented from tilting by the provision of flapping hinges which pivotally connect the rotor blades to the rotor shaft.

In the case of the BELL 222 helicopter model the two rotor blades are rigidly interconnected and hinged at the center by a common testering hinge which is in turn fastened to the rotor shaft (see fig. 76). This type of rotor arrangement offers significant advantages, both aerodynamically and as regards vibration-dampening.

With the blades free to flap as a unit, one of the blades moves up, while the other one moves downward. On moving downward the retreating rotor blade will fly at a higher angle of attack which produces a welcome increase of lift although it moves backward in relation to the helicopter. Rotor flapping with this type of hinge is markedly reduced thanks to the rigid interconnection of the rotor blades and the centrally arranged common hinge, which also results in low vibrational excitation in the hover mode.

The BELL 222 helicopter model provides means for reducing and partially compensating the seesaw motion of the rotor. These means consist of rubber damper rolls. These rollers are adjustable and allow altering the ride and control characteristics of the helicopter to suit.

The rotor head of this model copter is designed in such a manner as to provide, via its control system, an automatic reduction of the pitch angle when the rotor blade flaps upward, thereby creating a restoring moment. That's the reason why the rotor of this helicopter model spins with surprising smoothness and without major flapping motion.

The oscillations of the rotor blades cause an alternate increase and decrease, respectively, of the distance of the centers of mass of the blades from the center of rotation (see fig. 77), and thereby produce a phenomenon called Coriolis accelaration. This is an effect utilized by ice skaters to increase their rotational speed when performing a pirouette. Spreading his arms he gathers momentum and increases his rotational speed by pressing them against his body. Physically speaking this is an example of the preservation of rotational energy.

The faster a helicopter flies forward, the more will the resulting rotor force P be tilted in the direction of flight. The force acts on the rotor axis at a point positioned above the flapping hinge. This point is called neutral point, because its distance from the flapping hinge varies very little only.

18.7. Helicopter climbing in forward flight

Power requirements of a helicopter in level forward flight are lowest when it cruises at a speed corresponding to approx. 50 per cent of maximum speed. The excess power available can be utilized for climbing flight. That's the explanation why a helicopter climbs faster when traveling forward at low speed than when rising vertically. It will also climb to a higher ceiling using the climb-at-low-forward-speed technique. Thanks to its precision engineered mechanical components the BELL 222 copter disposes of lots of excess power for a high rate of climb of the order of 5 m/sec = 17 ft. per sec.

19. Spare parts

Whenever spare parts should be required use only original ones, provided with the appropriate properties and dimensions.

Available are both assembly groups and individual parts which are mentioned as such in the list of materials. Be sure to quote the complete part number in such a case.

That number is comprised of the order number, the assembly group number and the part number proper. In the case of the undercarriage struts it should, for example, read: 98/3/431.

August 1979

Subject to change serving technical progress.

Legend to figures 21, 25, 26, 27, 28, 30, 48, 52, 58, 59, 65, 73, 74, 75, 76, 77

(1) attach to inner hole of output
(2) servo output
(3) safety nut with LOP varnish
(4) ream holes to 2 mm = 5/64" diam.
(5) drill additional 2 mm = 5/64" diam. hole
(6) file off
(7) removed web
(8) upper longitudinal beam (400)
(9) safety with LOP varnish
(10) to aft bellcrank
(11) counter 002
(12) solder, with lever perfectly parallel
(13) solder
(14) low-speed, down
(15) swashplate tilted "forward"
(16) swashplate tilted laterally "right"
(17) swashplate tilted "backward"
(18) swashplate tilted laterally "left"
(19) full speed, up
(20) tail left
(21) tail right
(22) balancing the rotor blades
(23) method of covering the main rotor blades (schematically)
(24) parallel
(25) lift
(26) hovering flight
(27) weight
(28) vortex-ring state of flight; no longer controllable, copter crashes
(29) rate of sink excessively high
(30) forward flight
(31) semi-rigid rotor head, optimum solution for model copters
(32) flapping axis
(33) rotor blade
(34) rotor shaft
(35) Coriolis phenomen induced by flapping motion of rotor blades