KAMAN Rotor Tips

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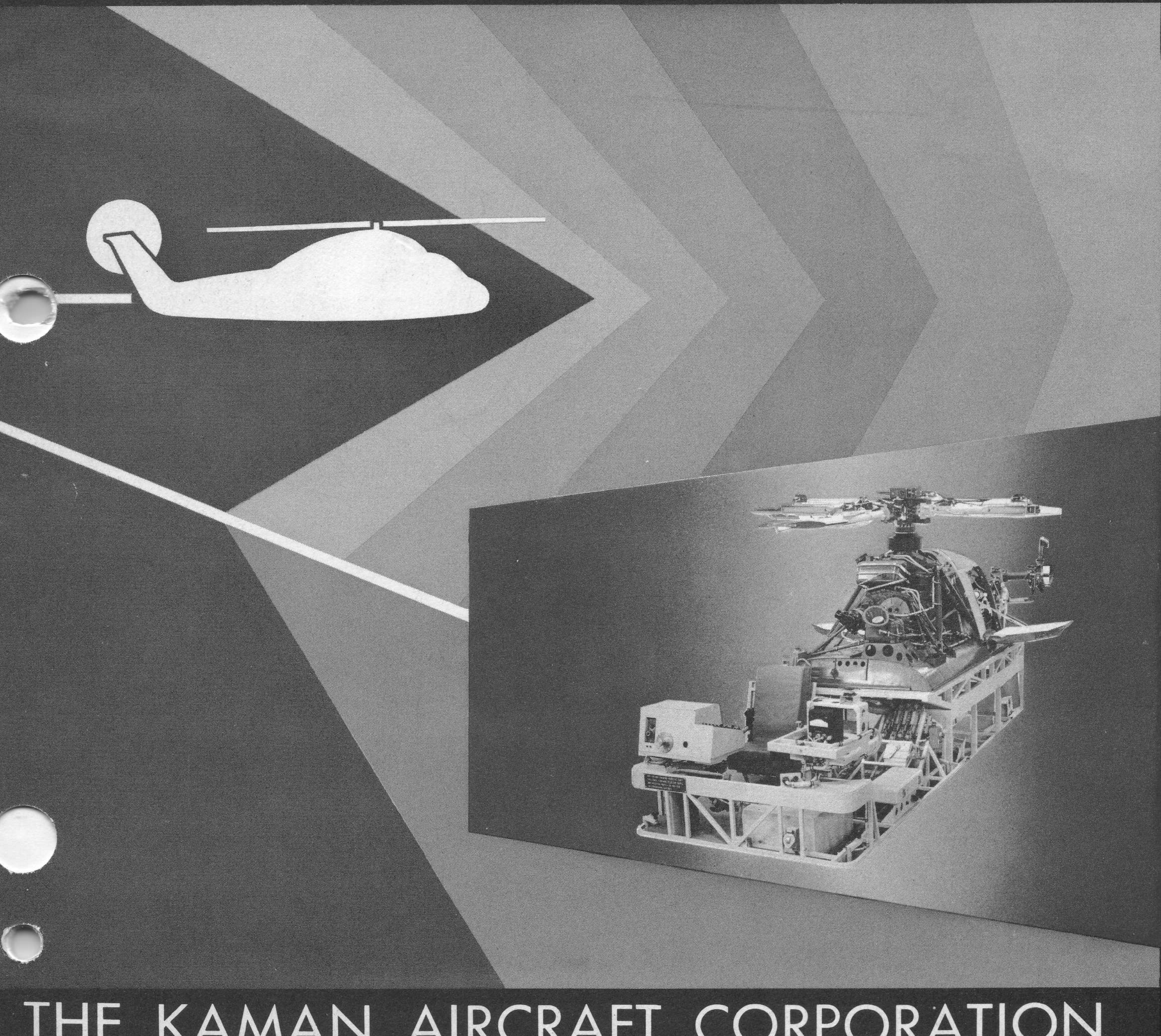

THE KAMAN AIRCRAFT CORPORATION

PIONEERS IN TURBINE POWERED HELICOPTERS

KAMAN

Kaman Rotor Tips

SEPTEMBER, 1960

ADDRESS ALL INQUIRIES TO:
Kaman Rotor Tips
Field Service Department
The Kaman Aircraft Corp.
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Bloomfield, Connecticut

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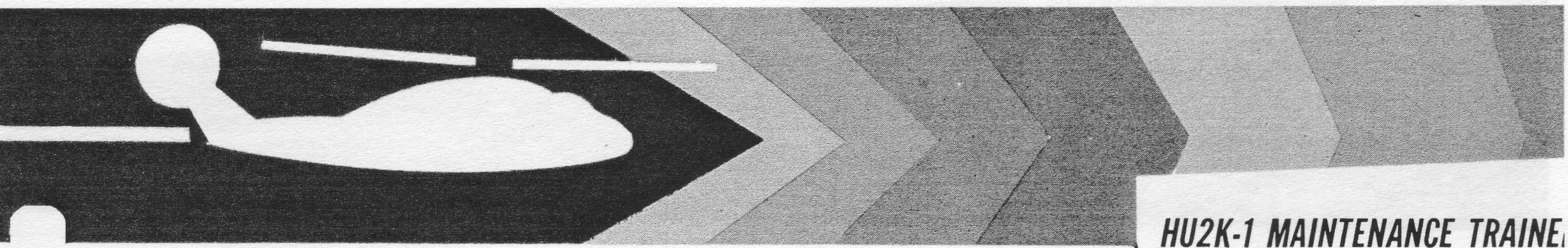
THE COVER

Pictured is the full-scale HU2K-1 Naval Aviation Maintenance Trainer being used at The Kaman Aircraft Corporation for instruction of U. S. Navy personnel.

—— *PLEASE SHARE THIS COPY* ——



HU2K-1 MAINTENANCE TRAINE

by R. C. ALLEN
Project Engineer, NAM

A seven-month factory training program on HU2K-1 maintenance began for U. S. Navy personnel a few days ago at The Kaman Aircraft Corporation. The high-speed, long-range helicopter now being produced at the Bloomfield, Conn., plant, is scheduled to join the Fleet next summer.

Seventy-three helicopter mechanics, instructors or other maintenance personnel will receive the specialized training. The first group, now attending the school, is from the Naval Air Test Center, NAS, Patuxent River, Maryland. The second group will be from the Naval Air Mobile Training Group, NAS Memphis, Tenn., while personnel from the Fleet and NATC are scheduled to attend the last two classes.

Classroom instruction is from four to eight weeks, depending on the personnel attending. Helicopter mechanics will receive four to six weeks training while the Navy instructors will be given two weeks additional time so they may learn to operate and maintain the trainer while conducting similar classes when they return to their activities. Forty hours of instruction is received each week during the factory training course and a three-hour examination will be given at the end of each training class. From 15 to 20 men will attend each of the four classes conducted during the seven-month period.

KAC Field Service Department instructors conducting the program under the supervision of Robert Spear, assistant supervisor, training; are: Homer Helm and Raymond Vokes, hydraulics, rigging and similar maintenance; Robert Krans, electrical; Frank Bober, electronics.

At a midway point in the program, the trainer now in use will be sent to Naval facilities on the East Coast for training Atlantic Fleet personnel.

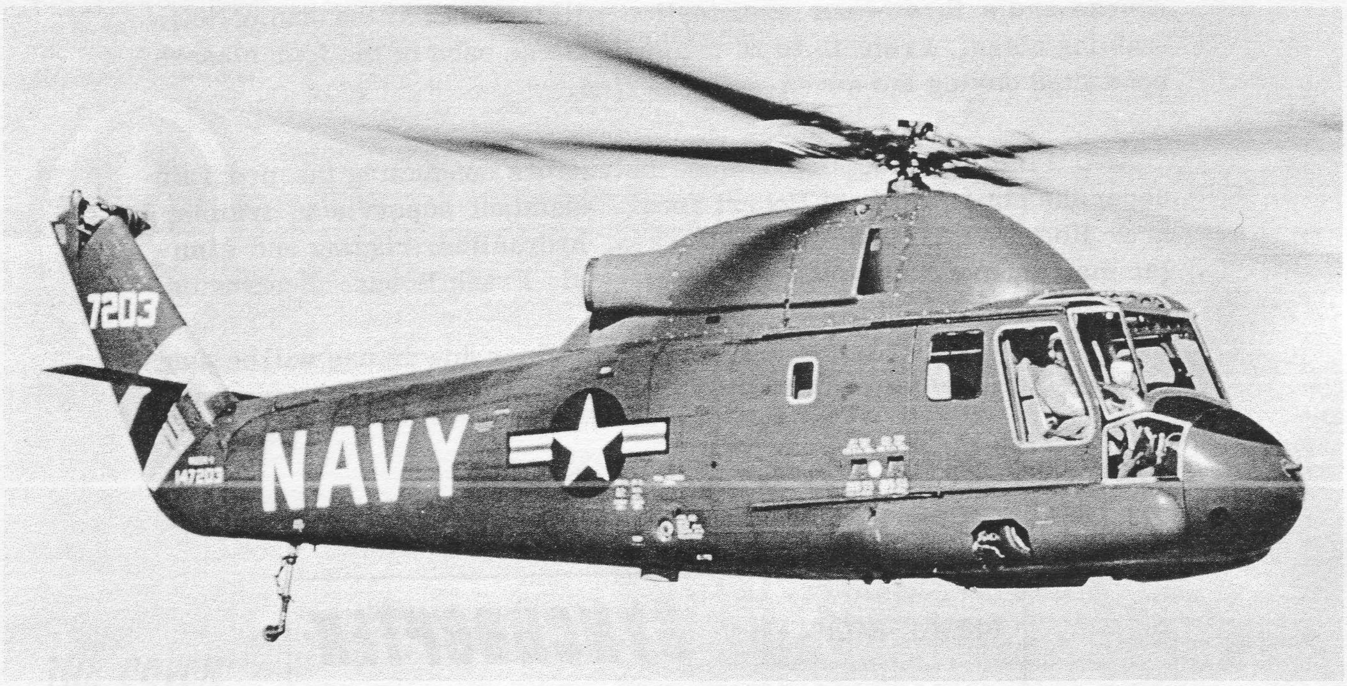
NEXT MONTH: **SYNCHROPTER**

A second trainer, now being assembled at Kaman Aircraft, will be used for instructing the last two Navy groups at the plant and then, after being checked out by NAMTG, Memphis; will be used for training Pacific Fleet personnel on the West Coast. Service representatives from the company's Field Service Department will accompany the trainers for a six-month period.

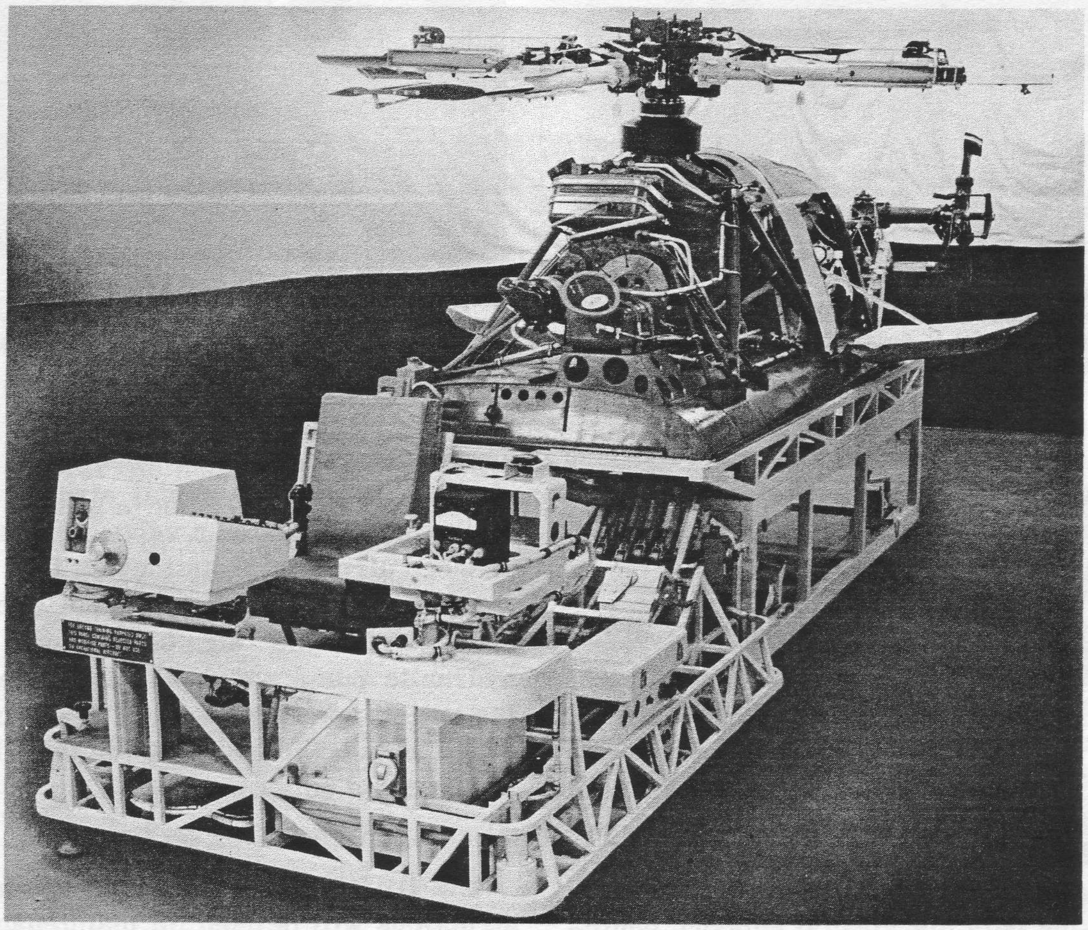
More than a year-and-a-half of research and planning in close cooperation with Navy experts is represented in the two trainers. Constantly in the minds of those at Kaman participating in the design and construction of the trainers was the Navy philosophy that the quality of the training devices used to instruct its personnel is of the utmost importance because of the major part good maintenance plays in the performance of an aircraft, or any other weapon.

The trainers consist of three panels: (1) Hydraulic; (2) Flight Controls, Transmission and Power Plant; (3) Electrical. Each panel is comprised of several sections and includes all helicopter components in the systems represented. Duplication of systems or components is avoided. However, in some cases, mock-ups or plastic animated devices are used to more clearly show operation and maintenance principles while the corresponding actual parts are mounted on one of the other panels to provide for training in servicing and in installation and removal.

The panels include provisions which enable the instructors to simulate possible malfunction in the various systems and components. In this way, maintenance personnel will receive actual experience in trouble shooting. Some examples are: Generator failure with resulting automatic operations of emergency

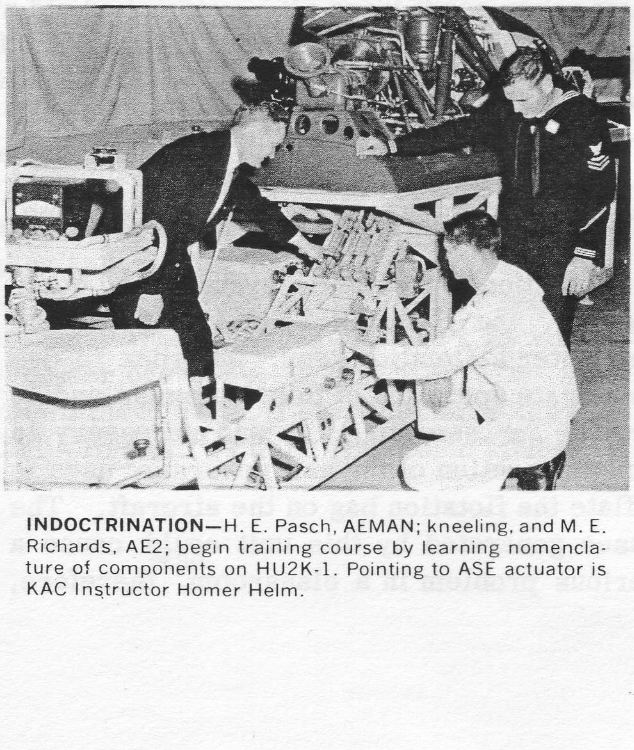


THE HU2K-1 SEASPRITE—U. S. Navy personnel are now undergoing intensive factory training in the maintenance of this high-speed, long-range helicopter. The turbine-powered aircraft will be used for search and rescue together with utility and liaison duty with the Fleet.



IT DOESN'T FLY—But this full-scale, 20 foot long HU2K-1 training panel does almost everything else. All of the helicopter's components have been installed in the trainer and many are motorized. More than a year-and-a-half of research and planning is represented in this and other training panels which Kaman Aircraft has designed and produced for the U. S. Navy.

CHIEF CHECK-OUT—V. F. Knight, AEC; sitting at controls, and R. E. Mikesell, AEC; are introduced to instruments for HU2K-1's Automatic Stabilization Equipment. Frank Bober of KAC is the instructor.



INDOCTRINATION—H. E. Pasch, AEMAN; kneeling, and M. E. Richards, AE2; begin training course by learning nomenclature of components on HU2K-1. Pointing to ASE actuator is KAC Instructor Homer Helm.

FIRST DAY—Robert Spear, assistant supervisor, training; explains operation of rescue hoist control on hydraulic system training panel to D. G. Beasley, AT2; and R. R. Porter, ATN3; during tour of classrooms.

'LECTRIC LECTURE—KAC Instructor Robert Krans explains HU2K-1 electrical system to R. E. Mikesell, AEC; M. E. Richards, AE2; V. F. Knight, AEC; D. G. Beasley, AT2; R. R. Porter, ATN3; and H. E. Pasch, AEMAN.

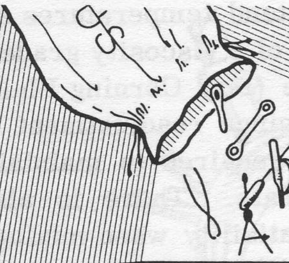
system, venting of accumulators requiring recharging; stoppage or loss of pressure in hydraulic lines and failure of electrical controls for the rescue hoist.

Some of the most unusual features of the trainer are in the design of the Flight Controls, Transmission and Power Plant panel. This panel, approximately 20 feet long, can be separated into three sections using quick disconnects. The maximum length, in shipping condition, of these sections is 12 feet. They can be reassembled under a 10-foot high ceiling using only the special support equipment supplied with the trainer. The forward, or cockpit section of this panel forms a complete Automatic Stabilization System (ASE) trainer and can be disconnected and rolled into a separate classroom for training on ASE while the aft sections are used in training on transmission, power plant, main and tail rotors and other components. This method of operation doubles the number of students receiving training in a given period of time.

In addition to hydraulic systems and components, the Hydraulic panel includes the helicopter's flotation gear. In order to demonstrate operation of this equipment and to provide for servicing, it was necessary to simulate action of the gas generator used to inflate the flotation bag on the aircraft. The gases generated by this unit could cause a serious problem in a classroom, therefore, an air compressor and tank have been included. Use of the actual aircraft controls on the panel actuates a valve releasing compressed air to the flotation bag thus inflating it in a manner similar to the action of the gas generator. The air compressor and the hydraulic pump which supplies pressure to the panel are mounted on a separate unit which may be located outside the classroom to eliminate noise.

The HU2K-1 Handbook of Maintenance Instructions will be used for maintenance training on the panels and all special support equipment required for the helicopter will be provided. This will insure, for the maintenance personnel, complete familiarity with the handbook and equipment they will be using in the Fleet.

To summarize the "HU2K-1 Trainer Story," every effort has been made by Kaman Aircraft to eliminate in the design of this trainer, all problems experienced by the Navy on existing equipment and to provide both a trainer and training that meet or exceed the Navy's high standards. When the instructors from NAMTG complete their check-out of the trainer later this year, we will have a good indication of how well this has been accomplished--but the final results will be best measured by the performance of the HU2K-1 Weapons System with the Fleet. K



MAINTENANCE MAILBAG

Dear Len,

Not too much doing here except your friend, Robby, is in the brig charged with "attempting to smuggle a goat aboard a Naval Air Station." I guess Robby almost got away with it except the goat, which was in his seabag, smelled pretty ripe, what with the heat and all. The O. D. thought it was Robby at first and made him take a shower, but when the smell still hung around, he looked in the bag. The goat never batted an eye or twitched a horn during the whole time; he was too full of the egg foo young and enchiladas Robby had been feeding him.

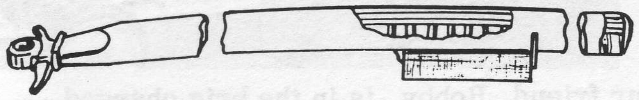
Oh yes, about all the trouble you ran into when taking out those round head Phillips screws which had corroded in place. I found the best thing to do if the holes are all rounded out and won't hold the Phillips screwdriver blade, is to get a hacksaw and cut a slot in the top of the screw, then use a regular screw driver which will get a better hold. Be careful if you use this method though—saw the screw head, not the 'copter! Remember Frenchy Von Hartzberg, the guy who wore the embroidered Japanese kimono and paratrooper boots around the barracks at night? I got a letter from him the other day. Frenchy may have some funny ideas about his relaxing clothes, but he really knows his helicopters. He spent three pages telling about a chopper his crew worked on. Says he spent meeney, meeney hours pulling friction tape off the engine oil lines and putting on new Adel hose clamps. Like he pointed out, friction tape is pretty good as a <u>temporary</u> field fix, but after a few hours of heat and oil, the condition of the tape gets pretty sad and no telling when it will let go. Frenchy said the tape was used to replace Adel clamps which had become oil soaked. When this happens the rubber in the clamps deteriorates and the clamps start slipping and twisting on the tube or line. This lets the line come in contact with the tube and chafing begins. I don't need to tell you what happens if an oil line breaks. These engines just don't go without oil and it can get pretty tough on the 'copter crew.

There goes chow call. Gotta' get down there quick, I heard a rumor they're serving "Marinated Truffles a la Charlie Brown." I think it is some kind of hot dog.

Mac

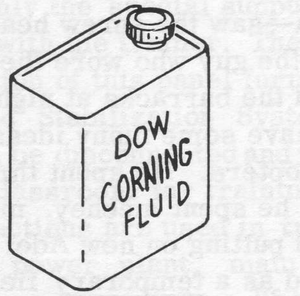
Q's AND A's

If you have a question regarding Kaman Aircraft maintenance, send it along to Rotor Tips. The Service Department's analysts will be glad to answer it.



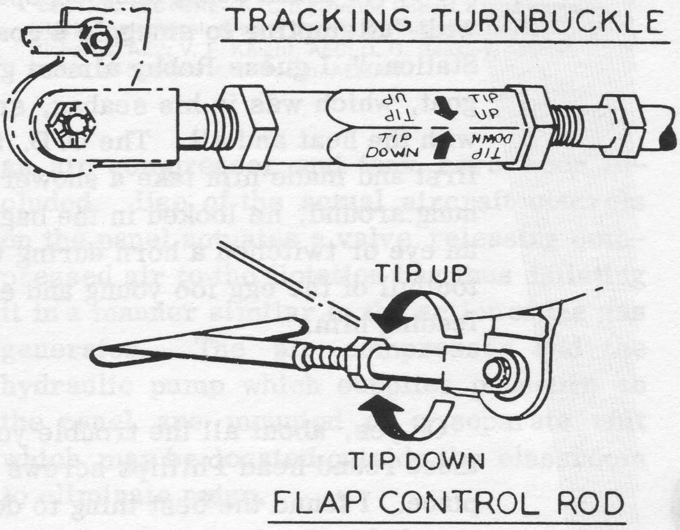
Q. ROTOR BLADES APPEAR TO HAVE A DIFFERENT FABRIC COVERING THAN DO THE FLAPS. IS THIS SO? (Applies HOK-1, HUK-1, H-43A, H-43B)

A. Yes. Blades are covered with cotton balloon cloth spec. MIL-C-332, Type III and the flaps are covered with a Rip-Stop nylon fabric, Spec. MIL-C-7020, which is thinner, lighter and stronger than balloon cloth. The Rip-Stop nylon fabric can be recognized by the checker-board texture, while balloon cloth has a smooth texture. — N. W.



Q. IS THERE AN ALTERNATE FLUID THAT CAN BE UTILIZED WHEN SERVICING THE CONTROL DAMPER P/N K350154-3, SESCO P/N p025-800E? (Applies HOK-1, HUK-1, H-43A, H-43B)

A. No, the only damping fluid specified for use in the P/N K350154-3 Sesco dampers at this time is Dow Corning #200, (100 centistoke), FSN 9150-269-8246. This fluid will be replaced in H-43B production aircraft in the near future with Dow Corning #510 (100 centistoke), FSN 9150-597-6628 because of its ability to withstand temperatures as low as -90°F. The use of a viscosity grade other than 100 centistoke (Dow Corning Fluid), is not recommended since readjustment of the damper would be required to maintain the desired damping rate. There is also the question of incompatibility when mixing silicone type fluids. As an example, #510 fluid when mixed with #200 causes clouding and a slight residue forms. — R. A. B.

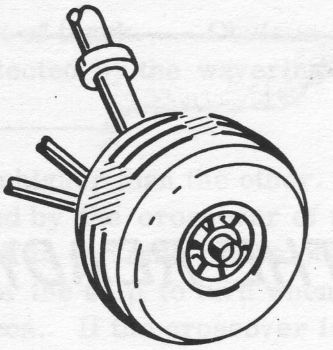


Q. WHEN TRACKING ROTOR BLADES HOW MUCH TIP TRAVEL OCCURS FOR A GIVEN AMOUNT OF ADJUSTMENT AT THE TRACKING TURNBUCKLE AND FLAP TO BLADE CONTROL ROD? (Applies HOK-1, HUK-1, H-43A)

A. The following blade tip travel figures are provided and should be construed as approximate because of variations in air density, temperature and blade spring constant. These figures are representative only with the collective pitch stick full down and engine rpm at 2200 during ground tracking in no wind conditions.

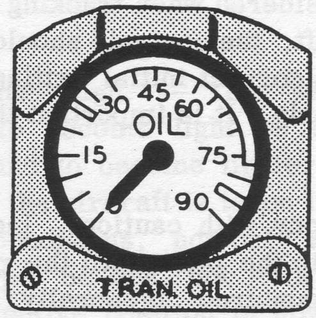
Adjustment Point	Amount of Adjustment	Flap Angle Change	Blade Tips Travel HOK-HUK, H-43A	
			HOK-1 Unmodified	Stiff
Blade Turn-Buckle	One Hole	0° .3'	3/16"	1/8"
	One Turn	0° .25'	1 1/2"	1"
Flap Rod Clevis	1/2 Turn	0° .42'	2 3/8"	1 5/8"

NOTE: One half turn of the flap rod clevis equals 13 holes of adjustment at the tracking turnbuckle. — C. N.



Q. SERVICE EXPERIENCE SHOWS THAT THE RIGHT-HAND MAIN WHEEL BRAKE PUCKS ON SOME AIRCRAFT HAVE A TENDENCY TO WEAR QUICKER THAN THE BRAKE PUCKS INSTALLED ON THE LEFT MAIN WHEEL. IS THERE A LOGICAL EXPLANATION FOR THIS CONDITION? (Applies HOK-1, HUK-1, H-43A)

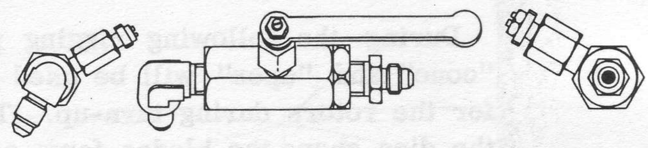
A. The reason for higher usage of right-hand brake pucks at some bases (not all), has been attributed to the fact that operating personnel use the towing eye in lieu of the towbar. The towing eye is located on the bottom of the aircraft approximately 2 1/4 inches off to the right of the centerline of the helicopter. When being towed by this method, the aircraft tends to ride off to the left side of the towing vehicle, and is kept in line by holding right brake. — R. A. B.



Q. CAN AN IMMEDIATE TAKE-OFF BE EXECUTED EVEN THOUGH THE TRANSMISSION OIL PRESSURE IS ABOVE THE GREEN ARC FOR AN ALERT OR SCRAMBLE MISSION? (Applies HOK-1, HUK-1, H-43A)

A. Take-off with a transmission oil pressure up to 100-110 PSI range is permissable, however, the pressure must be within normal operating limits after approximately one and a half (1.5) minutes of flight. This type of operation may be used as often as necessary without damage to the transmission.

If the oil pressure does not return to the limits specified by the T.O. 1H-43B-1, a normal landing should be made and a check of the transmission oil system performed in accordance with the T.O. 1H-43B-2. — C. W. J.



Q. WHAT CHANGES HAVE BEEN INCORPORATED TO ELIMINATE AIR LEAKS AROUND THE "O" RING GASKETS AT THE AIR FILLER VALVE AND AT THE ON-OFF VALVE OF THE FIRE FIGHTING KIT? (Applies H-43A, H-43B)

A. (a) New seals of a higher durometer hardness have replaced original seals at the air filler valve.

(b) A new on-off valve assembly, incorporating pipe threaded nipple and elbow, has replaced the original straight threaded assembly. This has eliminated the "O" rings and insures an air seal. — R.W.

	Original Part		New Part
1.	"O" Ring Gasket	MS29513-112	AN6290-6
	"O" Ring Gasket	MS29512-20	AN6290-20
2.	On-off valve assy.		Assy #72C54
	Shut-off valve	HT33GT	HP33GT
	Elbow	AN833-6C	MS20822-6-6C
	Nipple	AN815-6C	AN816-6-6C

(continued on page 18)

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Report FROM THE READY ROOM

SYNCHROPTER ROTOR SYSTEM TRACKING and RIGGING


ANDY FOSTER
Test Pilot

This article on rigging and tracking helicopters using the synchropter or intermeshing rotor blades design is aimed at aiding pilots checking out aircraft after new rotor blades have been installed.

During the following rigging procedures the terms "cone" and "apex" will be used to describe conditions for the rotors during turn-up. The cone of a rotor is the disc shape the blades form as the rotor is turning. The smaller the angle of the blades, as measured from a plane perpendicular to the rotor shaft, the lower the cone. The apex is the point at which the blade tip path planes of the two rotors intersect, often referred to as "crossover." The accompanying illustrations show the rotor cone and apex or crossover as they would appear facing the front of the helicopter. A properly rigged synchropter will require neutral rudder regardless of speed or power when the aircraft is in balanced flight on a constant heading.

Let's take an aircraft that has just had the new blades and flaps installed and review some of the points that should be considered when tracking is required. Prior to the pilot turning up the aircraft, the controls should have been inspected to determine that flaps are at the correct initial settings and all control rods are hooked up and secured properly. It is important that the helicopter face directly into the wind.

Turning up the aircraft initially should be done with caution. Increase rotor rpm at a rate that will be "comfortable" to the pilot until the rpm is above the speed where ground oscillation is encountered, (generally, in the range between 100 and 150 rpm). From this point on, acceleration should be slow, with the pilot being careful to observe blades out of track, one cone being much higher than the other, or both cones high, or both cones low.

Observations that will help the pilot determine which of the above conditions he may have are:

1. Blade out of track. — Obvious and can be visually detected by the wavering line of the rotor disc.

2. One cone higher than the other. — This can be detected by the crossover of the two rotors being off to one side or the other, or the tendency for the ship to turn when it gets light on the oleos. If the crossover is off to the left of the aircraft center line, the left cone will be high; if off to the right, the right cone will be high. Remember, if the initial cone settings are high and unbalanced, this turning tendency will be apparent on your first turn-up. This is the reason for increasing rpm slowly. The torque differential between the two rotors, if unbalance is great enough, can give the same effect as a single rotor helicopter with no tail rotor.

4. Both cones low. — In this case, the helicopter will either tend to become heavier with increased rpm, or if the blades are near flat pitch, rpm will have little effect on the aircraft. When blades are on the negative pitch side, it can easily be detected by easing in forward cyclic while still on the ground. This will give the aircraft a tendency to back up. Also, a small amount of aft stick will give the helicopter a tendency to roll forward. The response from cyclic input varies with the amount of pitch in the blades so it is not necessary to use large inputs since the "indication", only, is desired. Collective-position in this case will be higher for a given flight condition.

A properly rigged helicopter will feel solid at operating rpm and you will notice a slight

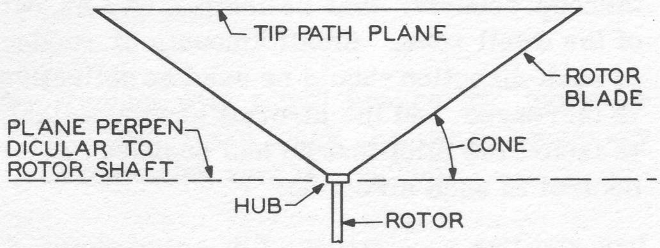
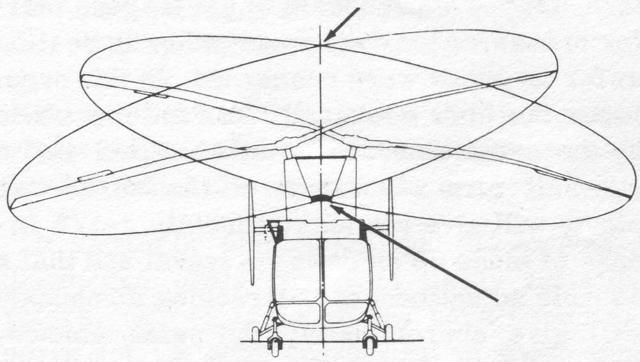


DIAGRAM SHOWS "cone" of a rotor as being the angle between the blades and a plane perpendicular to the rotor shaft. Synchropters have two cones—one for each rotor.



ARROWS SHOW FORE and aft apex on the center line of the aircraft. The apex is the point at which the blade tip path planes of the two rotors intersect, often called crossover.

3. Both cones high. — This will cause the aircraft to become light on the oleos prematurely and to become lighter as rpm increases. If the aircraft is taken into flight under these conditions, not only would the autorotation rpm be low, but it is possible that your collective position in hover could be in the reverser dwell zone. The term "dwell zone" indicates the small portion of collective control travel where the differential collective output resulting from rudder control displacement is practically zero. This condition exists due to the reverser assembly being midway between the powered flight position and the autorotation position.

dipping of the nose with small forward cyclic input, and, as expected, a slight nose raising with aft cyclic input.

It is impossible to cover every case which may arise, since the variations can be numerous and involve any combination of the above mentioned basic problems. The foregoing indications are generally easy enough to detect. However, there may be times when they won't be clear cut. The crossover of the rotors, for instance, will be affected if the ship is not facing directly into the wind, or because the pilot is not viewing the apex from the exact center of the aircraft. Because of these factors, some experience must be gained in order to see the crossover properly. You may get the indication that you need a much larger rudder correction than you really do, if the cones are high and the collective is in the dwell zone. This can happen quite easily when the gross weight of the aircraft is light. Rotor rpm is another variable, since less collective is required with higher rpm.

Now, let's go on with this imaginary rigging and tracking job and see what else develops. We are increasing rpm slowly and, as I mentioned earlier, any combination of the basic problems can be present. Let's say in this case you have been, and should be, holding brakes during your run-up, and as the rpm gets within the low flight rpm range, you encounter an "out-of-track" condition extreme enough to need correcting before you go any further. It is likely that in this brief turn-up, you were unable to get a "good feel" for crossover location or any other indication as far as cones were concerned. In this case, lower the high blade and raise the low blade by the same amount. You can expect that a one-half turn adjustment at the servo-flap clevis will give you approximately 1-1/2 inches of blade up or down tip travel and that a 13-hole adjustment at the tracking turnbuckle will give approximately the same amount. These figures can only be "ball park", or approximate, figures because of tolerance build-ups in blades and flaps.

After adjustments have been made, the next turn-up will again be slow, as you feel your way to a higher rotor rpm. This time, you can get maximum rpm, but as you release your wheel brakes, the helicopter wants to turn in one direction or the other. It will turn, in this case, in the direction opposite to the rotation of the high cone. Make your cone adjustment so as to favor the overall cone setting. You may have been able to feel the aircraft getting light on the oleos. This is generally the case where large torque differentials are experienced.

It may be worth mentioning at this point that you could have had a cone, or combination of cone settings, that would have made the aircraft light enough to turn in spite of the wheel brakes being on. In this case, reduce rotor rpm immediately. As for the amount of correction required to get the rudders back to neutral, we can expect it to be in excess of two turns at the flap. You can usually get one to 1-1/2 inches of differential rudder for every one-half turn at the flap on a cone adjustment. After having made this correction, you can expect that the rudders will be in the "ball park," and it is likely that you can go into a hover and, possibly, forward flight on this turn-up. Caution should still be used in getting the ship airborne, however, since it is possible (and it has happened with very good mechanics) that the adjustments have been made in the wrong direction.

In attempting to get the aircraft airborne for the first time, low flight rpm is recommended. The reason for this is that more collective will be required to get airborne, thereby assuring that collective will be out of the dwell zone. Small amounts of rudder in each direction should be used as collective is increased, and the aircraft becomes light, to assure the pilot that he has positive rudder control in each direction.

The remaining part of rigging and tracking the aircraft will be setting the autorotation rpm according to the chart, adjusting the rudders to neutral for hover and any "fine" blade tracking that might be required.

I might mention that this example of blade tracking is not usually the case, since initial rigging is seldom this far off; but it can, and does happen so the pilot must be prepared for it.

"Fine" tracking the aircraft is usually not too difficult but, sometimes bad weather conditions (wind and turbulence), and/or perhaps the occasional correction in the wrong direction, can cause the pilot to wonder what is happening to him. In the newer model aircraft the in-flight tracking equipment eliminates the need to do fine tracking on the ground, so far as tracking one blade to the other in the same disc is concerned. You merely need to make "coarse" adjustments mechanically, then make minor changes with the in-flight tracking actuator.

I would like to emphasize the fact that in order to get the best performance from the helicopter, it should be kept in as nearly perfect condition as is humanly possible. Rigging and tracking are extremely important maintenance requirements. The syncropter has more than adequate control within all rpm, gross weight and CG limitations, but when it is not properly rigged, you are sacrificing control in some area of the overall performance of the control system.

In summary, here are the general steps in rigging and tracking:

1. Make certain the aircraft is ready for run-up and preflighted, checking for proper static rigging and free movement of flight controls. Aircraft should be headed directly into the wind.

2. Run-up with wheel brakes on, increase rpm slowly, make track changes as necessary until operating rpm is reached.

3. Determine differential cone settings and reset in "ball park". Check by crossover method.

4. Determine cone setting and reset as necessary, check by cyclic input method.

5. Decrease rpm to low flight rpm. Taxi and use some up collective to determine that there is adequate rudder control for hover flight.

6. Slowly and smoothly execute hovering flight, using caution for the first attempt at becoming airborne.

7. Proceed to forward flight, correcting track, differential cone, and adjusting autorotation rpm.

8. One-half turn at flap equals about 1-1/2 inches tip travel.

9. Thirteen holes at tracking turnbuckle equals about 1-1/2 inches tip travel.

10. One-half turn at flap for cone adjustment equals 1 to 1-1/2 inches differential rudder.

11. One-half turn at flap to adjust autorotation rpm equals about five rpm.

Many of the above steps are integrated somewhat and can be changed as necessary for individual circumstances.

It should be pointed out that the foregoing discussion deals only with newly installed rotors. If, after the rotors have been properly set, a cone adjustment of more than one-half turn of the flap control rod is required to maintain neutral rudder pedals, the control system should be checked for wear or damage. K

KAMAN
RHYMES WITH
JAPAN

More From Les . . .

Each month in this column, C. L. Morris, Assistant Vice President–Field Service Manager reports on a subject in which particular interest has been shown

GROUND RESONANCE

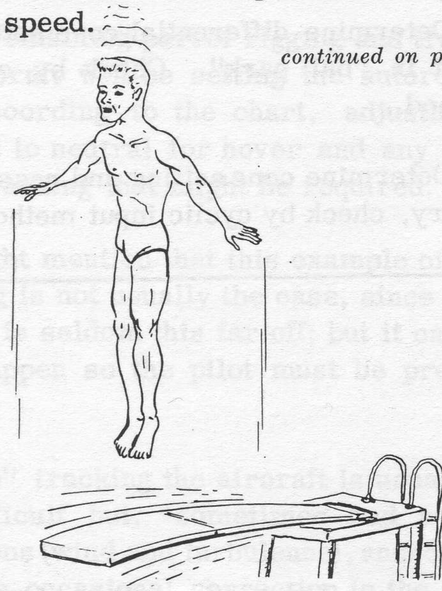
During the early training of helicopter pilots, emphasis is placed on so-called "ground resonance" and the destructive results that can develop from it unless proper corrective action is taken. Maintenance of the helicopter can have an important bearing on ground resonance, so it seems appropriate to discuss it briefly here.

Actually, there are two basic types of resonance generally associated with helicopters— one is the ground resonance just mentioned; the other is "rig" or "tie-down resonance" which is a particular type of ground resonance. In order to satisfactorily explain the meaning of these terms, it is first necessary to give a general description as to what resonance is as encountered in everyday life.

Any structure or mechanism has its own natural vibratory frequencies. If some particular vibratory force has the same frequency as one of the natural structural frequency, the structure or mechanism is said to be operating IN RESONANCE. An example of this occurs when a car is being driven over a rough road, for the occupants may find it especially rough at one speed, but, if the vehicle is driven faster or slower, it may get 'out of resonance' with the rough spots and the ride will be quite smooth.

A helicopter rotor system is no exception to the rule, for it has its own natural vibratory frequencies. Due to limitations on the size and construction of rotor blades, some of these natural frequencies may fall in a range that is resonant, or in phase with, the turning speed of the rotor or with other parts of the helicopter structure or mechanism. Since the whirling rotor mass has a tremendous amount of energy stored in it, engineers must introduce checks wherever such resonance is discovered in order to avoid serious difficulties from the rotor mass. The greatest problem of this nature is termed GROUND RESONANCE. This occurs when the landing gear, while in contact with the ground, transmits a rocking or sideward motion to the rotor system, at a particular frequency. This, in turn, forces the rotor blades somewhat out of their normal balanced pattern; the unbalanced rotor system then passes the impact back to the landing gear and the cycle repeats itself. Ground resonance need not be serious unless it is UNSTABLE or divergent, that is, unless it grows increasingly powerful. The rocking that some helicopters experience during rev-up or shut-down is not ground resonance; it is quite docile due to low rotor speeds and to the fact that the rotor soon passes through the resonant speed.

continued on page 16



EXAMPLE OF RESONANCE is shown in this sketch of a diver testing the board for spring. The original downward thrust of his legs, which removes the weight of his body and allows the board to spring into the air, establishes the first cycle. Providing his timing is correct, his feet will make contact with the board in phase, or in resonance, with the vibration of the board. However, if the diver's timing is off, he will no longer be in resonance with the vibration frequency of the board, and he is brought to an abrupt and jolting stop.

PITCH FEEDBACK ROTOR CONTROL SYSTEM

by D. W. ROBINSON Jr.
Project Manager, Special Projects

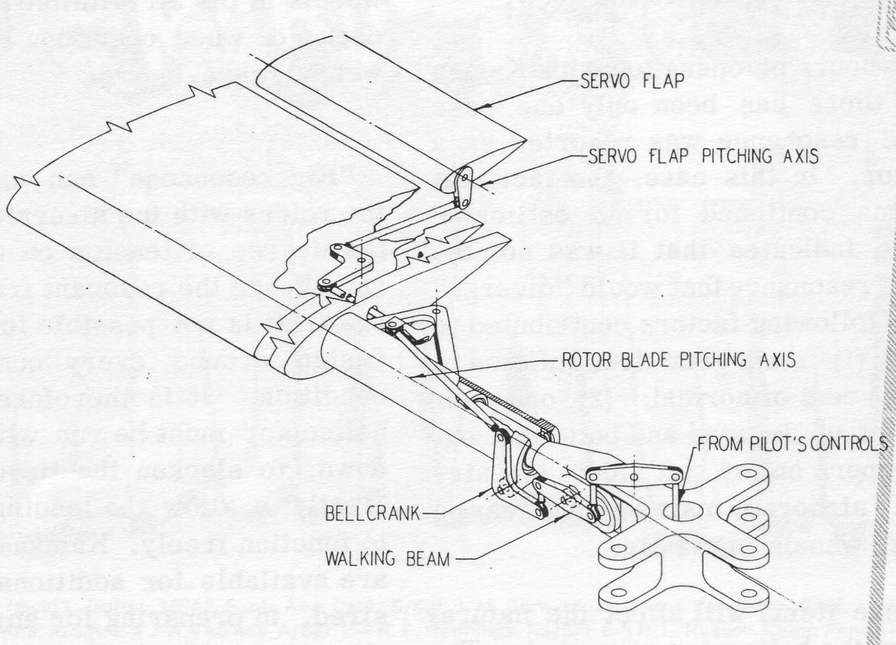
EDITOR'S NOTE: *In the August issue of Rotor Tips, Mr. Robinson explained the use of the Servo-flap on HOKs, HUKs, H-43As and H-43Bs. In this article he describes a further refinement of the Servo-flap control system which has been developed at Kaman to permit its utilization on high-speed helicopters such as the HU2K-1.*

In designing the high-speed HU2K-1, helicopter it was evident that the much greater collective and cyclic pitch range required near the maximum speed would increase flap loads to the point where there would be a significant power loss. An increase in blade stresses, and secondary increases in blade angle to offset the opposite flap load, might also be expected. If a way could be found to reduce the flap load, tip stall would be alleviated, and profile power requirements reduced, thus permitting a further speed and range increase for the helicopter.

An intensive research program was therefore initiated. All factors of the rotor system were analytically investigated. Control requirements and blade flexibility, design layouts and motion studies, whirl testing and fatigue testing all led eventually to flight testing of a new control system called the "Pitch Feedback Rotor Control System." This new control system is based on continuous self-centering of the pitch spring in response to control inputs, but retains the stiffness to disturbances required for good aeroelastic stability. While this would be difficult to do mechanically, it has been found possible to substitute aerodynamic forces for the mechanical spring, thus simplifying the task.

The aerodynamic spring is achieved by introducing "pitch feedback" into the servo-flap's control linkage so that if a gust of air or other disturbance twists the blade by a certain amount, the linkage pitches the servo-flap just the right amount in the opposite direction to return the blade to its proper position. No mechanical spring stiffness is required, therefore, to stabilize the blade.

This new linkage is shown in the schematic diagram. As can be seen, the "walking beam," is attached to, and pivots on the rotor hub, which rotates, but does not pitch with the blade. The movement of this "walking beam" is determined by the setting of the pilot's controls, and, therefore, represents the pilot's control command input. The "bell crank" linked to this "walking beam" is attach-



SCHEMATIC

KAMAN PITCH FEEDBACK ROTOR SYSTEM

ed to, and pivots on the blade, and it continues the pilot's control command to the servo-flap. However, if a gust of air or other disturbance twists the blades in one direction, the "bell crank" is forced to rotate with respect to the "walking beam"; and it thereby moves the remaining linkages within the blade to rotate the flap in the correcting direction. Thus, the aerodynamic spring is always centered. The pilot, by manipulating the controls, establishes this centering point of blade pitch; and the aerodynamic spring restores the blade, if disturbed, to this centered position.

If a mechanical spring was used, either the purely mechanical or the structural equivalent, only one centered position would be possible; and preloads have to be established through servo-flap loads, if the blade is to be stabilized at other than the centered position.

The aerodynamic spring therefore permits the servo-flap to operate at much lower total lift levels, reducing stresses not only in the flap and supporting structure, but in the portions of the blade influenced by the flap structural attachment. This design saves power, reduces vibration levels, and alleviates blade tip stall at high speeds. A further advantage of the Pitch Feedback Rotor Control System is that flap loads remain proportional to blade loads as altitude is increased. Therefore, the effectiveness of the control system no longer changes with altitude.

The basic research and design of this newest development of the Kaman Servo-Flap Control System has now been completed. It will be an integral feature of the HU2K-1 high speed utility helicopter as it enters service next year. Look for it!!! K

More From Les . . .

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Experience has proven that with "divergent" ground resonance, the oscillations can get progressively worse in an extremely short time—two to three seconds at most in some helicopters—causing severe damage to the aircraft and possible injury to the crew.

In 100,000 hours of operation with Kaman helicopters, there has been only one case where ground resonance was reported as a possible factor. In this case, the fact that the oscillations continued for an estimated eight seconds indicates that it was not the type of ground resonance that would "diverge" rapidly. The following factors contributed to this incident: (1) main gear tires inflated to only 50-60 per cent of normal; (2) one main landing gear strut deflated and bottomed out; (3) blade dampers on the soft side; (4) aircraft partially airborne, main landing gear on the deck, nose wheels in the air.

Each of these items will affect the natural frequencies of the helicopter as a whole. The importance of tire pressures, strut servicing and blade damper friction should be emphasized at all times, but these assume particular importance whenever operations are contemplated which may require keeping the nose wheels in the air with the main wheels on the deck, or when operating in the higher gross weight range.

"Rig resonance" can occur when running the rotors with the aircraft tied down. Since the degree of tension on the tie-down cable can change the resonant frequency of the aircraft, it is not possible for the engineers to design around every conceivable tie-down condition. It is therefore imperative, if a helicopter must be run with the aircraft tied down, to slacken the tie-down cables sufficiently to allow the landing gear oleo struts to function freely. Kaman Aircraft engineers are available for additional guidance, if desired, in preparing for any specific tie-down operations. K

TRAINING

SEVENTEEN PILOTS AND FIREMEN from K. I. Sawyer AFB, Mich., and Minot AFB, N. D., recently completed a fire-fighting course using the turbine-powered H-43B. During the instruction, which took place at Sawyer, each pilot and fireman fought a minimum of three fires. Ralph Lee, Kaman Aircraft pilot; and George Wright, KAC fire-fighter instructor; conducted the course. Shown discussing the H-43B's capabilities are, left to right, William C. Welden, KAC field service representative; Lee; Col. William B. Keyes, C.O., 4042nd Strategic Wing, SAC; S/Sgt. William H. Padfield, A/2c George Cantwell, firemen; Col. Philip N. Loring, C.O., 56th Fighter Group, ADC; Capt. D. M. Randell, 1st Lt. Earl Williams, H-43B pilots, K. I. Sawyer AFB. Other personnel who completed the course are: 1st Lts. D. J. Jogerst, M. L. Trainer and E. L. Gillian, pilots; A/1c William R. Combs and Charles E. Delaney; A/2c Marion L. Thompson, Berlin Smith, William F. Merrills and Joe L. C. Bundy, firemen, K. I. Sawyer AFB; T/Sgt. Earl D. Downs, S/Sgt. Charles N. McNeilly, A/1c Harry N. Quarles and James E. Marchand, firemen, Minot AFB.

SPECIAL HOK MAINTENANCE CLASS

Marine Air Group-36, Marine Air Wing, USMC

Left to right: AS/Sgt. David L. Guffey, MCAF, Santa Ana, Calif.; S/Sgt. J. M. Gerhard, Jr., Camp Pendleton, Calif; AM/Sgt. Edgar B. Stephens, Jr., Santa Ana; A/Sgt. E-4 J. A. Thomas, A/Sgt. E-4 R. E. Hennings, AS/Sgt. E-5 R. L. Russell, Camp Pendleton; AGy/Sgt. W. J. McDonald, Santa Ana; Cp. E-4 L. F. Whitham, 1st Lt. F. H. Keller, Camp Pendleton; Raymond A. Vokes, KAC; 1st Lt. D. L. Wright, Camp Pendleton.

MERCY FLIGHTS

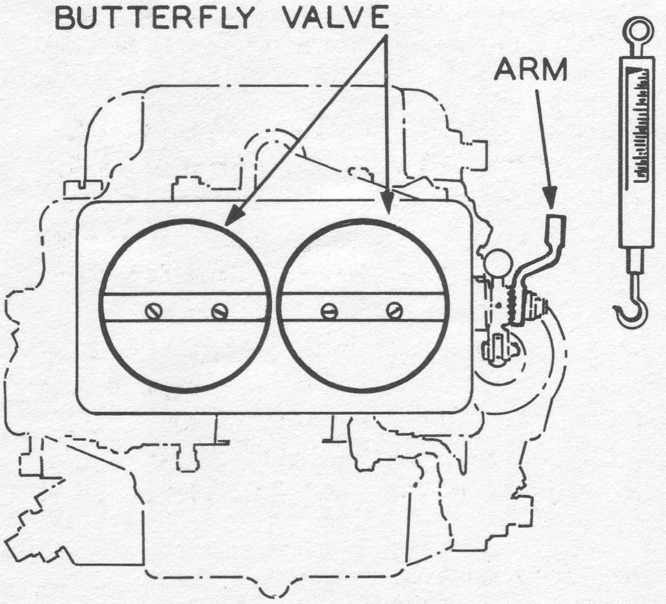
PLATTSBURG, N. Y., AIR FORCE BASE——This base, which recently received the H-43B, is making good use of the turbine-powered helicopter.

Recently the aircraft was used for an emergency night flight when the base hospital sent out an urgent call for a rare blood type. The nearest place where blood could be found was in a hospital in Burlington, Vt., 30 air miles away on the other side of Lake Champlain. Within 90 minutes after the emergency was called, the blood was at the base hospital.

This was the first night flight that the pilot, Capt. H.H. Davis has flown in the H-43B. He was accompanied by 1st Lt. J.A. Richardson and A/1c William Cole. In another, later flight, Captain Davis flew the helicopter to St. Johnsbury, Vt., to pick up an airman who was in an auto accident and returned him to the base hospital. Accompanying him on the flight was Lt. Col. J.H. Washington, Capt. L.S. McGinnis, MD; and Cole.

STEAD, NEV., AIR FORCE BASE——Major Jimmy Hamill of this base recently used the H-43B to fly serum to Lake Tahoe after an Air Force sergeant was bitten on the hand by a cottonmouth snake.

Q. s and **A.** s *(continued from page 9)*



Q. WHAT IS ONE CAUSE FOR A SLOW BREAKAWAY OF THE CLUTCH WHEN ENTERING INTO AUTOROTATION? (Applies HOK-1, HUK-1, H-43A)

A. Usually a sticky butterfly valve in the carburetor will have this effect. It can be checked as follows: With engine rpm stabilized at 2200 and rotors engaged while on the ground, reduce throttle to idle. Normal lapse of time for the engine to return to idle is approximately 2.5 seconds.

If the lapse time is in excess of 2.5 seconds, inspection of the carburetor butterfly valve for excessive friction would be in order, using the following procedure: With the carburetor bowl filled and the accelerating pump primed, a pull of 6.8 lbs on the 1-1/2 inch arm of the carburetor with a spring scale is desired. If this torque value is in excess of 6.8 lbs, replacement of the carburetor is recommended. — C.W.J. K

CURRENT CHANGES

TIME COMPLIANCE TECHNICAL ORDERS (USAF)

Applies — H-43B	T.O. 1H-43B-514, 23 August, 1960 Installation of Starting Fuel Cut-off Switch, H-43B helicopters.

FIELD INFORMATION DIGESTS (KAMAN)

Applies — H-43A	No. B-7, Revision 1, 25 August, 1960 Modification of the Rotor Blade Folding Lag Stop Assemblies.
Applies — HOK-1 HUK-1	No. A-45, Revision 1, 25 August, 1960 Modification of the Rotor Blade Folding Lag Stop Assemblies.

RESCUE!

A 13-year-old girl who suffered a head injury while on a hike at Paradise Lake, near Donner Peak in the rugged High Sierra territory, was rescued recently by two U.S. Air Force pilots from Stead Air Force Base in Nevada.

Maj. F. M. Carney and Capt. Phillip Maggart in an H-43B "Huskie" performed the rescue. Because of the rough terrain, Major Carney pinpointed the turbine-powered helicopter on the edge of the 7,500-foot-high lake, amid boulders and brush, and hovered the aircraft over the water with only the nose gear in contact with anything solid. The girl was then flown to a waiting ambulance. She was discharged from the hospital a few days later.

The mission began about 6 p.m. when the H-43B and another helicopter, manned by Lts. John Ogershok and Jack Herzik, took off for the accident scene, at first reported as being at Donner Lake. The helicopters searched the mountainous area for about 45 minutes before spotting a sheepherder who pointed in the general direction of the injured girl. A few minutes later, while the other 'copter stood by, the H-43B made the pickup from the almost inaccessible spot.

A few days later, an H-43B from Stead was called upon to perform another rescue in the Sierra country, when Major Carney, with Capt. Eric W. Kurgas as co-pilot, flew to an area west of Lake Tahoe, to aid a man injured when thrown from a horse. The night pickup was made at Phipps Lake at an altitude of 8,500 feet. The flyers were guided to the spot by Air Force survival crews who set out guide markers and started a beacon fire. A second helicopter was piloted by Capt. Merrill R. Hinckle with Lieutenant Ogershok as co-pilot. Also taken to the scene was an Air Force Doctor, Capt. Douglas Lawson. K

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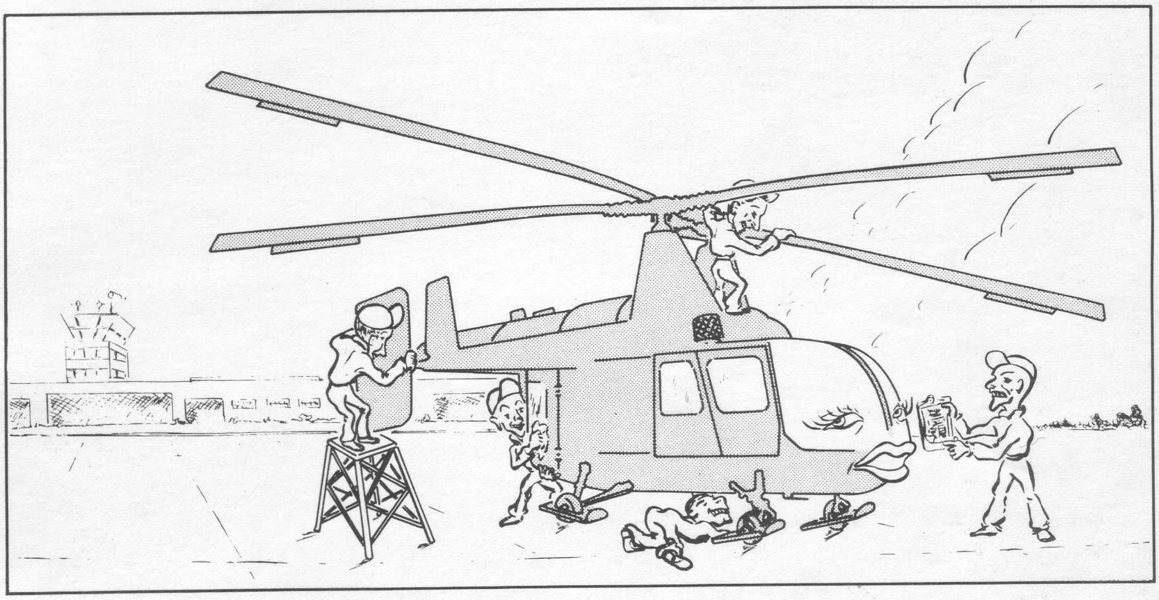
POEM



A DAY ON THE LINE

Let's hit it crew, here comes a guy,
A charger type, who loves to fly.

Check those tires for bruises or cuts,
Then for inflation along with the struts.

Doors secure and windows clean?
Visibility a must in this flying machine.

Rotor blades with wax a-glisten,
Be sure to check for flap position.

Flap cables clean, none are bound?
Check this one right from the ground.

Pylons, shear tie, and mounting strut,
All secure with bolt and nut.

Hub assemblies are important parts,
Give thorough check before bird starts.

Let's not forget the powerplant,
Ship's good without, but fly it can't.

Drive shaft turns at terrific speed,
Careful check here is the need.

What did the dash two handbook say?
It must be greased once every day.

Control rods have no excessive play?
A real must check for every day.

Gearbox security, look for leaks,
Very important when power peaks.

Let's not forget the rotating bar,
Control rods secure?, Yes they are!

Collective and cyclic are the rods,
Never, never, take any odds.

Long rods and their condition,
Improper cross is wrong position.

Is there something we did omit?
Internal cabin appearance, that is it.

Don't forget to check the rudder,
Any sloppiness makes pilot shudder.

What's the "scoop" on this brace cable?
Un-sure of tension? Check the table!

Be sure to check elevator stop,
First the bottom, then the top.

On turn-up, what does pilot get?
Control response check, you can bet.

Now let's check for proper track,
There's no sense in turning back.

Next check cone height position,
Then we can do some transition.

"Hands off," this bird flys like crazy!
Still, flyboy should not get lazy.

Let's see, we've been gone three hours,
Now go back and hit the showers.

Five minutes later we touch the mat,
Tell the crew chief it's a "going cat."

Now's no time for crew neglect,
Blades and airframe we must protect.

If winds come up, this will lick it,
Blade tie-down boots are the ticket.

Bird's to bed, sure it will stay?
It's your turn now to go and play.

The above tips are just a few,
A great deal more is up to you.

by BILL WELLS
KAC Senior Field Services Rep.

OPERATING UNITS PLEASE POST

Kaman Aircraft Corp.
Field Service Dept.
September, 1960