Complete cancellation of torque effect was attained by engineer Stehr from Dortmund, using counterrotating rotors. One engine for each. How would you like to help him start it going?

Dieter Schulter, left, made only successful but brief flight with scale. His Sikorsky S-58.

***INTRODUCTION:** The following report on the first international R/C helicopter competition was published in the October 1968 issue of the German magazine MODELL. The translation from German to English was headed up by John Burkam, a fellow modeler and R&D man with Boeing-Vertol in Morton, Pa. assisting him in the translation were other B-V helicopter engineers Herb Demel (German), Val Sankewitsch (Russian), and John Solak (Polish).*

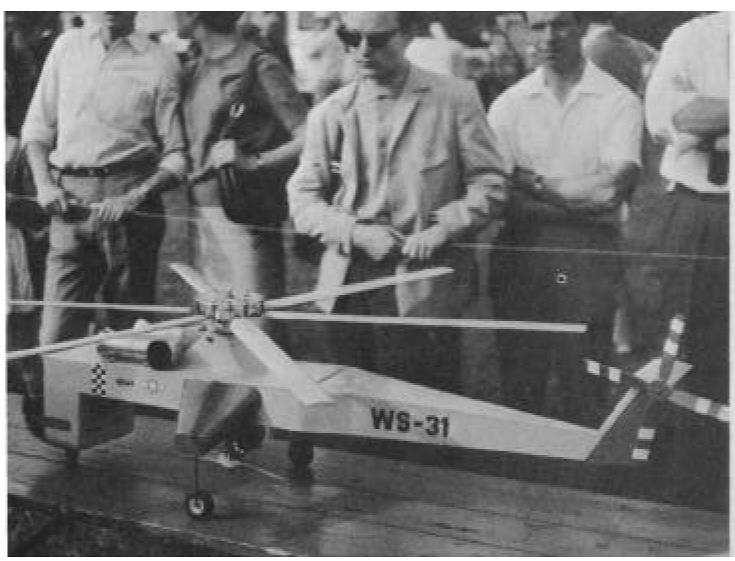
In order to retain the international flavor (and also to save us a lot of rewriting) the translation has been left pretty much in its original form.

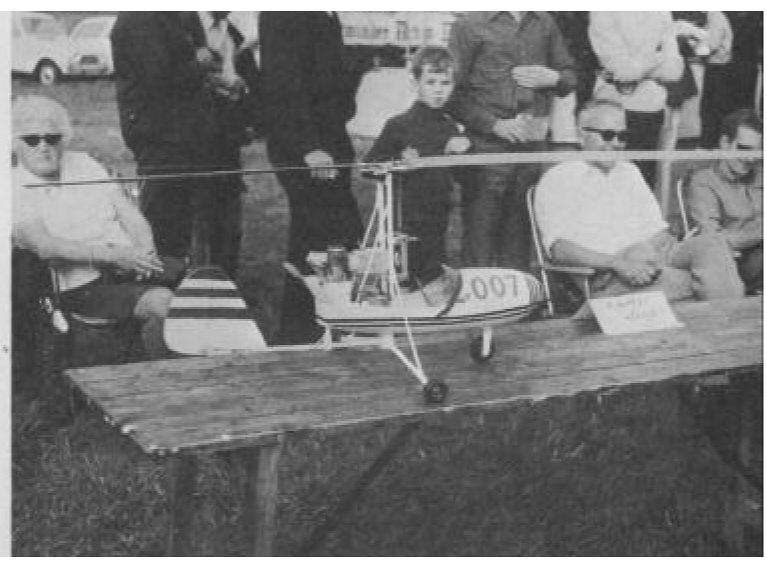
First International R/C Helicopter Competition

By JOHN BURKAM . . . If measured only by the number of successful flights, this competition would be called a flop. However, by any other standard, it was a giant pioneer step in the direction of controlled and maneuverable flight by radio operated helicopter.

It is finished. The high tension before this contest for model helicopters is over. A great impression remains, waiting to be understood. Out of so many interesting and technical new things it is difficult to mention all details to satisfy everybody. To appreciate all the variations of designs, ideas, and individual results, one has to have worked on the problem of remote controlled model helicopter for some time.

Summarizing in advance, it can be said that this contest was only the start for interesting development to come, with still many surprises in the future. One can agree in this respect with Mr. Rietdorf (an expert and sponsor from the industry), when he said in his final speech that this contest in Harsewinkel is to be considered a part of aviation history. The ability to command a remote controlled model helicopter is a great technical success. Especially people working on helicopter problems (big scale) can evaluate the immense technical effort. Harsewinkel was only the beginning, but it shows how much R&D work is to be done till model helicopters are flying perfectly controlled. In his opinion, there are

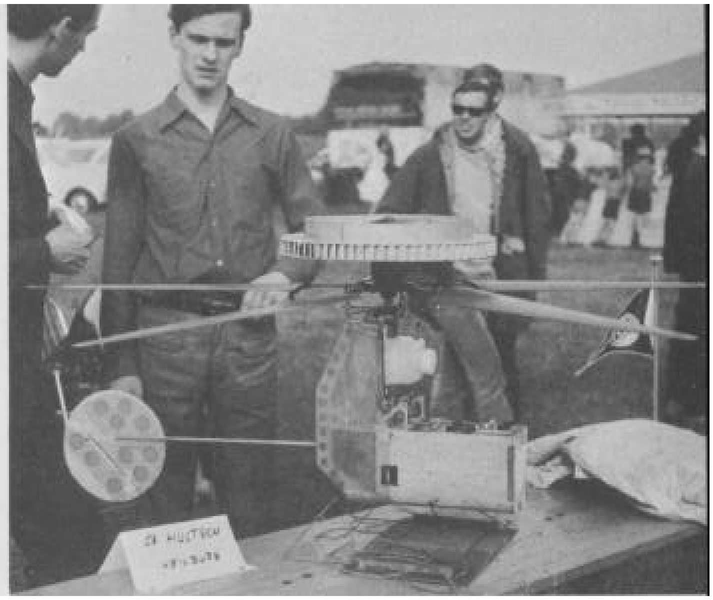




Semi-scale cargo helicopter built by Dr. Schlattmann uses regular prop on underslung engine for torque reaction. Tail rotor apparently dummy.

This "Benson-ish" gyrocopter was designed and built by H. "James Bond" Glafey, Munster. Supertiger 40, rotor tilt and rudder control, throttle.

The rotor shaft failed before G. Storig could make an attempt at an official flight with this model featuring aluminum tube construction.



Close up of the shroud around the torque reaction prop on Christoph Hulch's model. This was meant to improve rotor drive but was too small.

now already some excellent models in existence. Still to come is mainly the training of model pilots to fly this complicated flying machine.

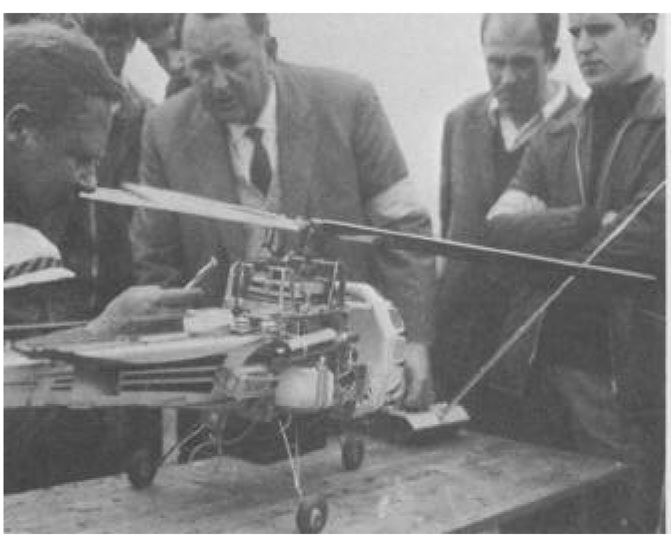
We like to be most grateful toward Ikarus Harsewinkel as well as Mr. Walter Claas (owner of Simprop) for their organization and financial rewards which were incentive for the interest in this competition. The amount of awards distributed, totaled 13,800 DM ($3,450). It was sponsored by individuals, industry and by the organizer.

It was decided during the contest, to cancel the difficult flight program and judge instead on general flight performance. The models were also judged on display for technical efforts and detail work involved. None of the participants would have been able to exercise the original scheduled flight program in an appropriate manner. As I report now in detail about flying performance and the technical concepts, please keep in mind that building a remote controlled helicopter is not comparable with building a normal, even sophisticated, remote controlled model.

Building a model helicopter takes basically completely different systems and methods. Only somebody who really faced this problem can judge their difficulties. In addition to this, the real problems are coming up if a certain degree of perfection is attained and the aim is near. Then the problems start. The biggest difficulty in flying a remote controlled helicopter is to control it. This requires extremely high precision and fast responding decisions from the pilot. It never occurs in ordinary model flight. (OH? R/C ED)

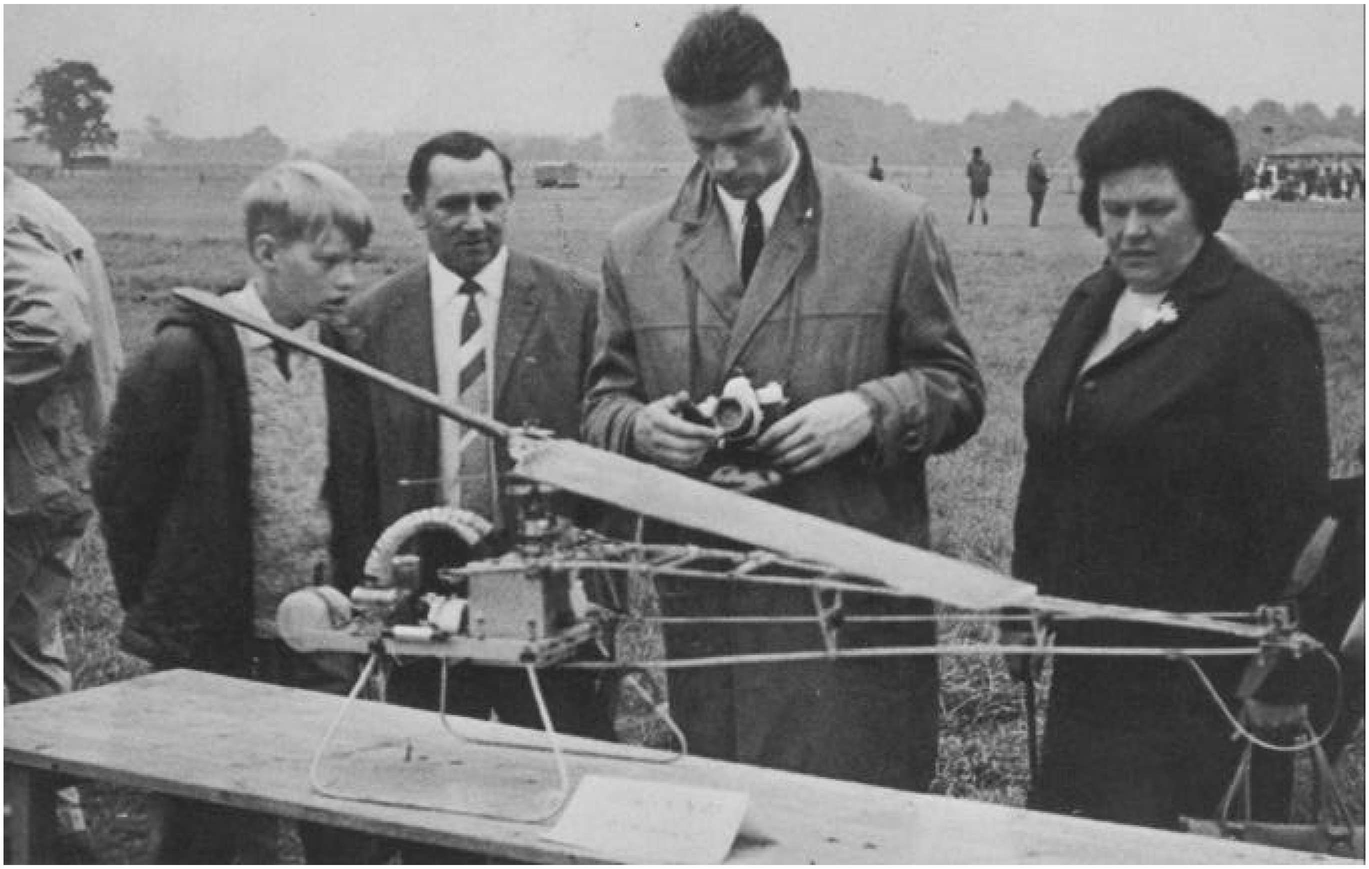
Harsewinkel presented some designs which had a certain technical perfection and flying capability. But what was completely missing, was adequate training of the pilots. The biggest difficulty is resulting from the fact that the helicopter has to start with the most difficult maneuver. This is to hover on ground, in the so-called ground effect. Especially this flight condition requires a great amount of concentration from the pilot of a big helicopter too. At least 35 hours of training for a (full scale) helicopter pilot have their reasons. It is exactly this training we lack as model helicopter pilots. The control mechanism of a model helicopter is so sensitive that a small dip or roll during take-off can result in heavy destruction and long repair work. To save his model, the pilot is forced to carry out at least two, mostly three or four control functions in fractions of one second. This shows the high demand on a model helicopter pilot.

In the moment of take-off you must not only con- *(Continued on next page)*



Sponsor Walter Claas, left, gets demonstration of controls on Joseph Bergenkotter's model. One of few models that featured autorotation.

About the most ingenious model entered, Bergenkotter's did not fly. The whole midsection of fuselage was of lattice construction. Complex!



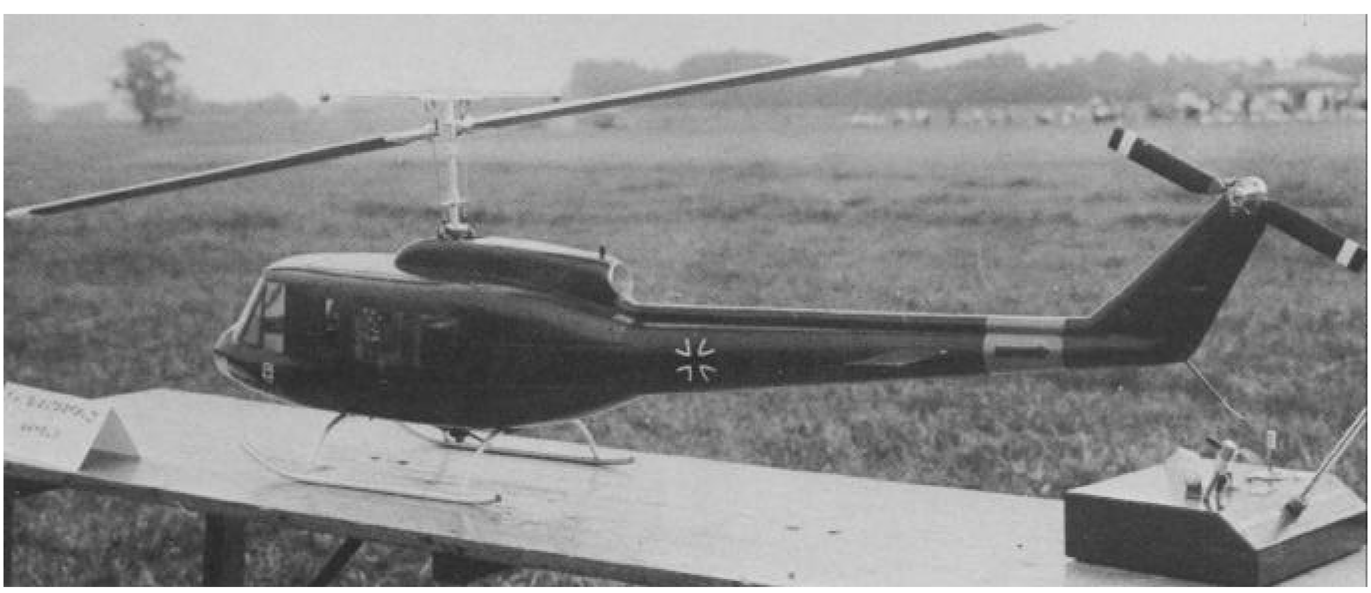
Flexible tubes carried exhaust oil residue back to rotor gearcase. The control system is almost exact replica of Bell 47G. H. W. Knaaf. DNF.

INTERNATIONAL R/C HELICOPTER COMPETITION CONTINUED

trol the take-off, but simultaneously equalize the torque and execute lateral and longitudinal control with the main rotor. This is so much, that only a long training and enormous perseverance can succeed. None of the pilots had this training however, because each one had the same problem to make the power and control to work correctly. So it is not surprising that practically no model made the free flight. Most of them toppled beyond rescue on the first take-off attempt.

The only two who succeeded in a clear take-off were Biesterfeld and Schulter. Biesterfeld's UHD-1 succeeded in a "flying time" of 4 to 5 seconds and altitude of approximately 3 feet then wrecked the blades, and my Sikorsky S-58 twice flew for 10 to 15 seconds to the altitude of 4 to 5 yards, but both times suffered wide spread damage of the model.

That it was at all possible to make the second attempt I owe to an extensive provision of spare parts and to the help of my club buddies. When one encounters such "performance", one can speak of a disappointment, but listening to the "shop-talk" one had the impression that in those few seconds quite a lot has been achieved. Probably all who tackled this problem came to the conclusion that the real difficulties start with *(Continued on page 69)*



F. W. Biesterfeld won first in scale and second in flight with this UHD-1. A beautiful model. He's well known for his many excellent delta designs. The beautifully machined components functioned realistically. Piloting ability, reduced weight vs lifting power are everyone's problem.

Helicopter Competition

(Continued from page 34) flying and controlling.

Although I cannot tell you much about flying of the choppers, I will give you an account of the performances and designs to give a general idea to those interested in remotely controlled helicopters, what are the possibilities in this area.

Basically one must differentiate between models, which are driven with balanced rotor torque, and those, which had the motor in the fuselage and a suitable anti-torque device. Most designers have chosen the arrangement where the conventional propeller is free to turn, and the motor body is attached to the rotor shaft. This system has the advantage of a free torque (apart from small bearing friction) and the pilot is not required to neutralize it by controlling. It was found, however, that this method of power can produce not more than 3 KG lift (6 Ib. approx.). It is however difficult to build a model significantly lighter than 6 Ib. and therefore it is difficult to bring the model beyond the ground effect, not to mention having the reserve to start forward flight. There was not a single modeler who could make such a model hover. Some light models succeeded briefly, then turned over. This happened above all with models whose motor was so close to the ground that the model was "standing" on the propeller stream, not hanging on the rotor. A small side motion and the upsetting moment was so great that there was no possibility to catch it. Efforts to correct this don't look promising, the idea being to move the propeller up, either by locating the motor directly on the rotorhead, or by suspending the motor below but with the propeller driveshaft coming up through the tubular rotorshaft and then the propeller arranged above the rotor. This method weakens the propeller stream but the main motor power also remains very small.

Most promising were the efforts to drive the rotor through a suitable gear drive from a motor mounted inside the model. The efficiency is substantially higher and I believe that by a suitable selection of the drive ratio and proper selection of blades it will be possible to reach a lift of the order of 5 to 6 Kg (10 to 12 Ibs.). The model of Mr. Biesterfeld, according to his data, had the weight of approximately 3.6 Kg (7.5#) on the arrival. I think, however, that in comparison to my model, he could have reported as much as 4.5 Kg, (9#). My model, also with a fixed motor inside the fuselage had the weight of 4.3 Kg. (8.5# approx.). His model and my model lifted without trouble, and exhibited a good climb, which indicated certain spare power. How would other models with a fixed motor perform, I cannot ascertain, because they either didn't lift, or immediately turned over. I think however that 1 can say even today, that a fixed motor with anti-torque arrangement is superior too as far as performance, to the presently known automatic anti-torque arrangements.

The only exception is probably illustrated by the construction of Eng. Stehr, which consisted of two motors being installed in opposed cylinder fashion on the lower hub of the one-over-one double rotor. Both motors worked through a reduction of approximately 2:1 on the gear, which was attached to the shaft of the upper of the two rotors. This method of propulsion has the result that the upper rotor supports itself and the motors on the lower rotor and both give rise to a complete cancellation of the propulsion torque because of counterrotation. For this installation it is surely difficult to start the motors for one must hold one blade pair and start the motor with the other blade pair. Great care must be exercised once the motors are started for the rotors turn quite rapidly, up to 2500 to 3000 rpm, with which of course a considerable loading of the blade roots is associated. The only type of control, which may be considered with only a reasonable technical effort, is a simultaneous control of the blades so that control about the longitudinal and lateral axis is possible only by tipping the rotor head.

Very many variations were seen in the construction of rotor heads. Some used completely rigid rotor heads, which allowed no excursion of the blades either in the vertical direction nor in the plane of rotation. Other constructions employed the so-called semi-rigid rotor head type in which two blades are attached to a common pivoted cross axis so that opposing flap motion can be accomplished. There was only one two-bladed rotor, which had individual flap hinges. All three-bladed rotors were rigid and only most of the four bladed rotors had a flap hinge for every blade. Lag hinges, which allow motion of the blade in the direction of rotation, were present in my model only. My lag hinges were equipped with nylon friction dampers in order to avoid too large a motion in the lag direction.

Some kind of control over the blade angle of attack of the main rotor was present in all models. This was accomplished in most cases through use of a swash plate and only in a very few instances through the use of a so-called spider. However, there were many differences in controlling the lateral and longitudinal motion of the vehicle. Some models were equipped with a so-called head tilt control in which the rotor axis together with the entire rotor system can be tilted about the longitudinal or lateral axis of the model. The overwhelming majority of the models were provided with periodic blade control.

In the best kind of control, the position of the rotor shaft remains unchanged and an inclination of the rotor plane about the longitudinal or lateral axis is accomplished through a periodic variation of the blade angle of attack. This method of control requires a flap hinge in every case and in most instances, as already mentioned above, this was accomplished through a flapping axis, which however was common to both blades. I, too, employed a periodic variation of the blades angle of attack for longitudinal and lateral control; especially since my rotor shafts were already equipped with flap hinges.

All models with rigidly built-in motors had a tail rotor for the purpose of balancing the counter-torque. The tail rotor was sometimes driven through a shaft, sometimes with a belt. All tail rotors were equipped with pitch control to change their thrusts. The most powerful ten cc. motor available at that time on the market was installed in the model. This indicates that every modeler required the maximum performance from his power plant from the very beginning.

The power transfer from the motor to the main rotor or to the tail rotor showed again many variations. Some utilized a combination of belt drive and gear drives. Others again worked with belt drives only. Some of the solutions can be very interesting in the respect that the belt drive can be used very effectively as a clutch during start-up. As a rule this was used in the following manner; while the motor was started the belt was loose around the motor pulley. And only then was it pulled tight by a displacement of the motor or through pressure supplied by an idler pulley such that a gradual rotor engagement was accomplished.

The models of Knaf, Biesterfeld and myself have a driving clutch. Knaf and I put the clutch directly on the motor, which means the highest revolutions, whereas Biesterfeld built his clutch somewhat bigger since it is built in between the first and second stage of gearing. To the best of my knowledge all transmissions had toothed gears, however I had a worm drive which has the disadvantage of poor efficiency. Yet it has the advantage that with a single step you could immediately reach final rotor speed. The disadvantage of the worm drive is that it is irreversible, that is, it can be turned only from the motor side. The transmission is locked when the motor stalls or the clutch is disengaged. This means that a free wheeling clutch is needed after the transmission, which I have so built in my case, so that one kind of ratchet coupling can suffice.

What I have presumed, and what to some extent was also over looked by me was that on practically no model was there provision for an autorotation control; that is for a propeller like adjustment which indeed becomes necessary as soon as the engine stops. One can argue concerning this, naturally, whether such a construction is necessary at the present state of flight performance, as long as one does not stay in the air for long duration and scarcely gets in trouble if the model remains near the ground. Nevertheless I myself have achieved this state of advancement in such a manner that in the event of sudden motor stoppage the aforementioned clutch functions by itself, by which means the rotor gives a cushioning effect and at the time a pitch change brings about autorotation flight. I have never, to be sure, been in a situation where this capability could have been of use.

Concerning the design of blade profiles, blade construction and weights, extremely different opinions still prevail, and it signifies that there is no clear-cut trend of development. Most important, the real flying experience was entirely lacking. There were blades of hollow hardwood with a weight of about 500 grams, there were blades out of fiberglass reinforced plastic colored material, there were blades out of balsa with inlaid steel wire and GFX reinforced, etc. What all blades had in common, however, was that by one fall of the model they more or less became wreckage.

The blade profiles were very different. There were extremely thin fully symmetrical airfoils used, relatively thick Clark-Y shaped airfoils, straight and tapered blades, and even a blade with an "S" profile was there.

Concerning the construction of fuselages I shall express myself not separately. There were also here again many variations between all wood construction and bare wire frame, even to polyester fuselages and flimsy looking light metal trellis construction. To those on the outside it was not surprising that a fantastically true model of the UHD-1 would place high. That was a beautifully built model and therefore it turned out that Mr. Biesterfeld was also entitled to the grand prize of the Count of Hardenberg for the best true model. I came next with my S-58.

All in all this helicopter competition was a highly interesting and tense affair. What yet we need is the further development of already begun construction, and one needs much patience and practice.