HELICOPTER/SHIP INTERFACE

CANADIAN EXPERIENCE OF HELICOPTER HAULDOWN AND RAPID SECURING DEVICE

BY

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Introduction

Reference to *Jane's Fighting Ships* will show a clear trend towards the combination of small ships and helicopters as the universal surface ASW unit. This trend is attributed to four facts:

(*a*) The alternative to the small ship/helicopter unit is a multi-helicopter carrier with the size, crew, and sophisticated facilities this implies. Ships of this type are too expensive for most nations and are also a delicious target for stand-off weapons.

(*b*) The modern submarine is superior to the ASW destroyer in virtually every respect. Surface ships are slower, noisier and detectable at ten times their own effective sonar range. The surface vessel must extend its detection range somehow and the helicopter is the obvious answer.

(*c*) The helicopter has advanced at a breath taking rate in the past fifteen years. This, combined with advances in airborne ASW equipment, makes the modern helicopter a very effective all-weather detection and weapon delivery device.

(*d*) The fact that certain 'pioneer' nations such as Canada and the U.K. have been successful in mating ASW helicopters to small ships.

It is interesting to note that two schools have developed in small ship/helicopter operations—the large helicopter (18 000 lb +) school and the small helicopter (10 000 lb −) school. Although both schools can provide ample justification for their course of action, there is a suspicion that the decisions that set them on their paths were more political than tactical.

Today, Canada's east coast surface force is almost entirely large helicopter oriented. It consists of eight destroyers of the *St. Laurent* and later classes, each capable of operating one Sikorsky Sea King (SH-3A) helicopter; four gas-turbine destroyers of the 280 class, each with two Sea Kings; and two Operational Support Ships (AORs) which can hangar three spare Sea Kings and have facilities to provide second-line maintenance support to other ships.

The concept has proved so successful as an ASW weapon that any destroyers built for the Canadian Navy in the next twenty years will probably be helicopter carriers.

Development of the Helicopter Destroyer (DDH) in the Canadian Navy

Recently, archivists have uncovered a memorandum dated 1943, addressed to the Canadian wartime shipbuilding agency, in which it was suggested that 'some of the frigates under construction should be completed as anti-submarine helicopter carriers'. Apparently the wisdom of this suggestion was not appreciated as evidenced by the fourteen-year lapse before any action was taken.

The first Canadian ASW helicopter squadron was formed in July 1955 using the Sikorsky H04S (affectionately known as the 'horse'). It flew operationally from the aircraft carrier *Magnificant* and later from the carrier *Bonaventure*.

The tactical potential of the helicopter was becoming obvious by the mid 1950's, but equally obvious was the fact that a large ASW helicopter carrier was not economically feasible for the Canadian Navy. Budget constraints limited efforts to using available aircraft and ships in being. Consequently a 34 × 45-foot flight deck was installed on the quarterdeck of an aging frigate (H.M.C.S. *Buckingham*) and a three-month rough-weather flying trial commenced in October 1956.

The results of this trial were significant. Not only was the feasibility of operating a large helicopter from such a small platform clearly demonstrated, but the limitations appeared to be not in the pilot's ability to land on the small deck, but in the inability of the flight deck crewmen to secure the helicopter before there was a danger of it sliding or toppling due to ship's motion. The need for an instantaneous securing device became apparent very early in the program. Also, attempts to reposition the helicopter on deck using manpower alone led to potentially dangerous situations in even moderate sea conditions. There was also evidence that a shipborne helicopter would remain serviceable a great deal longer if it were sheltered in a hangar and provided with selected maintenance facilities.

The decisions made as a result of the *Buckingham* trial firmly committed the Canadian Navy to a series of programs designed to make the helicopter an integral part of the ASW armament and to make helicopter services an integral part of the ships structure. These programs were:

(*a*) to engineer a modification package to fit flight deck, hangar, maintenance facilities, and aircrew accommodation in six existing ships and in the two unbuilt members of the class;

(*b*) to procure a helicopter to replace the aging H04s with capabilities to match the demands of DDH staff requirements. Although larger than originally envisaged, the Sikorsky SH-3A 'Sea King' helicopter was selected because of its endurance, all-weather flying capability, twin engines, and other characteristics that made it a first-class ASW helicopter. This large (19 000 lb) and sophisticated helicopter, while most welcome to the operators, compounded the problems of operating a helicopter from an escort-sized ship.

(*c*) to develop a method of instantly securing the helicopter to the deck upon landing as well as providing a means of controlled traverse in and out of the fixed hangar. A development contract was given to Canadian industry in 1959 which resulted in what is now known as the Helicopter Hauldown and Rapid Securing Device (HHRSD).

The three separate programs came together in H.M.C.S. *Assiniboine* in late 1964 when extensive flight deck and hangar compatibility trials commenced, and the HHRSD system was refined and finally proven at sea. During the three-year trial period, tentative maintenance support and personnel manning policies were also established, and changes to many associated systems were made. Of paramount importance during the early years of the DDH evaluation were the safety considerations of both the ship and the aircraft. Often, the pressures to advance the program quickly were prudently moderated to ensure that the training and experience of the personnel and the adequacy of the equipment matched the pace of development. The accent on safety established in those early stages of the program has persisted to this day.

The first operational air detachment with their Sea King helicopter embarked in H.M.C.S. *Saguenay* in 1967 just ten years after the start of the *Buckingham* trial. By the autumn of 1969 all eight DDHs were operational in their new role.

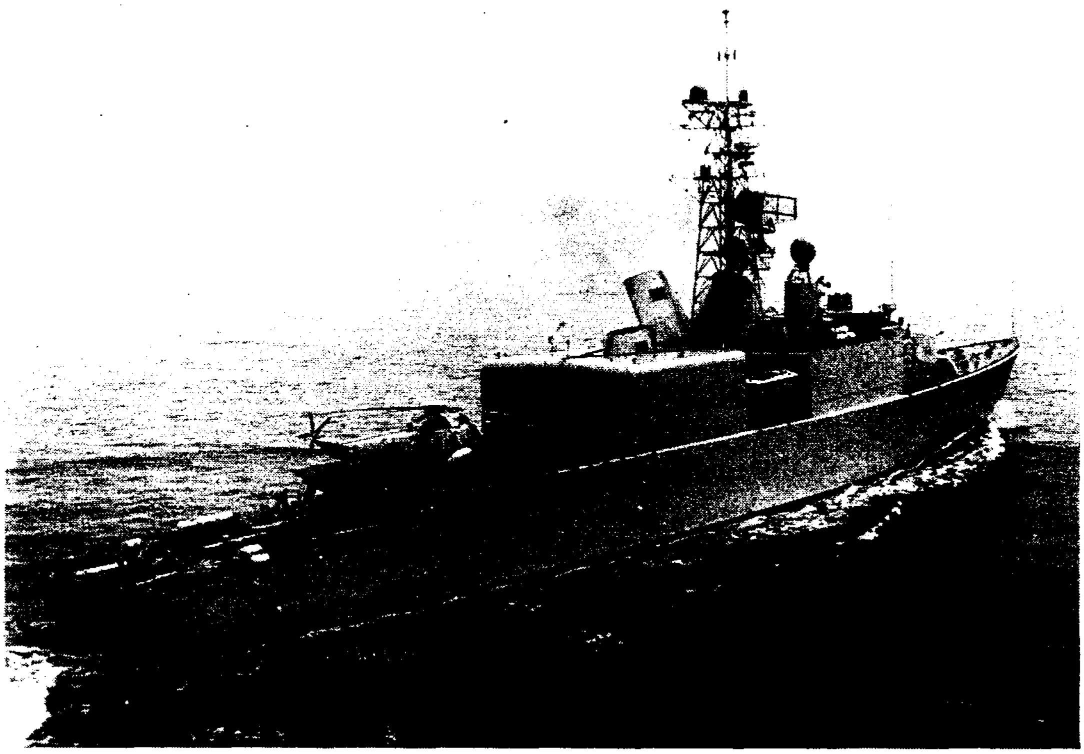

FIG. 1—H.M.C.S. 'IROQUOIS', A DDH 280 CLASS DESTROYER

The DDH 280 Class ships were designed specifically as helicopter destroyers. The width of the ships, for example, was based on the width required for a hangar to house two Sea Kings. Funnels were made 'Vee' shaped to direct exhaust gases away from the flight deck, palatial maintenance spaces and air-crew accommodation were provided and the ship was fitted with a dual HHRSD of advanced design. Although some feel that the DDH 280's go too far to accommodate the helicopter at the expense of other roles, there can be no doubt that they are a significant example of the marriage of helicopters and warships.

The Deck Securing Problem and the Canadian Solution

As mentioned earlier, the danger period during the landing of a large helicopter on the flight deck of a small ship is the interval between when the helicopter ceases to be in flight and when it becomes part of the ship through the action of tie downs or other securing devices. This was the problem presented to industry in 1959 along with the requirement to provide a means to traverse the helicopter with the main and tail rotors folded, into the hangar. The specification called for a system to secure the helicopter within 4 seconds of the main wheels touching the deck, with the deck at 31° of roll, 9° of pitch and heaving up to 20 feet per second in winds of 50 knots.

The system adopted consists of a spring loaded retractable probe near the centre of gravity of the aircraft (FIG. 2) which is 'trapped' by the jaws of a Rapid Securing Device (RSD) secured to the ship in the centre of the flight deck. The hold of the RSD (often called the 'Beartrap' for obvious reasons) on the helicopter main probe prevents upward, forward, and sideways motion. Rotation about the main probe is prevented by another retractable probe located near the tail wheel of the helicopter which engages a series of slots on the after end of the flight deck called the Tail Grid (FIG. 3). The Tail Grid is extended to allow the tail probe to be engaged even when the helicopter lands up to 30 degrees (approximately) off the centre line of the ship.

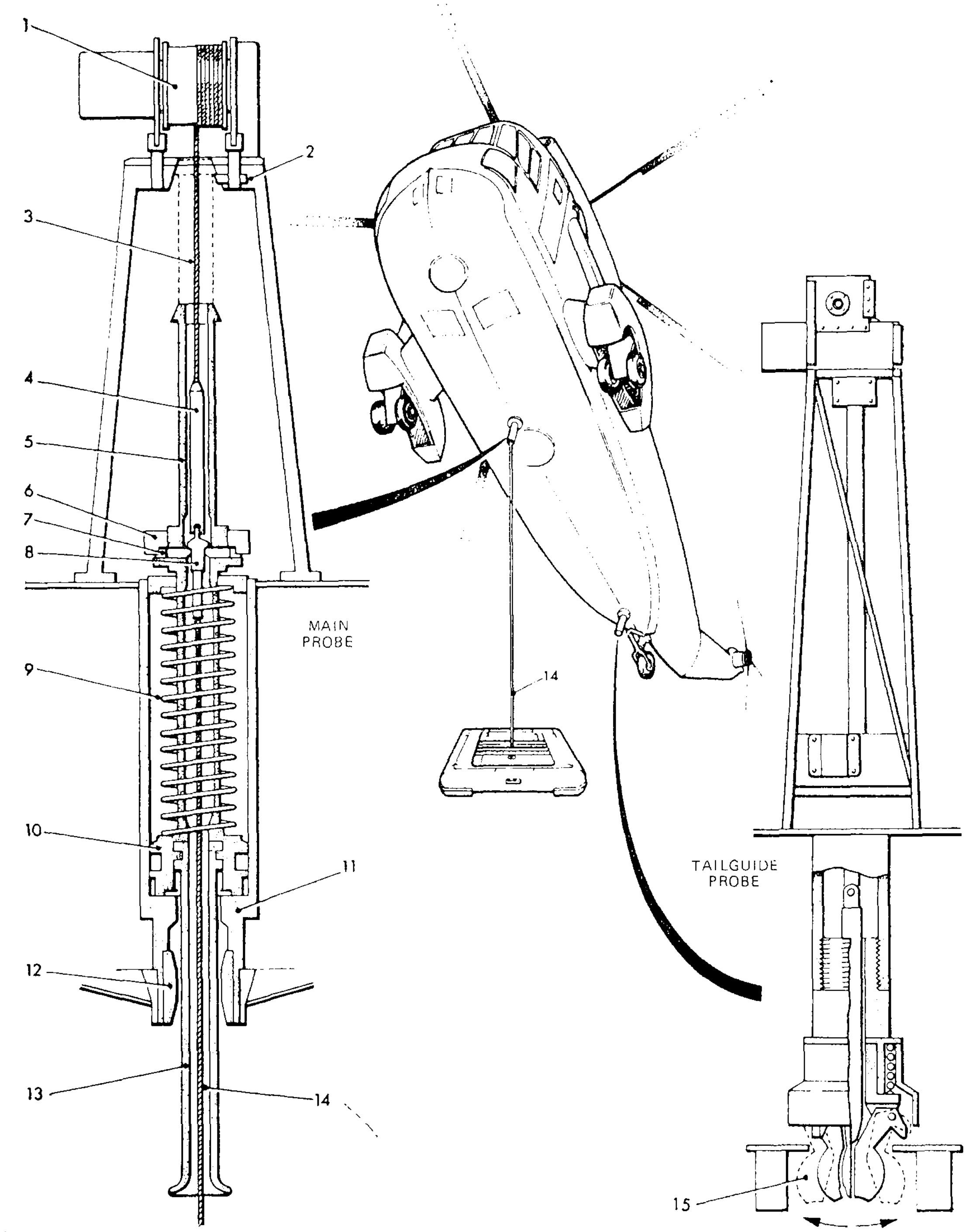

FIG. 2—HELICOPTER MAIN AND TAIL PROBES

Key:
(1) Messenger Winch
(2) Retractable Lock
(3) Messenger Cable
(4) Messenger Probe
(5) Hub
(6) Probe Up-lock Actuator
(7) Retractable Locks
(8) End Fitting, Hauldown Cable
(9) Buffer Spring
(10) Slide Housing
(11) Outer Housing
(12) Shock-mounted Guide Sleeve
(13) Main Probe
(14) Hauldown Cable
(15) Tail Probe Extended

The RSD must fit under the Sea King and between its main wheels. This requirement limits the open or 'target' area of the RSD to a 36 × 42-inch rectangle. Thus in order to be 'trapped' successfully the pilot must place his main probe in a 10·5 sq. ft patch which is out of sight under the aircraft for the critical final seconds of the operation. Clearly the pilot needs help and gets it from three sources:

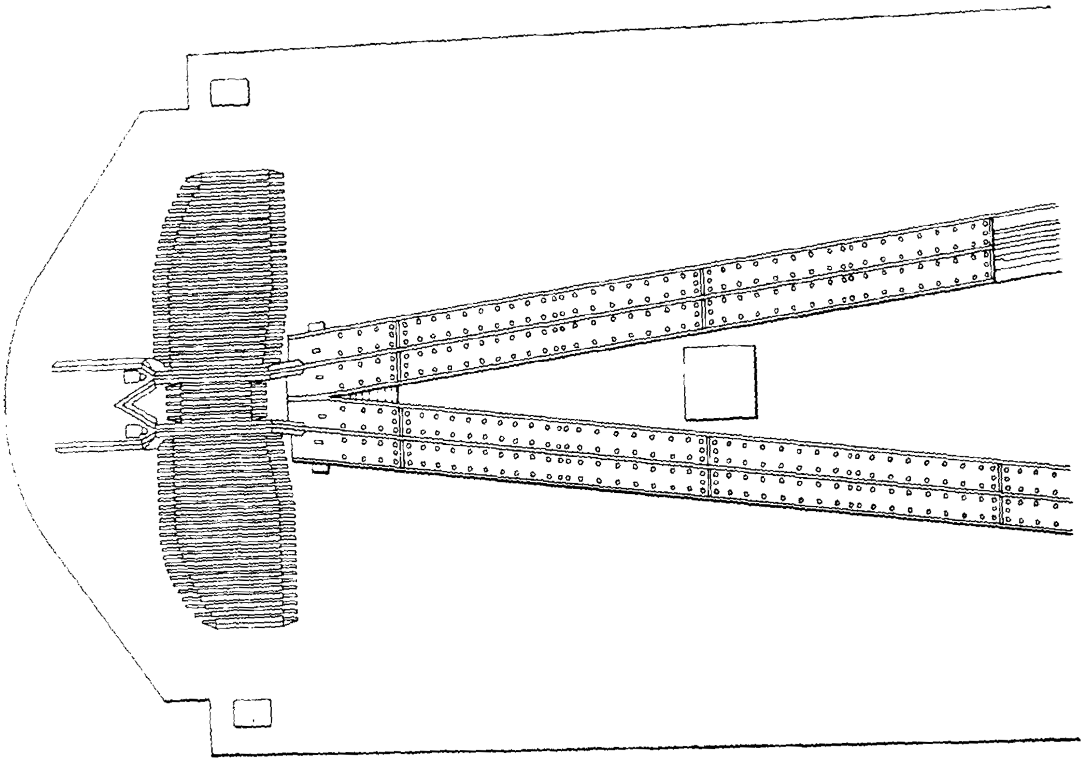

FIG. 3—TAIL GRID

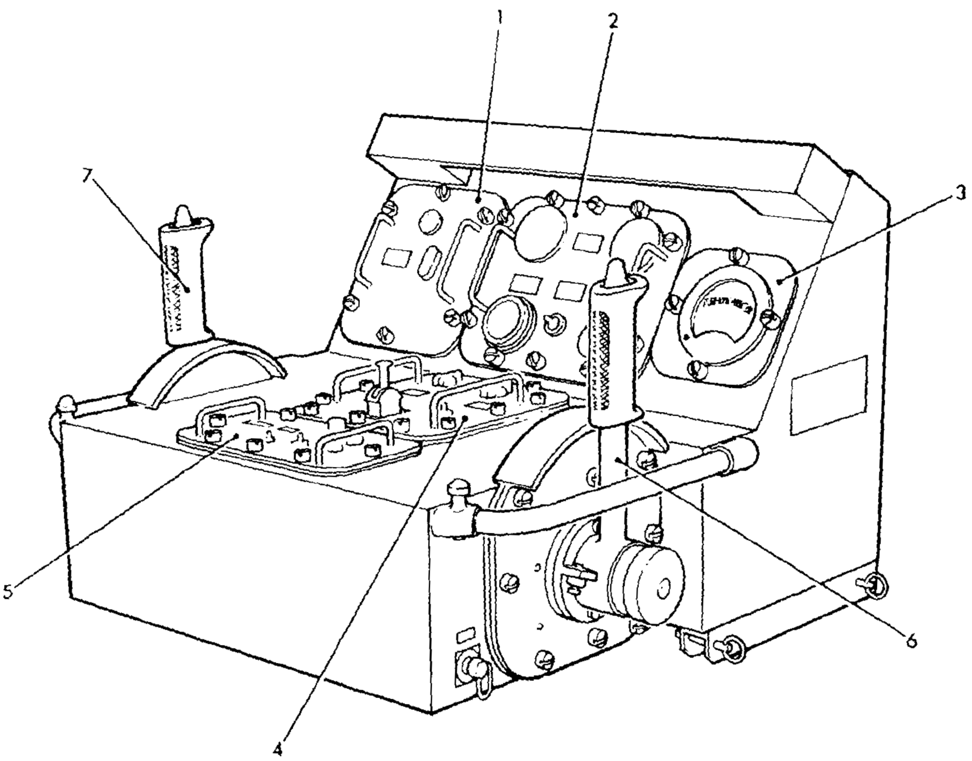

FIG. 4—LSO CONSOLE

Key:

(1) Intercommunication Panel
(2) Hauldown Control Panel
(3) Tension Meter
(4) Trap Control Panel
(5) Bridge Information Panel
(6) Hauldown Control Lever
(7) Traverse and TGW Lever

(*a*) Deck markings, lights, and other visual aids to tell the pilot where he is with respect to the RSD and to give an indication of deck motion.

(*b*) A Landing Signals Officer (LSO) who is located on the flight deck in a position to see the RSD and the main probe. The LSO 'talks' the pilot down into the RSD and closes the jaws on the probe using the facilities on his LSO's console (FIG. 4).

(*c*) A cable, incorrectly called the Hauldown Cable, which passes up through the centre of the RSD and is secured to the helicopter through the main probe. The tension on this cable is controlled by the LSO. A hydraulic control system below the flight deck maintains the hauldown cable at constant tension with reel-in speeds up to 20 feet per second (FIG. 5).

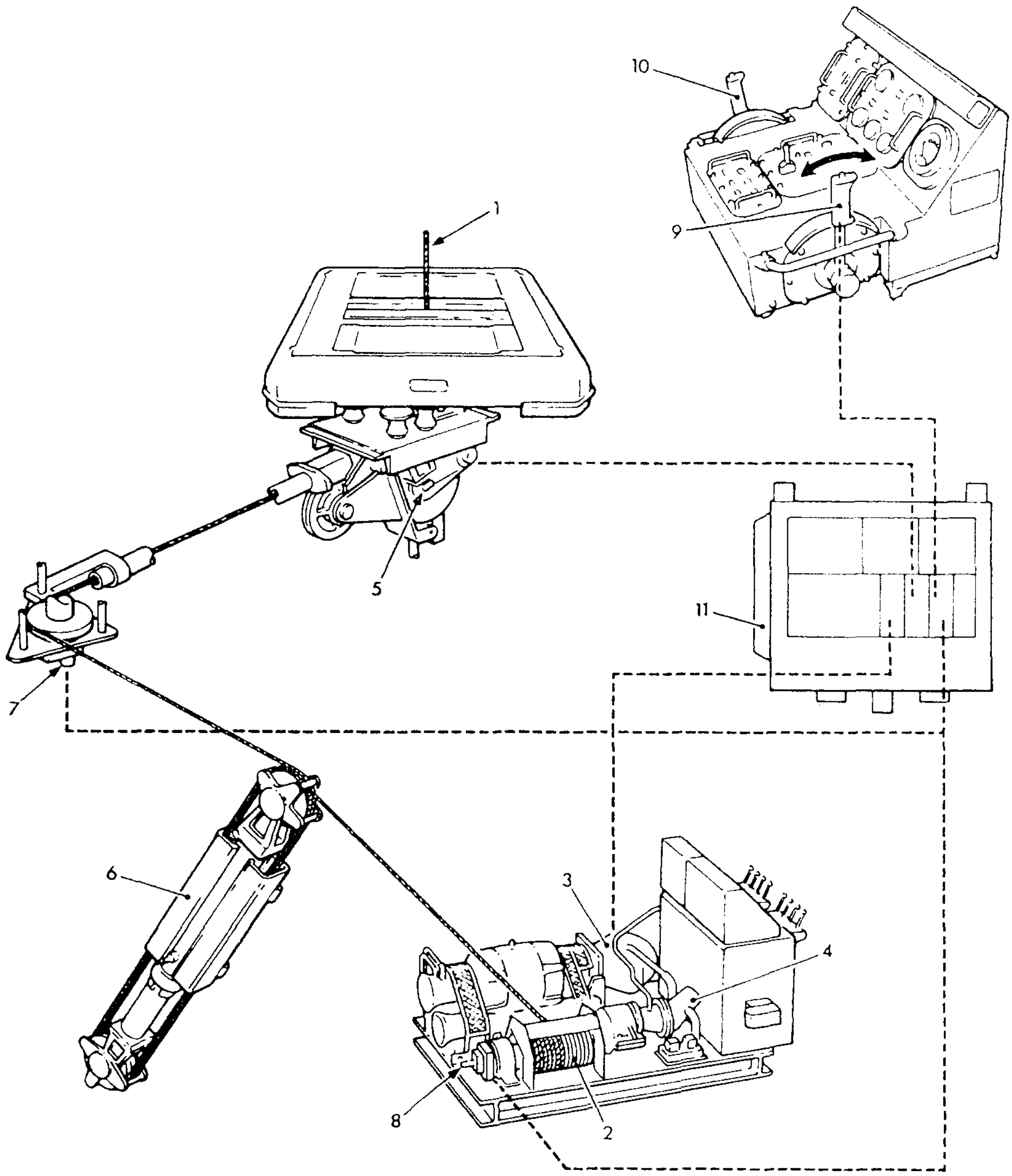

FIG. 5—DIAGRAMMATIC VIEW OF HAULDOWN SYSTEM

Key:
(1) Hauldown Cable
(2) Hauldown Winch
(3) Dowmatic Pump
(4) Dowmatic Motor
(5) Load Cells, Swinging Bellmouth
(6) Rope Accumulator
(7) Sheave Tachogenerator
(8) Winch Tachogenerator
(9) Hauldown Lever, Control Console
(10) Traverse and TGW Lever, Control Console
(11) Amplifier Comparator Unit (ACU)

A Typical Landing

Prior to the aircraft's return for landing, the RSD is positioned over the housed hauldown cable. With the cable tension set at zero on the LSO's console, approximately 50 feet of hauldown cable is drawn up through the centre of the RSD and flaked on the deck.

With the ship at Flying Stations the course is altered to put the relative wind 30 degrees on the port bow. The Sea King approaches over the stern of the ship and takes up a hover 20–25 feet above the centre of the flight deck. The pilot lowers a $\frac{1}{8}$-in wire messenger to the deck which is grasped by one of the deck crew using a pair of grounded tongs to discharge any static electric charge. The hauldown cable is connected to the messenger and the two are drawn up the centre of the main probe by the messenger winch (FIG. 1). The messenger winch also controls the lowering of the spring-loaded main probe which is manually housed in flight. With the hauldown cable connected to the aircraft and the main probe extended, the flight deck is cleared of all personnel except the LSO and the landing begins.

The LSO brings the hauldown winch into operation at minimum tension and the excess hauldown cable is taken up on the drum. When the cable is taut the LSO applies 2000 lb tension which the pilot matches with power to maintain a

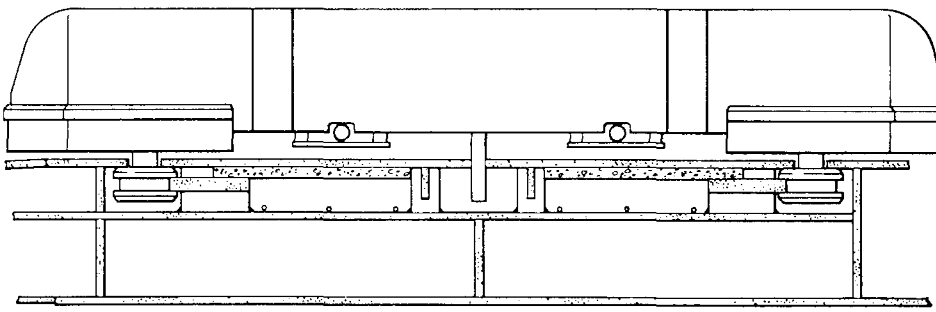

FIG. 6—FRONT VIEW OF RSD SHOWING TRAVERSE TRACK

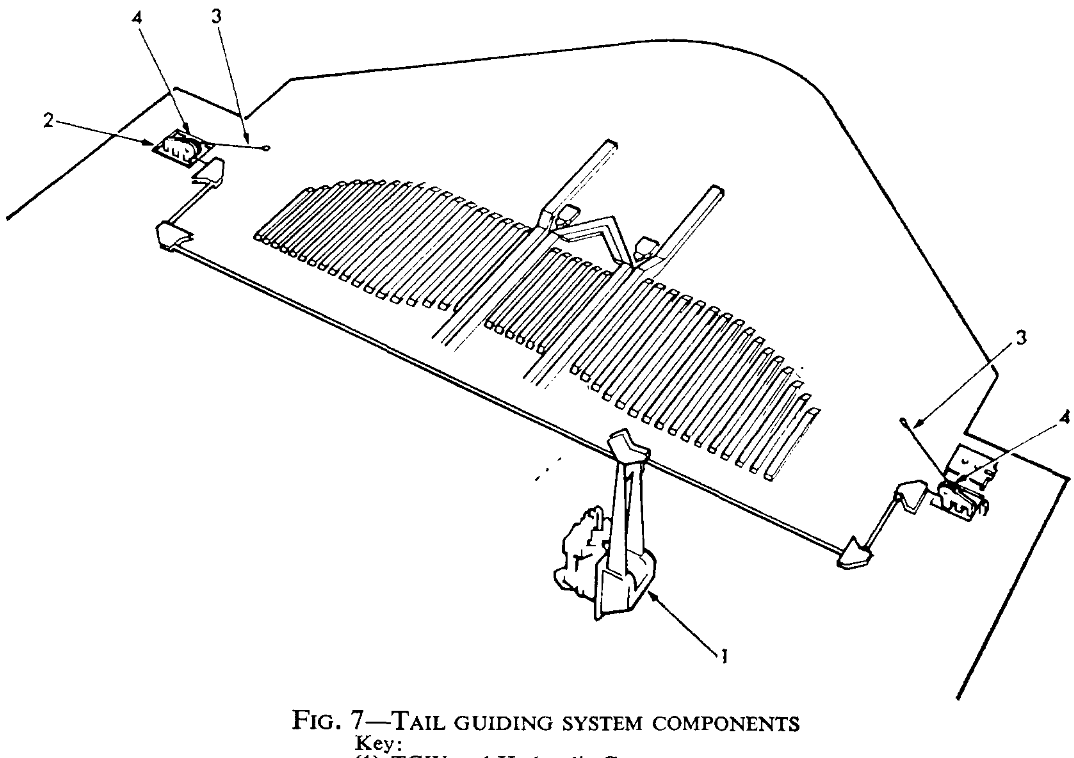

FIG. 7—TAIL GUIDING SYSTEM COMPONENTS

Key:
(1) TGW and Hydraulic Components
(2) Pulley Wells
(3) Cables
(4) Sheaves

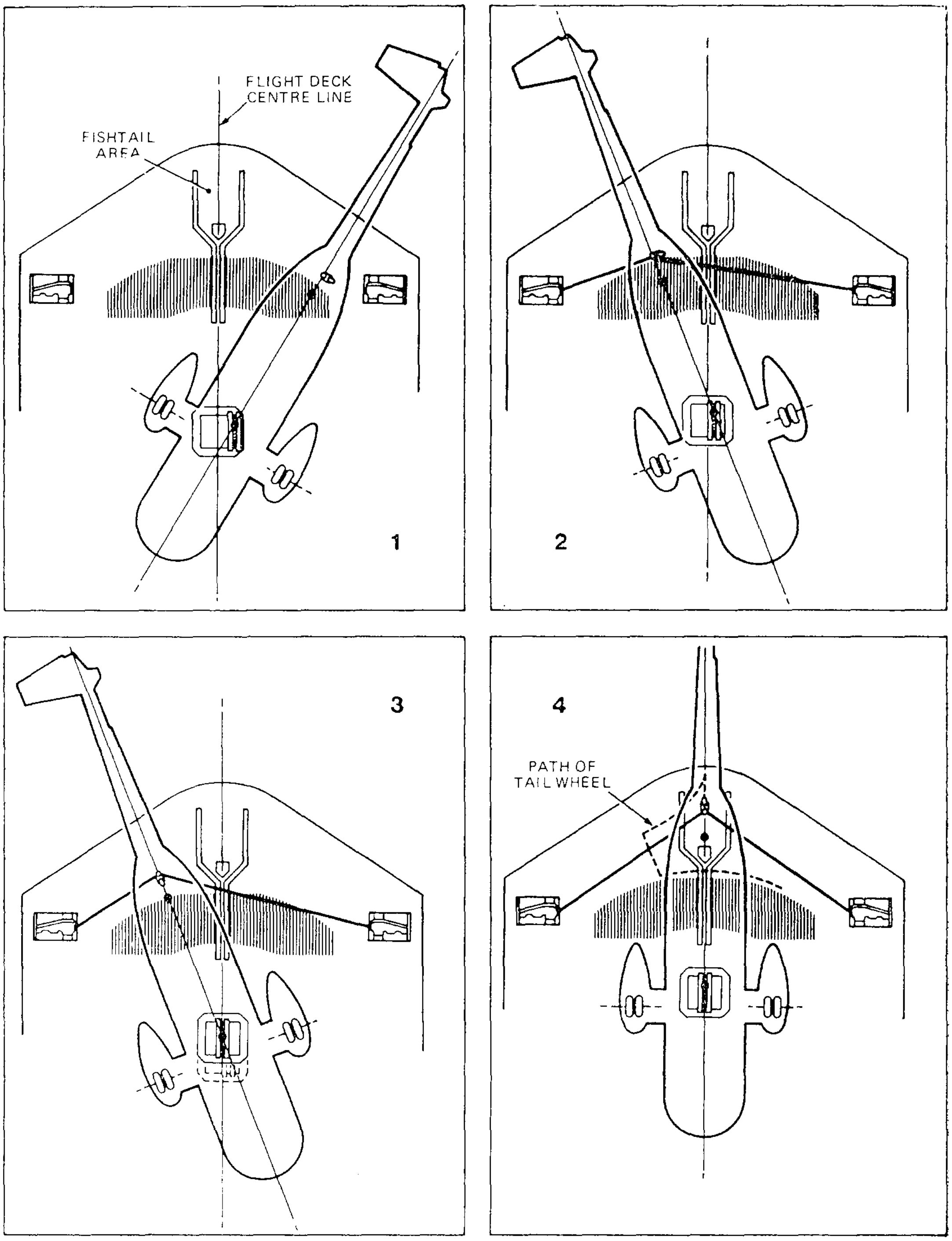

FIG. 8—THE STRAIGHTENING OPERATION

hover of approximately 8–10 feet. When the LSO judges the deck will be steady for touchdown he increases tension to 3000 lb and tells the pilot to land. The pilot controls the rate of descent and actually flies down rather than being hauled down. He has no less than four methods at his disposal to release the helicopter from the hauldown cable if an emergency develops. The tensioned cable has a stabilizing effect that helps the pilot maintain a precise hover and also to land consistently into the Rapid Securing Device.

When the LSO sees the probe within the confines of the RSD he fires the jaws which close around the main probe and secures the helicopter to the deck. Once the main probe is trapped the pilot lowers the tail probe into the tail grid and the helicopter is now effectively part of the ship.

Straightening and Traversing

Having secured the helicopter to the ship the next requirement is to traverse it into the hangar while keeping it firmly anchored and under positive control. The size of the helicopter leaves little clearance at the hangar door and requires accurate alignment during traversing.

The strength and control requirements are achieved by using the RSD as a mule to pull the helicopter via the main probe. The alignment requirements are met by the use of deck tracks which guide and restrain the RSD (FIG. 6) and by engaging the tail probe in a slot that parallels the RSD tracks (FIG. 3).

Straightening refers to the process of positioning the helicopter's main probe in the centre of the RSD and its tail probe in the centre-line slot both in preparation for traversing. This operation is accomplished using a tail guide winch and cable system (FIG. 7) and the RSD itself.

Consider the case shown in FIG. 8 where the helicopter's main probe has been trapped on the port side of the RSD and its tail probe is engaged in the port tail grid. The first step requires the deck crew to run out the tail guide winch cables and connect them to the helicopter's tail wheel assembly. The tail probe is retracted by the pilot and the LSO swings the tail of the helicopter to the starboard side. He then traverses the RSD aft causing the arrester beams to move to the left until they reach the middle of the RSD where they are automatically locked. The LSO then swings the tail of the helicopter to the midships position and instructs the pilot to lower the tail probe. With the main probe in the middle of the RSD and the tail probe in the centre-line slot, the helicopter can be smoothly traversed into the hangar from the LSO console.

Once in the hangar the helicopter can continue to be secured by the RSD or there are ample tie down points to enable the RSD to be returned to the deck or free for maintenance.

Present and Future

The HHRSD is installed in twelve ships of the Canadian Navy and has proved to be a low maintenance reliable system. International interest has led the manufacturer—DAF INDAL of Toronto—to develop and market at least three versions:

(*a*) A system very similar to that fitted in the Canadian DDH 280 has been supplied to the Japanese Navy for their *Tachikaze* frigate and will be supplied to the West German Navy to handle Puma helicopters in their S-type frigates.

(*b*) A less expensive simplified version has been developed without an RSD and using an eddy current clutch to control cable tension. Two of these systems are being supplied to the Indian Navy *Leander*-type frigates to handle Westland Sea King helicopters.

(*c*) The USN has recently awarded DAF INDAL a development contract to modify the 280 Class HHRSD to be compatible with the LAMPS MK III air vehicle (a Sikorsky helicopter yet to be supplied). The specification calls for as few changes as possible from the Canadian system and it appears that the RSD will be the only component requiring major redesign.

The USN has assigned the acronym RAST to the project which is short for Recovery Assist Secure and Traverse System. Present plans call for the RAST system to be installed in over 100 ships including the FFG 7 and DD963 classes.