Unmanned Remote-Controlled Military Aircraft – Early Attempts

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Abstract—**The article is devoted to the first work on unmanned remote-controlled aircraft in Germany and in the USSR. It gives also information about an attempt to use Russian aircraft-bomb in the beginning of Second World war.**

Keywords-radio-controlled aircraft; unmanned aircraft; flying bomb

Shortly after the outbreak of World War 1, the German military launched a project for developing remote control systems for naval vessels and aircraft. Responsible for this task became the "Verkehrstechnische Prüfungs-Kommission / VPK" (Evaluation Commission for Transport Technology) headed by Professor Wirth. Having evaluated three different control systems developed by Wirth, Röver and Siemens, the commission concluded that remote control of vehicles both on water and the air was fully practicable. Thereafter the project continued under the auspices of the German Navy in cooperation with Siemens, at that time one of Germany's largest industrial conglomerates. Remotely controlled so called FL-boats of the German Navy were in time deployed in battle operations along the English Channel. Siemens, meanwhile, was also experimenting with remotely controlled "Torpedo-gleiter" (glide-bombs) launched from airships. In the end, the glide-bomb project, headed by the engineers Dorner and Dietzius, turned out to be a futile effort [1].

Realizing the increasing importance of the air weapon in the conduct of war, the German military authorities, like their counterparts in France, England and Russia, spent considerable efforts in further developing this service. On the German side, included in these endeavors was the issue of remote control of unmanned aircraft. A central role thereby was again played by Siemens, which had extensive hands-on experience regarding different kind of remote control apparatus, like the one installed on the FL-boats. In addition, Siemens was conducting research with remotely controlled (by wire) glide-bombs and built both combat aircraft and engines. The so called "Fledermaus-Versuche", launched in 1917, formed a central part in these for the times highly advanced technological efforts [2].

In mid-October 1918, some few weeks before the war ended, the three main participants in the "Fledermaus" project – Idflieg (Inspektion der Fliegertruppen) represented by the "Funken-Telegraphie-Versuchsabteilung / FT-VA" (Depart-ment for Experiments with Wireless Telegraphy), Siemens-Halske (S&H), and Mannesmann-Mulag (M&M) – again met to coordinate further progress [3]. The new apparatus, according to M&M's representative, the Swedish engineer Villehad Forssman, made both pilot and observer redundant. In flight, it was controlled by two instruments, a special compass ("Selensteuerkompass") that automatically corrected deviations from course, and an anemometer that registered distance. After take-off, at a preset distance, a bomb throwing mechanism was automatically activated and the aircraft's course changed for return to base. On landing, the anemometer triggered a large parachute that safely put down the aircraft on ground. Radio-control ("FT-Fernlenkung") meant that aircraft operations could take place irrespective of any adverse weather conditions.

The fuselage of the "Fledermaus" had an aerodynamically advanced design, a 100 HP engine allowing speeds of up to 200–220 km/h. Future models were to be powered by 160 HP engines in order to increase the rate of climb (not speed). According to Forssman, three airplanes equipped with 100 HP engines had already been assembled at M&M's workshop in Köln-Westhoven, while other models were in various stages of production. The only piece of equipment still missing was the compass. Practical flight tests were expected to start in the nearest future.

What is not clear from Forssman's account is the question of flight control, meaning how was the aircraft to be handled in flight (roll, pitch, course, climb, speed etc.)? Had some rudimentary form of autopilot been installed? Following what FT-AV's representative Niemann mentioned later, a flight-control system was to be developed by the German engineer Drexler.

In sum, the following scenario emerges regarding the participants and their responsibilities in the "Fledermaus" project:

- project owner Niemann / Idflieg
- project manager Niemann & Forssman
- aircraft Forssman / M&M
- remote control Dorner and S&H engineers / based on a Siemens & Röver system
- flight control Drexler (?)

No documentary evidence has so far surfaced about any flight tests involving the "Fledermaus" apparatus. The same goes for technical drawings, calculations and other documentary evidence regarding the construction of the

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apparatus. According to Idflieg's last monthly report issued on 8 November 1918, meaning three days before the armistice, one of Germany's arguably most advanced technological projects at that time – unmanned, radio-controlled aircraft – had not yet progressed to the stage of practical tests.

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In the Soviet Union, work with unmanned aircraft started only in 1930s, but the impressive results were achieved. In the spring of 1932, a technical bureau in Leningrad specializing in developing new weapons received an order to design radio- and other equipment necessary for constructing a remotely controlled airplane, at the time called "tele-plane". Serving as test platforms were to be decommissioned military airplanes. The new vehicle was to serve several purposes: it was to be loaded with explosives and used as a flying bomb, dropping ordnance on the enemy or returning to base by command signals transmitted via radio; in addition, it was to serve as a flying target together with the training anti-aircraft artillery. The initiators of this new weapon were M.N. Tukhachevsky and G.V. Korenev: Tukhachevsky, at that time, was the Red Army's chief of armaments while Korenev – a specialist in theoretical mechanics – headed the scientific and technical development of radio-controlled aircraft.

Two devices were basically required to solve the problem: an autopilot for inflight control according to given parameters, and a device for transmitting signals to the autopilot to change course and for activating other inflight-related functions.

The autopilot, called AVP-2, was developed during autumn of 1932 by a team of specialists headed by Korenev. It consisted of two free gyroscopes for determining the nautical course and longitudinal-transverse, and an onboard steering apparatus which pneumatically activated the flight control surfaces of the aircraft. In 1933, a AVP-2 was installed on a TB-1 bomber and practically tested in flight; included in these tests was an 8-hour flight along the route Evpatoria (Crimea) – Kharkov – Moscow.

Meanwhile, a technical bureau headed by Academician V.F. Mitkevich had developed a device called "Daedalus", which allowed remote, radio-control control of aircraft equipped with signal receivers and autopilots, the command signals being transmitted either from ground or from an airplane nearby. "Daedalus" was able to handle 16 different signals which allowed changing the course, roll, pitch, speed and climb of the remotely controlled aircraft. The signals were in tonal format, the transmitter having a tonal encoder and the receiver onboard the aircraft a same decoder. Both receiver and transmitter were accurately tuned to resonance, and worked in a highly stable mode. Signals could be transmitted over distances of about 25 km, the maximum response delay being 4 seconds. When designing the "Daedalus", the project team relied on experience gained in developing radio-controlled Soviet torpedo boats.

In November 1933, "Daedalus" in combination with a AVP-2 autopilot was tested in Moscow onboard a TB-1 bomber. Pressing the controls on the "Daedalus" device caused the AVP-2 to carry out the intended flight maneuvers. After the first successful flight, an inspector onboard the bomber reported that the flight crew, during command execution, had not touched the flight controls – from the point of view of the pilots, operations based on these automatic devices were apparently unproblematic. After completion of these initial tests, continued evaluations of the experimental "Daedalus & AVP-2" set-up were to follow. Their designers, together seven persons, were awarded with the Order of Lenin and the Red Star [4].

During the mid-1930s, work with remote control continued, Tukhachevsky stipulating more specific requirements: "A group of two "telemechanic" airplane (TMS), a TB-1 and TB-3, is to be used for bombing heavily defended targets on land, on water and in the air, as well as for attacking enemy air defenses. The airplanes take-off under the manual control of pilots who, after having set the correct course, leave the aircraft by parachute. Inflight control, focusing on the target, is done telemechanically by radio signals sent by an operator onboard the TB-3 bomber from a distance of 10-20 km. The final bombing run and subsequent explosion of the TB-1 is carried out by remote control, by a telemechanical device. In the future, the task of landing unmanned, remotely controlled aircraft after mission completion needs to be solved. Supervising the bombing run requires special optical instruments, allowing a range of observation of up to 10-20 km ... Thereby, the accuracy of guidance is hitting inside a circle with a radius of 250 m …" [5]

Military tests started in the summer of 1936 at the Krechevitsa airfield in the Leningrad District. There, at the home of the 2nd Heavy Bomber Brigade, a special air squad was formed with six TB-1 bombers equipped with AVP-2 autopilots, "Daedalus" devices and compressors activated by small propellers installed outside the aircraft. The airplanes set aside for testing were generally worn out and required repairs. Worse still was the state of the onboard equipment, which often did not function. "14 flights performed in autopilot mode during 2 months does not allow to make any real assessment of the devices' performance – during each flight, either autopilot or the compressor supplying it with power were systematically at fault ... Naturally, flights under radio control were out of the question" [6].

First successes were experienced only in January of the following year. During the course of 2 hours a TB-1, in autopilot mode, executed all commands transmitted by radio from a ground station at distances of up to 18 km without any manual interference by the pilot in command. This was followed by two another successful tests. Still, both autopilots and compressors often continued to malfunction. "The order for 'TMS-36' is unsatisfactory. Prepared <...> for only one group (2 airplanes, 1 command aircraft). The remaining two groups could not finish their tests due to a lack of compressors,

the factory responsible being unable to fulfill the delivery", the People's Commissar of Defense, K.E. Voroshilov, wrote on 23 April 1937 [7].

In September 1937, leading members of the OKB's (KB-21) staff was caught up in the ongoing purges, leading to the arrest of Bekauri, the chief of Bureau, Korenev, the developer of the remote-control system, and 70 more people. Several persons involved, including Bekauri, were shot. OKB-21, in turn, was liquidated, its specialists being moved to other institutions.

But in 1938 work with remotely controlled aircraft continued. At plant No. 379 in Leningrad, specialized in aircraft instruments, three TB-1 bombers were re-equipped with modified autopilots and compressors. On aircraft No. 692 (factory number) the "Daedalus" control equipment was installed; aircraft No. 772, in turn, received a control system which was to allow its employment as a radio-controlled bomb; and aircraft No. 712 was equipped for automatic take-offs and landings.

In 1934, under the direction of engineer R.G. Chachikian, an automatic landing system had been developed which worked as follows: at an altitude of 180-220 m the aircraft, ordered by radio signals, entered along a glide path having an inclination of 4 degrees. Steering the aircraft was done by autopilot, which ensured a constant angle of attack and kept a fixed engine run; air speed was set at 130 km/h. Simultaneously, a measuring device loaded down at the end was extended from the underbelly of the aircraft. Having descended to around 10 meters, this device touched ground and thereby fed an electric impulse to the airplane's control system. At the same time, engine thrust was decreased to a minimum. The landing gear controlled the autopilot's longitudinal channel according to a special program, which selected a correct setting for the steering wheel. This program had been experimentally tested for alignment, holding and landing modes on different aircraft, taking into account their particular parameters.

Factory-tests of the new equipment, using TB-1 No. 712, were carried out from 23 November to 3 December 1938 at the Krechevitsa airfield. Piloting the aircraft were three test-pilots from the 379th factory, i.e. M.I. Magalashvili, N.I. Smirnov and V.G. Novoseltsev. In remote-control mode, no less than 17 take-offs and 22 landings were performed. Included in these tests were also 10 take-offs and 5 landings based on radio signals, using TB-1 No. 692 as test-bed. In sum, the tests were considered to have been generally successful. However, flights without flight crews onboard were not conducted for fear of equipment failure, with secret aircraft accidentally flying to Finland or Estonia.

An airfield near Stalingrad was subsequently selected for state-tests, Major M.A. Nyuhtikov acting as chief test pilot. Between 25 to 29 May 1939, using two telemechanically equipped TB-1s, 10 flights were carried out under radio control. Sending command signals either from another aircraft or from a command post on ground, automatic take-offs, navigating along a closed route and landings took place. On 9 out of 10 flights control crews were placed onboard the aircraft, while the 10th flight, on 29 May, was carried out in unmanned, remotely-controlled mode. Control from ground took place over distances of up to 25 km, inflight control from TB-1 No. 692 at distances of up to 6 km.

After these tests it was concluded that:

"1. In the USSR, these tests have for the first time shown that the task of constructing a heavy-type, telemechanically equipped aircraft able to perform flights from take-off to landing, including flights without flight crews, is principally solved.

2. The work performed with telemechanically equipped TB-1 aircraft so far allows to proceed with the development of a modern telemechanic airplanes.

3. On the basis of a TB-1 telemechanically equipped airplane it is already now possible to start combat operations with telemechanic aircraft "[8].

Simultaneously with the TB-1, a U-2 light biplane was used for remote control tests - also this airplane succeeded to land in unmanned mode.

The results achieved so far were considered to be most encouraging. On 20 January 1940, the USSR Defense Committee issued a decree for the production of new radio-controlled airplanes. Thereby, plant No. 379 was ordered to manufacture two telemechanically equipped, four-engine TB-3 bombers in two basic variants, one as a single-used flying bomb and the other for multiple purposes and equipped with an automatic landing system. In addition, the plant received orders for two high-speed SB bombers equipped the same way as the TB-3s, with one SB and one long-range TB-3 planned to be used as airborne command post.

During the first half of 1941, one remotely controlled TB-3 bomber passed state acceptance tests. The control report of these tests has survived: "The TB-3 'tele-aircraft', at the beginning of testing, was controlled from a special pilot panel installed onboard the airplane. Pressing the required buttons on this panel, the aircraft automatically performed intended maneuvers.

After having established the reliability of automatic piloting via the panel installed onboard the airplane, tests with remote control by radio signals sent from a ground station were to follow. Thereby, the operator on ground activated the command "take-off" by which the aircraft performed an automatic take-off run without any pilot interference. At an altitude of 200-250 meters, the aircraft automatically switched to horizontal flight mode and carried out flight maneuvers - without pilot intervention - according to commands transmitted from ground via radio signals (turns, exiting course, climb, changing speed, landing). During testing, the airplane performed:

- two automatic take-offs based on radio signals;
- eight automatic take-offs controlled via a control panel onboard the airplane;
- flights to specified locations, and return to the airfield under radio control;
- remotely controlled high-altitude flights up to 5,572 m.

A total of 86 flights were carried out under radio control; using the control panel onboard the aircraft 250 flights were executed. Flights under radio control lasted for 2 hours 50 minutes, under automatic control via the onboard control panel for 12 hours and 52 minutes [9].

Included in the construction of a remotely controlled airplane-bomb was the onboard installation of a high-power combat charge, a device specially designed by a team headed by Professor N.I. Galperin. This ordnance consisted of several parts and was loaded through the bomb-bay inside the fuselage of a TB-3 bomber, where it was finally assembled.

After the beginning of World War 2, both combat- and test pilots undertook renewed tests with the five airplanes which had been equipped for remote control. However, no decision was taken about their eventual use in combat. Instead, considering "special secrecy" which surrounded this weapon, the airplanes were moved out of the battle-zone into the rear of the country. At the end of 1941, two pairs of command aircraft as well as one radio-controlled TB-3 No. 22685 were stationed in Kazan, while TB-3 No. 22707 - loaded with 3.5 tons of explosives – and a DB-3F command aircraft were stationed at Ivanovo airport.

The situation changed when R.G. Chichakyan wrote to G.M. Malenkov, a high-ranking member of the Soviet government, complaining that "when tools for combat are ready and could be effectively employed, this is left aside without any notice paid from some quarters" [7]. Malenkov, in turn, instructed the Commander of the Red Air Force to introduce remotely controlled aircraft in combat.

On 25 March 1942, the TB-3 based in Ivanovo loaded with explosives, accompanied by a DB-3F airplane, was sent on a mission to destroy the Vyazma railway junction. Onboard the TB-3 were first pilot, Major A.N. Tyagunin; a second pilot sitting on right side, R.G. Chachikian, acted as weapons operator and was also responsible for automated flight control; the third crew member was the flight engineer
V.G. Moiseyev. The decision to place a flight crew onboard an aircraft equipped with an automated piloting system was primarily based on safety considerations: a failure at take-off from an airfield full of equipment and troops could cause considerable harm. After take-off, having transferred the TB-3 to radio control mode, the flight crew left the airplane on parachutes. The continued flight of the TB-3 was controlled by the military engineer V.Ya. Kravets from the accompanying DB-3F; the commander of the DB-3F was Flight Captain V.V. Ponomarenko. The mission could not be completed, though. On approaching Vyazma, the DB-3F's radio antenna got damaged by enemy anti-aircraft fire, causing the now uncontrollable TB-3 airplane-bomb to eventually crash and explode in the rear of German lines north-east of Vitebsk.

The second telemechanically equipped TB-3 was later destroyed at an airfield when ammunition blew up in a neighboring aircraft. Soon thereafter, the operations of OKB No. 379 were discontinued, and its staff moved to other aircraft facilities.

A significant drawback of unmanned aircraft controlled from another aircraft was that effective flight control could only be carried out under conditions of good visibility, disallowing flight operations in clouds or at night. Still, successful tests with automated take-offs and landings, including multi-engine aircraft, during the late 1930s and early 1940s, tests carried out without any accidents, are nothing but outstanding examples of the high level of scientific and technical achievements of the USSR.

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